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AUSTRALIAN ATOMIC ENERGY COMMISSION

RESEARCH ESTABLISHMENT

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ENVIRONMENTAL SURVEY AT LUCAS HEIGHTS RESEARCH LABORATORIES, 1984

by

M.S. GILES

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ABSTRACT

Results are presented of the environmental survey conducted in the neighbourhood of the Lucas Heights Research Laboratories during 1984. These results are satisfactory. No radioactivity which could have originated from these laboratories was found in samples collected from possible human food chains. All low-level liquid and gaseous waste discharges were within authorised limits. The maximum possible annual dose to the general public from airborne waste discharges during this period is estimated to be less than 0.01 millisieverts, which is one per cent of the limit for long-term exposure that is recommended by the National Health and Medical Research Council.

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AAEC; AIR; AUSTRALIA; BERYLLIUM 7; CESIUM 137; COBALT 60; CONTAMINATION; ENVIRONMENT; EXPERIMENTAL; DATA; FRESH WATER; GASEOUS WASTES; GROUND WATER; HUMAN POPULATIONS; IODINE 131; LIQUID WASTES; MAN; MILK; PLUTONIUM 239; PLANTS; RADIATION DOSES; RADIATION MONITORING; RADIOACTIVITY; RIVERS; SAND; SOILS; STRONTIUM 90; TRITIUM;

ERRATA

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Page 2, Section 5.6

^{239}Pu 2 x 10^{-5} Bq m^{-3} should read ^{239}Pu 5 x 10^{5} Bq m^{-3}

Page 14, Table 13 Column 2 should read

-
9
-
31
635
26
87

and the MDL for ^{239}Pu should read <5 x 10^{-5} Bq m^{-3}

Page 20, Appendix B, Section B1.1

3 km s^{-1} should read 3 m s^{-1}

Page 20, Appendix B, Section B.1.1

3 L min^{-1} should read 8 L min^{-1}

CONTENTS

1. INTRODUCTION

Since 1959, surveys have been made by the Australian Atomic Energy Commission (AAEC) of the radioactive content in samples collected in the vicinity of the Lucas Heights Research Laboratories (LHRL) to ensure that no unacceptable health effects either have occurred or will occur as a result of nuclear research and operation. The results obtained in these surveys have been published regularly and are listed in **Appendix A.**

During the early surveys (*i.e.* throughout the 1960s), weapons test fallout was readily detectable in samples collected around Lucas Heights [Giles and Stockdale 1966]. Because of this, a large program of sampling was undertaken to establish the general levels of radioactivity arising from weapons test fallout, and so enable additional radioactivity caused by nuclear operations at Lucas Heights to be assessed. To establish this general background, samples were collected within a 60 km radius of the site; this expanded program was scaled down in 1970 because the Australian Radiation Laboratory (ARL) had set up a monitoring system throughout Australia and routinely measured samples from the Sydney region. Results of these early surveys were published between 1957 and 1970, as described by Giles and Dudaitis [1982]. Further reports have been made by the Australian Ionising Radiation Advisory Council [AIRAC 1975] and the United Nations Scientific Committee on the Effects of Atomic Radiation [UNSCEAR 1977]. These studies are used as a basis for comparison with the results for milk samples reported in the later AAEC surveys.

The present monitoring system is designed to detect radioactive contaminants which may have been released from the LHRL, either routinely (under authorisations from the New South Wales Department of Health) or accidentally, and to ensure that such concentrations do not result in radiation doses to members of the public in excess of limits recommended by the International Commission on Radiological Protection [ICRP 1977] and by the National Health and Medical Research Council of Australia [NH&MRC 1981]. Doses recommended by these bodies are set for periods of time which extend over a normal life-time span.

2. SAMPLE COLLECTION AND PREPARATION

Samples were collected at the sites shown in **figure 1**, and details of collection and sample preparation methods are given in **table 1**. (Note: The isotope symbols used are listed in **Appendix C.**)

3. ANALYTICAL METHODS

Analytical methods which have been modified and methods which have been introduced since the previous survey are described in **Appendix B.**

4. RESULTS

Environmental survey measurements taken during 1984 are presented in **tables 2** to **13**. Authorised airborne releases are given in **tables 14** and **15**. Authorised liquid effluent discharges to the Metropolitan Water Sewerage and Drainage Board (MWS&DB) sewers are given in **table 16.**

5. DISCUSSION OF RESULTS

Throughout the tables, where gamma spectrometry has revealed small unresolvable peaks at particular energies, these have been reported as trace amounts. This indicates the possible presence of the isotope in question but the amount is not quantifiable.

5.1 Airborne Releases

Measurable concentrations of ^{131}I were recorded in air samples, particularly during the second half of the year. The highest reading was registered for the week ending 28 August and was 5.4×10^{-2} of the derived working limit of 10 Bq m^{-3}. The derived air concentration for child members of the public [ICRP 1977, 1979], *i.e.* the most sensitive individuals, is 10 Bq m^{-3}. The average ^{131}I-in-air concentration for the year would have resulted in an effective dose of 0.2 μSv y^{-1} or 2×10^{-4} of the limit.

The milk monitoring data for caesium-137 and iodine-131 are given in **table 3.** At most, a trace of caesium-137 was found, with a limit of determination of 0.3 mBq g^{-1} (fresh weight). This was less than 6×10^{-3} of the derived limit, based on the assumption that an infant consumes 700 mL of milk per day. The limit of determination for ^{131}I in milk represents 4.5×10^{-2} of the derived limit.

Noble gas releases were always below the authorised limit during the year. The methodology of Petersen [1982] was used to calculate that, for an average year and given maximum authorised discharge levels, the most

exposed individual would receive less than 0.01 mSv y^{-1}, *i.e.* less than one per cent of the NH&MRC recommendation.

5.2 Woronora Estuary Samples

Discharges of liquid effluent to the Woronora River ceased on 1 July 1980. Residual levels of radioactivity in samples from the estuary were monitored until December 1983 when no further radioactivity could be measured. No samples were collected from the estuary during 1984 except for water samples which were measured for tritium as a precaution against unknown accidental discharges. No tritium was detected in these samples during 1984.

5.3 Stormwater Outlets

During 1984 water samples have been collected from Strassman Creek, Barden Creek and MDP Creek at points designated by the State Pollution Control Commission (SPCC). These points are shown on **figure 1**. Results for these samples are given in **table 6**. All results were well below the Clean Waters Regulation limits of 1.1 Bq L^{-1} for gross α activity and 11.1 Bq L^{-1} for gross β activity.

Results for samples collected near stormwater outlets as a check on good housekeeping are shown in **table 5**. Some α radioactivity was found in water samples from the No.1 outlet which drains the south east corner of the site into MDP Creek. Detectable amounts of ^{60}Co, ^{144}Ce and ^{3}H were also found.

If it were to be assumed that a person took all his or her drinking water supplies from the stormwater, the highest concentrations of ^{60}Co, ^{144}Ce and ^{3}H measured represent, respectively, 3.7×10^{-3}, 8.9×10^{-3} and 5.6×10^{-3} of the derived working limit (DWL). When, as recommended by the ICRP, the concentrations are averaged over the year, the corresponding ratios to the DWL become 1×10^{-5}, 2.4×10^{-4} and 4.4×10^{-5}, respectively.

The ephemeral creek into which this stormwater flows is not used as a source of drinking water.

5.4 Effluent Discharge Pipeline

The survey of radiation being emitted from the discharge pipeline revealed the dose rates shown in **table 7**. The maximum annual radiation dose for members of the public recommended by the ICRP is 1000 μSv per year [ICRP 1979]. Because of the isolated position of the exposed sections of the discharge pipe, the likelihood of occupancy by members of the public is very low and thus the limits would not be exceeded. Checks on water and soil at points along the pipeline revealed no extraneous radioactivity (see **table 8**).

5.5 Freshwater Sections of the Woronora River

Checks were made throughout the year on radioactivity in the freshwater section of the Woronora River at the point of entry for drainage from LHRL. Samples were also collected at the Heathcote Road crossing, upstream and above any possible input from LHRL, to provide a direct measure of background levels. These are presented in **table 9**. All readings represent normal background levels.

5.6 Little Forest Burial Ground

Results of measurements at the Little Forest Burial Ground (LFBG) are given in **tables 10, 11** and **13**. The positions of sampling points are shown on **figure 2**. Tritium levels in BH10 have risen, in line with trends noted previously, and small amounts of tritium have appeared in bores BHD and BHF outside the fenced area. BHF is a new sampling bore $\sim$ 30 m from the system of trenches. The tritium found in BHD and BHF, which is acting as a tracer, has no health significance since groundwater is not used from this area. No tritium was found in creeks draining the LFBG.

Surface soil levels of radioactivity have been reduced to normal background levels since top dressing was done as part of the regular maintenance. A remotely operating air sampler has been installed at LFBG to monitor for ^{239}Pu and Be in air. No ^{239}Pu or Be was detected. The minimum detectable level (MDL) for Be is 0.001 $\mu g\ m^{-3}$ and for ^{239}Pu 2×10^{-5} Bq m^{-3} after sampling 20 m^3 of air. If more air is sampled these limits are proportionally lowered. The threshold level value (TLV) for Be is 2 $\mu g\ m^{-3}$ and the derived working concentration (DWC) for ^{239}Pu is 5×10^{-4} Bq m^{-3}. These exposure limits were calculated assuming permanent exposure for 24 hours each day.

6. SUMMARY

None of the samples taken from possible human food chains in the environs of the Lucas Heights Research Laboratories contained radioactivity which could be attributed to the operation of the site.

Discharges of airborne radioactive gases were always within authorised limits (**table 15**). The dose to the most sensitive members of the public from ^{131}I releases, calculated from results in **table 2**, was 8×10^{-4} mSv y^{-1} and the calculated dose from released noble gases to the most exposed individuals was less than 0.01 mSv. These figures represent less than 1 per cent of the most restrictive limit recommended by the NH&MRC.

7. ACKNOWLEDGEMENTS

The authors would like to thank Mr J.A. Fogden for his assistance in field and laboratory work. Potassium levels were determined by the CSIRO's Division of Energy Chemistry.

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TABLE 1
SAMPLE COLLECTION SCHEDULE AND PREPARATION DETAILS

Sample	Station	Frequency	Collection Details	Special Preparations
Stormwater	No.1	Weekly	Sampled by bucket at the outlet of the drain	10 L sample evaporated to dryness and the residue counted
	Others	Quarterly		
Estuary water	E5.9	Weekly	From surface by bucket	Distilled for tritium
Radioactive iodine in air	TO	Weekly	Collected on Maypacks (charcoal filters)	Gamma spectrometry of Maypacks
Milk	T3	Monthly	Sampled from milk produced by locally grazed cows	Gamma spectrometry of whole milk
Vegetation	T1, LHRL stormwater outlets	Six-monthly	Cut by hand clippers	Whole unwashed vegetation ashed
Sand/soil	TO, T1; LHRL stormwater outlets	Six-monthly	Scooped from surface	As for beach sand
Groundwater	LHRL Burial Ground	Six-monthly	Boreholes pumped dry, allowed to refill and sampled from bottom	10 L sample evaporated to dryness and the residue counted
Be, ^{239}Pu in air	LHRL Burial Ground	Quarterly	Collected on membrane filter	Nil
Creekwater	T2	Yearly	Sampled by bucket or bottle	As for groundwater Prepared according to Clean Waters Act Regulations
	MDP Creek Strassman Creek Barden Creek	Monthly		

TABLE 2
RADIOACTIVE IODINE IN AIR, 1984

Week ending (1984)	^{131}I (Bq m^{-3})	Week ending (1984)	^{131}I (Bq m^{-3})
3/1	n.d.	3/7	4.6×10^{-3}
10/1	n.d.	10/7	6.8×10^{-3}
17/1	4.8×10^{-3}	18/7	6.0×10^{-3}
24/1	n.d.	24/7	1.4×10^{-3}
31/1	trace	31/7	1.3×10^{-2}
7/2	n.d.	7/8	2.6×10^{-3}
14/2	trace	14/8	1.1×10^{-2}
22/2	trace	21/8	4.3×10^{-3}
28/2	n.d.	28/8	5.4×10^{-1}
6/3	trace	4/9	1.1×10^{-2}
13/3	trace	11/9	7.0×10^{-3}
20/3	n.d.	18/9	trace
27/3	trace	25/9	3.2×10^{-3}
3/4	n.d.	3/10	trace
10/4	trace	9/10	5.5×10^{-3}
17/4	trace	16/10	2.8×10^{-3}
24/4	6.1×10^{-3}	23/10	trace
1/5	trace	30/10	4.5×10^{-3}
8/5	trace	7/11	n.d.
16/5	4.7×10^{-3}	13/11	5.6×10^{-3}
22/5	trace	20/11	n.d.
29/5	trace	28/11	trace
5/6	5.3×10^{-2}	4/12	trace
12/6	4.7×10^{-2}	12/12	trace
19/6	1.5×10^{-2}	18/12	n.d.
26/6	1.3×10^{-2}	24/12	n.d.

Three air samplers are located along the eastern boundary of the site, where suburban residences are closest. Results are calculated making the conservative assumptions that (1) all activity was released during the first day of sampling period; and (2) all the activity was concentrated at one sampling point.

n.d. = not detected. Limit of detection = 2.5×10^{-3} Bq m^{-3}.

TABLE 3
RADIOACTIVITY IN MILK SAMPLES, 1984

Station	Date 1984	Radioactivity (Bq g^{-1} fresh volume)	
		^{137}Cs	^{131}I
T3	31/1	n.d.	n.d.
(Menai)	29/2	n.d.	n.d.
	30/3	n.d.	n.d.
	30/4	trace	n.d.
	29/5	n.d.	n.d.
	28/6	n.d.	n.d.
	31/7	n.d.	n.d.
	30/8	n.d.	n.d.
	30/10	n.d.	n.d.
	29/11	n.d.	n.d.
	28/12	n.d.	n.d.

The analytical method used for ^{131}I in milk has a minimum detectable level of 1×10^{-3} Bq g^{-1}. For ^{137}Cs the minimum detectable level was 3×10^{-4} Bq g^{-1}.

n.d. = not detected.

TABLE 4
TRITIUM IN WORONORA WATER SAMPLES AT STATION E5.9, 1984

Date 1984	Tritium[1] (Bq mL^{-1})	Date 1984	Tritium (Bq mL^{-1})	Date 1984	Tritium (Bq mL^{-1})
3/1	< 0.25	24/4	< 0.25	14/8	< 0.25
10/1	< 0.25	1/5	< 0.25	21/8	< 0.25
17/1	< 0.25	8/5	< 0.25	28/8	< 0.25
24/1	< 0.25	15/5	< 0.25	4/9	< 0.25
31/1	< 0.25	22/5	< 0.25	11/9	< 0.25
7/2	< 0.25	29/5	< 0.25	18/9	< 0.25
14/2	< 0.25	5/6	< 0.25	16/10	< 0.25
22/2	< 0.25	12/6	< 0.25	23/10	< 0.25
28/2	< 0.25	19/6	< 0.25	30/10	< 0.25
6/3	< 0.25	26/6	< 0.25	7/11	< 0.25
13/3	< 0.25	3/7	< 0.25	13/11	< 0.25
20/3	< 0.25	10/7	< 0.25	20/11	< 0.25
27/3	< 0.25	18/7	< 0.25	28/11	< 0.25
3/4	< 0.25	24/7	< 0.25	4/12	< 0.25
10/4	< 0.25	31/7	< 0.25	12/12	< 0.25
17/4	< 0.25	7/8	< 0.25	18/12	< 0.25
				24/12	< 0.25

Derived limiting concentration (DLC) [ICRP 1979]

DLC = 80 Bq mL^{-1} (if taken as drinking water).

TABLE 5
RADIOACTIVITY IN SAMPLES FROM STORMWATER OUTLETS, 1984

Station	Date	Sample	Radioactivity (Bq g^{-1} fresh weight) Gross α	Gross β (less ^{40}K)	γ-emitters	^{3}H (Bq mL^{-1})	K ($\mu g\ g^{-1}$)
Drain behind	11/1	water	-	-	-	<0.25	-
Bld.1	27/4	water	-	-	-	<0.25	-
	30/7	water	-	-	-	<0.25	-
	31/10	water	-	-	-	<0.25	-
Drain behind	11/1	soil	0.63	0.37	trace ^{238}U + ^{232}Th series	-	850
Bld.9	11/1	water	-	-	-	<0.25	-
	27/4	water	-	-	-	<0.25	-
	27/4	soil	0.51	0.33	trace ^{238}U + ^{232}Th series	-	1650
	30/7	soil	0.45	0.27	trace ^{238}U + ^{232}Th series	-	2250
	30/7	water	-	-	-	<0.25	-
	31/10	soil	0.50	0.35	trace ^{238}U + ^{232}Th series	-	750
Drain opposite	11/1	water	-	-	-	<0.25	-
sub-station	11/1	soil	0.37	0.17	trace ^{238}U + ^{232}Th series	-	450
	27/4	soil	0.59	0.03	trace ^{238}U + ^{232}Th series	-	1350
	27/4	water	-	-	-	<0.25	-
	30/7	water	-	-	-	<0.25	-
	30/7	soil	0.47	0.19	trace ^{238}U + ^{232}Th series	-	1250
	31/10	soil	0.49	0.22	trace ^{238}U + ^{232}Th series	-	1300
Drain at	11/1	soil	0.28	0.20	trace ^{238}U + ^{232}Th series	-	350
boom gate	27/4	soil	0.22	0.09	n.d.	-	200
	27/4	water	-	-	-	<0.25	-
	30/7	water	-	-	-	<0.25	-
	30/7	soil	0.27	0.12	trace ^{238}U + ^{232}Th series	-	400
	15/11	soil	0.25	0.22	trace ^{238}U + ^{232}Th series	-	1050
Drain on road	11/1	soil	0.45	0.26	trace ^{238}U + ^{232}Th series	-	500
at west fence	11/1	water	-	-	-	<0.25	-
	27/4	water	-	-	-	<0.25	-
	27/4	soil	0.39	0.14	trace ^{238}U + ^{232}Th series	-	500
	30/7	soil	0.26	0.20	trace ^{238}U + ^{232}Th series	-	500
	30/7	water	-	-	-	<0.25	-
	31/10	soil	0.40	0.24	trace ^{238}U + ^{232}Th series	-	600
Drain west of	11/1	soil	0.82	0.94	trace ^{238}U + ^{232}Th series	-	800
test compound	27/4	soil	0.39	0.54	trace ^{238}U + ^{232}Th series	-	700
	30/7	soil	0.65	0.67	trace ^{238}U + ^{232}Th series	-	550
	31/10	soil	0.56	0.68	trace ^{238}U + ^{232}Th series	-	550
Drain near	11/1	soil	0.36	0.27	trace ^{238}U + ^{232}Th series	-	550
yellowcake	11/1	water	-	-	-	<0.25	-
store	27/4	water	-	-	-	<0.25	-
	27/4	soil	0.46	0.28	trace ^{238}U + ^{232}Th series	-	850
	30/7	soil	0.43	0.31	trace ^{238}U + ^{232}Th series	-	850
	30/7	water	-	-	-	<0.25	-
	31/10	water	-	-	-	<0.25	-
	31/10	soil	0.52	0.30	trace ^{238}U + ^{232}Th series	-	500

TABLE 5 (cont.)

Station	Date	Sample	Radioactivity (Bq g^{-1} fresh weight) Gross α	Gross β (less ^{40}K)	γ-emitters	^{3}H (Bq mL^{-1})	K ($\mu g\ g^{-1}$)
Drain at Fermi St.	11/1	soil	0.32	0.18	trace $^{238}U + ^{232}Th$ series	-	550
	11/1	water	-	-	-	0.42	-
	27/4	water	-	-	-	<0.25	-
	27/4	soil	0.40	0.35	trace $^{238}U + ^{232}Th$ series	-	1400
	30/7	soil	0.34	0.20	trace $^{238}U + ^{232}Th$ series	-	950
	30/7	water	-	-	-	<0.25	-
	31/10	soil	0.31	0.21	trace $^{238}U + ^{232}Th$ series	-	1050
Drain opposite Bld.23	11/1	soil	0.53	0.39	^{60}Co = 0.12 ^{137}Cs = trace trace $^{238}U + ^{232}Th$ series	-	800
	27/4	soil	0.48	0.39	^{60}Co = trace trace $^{238}U + ^{232}Th$ series	-	950
	30/7	soil	0.53	0.38	^{60}Co = 0.03 ^{137}Cs = trace trace $^{238}U + ^{232}Th$ series	-	1000
	30/7	water	-	-	-	<0.25	-
	31/10	soil	0.50	0.41	^{60}Co = 0.11 ^{137}Cs = trace trace $^{238}U + ^{232}Th$ series	-	850
Drain No.1 opposite Strassman Cr.	11/1	soil	0.20	0.18	trace $^{238}U + ^{232}Th$ series	-	400
	11/1	water	-	-	-	<0.25	-
	27/4	water	-	-	-	<0.25	-
	27/4	soil	0.22	0.16	trace $^{238}U + ^{232}Th$ series	-	700
	30/7	soil	0.26	0.13	trace $^{238}U + ^{232}Th$ series	-	250
	30/7	water	-	-	-	<0.25	-
	31/10	water	-	-	-	<0.25	-
	31/10	soil	0.50	0.26	trace $^{238}U + ^{232}Th$ series	-	400
Drain No.2 opposite Strassman Cr.	11/1	soil	0.53	0.48	^{60}Co = trace ^{137}Cs = trace trace $^{238}U + ^{232}Th$ series	-	1000
	11/1	water	-	-	-	<0.25	-
	27/4	soil	0.51	0.37	^{137}Cs = 0.05 ^{60}Co = 0.02 trace $^{238}U + ^{232}Th$ series	-	1350
	30/7	soil	0.51	0.14	trace $^{238}U + ^{232}Th$ series	-	500
	31/10	soil	0.55	0.18	trace $^{238}U + ^{232}Th$ series	-	450
Drain behind Bld.20	11/1	soil	0.34	0.17	trace $^{238}U + ^{232}Th$ series	-	450
	11/1	water	-	-	trace $^{238}U + ^{232}Th$ series	< 0.25	-
	27/4	water	-	-	-	<0.25	-
	27/4	soil	0.33	0.12	n.d.	-	500
	30/7	soil	0.20	0.03	trace $^{238}U + ^{232}Th$ series	-	150
	30/7	water	-	-	-	<0.25	-

TABLE 5 (cont.)

Station	Date	Sample	Radioactivity (Bq L^{-1})			^{3}H (Bq L^{-1})	K ($\mu g\ g^{-1}$)
			Gross α	Gross β (incl. ^{40}K)	Gamma Emitters		
LHRL stormwater	3/1	water	0.06	0.13	n.d.	<0.25	-
outlet No.1	10/1	water	0.14	0.16	n.d.	<0.25	-
near south gate	17/1	water	0.10	0.17	n.d.	<0.25	-
	24/1	water	0.07	0.12	n.d.	<0.25	-
	31/1	water	0.04	0.14	n.d.	<0.25	-
	7/2	water	0.09	0.14	n.d.	<0.25	-
	14/2	water	0.04	0.11	n.d.	<0.25	-
	22/2	water	0.05	0.14	n.d.	<0.25	-
	28/2	water	0.09	0.14	n.d.	<0.30	-
	6/3	water	0.09	0.08	n.d.	<0.25	-
	13/3	water	0.06	0.06	n.d.	<0.25	-
	20/3	water	0.03	0.08	n.d.	<0.25	-
	27/3	water	0.03	0.19	n.d.	<0.25	-
	3/4	water	0.09	0.12	n.d.	<0.25	-
	10/4	water	0.11	0.14	n.d.	0.25	-
	17/4	water	0.05	0.14	n.d.	<0.25	-
60 m from LHRL	24/4	water	0.11	0.29	n.d.	<0.25	-
stormwater	1/5	water	3.49	1.43	trace $^{238}U + ^{232}Th$ series	0.30	-
outlet No.1	8/5	water	0.13	0.25	n.d.	<0.25	-
	15/5	water	0.87	6.09	$^{60}Co = 0.64$ $^{144}Ce = 2.00$ $^{95}Zr + ^{95}Nb$ = trace ^{137}Cs = trace	<0.25	-
	22/5	water	<0.01	0.34	n.d.	<0.25	-
	29/5	water	0.46	0.47	n.d.	<0.25	-
	5/6	water	0.47	0.62	n.d.	<0.25	-
	12/6	water	0.45	0.43	n.d.	0.36	-
	19/6	water	0.23	0.28	n.d.	<0.25	-
	26/6	water	1.27	0.59	trace $^{238}U + ^{232}Th$ series	<0.25	-
	3/7	water	1.18	0.48	trace $^{238}U + ^{232}Th$ series	<0.25	-
	10/7	water	0.60	0.61	n.d.	<0.25	-
	18/7	water	0.31	0.38	n.d.	<0.25	-
	24/7	water	0.89	0.41	n.d.	<0.25	-
	31/7	water	2.06	1.51	trace $^{238}U + ^{232}Th$ series	<0.25	-
	7/8	water	0.62	0.33	^{137}Cs = trace trace $^{238}U + ^{232}Th$ series	<0.25	-
	14/8	water	0.30	0.15	n.d.	<0.25	-
	21/8	water	0.45	0.32	n.d.	<0.25	-
	28/8	water	0.14	0.11	n.d.	<0.25	-
	4/9	water	0.24	0.18	n.d.	<0.25	-
	11/9	water	0.37	0.25	n.d.	<0.25	-
	18/9	water	0.90	0.34	n.d.	<0.25	-
	16/10	water	0.33	0.30	n.d.	<0.25	-
	23/10	water	0.36	0.27	n.d.	<0.25	-
	30/10	water	0.32	0.23	n.d.	<0.25	-
	7/11	water	0.23	0.15	n.d.	<0.25	-
	13/11	water	0.34	0.32	n.d.	<0.25	-
	20/11	water	0.19	0.24	n.d.	<0.25	-
	28/11	water	0.20	0.24	n.d.	<0.25	-
	4/12	water	0.10	0.21	n.d.	<0.25	-
	12/12	water	0.18	0.54	n.d.	<0.25	-
	18/12	water	0.23	0.25	n.d.	<0.25	-
	24/12	water	0.14	0.20	n.d.	0.30	-

TABLE 5 (cont.)

Station	Date	Sample	Radioactivity (Bq L^{-1})			^{3}H (Bq L^{-1})	K ($\mu g\ g^{-1}$)
			Gross α	Gross β (less ^{40}K)	Gamma Emitters		
20 m from LHRL stormwater outlet No.1	11/1	vegetation	0.01	0.13	0.5 MeV = 0.01 ^{137}Cs = 0.01	-	3900
	27/4	soil	1.36	0.57	^{137}Cs = trace ^{60}Co = trace trace ^{238}U + ^{232}Th series	-	750
	27/4	water	-	-	-	<0.25	-
	27/4	vegetation	0.01	0.07	0.5 MeV = 0.01 ^{137}Cs = 0.01 ^{60}Co = trace trace ^{238}U + ^{232}Th series	-	3800
	31/7	soil	1.00	1.28	^{137}Cs = 0.15 ^{60}Co = 0.20 trace ^{238}U + ^{232}Th series	-	1300
	31/7	water	-	-	-	<0.25	-
60 m from LHRL stormwater outlet No.1	11/1	soil	0.37	0.13	trace ^{238}U + ^{232}Th series	-	500
	27/4	soil	0.44	0.21	trace ^{238}U + ^{232}Th series	-	100
	31/7	soil	0.17	0.09	trace ^{238}U + ^{232}Th series	-	450
	31/10	soil	0.58	0.11	trace ^{238}U + ^{232}Th series	-	250

The γ-ray peaks detected at approximately 0.5 MeV could be ^{7}Be (0.48 MeV), ^{103}Ru (0.5 MeV) or ^{106}Ru (0.51 MeV); ^{7}Be is a cosmic-ray produced spallation product, and ^{103}Ru and ^{106}Ru are fission products. In column 6 of this table Bq g^{-1} refers to the number of disintegrations per second per gram at the energies indicated.

n.d. = not detected. - = not measured.

TABLE 6
RADIOACTIVITY AT SPCC SAMPLING POINTS, 1984

(Bq L^{-1}) [a]

Date	Strassman Creek		Barden Creek		MDP Creek	
1984	Gross α	Gross β*	Gross α	Gross β*	Gross α	Gross β*
18/1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
22/2	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
23/3	n.d.	n.d.	n.d.	n.d.	n.d.	n.d
26/4	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
31/5	n.d.	0.13	n.d.	n.d.	n.d.	n.d.
21/6	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
26/7	n.d.	n.d.	n.d.	n.d.	-	-
24/8	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
19/9	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
15/10	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
21/11	n.d.	n.d.	n.d.	n.d.	n.d.	0.13
19/12	n.d.	n.d.	n.d.	n.d.	n.d.	0.13

[a] MDL α = 0.07 Bq L^{-1}, MDL β = 0.1 Bq L^{-1}

* includes ^{40}K contribution, n.d. = not detected,

- = not measured.

TABLE 7
GAMMA SURVEY — EFFLUENT DISCHARGE PIPE LINE, 1984

Surveys of exposed portions of pipeline between LHRL and the MWS&DB sewer connection using an Ericsson type 1368A field rate meter

Date	Location	Dose Rate (μSv h^{-1})
30/5	All pipe sections	<0.4
	Soil below joints	<0.3
21/11	All pipe sections	<0.4
	Soil below joints	<0.3

TABLE 8
RADIOACTIVITY IN SAMPLES TAKEN NEAR EFFLUENT DISCHARGE PIPELINE, 1984

Station	Date	Sample	Radioactivity (Bq g^{-1} dry weight)			^{3}H (Bq mL^{-1})	K (μg g^{-1})
			Gross α	Gross β (less ^{40}K)	γ-emitters		
Near scour	30/5	soil	0.25	0.09	n.d.	-	350
valve No.1	30/5	water	-	-	-	<0.25	-
	21/11	water	-	-	-	<0.25	-
	21/11	soil	0.23	0.06	n.d.	-	450
River at point	30/5	soil	0.37	0.09	n.d.	-	500
where crossed	30/5	water	-	-	-	<0.25	-
by effluent	21/11	water	-	-	-	<0.25	-
discharge pipe	21/11	soil	0.90	0.07	trace ^{238}U + ^{232}Th series	-	600

n.d. = not detected, - = not measured

TABLE 9
RADIOACTIVITY IN FRESHWATER SECTION OF WORONORA RIVER, 1984

Station	Date 1984	Radioactivity		
		Sand	Water	
		^{90}Sr (Bq g^{-1})	^{90}Sr (Bq L^{-1})	^{3}H (Bq mL^{-1})
Woronora River at	18/1	0.00006	0.035	<0.25
Heathcote Rd crossing	27/4	0.00013	0.010	-
(upstream of LHRL)	31/7	0.00016	0.007	<0.25
	25/10	0.00005	0.007	<0.25
Woronora River at	18/1	0.0004	0.033	<0.25
the point of	27/4	0.0001	0.012	<0.25
Lucas Heights drainage	31/7	0.0009	0.014	<0.25
	25/10	0.00095	0.024	<0.25

- = not measured.

TABLE 10
RADIOACTIVITY IN SAMPLES OF SOIL AND VEGETATION FROM LITTLE FOREST BURIAL GROUND, 1984

Location	Sample	Date 1984	Radioactivity (Bq g^{-1} fresh weight)					K
			Gross α	Gross β (less ^{40}K)	Gamma Emitters			
					0.5 MeV	^{60}Co	$^{238}U + ^{232}Th$	($\mu g\ g^{-1}$)
TR 1-5	Soil	27/6	0.69	0.57	n.d.	n.d.	trace	3200
TR 56-57	Soil	27/6	1.62	0.89	n.d.	0.06	trace	3600
TR 68-69	Soil	27/6	1.24	1.56	n.d.	0.06	trace	3500
TR 72-73	Soil	27/6	0.94	0.92	n.d.	n.d.	trace	4100
TR 69-70	Grass	27/6	0.01	0.19	0.01	n.d.	n.d.	1700

The γ-ray peaks detected at approximately 0.5 MeV could be ^{7}Be (0.48 MeV), ^{103}Ru (0.5 MeV) or ^{106}Ru (0.51 MeV); ^{7}Be is a cosmic-ray produced activation product, and ^{103}Ru and ^{106}Ru are fission products.

n.d. = not detected.

TABLE 11
RADIOACTIVITY IN SAMPLES OF GROUNDWATER FROM LITTLE FOREST BURIAL GROUND, 1984

Bore Hole No.	Sediment (Bq g^{-1})						^{3}H (Bq mL^{-1})	
	Gross α		Gross β (incl. ^{40}K)		Gamma emitters			
	June	Dec.	June	Dec.	June	Dec.	June	Dec.
BH1	3.41	*	1.15	*	trace $^{238}U + ^{232}Th$ series	*	<0.25	*
BH2	2.15	2.88	0.77	1.23	trace $^{238}U + ^{232}Th$ series	trace $^{238}U + ^{232}Th$ series	<0.25	<0.25
BH3	3.34	*	1.02	*	trace $^{238}U + ^{232}Th$ series	*	<0.25	*
BH4	2.63	2.28	0.78	0.89	n.d.	trace $^{238}U + ^{232}Th$ series	<0.25	<0.25
BH6	0.96	3.60	0.28	1.06	n.d.	trace $^{238}U + ^{232}Th$ series	<0.25	<0.25
BH10	0.75	0.51	0.38	0.35	trace $^{238}U + ^{232}Th$ series	trace $^{238}U + ^{232}Th$ series	1.76	2.19
OS1	0.85	2.12	0.49	0.81	n.d.	trace $^{238}U + ^{232}Th$ series	<0.25	<0.25
OS2	2.05	1.50	1.40	1.16	trace $^{238}U + ^{232}Th$ series	trace $^{238}U + ^{232}Th$ series	6.26	4.40
OS3	2.03	2.53	4.85	6.32	n.d.	trace $^{238}U + ^{232}Th$ series	7.19	11.77
BHA	1.23	0.41	0.68	0.34	n.d.	n.d.	<0.25	<0.25
BHB	0.14	0.12	0.16	0.14	n.d.	n.d.	<0.25	<0.25
BHC	0.03	0.06	0.17	0.15	n.d.	n.d.	<0.25	<0.25
BHD	0.60	0.31	0.44	0.29	n.d.	n.d.	<0.25	1.18
BHE	0.21	0.24	0.17	0.21	n.d.	n.d.	<0.25	<0.25
BHF	-	1.70	-	1.93	trace $^{238}U + ^{232}Th$ series	trace $^{238}U + ^{232}Th$ series	-	1.53

n.d. = not detected, * = bore holes were dry, - = not measured.

TABLE 12
RADIOACTIVITY IN SAMPLES TAKEN FROM CREEKS NORTH OF LITTLE FOREST BURIAL GROUND, 1984

SAND

Station	Date	Radioactivity (Bq g^{-1} dry weight) Gross α	Gross β (less ^{40}K)	γ-emitters	K ($\mu g\ g^{-1}$)
Barden Creek above junction with Mill Creek	20/12	0.39	0.06	trace $^{238}U + ^{232}Th$ series	300
Mill Creek above junction with Barden Creek	20/12	0.50	0.08	trace $^{238}U + ^{232}Th$ series	300

WATER

Station	Date	Radioactivity (Bq L^{-1}) Gross α	Gross β (incl. ^{40}K)	γ-emitters	^{3}H (Bq mL^{-1})
Barden Creek above junction with Mill Creek	20/12	0.18	0.18	n.d.	<0.25
Mill Creek above junction with Barden Creek	20/12	0.16	0.08	n.d.	<0.25

n.d. = not detected.

TABLE 13
RESULTS OF AIR SAMPLING AT LITTLE FOREST BURIAL GROUND, 1984

Period	Air Volume Sampled (m^3)	Be ($\mu g\ m^{-3}$)	^{239}Pu (Bq m^{-3})
1/3 - 18/4	-	n.d.	-
18/4 - 23/5	-	n.d.	-
23/5 - 2/8	24.05	n.d.	-
9/8 - 28/8	88.00	n.d.	-
28/8 - 18/10	1793.28	n.d.	n.d.
18/10 - 23/11	60.00	n.d.	n.d.
23/11 - 28/12	246.00	n.d.	n.d.

n.d. = not detected. - = not measured.

TLV for Be = 2 $\mu g\ m^{-3}$. DWC for $^{239}Pu = 5 \times 10^{-4}$ Bq m^{-3}.
MDL for Be $< 10^{-3}$ $\mu g\ m^{-3}$. MDL for $^{239}Pu < 2 \times 10^{-5}$ Bq m^{-3}.

TABLE 14
AIRBORNE RADIOACTIVITY RELEASES, 1984

Period and Bld No.	Gross α (kBq)	^{131}I (MBq)	^{90}Sr (MBq)	^{3}H (GBq)	^{41}Ar (TBq)	Fission Product Noble Gases (TBq)	Other Activity (MBq)
Quarter No.1							
Bld. 2	1.8×10^2	3.6×10^3	<0.6	-	-	51	1.3×10^4
15	<4	<2	<0.3	1.3×10^3	17	-	1.1×10^2
19	<22	8.4	<0.4	-	-	-	<1
23A	<10	5.0×10^3	<0.2	-	-	-	<1
23B	<2	<1	<0.05	-	-	-	<1
41	<8	<1	<0.1	-	-	-	<1
57	-	0.9	-	101	-	-	
Quarter No. 2							
Bld. 2	3.8×10^2	1.2×10^4	<0.3	-	-	45	3.9×10^4
3	30	11	-	-	-	-	<1
15	7.3	3.2	0.7	8.8×10^2	18	-	86
19	31	23	<0.2	-	-	-	<1
23A	28	8.1×10^3	<1	-	-	-	<1
23B	<2	1.8	<0.01	-	-	-	<1
41	<8	4.7	<0.05	-	-	-	<1
56	15	9.4	-	-	-	-	-
57	5.5	2.1	<0.03	16	-	-	-
Quarter No.3							
Bld 2	1.14×10^{-2}	1.25×10^4	<0.04	-	-	52.2	6.97×10^4
3	47	4.4	<0.04	-	-	-	-
15	<3.7	3.4	<0.2	9.2×10^2	17.2	-	1.1×10^2
19	<22	12.6	<0.1	-	-	-	-
23A	<12	8.15×10^3	<3.1	-	-	-	3.75×10^2
23B	<5	1.1	<0.01	-	-	-	0.1
41	<8	3.6	<0.04	-	-	-	-
56	58	21.8	<0.1	-	-	-	-
57	<5.2	1.43	1.43	67.3	-	-	-
Quarter No.4							
Bld.2	<32	1.43×10^4	<0.04	-	-	67.9	14.9×10^4
3	87	1.9	<0.07	-	-	-	-
15	<6	1.9	<0.92	1.12×10^3	14.9	-	179
19	<33	5.3	<0.1	-	-	-	-
23A	<11	10.3×10^2	<0.24	-	-	-	91
23B	<1.6	0.3	<0.01	-	-	-	-
41	<5	1.2	<0.04	-	-	-	-
56	<15	2	<0.1	-	-	-	-
57	<3	0.8	<0.01	32.4	-	-	-

- = not measured.

TABLE 15
AIRBORNE RADIOACTIVITY DISCHARGES FROM INDIVIDUAL DISCHARGE POINTS EXPRESSED AS FRACTIONS OF AUTHORISED QUARTERLY POINT DISCHARGE FOR 1984

Period and Bld. No.	Gross α	^{131}I	^{90}Sr	^{3}H	^{41}Ar	Fission Product Noble Gases	Other Activity
Quarter No.1							
Bld.2	2.7×10^{-4}	5×10^{-2}	$<9.4 \times 10^{-7}$	-	-	0.30	8.1×10^{-3}
15	$<1.2 \times 10^{-4}$	$<1.3 \times 10^{-4}$	$<1.2 \times 10^{-5}$	1.0×10^{-2}	0.63	-	1.7×10^{-3}
19	$<6.7 \times 10^{-5}$	2.5×10^{-4}	$,1.5 \times 10^{-6}$	-	-	-	$<1.5 \times 10^{-6}$
23A	$<6.3 \times 10^{-4}$	0.31	$<1.5 \times 10^{-5}$	-	-	-	$<3.0 \times 10^{-5}$
23B	$<3.0 \times 10^{-4}$	$<6.3 \times 10^{-5}$	$<7.8 \times 10^{-6}$	-	-	-	$<6.3 \times 10^{-5}$
41	$<2.4 \times 10^{-5}$	$<6.3 \times 10^{-5}$	$<3.8 \times 10^{-7}$	-	-	-	$<1.5 \times 10^{-6}$
57	-	3×10^{-4}	-	0.67	-	-	-
Quarter No. 2							
Bld 2	5.8×10^{-4}	1.8×10^{-1}	$<4.7 \times 10^{-7}$	-	-	0.26	2.4×10^{-2}
3	2.5×10^{-2}	9.2×10^{-4}	-	-	-	-	$<4.0 \times 10^{-4}$
15	2.2×10^{-4}	2.0×10^{-4}	2.7×10^{-5}	6.8×10^{-3}	0.67	-	1.3×10^{-3}
19	9.4×10^{-5}	7.0×10^{-4}	$<7.7 \times 10^{-7}$	-	-	-	$<1.5 \times 10^{-6}$
23A	1.8×10^{-3}	5.1×10^{-1}	$<7.7 \times 10^{-5}$	-	-	-	$<3.0 \times 10^{-5}$
23B	$<3.0 \times 10^{-4}$	1.1×10^{-4}	$<1.6 \times 10^{-6}$	-	-	-	$<6.3 \times 10^{-5}$
41	$<2.4 \times 10^{-5}$	2.9×10^{-4}	$<1.9 \times 10^{-7}$	-	-	-	$<1.5 \times 10^{-6}$
56	3.1×10^{-3}	3.4×10^{-4}	-	-	-	-	-
57	3.4×10^{-3}	2.4×10^{-4}	$<1.4 \times 10^{-3}$	3.6×10^{-3}	-	-	-
Quarter No. 3							
Bld. 2	1.7×10^{-4}	1.9×10^{-1}	$<6.3 \times 10^{-8}$	-	-	0.31	4.4×10^{-2}
3	3.0×10^{-2}	2.8×10^{-4}	$<3.1 \times 10^{-5}$	-	-	-	-
15	$<1.1 \times 10^{-4}$	2.1×10^{-4}	$<7.7 \times 10^{-6}$	7.1×10^{-3}	0.65	-	1.7×10^{-3}
19	$<6.7 \times 10^{-5}$	3.8×10^{-4}	$<3.8 \times 10^{-7}$	-	-	-	-
23A	$<7.5 \times 10^{-4}$	0.51	$<2.4 \times 10^{-4}$	-	-	-	1.1×10^{-2}
23B	$<7.6 \times 10^{-4}$	6.9×10^{-5}	$<1.6 \times 10^{-6}$	-	-	-	6.3×10^{-6}
41	$<2.4 \times 10^{-5}$	2.3×10^{-4}	$<1.5 \times 10^{-7}$	-	-	-	-
56	7.3×10^{-3}	4.8×10^{-4}	$<9.1 \times 10^{-4}$	-	-	-	-
57	$<4.3 \times 10^{-3}$	2.1×10^{-4}	$<5.9 \times 10^{-5}$	2.0×10^{-2}	-	-	-
Quarter No 4							
Bld 2	$<4.8 \times 10^{-5}$	2.2×10^{-1}	$<6.3 \times 10^{-8}$	-	-	0.40	9.3×10^{-2}
3	5.4×10^{-2}	1.2×10^{-4}	$<5.4 \times 10^{-5}$	-	-	-	-
15	$<1.8 \times 10^{-4}$	1.2×10^{-4}	$<3.5 \times 10^{-5}$	8.6×10^{-3}	0.55	-	2.7×10^{-4}
19	$<1.0 \times 10^{-4}$	1.6×10^{-4}	$<3.8 \times 10^{-7}$	-	-	-	-
23A	$<6.9 \times 10^{-4}$	6.4×10^{-2}	$<1.8 \times 10^{-5}$	-	-	-	2.8×10^{-3}
23B	$<2.4 \times 10^{-4}$	1.9×10^{-5}	$<1.6 \times 10^{-6}$	-	-	-	-
41	$<1.5 \times 10^{-5}$	7.5×10^{-5}	$<1.5 \times 10^{-7}$	-	-	-	-
56	$<1.9 \times 10^{-3}$	4.4×10^{-5}	$<9.1 \times 10^{-5}$	-	-	-	-
57	$<2.5 \times 10^{-3}$	1.2×10^{-4}	$<5.9 \times 10^{-5}$	9.5×10^{-3}	-	-	-

- = not measured.

TABLE 16
RADIOACTIVITY DISCHARGED TO THE MWS&DB SEWER DURING 1984

Quarter	Radioisotopes Measured (MBq)			Percentage of authorised limit**
	* α_u	^{3}H	† β_u	
1	16.0	2.6×10^{5}	396	22.6
2	15.6	9.4×10^{4}	384	22.0
3	16.9	12.4×10^{5}	491	27.4
4	15.2	4.8×10^{5}	291	17.2

* α_u = A mixture of unidentified α-emitting nuclides taken as being all ^{226}Ra (*i.e.* the worst possible case) in calculating percentage of authorised limit.

† β_u = A mixture of unidentified β-emitting nuclides taken as being all ^{90}Sr (*i.e.* the worst possible case) when calculating the percentage of autdorised limit.

** In the case of discharge to the MWS&DB sewer, the authorised limit is outlined in the regulations to the NSW Radioactive Substances Act published in Government Gazette No.136, 19 September 1980.

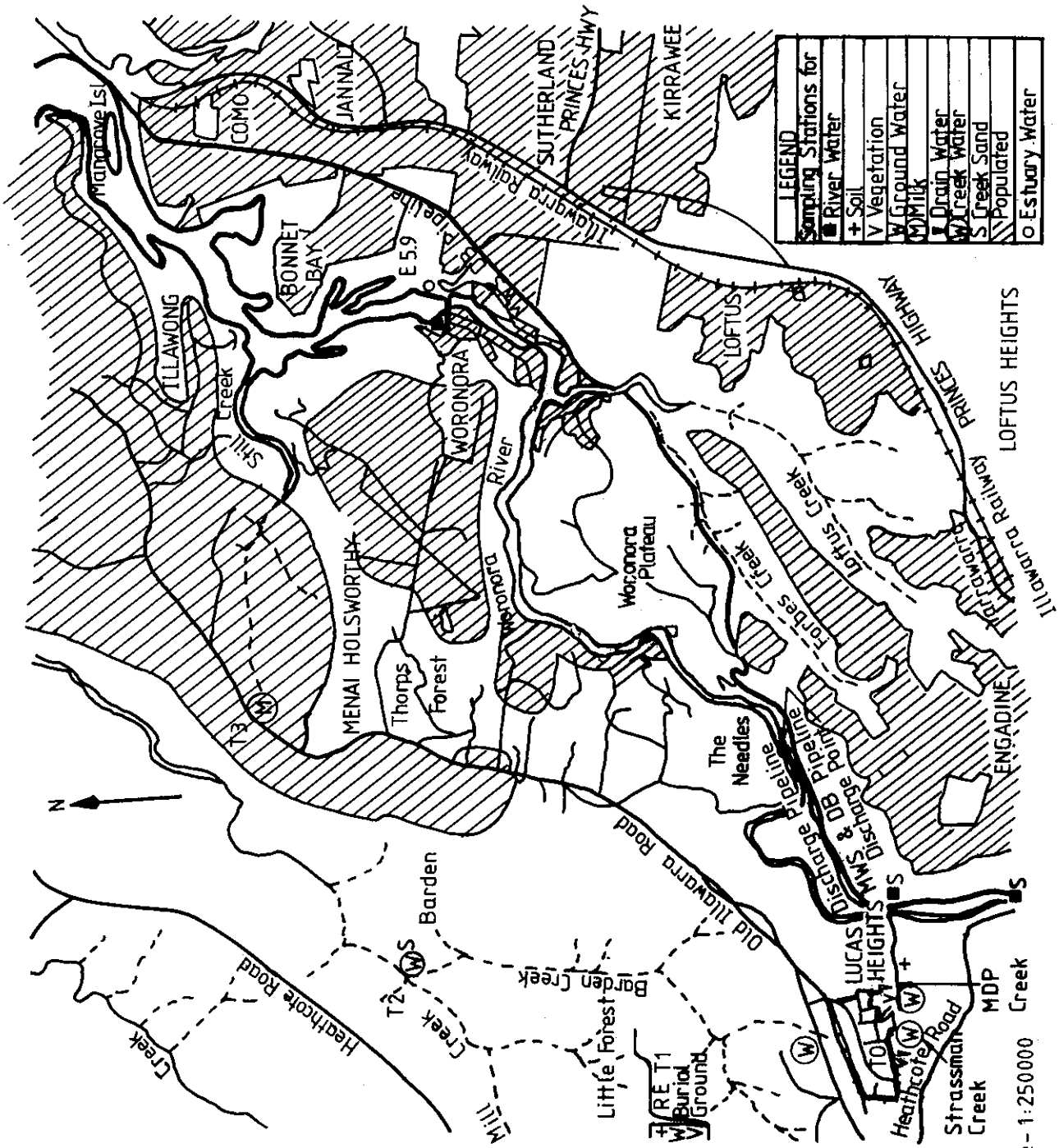
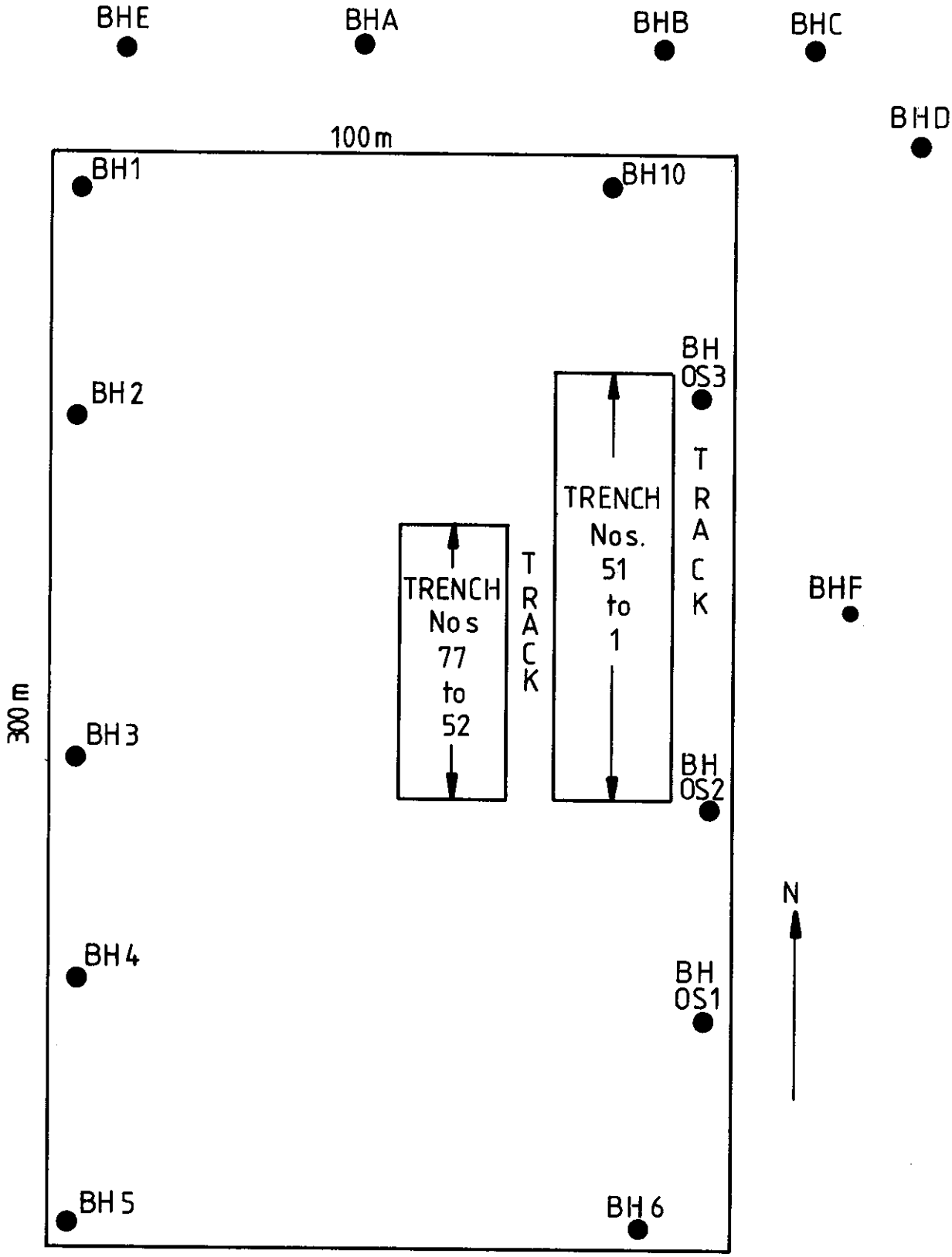


Figure 1 Lucas Heights district - location of sampling stations



BURIAL GROUND
SHOWING BOREHOLES AND TRENCHES

not to scale

Figure 2 Little Forest Burial Ground — location of sampling stations

APPENDIX A
PREVIOUS ENVIRONMENTAL SURVEY REPORTS

Giles, M.S., Stockdale, J.A. [1966] - Results of the Lucas Heights Biological Survey, December 1959 to December 1964. AAEC/E151.

Cook, J.E., Dudaitis, A., Giles, M.S. [1969] - Environmental Survey at the AAEC Research Establishment, Lucas Heights. Results for 1965, 1966 and 1967. AAEC/E151 Supplement No. 1.

Cook, J.E., Dudaitis, A. [1970] - Environmental Survey at the AAEC Research Establishment, Lucas Heights. Results for 1968. AAEC/E151 Supplement No. 2.

Cook, J.E., Dudaitis, A. [1970] - Environmental Survey at the AAEC Research Establishment, Lucas Heights. Results for 1969. AAEC/E151 Supplement No. 3.

Conway, N.F., Dudaitis, A. [1972] - Environmental Survey at the AAEC Research Establishment, Lucas Heights. Results for Period January - July 1970. AAEC/E246.

Dudaitis, A. [1973] - Environmental Survey at the AAEC Research Establishment, Lucas Heights. Results for Period August 1970 to December 1971. AAEC/E271.

Dudaitis, A. [1974] - Environmental Survey at the AAEC Research Establishment, Lucas Heights. Results for 1972. AAEC/E301.

Davy, D.R., Dudaitis, A. [1974] - Environmental Survey at the AAEC Research Establishment, Lucas Heights. Results for 1973. AAEC/E335.

Davy, D.R., Dudaitis, A. [1976] - Environmental Survey at the AAEC Research Establishment, Lucas Heights. Results for 1974. AAEC/E375.

Giles, M.S., Dudaitis, A. [1980] - Environmental Survey at the AAEC Research Establishment, Lucas Heights. Results for 1979. AAEC/E508.

Giles, M.S., Dudaitis, A. [1982] - Environmental Survey at the AAEC Research Establishment, Lucas Heights. Results for 1980. AAEC/E542.

Giles, M.S., Dudaitis, A. [1984] - Environmental Survey at the Lucas Heights Research Laboratories, 1982. AAEC/E591.

Giles, M.S., Dudaitis, A. [1985] - Environmental Survey at Lucas Heights Research Laboratories, 1983. AAEC/E622.

Hespe, E.D. [1979a] - Environmental Survey at the AAEC Research Establishment, Lucas Heights. Results for 1975, 1976 and 1977. AAEC/E467.

Hespe, E.D. [1979b] - Results of the 1978 Environmental Survey at the AAEC Research Establishment, Lucas Heights. AAEC/E494.

Williams, A.R., Dudaitis, A. [1983] - Environmental Survey at the Lucas Heights Research Laboratories, 1981. AAEC/E563.

Giles, M.S., Dudaitis, A. [1984] - Environmental Survey at Lucas Heights Research Laboratories, 1982. AAEC/E591.

Giles, M.S., Dudaitis, A. [1985] - Environmental Survey at Lucas Heights Research Laboratories, 1983. AAEC/E622.

APPENDIX B
NEW ANALYTICAL PROCEDURES

B.1 Be AND ^{239}Pu IN AIR AT LITTLE FOREST

B.1.1 Little Forest Burial Ground

A solar-powered, remotely-operating air sampler has been set up at Little Forest Burial Ground (LFBG). The system is triggered by wind speeds of 3 km s^{-1} or more. Below this speed, surface dusts are not raised into the air from this type of landform. Air is sampled at 3 L per minute on to membrane filters.

Beryllium is determined by the standard method advocated by the US Department of Environment's Radiological Environmental Science Laboratory [RESL 1982].

B.2 STATE POLLUTION CONTROL COMMISSION (SPCC) SAMPLES

The SPCC requires the limits set out in the Clean Waters Act Regulations to be met. This calls for samples to be collected at specific sites and to be analysed for gross α and gross β radioactivity according to method No.703 of the American Public Health Association [APHA 1980].

APPENDIX C
LIST OF ISOTOPE SYMBOLS USED IN TABLES OF SURVEY RESULTS

Symbol	Name
^{41}Ar	argon-41
^{7}Be	beryllium-7
^{60}Co	cobalt-60
^{137}Cs	caesium-137
^{3}H	tritium
^{131}I	iodine-131
K	potassium (stable)
^{40}K	potassium-40
^{226}Ra	radium-226
^{103}Ru	ruthenium-103
^{106}Ru	ruthenium-106
^{90}Sr	strontium-90
^{232}Th	thorium-232
^{238}U	uranium-238
^{65}Zn	zinc-65