Soil Sampling for Heavy Metal Contaminants — Brukunga Township Reserve

Andrew Burtt and Justin Gum
Geological Survey Branch

January 2001

Report Book 2001/00001

PRIMARY INDUSTRIES AND RESOURCES SA

CONTENTS

FIGURES

TABLES

PRIMARY INDUSTRIES AND RESOURCES SA

REPORT BOOK 2001/00001

SOIL SAMPLING FOR HEAVY METAL CONTAMINANTS — BRUKUNGA TOWNSHIP RESERVE

Andrew Burtt and Justin Gum

A soil-sampling program conducted on the reserve adjacent to Dawesley Creek in the township of Brukunga was designed to determine the likely hazard of heavy metal contamination in the reserve. The reserve is on a site containing a small amount of fill, probably derived from Brukunga Mine pyritic waste. This fill has been covered by topsoil and vegetated.

Apart from one slightly elevated zinc value (240 ppm) near galvanised iron fencing bordering the reserve, no elevated heavy metal concentrations were found at surface. The only other elevated heavy metal values consist of three arsenic samples (28, 40 and 64 ppm) from the subsurface (0.2–0.4 m) zone. These values are typically lower than those of outcropping pyritic schist in the Dawesley–Bremer catchment. Any hazard is likely to be mitigated by the covering of topsoil in the area.

No further sampling or remediation is recommended.

INTRODUCTION

Over the past 10 years, residents in the Brukunga–Dawesley area have become increasingly aware of heavy metal contamination of soil and water due to Acid Mine Drainage (AMD) from the abandoned Brukunga Pyrite Mine. As a result, various areas in and around the mine site have been investigated for potential AMD contamination by the Office of Mineral and Energy Resources' Geological Survey Branch (Burtt and Gum, 2000a,b). One such area is the grassed reserve adjacent to Dawesley Creek between the township of Brukunga and the Brukunga Pyrite Mine (Fig. 1).

Residents of Brukunga, concerned for children playing in this reserve, brought the area to the attention of the Brukunga Remediation Board, which instigated a soil sampling investigation to test for any potential heavy metal contamination.

SOIL SAMPLING METHODS

Australian Standard AS4482.1 — 'Guide to the sampling and investigation of potentially contaminated soil, Part 1: Non–volatile and semi–volatile compounds' — was used as a guide for collecting soil samples from the reserve area.

At each sampling location, a composite of five soil samples was collected to a depth of 0.2 m and riffle split. The five samples were collected from the four points of an ~2 m^2 quadrate, with a central sample. At the centre point, a 0.2–0.4 m deep sample was collected unless buried rocks or bedrock were encountered first.

SAMPLES AND ANALYSES

Samples were collected from the edges of the reserve and from the centre, resulting in 23 soil samples from 12 sites (Fig. 1). The ~500 g samples were sent to Amdel (a NATA approved laboratory) for analyses for the following heavy metals: As, Cd, Co, Cr, Cu, Fe, Mo, Ni, Pb, Sn, Sb and Zn, and a range of other elements (Appendix 1). Electrical Conductivity (EC), trace and rare earth elements and pH were also tested for each sample (Appendix 1).

Each soil sample was dried to a core temperature of 110°C and then milled in a LM5 pulveriser to a nominal 90% passing of 106 µm. A pulp of 250 g was taken from the original and used for analysis. The heavy metal elements, detection limits, ANZECC'92 (Imray and Langley, 1992) investigation levels, Amdel analytical code and analytical method for each soil sample are listed in Tables 1 and 2.

Table 1 *Detection limits and investigation levels for the various heavy metal elements analysed for in soil samples from the Brukunga Reserve*

Element	Detection Limit (ppm)	ANZECC'92 soil level (ppm)	EPA biosolid levels* (ppm)	Amdel code	Sample statistics (ppm)		
					Range	Average	Median
Ag	1.0	–	–	IC3M	<DL	–	–
As	3.0	20	20	IC3M	4–64	14.26	10.00
Ba	10	–	–	IC4E	320–650	400	380
Be	2.0	–	–	IC4M	<DL	–	–
Bi	0.1	–	–	IC3M	<DL–0.7	0.27	0.20
Cd	0.1	3	3	IC3M	<DL–0.80	0.42	0.40
Co	2.0	–	–	IC3M	3.0–10.0	5.65	6.00
Cr	20	50	–	IC4E	<DL–430	205.79	200.00
Cu	2.0	60	200	IC3M	11–77	23.17	19.00
Mn	0.008%	500	–	IC4E	0.015–0.046	0.023	0.023
Mo	0.1	–	–	IC3M	0.4–10.0	3.77	2.00
Ni	2.0	60	60	IC3M	9–26	16.30	15.00
Pb	5	300	200	IC3M	10–155	34.57	20.00
Sb	0.5	20	–	IC3M	<DL–4.50	1.17	0.75
Sn	10	50	–	IC4M	<DL–105	46.67	<DL
Zn	0.5	200	250	IC3M	24–240	60.48	50.00
EC	1 (S/cm)	–	–	SIE6	25-316	84.26	73
pH	0.01	–	–	SIE4	4.76–8.60	6.09	5.90

*** Note:** The EPA Guideline levels vary slightly from the ANZECC'92 levels and are specifically used as guidelines to protect agricultural soil. They have therefore been used in preference to the ANZECC'92 levels. DL = detection limit.

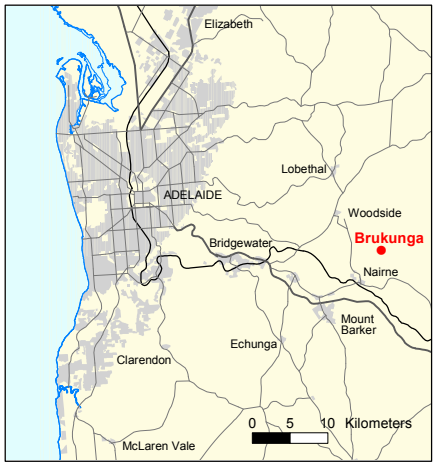
Table 2 *Amdel analysis methods and descriptions*

Amdel code	Description	Type of sample
FA3	A subsample of up to 50 g of analytical pulp is fused in a lead collection fire assay. The resulting prill is digested in aqua–regia and the Au–Pt–Pd content of the sample is determined by graphite furnace AAS.	soil and stream sediments
IC4E	A 0.1 g subsample of analytical pulp is fused with lithium metaborate followed by dissolution to give a 'total solution'. The solution is analysed using an ICPOES.	soil and stream sediments
IC4M	A 0.1 g subsample of analytical pulp is fused with lithium metaborate followed by dissolution to give a 'total solution'. The solution is analysed using an ICPMS.	soil and stream sediments
IC3M	A subsample of up to 0.5 g of analytical pulp is digested using HF/multi-acid digest and the solution is analysed using an ICPMS.	soil and stream sediments
IC3R	A subsample of up to 0.5 g of analytical pulp is digested using HF/multi-acid digest and the solution is analysed using an ICPMS.	soil and stream sediments
AA6	A 0.75 g sample is digested using a mixture of nitric and hydrochloric acid. The resulting solution is bulked to volume with water and quantified by cold vapour AAS.	soil and stream sediments
SIE4	pH determination on soil using 1:5 ratio sample to water.	soil and stream sediments
SIE6	Determines electrical conductivity (EC) of soil.	soil and stream sediments

BRUKUNGA TOWNSHIP SOIL SAMPLES

PRIMARY INDUSTRIES AND RESOURCES SA

Government of South Australia



B127 Sample number

0 25 50 Meters

Datum GDA 94
Projection UTM MGA Zone 54

Sample numbers

Figure 1

AV: 200577_001

RESULTS

ARSENIC

Three soil samples from the reserve returned arsenic values greater than EPA recommended maximum for biosolid reuse and the ANZECC'92 environmental investigation level of 20 ppm (Table 1).

A maximum value of 64 ppm was recorded at site B116, with 28 and 40 ppm recorded at B124 and B127, respectively (Fig. 2). All the results above the investigation level are restricted to the 0.2–0.4 m zone. All results for the surficial 0–0.2 m zone were less than the 20 ppm investigation level for arsenic.

ZINC

One soil sample (B118, 240 ppm) returned a zinc value greater than the EPA biosolid level of 200 ppm (Fig. 3). The only other elevated result is associated with the highest arsenic results at site B116 (ie. 110 ppm Zn and 64 ppm As). This value is related to the 0.2–0.4 m zone whereas the highest zinc value is from the 0–0.2 m zone.

At all the other sites, from both the 0–0.2 and 0.2–0.4 m zones, zinc values are below the EPA biosolid and ANZECC'92 investigation levels.

CADMIUM

All cadmium values for both the 0–0.2 and 0.2–0.4 m zones are below the EPA biosolid level and the ANZECC'92 investigation level of 3 ppm (Fig. 4). The highest value recorded was 0.8 ppm at sites B119 and B121. The potential for contamination by cadmium is therefore very low in the reserve area.

DISCUSSION

The reserve area has been modified from its natural state by addition of various materials, possibly including mine waste rock, soil and sandy loam. This was confirmed during the sampling of the area. In addition, fragments of rusting iron were found in several samples (eg B122 and B123).

The fill in the reserve area has been covered by topsoil and there is no evidence of the fill being exposed. Sampling indicates the cover to vary in depth from ~0.1 to 0.2 m.

If the base of the reserve area consists of mine waste material, then transport of heavy metals to surface soil could be expected, resulting in elevated heavy metal in soil. However, the volume of fill in this area is not likely to be sufficient to rapidly release large quantities of heavy metals.

Similarly, the road along the eastern edge of the reserve consists of rubble and compacted clay-rich soil. This material appears to have been transported from a source other than the mine. However, numerous pyrite-rich pebbles were noted within the road surface as were several pyrite-rich boulders resting against various residential fences. The pebbles and boulders are weathering and as the natural slope for water run-off is from the road, over the reserve to Dawesley Creek, these materials are possibly contributing a small amount of heavy metal to the area.

During sampling, it was also noted that a considerable amount of metal products are stored in various residential properties adjacent to the eastern edge of the reserve. These collections of metals and other materials, particularly the galvanised iron fences bordering the reserve, are deteriorating and possibly shedding metal such as zinc into the reserve area. This is the most likely source of the single surface zinc anomaly as the anomalous site (B118) is one of the closest to the fence.

CONCLUSION

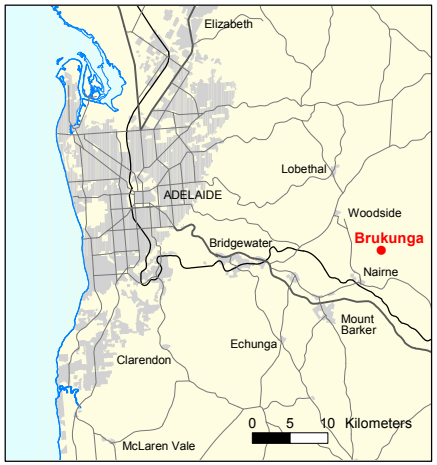
In conclusion, the reserve is situated on a site containing a small amount of fill probably derived from mine waste. This fill has been covered by topsoil and vegetated. Apart from one slightly elevated zinc value near galvanised iron fencing bordering the reserve, no elevated heavy metal concentrations were found at surface.

The only other elevated heavy metal values consist of three arsenic samples from the subsurface (0.2–0.4 m) zone. These values are typically lower that the values of outcropping pyritic schist in the Dawesley–Bremer catchment (Burtt and Gum, 2000a). The covering of topsoil in the area provides a significant barrier between the subsurface and surface.

BRUKUNGA TOWNSHIP SOIL SAMPLES

PRIMARY INDUSTRIES AND RESOURCES SA

Government of South Australia



6.00 *As* Samples 0-20 cm (ppm)

8.00 *As* Samples 20-40 cm (ppm)

0 25 50 Meters

Datum GDA 94
Projection UTM MGA Zone 54

Arsenic results for 0-20cm and 20-40cm

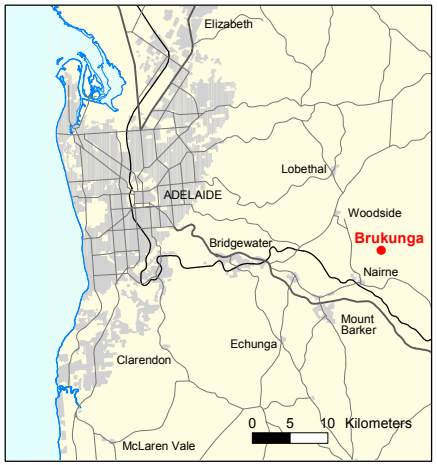
Figure 2

AV: 200577_002

BRUKUNGA TOWNSHIP SOIL SAMPLES

PRIMARY INDUSTRIES AND RESOURCES SA

Government of South Australia



● 40.00 *Zn* Samples 0-20 cm (ppm)

● 36.00 *Zn* Samples 20-40 cm (ppm)

0 25 50 Meters

Datum GDA 94
Projection UTM MGA Zone 54

Zinc results for 0-20cm and 20-40cm

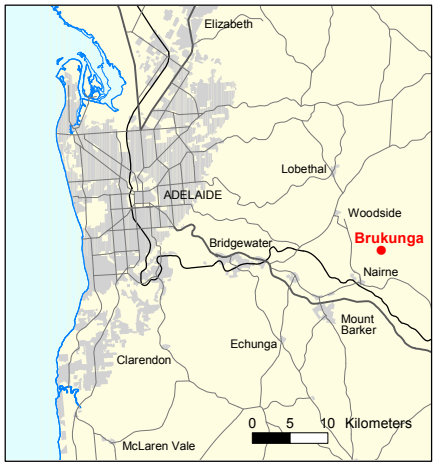
Figure 3

AV: 200577_003

BRUKUNGA TOWNSHIP SOIL SAMPLES

PRIMARY INDUSTRIES AND RESOURCES SA

Government of South Australia



● 0.50 *Cd* Samples 0-20 cm (ppm)

● 0.60 *Cd* Samples 20-40 cm (ppm)

0 25 50 Meters

Datum GDA 94
Projection UTM MGA Zone 54

Cadmium results for 0-20cm and 20-40cm

Figure 4

AV: 200577_004

APPENDIXES

Appendix 1 Sample type and location data

Sample number	Easting	Northing	Sample type	Soil type	Sample description	R Number	Depth (m)
B116	312093	6124714	Composite soil	A	Dark-brown soil + (Vegetable matter) + (Yellow, limonite soil + Rock fragments).	445190	0–0.2
B116	312093	6124714	Soil	A	Dark-brown soil + Yellow, limonite rock + Clay (fill).	445191	0.2–0.4
B117	312081	6124721	Composite soil	A	Brown soil.	445192	0–0.2
B117	312081	6124721	Soil	A	Brown soil +(Yellow-orange, limonite soil).	445193	0.2–0.4
B118	312114	6124761	Composite soil	A	Dark-grey, clay-rich soil + Charcoal + Light-brown, sandy soil.	445194	0–0.2
B119	312102	6124763	Composite soil	A	Light-brown, sandy soil (Possible fill site for BMX).	445195	0–0.2
B119	312102	6124763	Soil	A	Light-brown, sandy soil + (Trace, orange, limonite soil) (Possible fill site for BMX).	445196	0.2–0.4
B120	312135	6124810	Composite soil	A	Light-brown + yellow, sandy soil.	445197	0–0.2
B121	312120	6124813	Composite soil	A	Brown, clay soil + Grey, clay soil + (Yellow, limonite soil).	445198	0–0.2
B121	312120	6124813	Soil	A	Brown, clay soil.	445199	0.2–0.4
B122	312115	6124730	Composite soil	A	Dark-brown, organic-rich silt + (Orange, limonite soil) + (Trace, rusty, iron fragments).	445200	0–0.2
B122	312115	6124730	Soil	A	Dark-brown, sandy organic-rich soil.	445201	0.2–0.4
B123	312101	6124748	Composite soil	A	Dark-brown, sandy soil + (Limonite soil) + (Rusted iron wire / battery?).	445202	0–0.2
B123	312101	6124748	Soil	A	Dark-brown, sandy soil.	445203	0.2–0.4
B124	312175	6124867	Composite soil	A	Light-brown, sandy soil + Yellow sand (washed off track).	445204	0–0.2
B124	312175	6124867	Soil	A	Yellow-white, sandy soil (fill).	445205	0.2–0.4
B125	312169	6124879	Composite soil	A	Light-brown, sandy soil + (Trace greywacke fragments).	445206	0–0.2
B126	312139	6124846	Composite soil	A	Light-brown, sandy soil + (Trace greywacke) + (Trace orange, limonite soil).	445207	0–0.2
B126	312139	6124846	Soil	A	Light-brown, sandy soil + (Trace greywacke).	445208	0.2–0.4
B127	312202	6124899	Composite soil	A	Brown + off-white, sandy soil (possible fill site for BMX).	445209	0–0.2
B127	312202	6124899	Soil	A	Light-brown, sandy soil + Yellow-brown, clay soil (possible fill site for BMX).	445210	0.2–0.4
B128	312222	6124953	Composite soil	A	Brown, sandy soil + (Orange, limonite soil).	445211	0–0.2
B128	312222	6124953	Soil	A	Brown, sandy soil + (Orange, limonite soil).	445212	0.2–0.4

Appendix 2 Soil sample assay data (Report 0AD2006)

Element	Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	MnO	Na_2O	P_2O_5	SiO_2	TiO_2	LOI
Units	%	%	%	%	%	%	%	%	%	%	%
Method	IC4	IC4	IC4	IC4	IC4	IC4	IC4	IC4	IC4	IC4	GRAV7
Detection Limit	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.005	0.01
RS445190	7.79	1.12	3.21	1.48	0.60	0.03	1.42	0.10	77.10	0.410	6.04
RS445191	9.55	1.59	10.90	2.07	1.06	0.06	1.53	0.14	62.80	0.470	9.73
RS445192	9.03	0.97	2.61	1.56	0.65	0.04	1.48	0.06	76.00	0.435	6.22
RS445193	9.44	0.96	3.47	1.69	0.69	0.03	1.49	0.07	73.70	0.480	6.9
RS445194	8.81	1.37	3.99	1.70	0.79	0.04	1.26	0.17	70.30	0.525	9.72
RS445195	7.80	0.95	2.25	1.41	0.53	0.04	1.45	0.05	80.40	0.460	3.72
RS445196	8.37	1.01	1.92	1.52	0.51	0.02	1.73	0.05	81.70	0.455	2.79
RS445197	8.10	1.24	3.48	1.51	0.76	0.03	1.47	0.07	76.40	0.410	5.23
RS445198	8.01	2.14	2.09	1.40	0.76	0.02	1.43	0.04	77.30	0.450	5.22
RS445199	7.19	0.97	2.51	1.30	0.50	0.03	1.40	0.05	80.90	0.440	2.89
RS445200	8.26	1.01	2.83	1.49	0.56	0.03	1.56	0.06	77.10	0.425	5.78
RS445201	8.00	0.93	2.72	1.48	0.52	0.02	1.54	0.06	76.90	0.390	6.74
RS445202	7.99	1.00	2.30	1.50	0.56	0.04	1.48	0.06	78.00	0.500	5.48
RS445203	6.99	0.98	2.74	1.28	0.55	0.04	1.25	0.06	78.10	0.465	5.91
RS445204	8.19	0.81	2.05	1.48	0.40	0.02	1.60	0.05	80.60	0.430	2.99
RS445205	10.50	0.64	3.24	1.77	0.63	0.02	1.48	0.03	77.00	0.570	2.8
RS445206	7.48	0.87	1.91	1.39	0.53	0.02	1.44	0.03	81.40	0.395	2.75
RS445207	7.17	0.79	2.08	1.27	0.47	0.02	1.35	0.04	82.10	0.370	2.55
RS445208	7.26	0.83	2.28	1.32	0.52	0.02	1.31	0.04	82.80	0.375	2.21
RS445209	8.66	0.74	2.16	1.47	0.43	0.02	1.49	0.05	79.20	0.480	4.52
RS445210	15.00	0.54	5.00	1.99	1.14	0.03	1.07	0.04	67.60	0.685	6.38
RS445211	7.95	0.84	2.31	1.41	0.54	0.02	1.32	0.06	80.30	0.410	3.57
RS445212	7.28	0.79	2.09	1.21	0.46	0.02	1.26	0.04	82.30	0.380	2.29
Minimum	6.99	0.54	1.91	1.21	0.40	0.02	1.07	0.03	62.80	0.370	2.21
Maximum	15.00	2.14	10.90	2.07	1.14	0.06	1.73	0.17	82.80	0.685	9.73
Average	8.47	1.00	3.05	1.51	0.62	0.03	1.43	0.06	77.39	0.453	4.89
Median	8.01	0.96	2.51	1.48	0.55	0.03	1.45	0.05	78.00	0.440	5.22

Element	As	Ba	Be	Bi	Cd	Ce	Co	Cr	Cs	Cu	EC	Ga	Hf
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	us/cm	ppm	ppm
Method	IC3E	IC4M	IC3E	IC3M	IC3M	IC3M	IC3E	IC4	IC3M	IC3E	SIE6	IC3M	IC4M
Detection Limit	3	10	2	0.1	0.1	0.5	2	20	0.1	2	1	0.1	1
RS445190	20	390	<2	0.50	0.40	66	3	200	1.60	25	147	11	6
RS445191	64	650	<2	0.60	0.50	62	10	180	3.40	33	316	16.5	5
RS445192	10	470	<2	0.20	0.40	73	6	<20	1.70	22	100	11.5	8
RS445193	8	470	<2	0.20	0.10	84	7	280	2.10	28	113	13	7
RS445194	20	460	<2	0.40	0.80	63	8	150	2.50	77	188	13	6
RS445195	4	360	<2	0.10	0.20	79	7	150	1.10	13	73	10.5	9
RS445196	6	420	<2	<0.10	<0.10	79	3	<20	1.00	11	53	10	10
RS445197	18	470	<2	0.20	0.30	60	5	200	1.70	27	93	11	8
RS445198	6	340	<2	0.10	0.80	63	5	20	1.20	19	82	10	9
RS445199	8	330	<2	<0.10	0.60	86	7	370	0.90	17	79	9	11
RS445200	8	380	<2	<0.10	0.50	73	6	140	1.20	19	73	10.5	9
RS445201	10	360	<2	0.20	0.40	67	7	320	1.50	23	100	11	7
RS445202	6	380	<2	0.10	0.30	75	5	20	1.20	16	53	10.5	12
RS445203	10	340	<2	0.10	0.40	77	8	430	1.20	18	54	9.5	13
RS445204	12	450	<2	0.20	0.20	67	4	290	1.30	20	46	11	8
RS445205	28	420	<2	0.50	<0.10	73	6	210	2.50	16	43	15	7
RS445206	8	340	<2	<0.10	<0.10	67	4	<20	1.10	12	25	10	8
RS445207	4	330	<2	0.10	0.50	63	6	240	1.00	19	36	10	6
RS445208	4	320	<2	0.10	0.60	65	4	220	1.20	27	47	9.5	7
RS445209	16	380	<2	0.50	<0.10	73	4	200	1.30	12	45	12	7
RS445210	40	420	<2	0.70	<0.10	78	8	100	5.00	42	90	24	7
RS445211	6	390	<2	0.20	0.20	66	4	<20	1.40	21	45	11	9
RS445212	12	340	<2	0.10	<0.10	65	3	190	1.00	16	37	9.5	8
Minimum	4.00	320.00		0.10	0.10	60.00	3.00	20.00	0.90	11.00	25.00	9.00	5.00
Maximum	64.00	650.00		0.70	0.80	86.00	10.00	430.00	5.00	77.00	316.00	24.00	13.00
Average	14.26	400.43		0.27	0.42	70.61	5.65	205.79	1.66	23.17	84.26	11.70	8.13
Median	10.00	380.00		0.20	0.40	67.00	6.00	200.00	1.30	19.00	73.00	11.00	8.00

Element	La	Mo	Nb	Ni	Pb	pH	Rb	S	Sb	Sc	Se	Sn	Sr
Units	ppm	ppm	ppm	ppm	ppm		ppm	ppm	ppm	ppm	ppm	ppm	ppm
Method	IC3M	IC3M	IC4M	IC3E	IC3E	SIE4	IC4M	IC3E	IC3M	IC3E	IC3M	IC4M	IC4M
Detection Limit	0.5	0.1	10	2	5	0.01	0.5	50	0.5	2	0.5	10	5
RS445190	41.0	2.0	<10	16	85	7.00	51.0	2550	1.5	5	1.0	<10	90
RS445191	40.0	9.5	<10	22	155	6.90	79.0	13300	4.5	7	1.5	<10	115
RS445192	45.5	0.9	<10	13	40	5.80	57.0	1350	0.5	6	<0.5	20	85
RS445193	49.0	7.5	<10	24	40	5.40	68.0	1350	1.0	6	0.5	<10	90
RS445194	34.5	3.3	<10	19	120	7.30	67.0	4000	2.0	6	<0.5	<10	90
RS445195	49.5	4.0	<10	15	15	6.20	45.0	200	<0.5	5	<0.5	105	80
RS445196	48.0	0.4	<10	9	10	4.91	47.0	200	<0.5	5	<0.5	<10	95
RS445197	37.0	6.0	<10	17	45	7.10	56.0	2850	1.0	6	0.5	<10	95
RS445198	40.0	0.5	<10	10	15	8.60	48.0	300	<0.5	5	<0.5	<10	100
RS445199	53.0	8.5	<10	23	15	7.20	40.5	250	<0.5	5	<0.5	<10	75
RS445200	45.0	1.3	<10	13	15	5.90	49.0	450	<0.5	5	<0.5	15	90
RS445201	41.0	8.0	<10	23	15	5.50	52.0	550	<0.5	5	<0.5	<10	80
RS445202	46.0	1.0	<10	10	25	5.50	51.0	850	0.5	5	0.5	<10	85
RS445203	49.0	10.0	<10	26	15	6.30	43.0	500	<0.5	5	<0.5	<10	75
RS445204	43.0	1.9	<10	12	25	5.90	51.0	1000	0.5	5	<0.5	<10	90
RS445205	48.5	5.5	<10	20	30	6.30	72.0	100	0.5	7	<0.5	<10	80
RS445206	41.5	0.5	<10	9	10	5.10	45.5	100	<0.5	5	0.5	<10	80
RS445207	39.0	5.5	<10	20	10	5.60	42.5	150	<0.5	5	<0.5	<10	75
RS445208	40.5	1.2	<10	13	15	5.50	45.5	300	<0.5	5	<0.5	<10	70
RS445209	47.0	6.0	<10	14	30	5.80	51.0	250	0.5	5	<0.5	<10	80
RS445210	43.0	1.6	<10	26	35	6.00	120.0	150	1.0	12	0.5	<10	75
RS445211	41.5	0.6	<10	10	20	4.76	51.0	1000	0.5	6	<0.5	<10	75
RS445212	40.0	1.0	<10	11	10	5.40	44.0	150	<0.5	5	<0.5	<10	75
Minimum	34.50	0.40		9.00	10.00	4.76	40.50	100.00	0.50	5.00	0.50	15.00	70.00
Maximum	53.00	10.00		26.00	155.00	8.60	120.00	13300.00	4.50	12.00	1.50	105.00	115.00
Average	43.59	3.77		16.30	34.57	6.09	55.48	1386.96	1.17	5.70	0.71	46.67	84.57
Median	43.00	2.00		15.00	20.00	5.90	51.00	450.00	0.75	5.00	0.50	20.00	80.00

Element	Te	Th	Tl	U	V	W	Y	Zn	Zr
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Method	IC3M	IC3M	IC3M	IC3M	IC4	IC4M	IC4M	IC3E	IC4M
Detection Limit	0.2	0.02	0.1	0.02	20	3	1	2	15
RS445190	<0.2	12.0	1.3	1.85	50	<3	17	110	240
RS445191	<0.2	11.5	5.5	1.65	90	18	20	89	180
RS445192	<0.2	14.0	0.7	1.95	50	<3	22	87	250
RS445193	<0.2	15.0	0.8	2.20	70	22	25	64	280
RS445194	<0.2	13.0	1.2	1.85	50	4	18	240	240
RS445195	<0.2	14.5	0.3	2.00	50	14	22	42	350
RS445196	<0.2	14.0	0.3	1.90	30	<3	67	33	360
RS445197	<0.2	11.5	1.1	1.80	60	16	19	75	300
RS445198	<0.2	13.0	0.4	1.80	40	4	20	56	340
RS445199	<0.2	14.0	0.3	1.95	60	30	23	37	410
RS445200	<0.2	13.0	0.4	2.00	40	<3	23	60	350
RS445201	<0.2	12.0	0.4	1.85	50	26	20	40	270
RS445202	<0.2	14.5	0.5	1.95	40	<3	20	65	480
RS445203	<0.2	14.0	0.3	1.90	70	34	23	54	500
RS445204	<0.2	13.5	0.5	1.90	40	4	23	50	310
RS445205	<0.2	16.5	0.5	2.30	70	18	22	28	280
RS445206	<0.2	11.5	0.3	1.70	40	<3	15	27	310
RS445207	<0.2	11.5	0.3	1.75	50	18	19	40	260
RS445208	<0.2	10.5	0.3	1.80	40	<3	19	36	280
RS445209	<0.2	15.0	0.4	2.20	60	18	21	24	260
RS445210	<0.2	18.0	0.9	2.90	80	<3	23	39	240
RS445211	<0.2	12.5	0.5	1.95	40	<3	16	61	360
RS445212	<0.2	11.0	0.3	1.70	40	<3	19	34	310
Minimum		10.50	0.30	1.65	30.00	4.00	15.00	24.00	180.00
Maximum		18.00	5.50	2.90	90.00	34.00	67.00	240.00	500.00
Average		13.30	0.76	1.95	52.61	17.38	22.43	60.48	311.30
Median		13.00	0.40	1.90	50.00	18.00	20.00	50.00	300.00

REFERENCES

Burtt, A.C. and Gum, J.C., 2000a. Soil and stream sediment sampling of the Dawesley–Bremer catchment for potential environmental contaminants. *South Australia. Department of Primary Industries and Resources. Report Book,* 2000/3.

Burtt, A.C. and Gum, J.C., 2000b. The Dawesley–Bremer catchment: Phase 2 sampling program for potential environmental contaminants. *South Australia. Department of Primary Industries and Resources. Report Book,* 2000/19.

Imray, P. and Langley, A., 1996. Health based soil investigation levels. *In:* Australian and New Zealand guidelines for the assessment and management of contaminated sites. 3rd National Workshop on the Health Risk Assessment and Management of Contaminated Sites. Proceedings. *Contaminated Sites Monograph,* 5:191-217. (ANZECC'92 Environmental Guidelines).