Gilbert & Sutherland
Specialist Soil and Water Scientists

Soil Contamination Assessment for 'Area E' Properties Terranora

Volume 1 - Report

Prepared for
Metricon Queensland Pty Ltd

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Also at Kawana and Ballina

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1. Introduction

1.1 Background

Gilbert and Sutherland Pty Ltd was commissioned by Metricon QLD Pty Ltd to conduct a Soil Contamination Assessment for several properties located within the 'Area E' planning catchment, Terranora. The property locations are shown on Drawing Number GJ0128.1.1. The properties investigated are listed in Table 1 below:

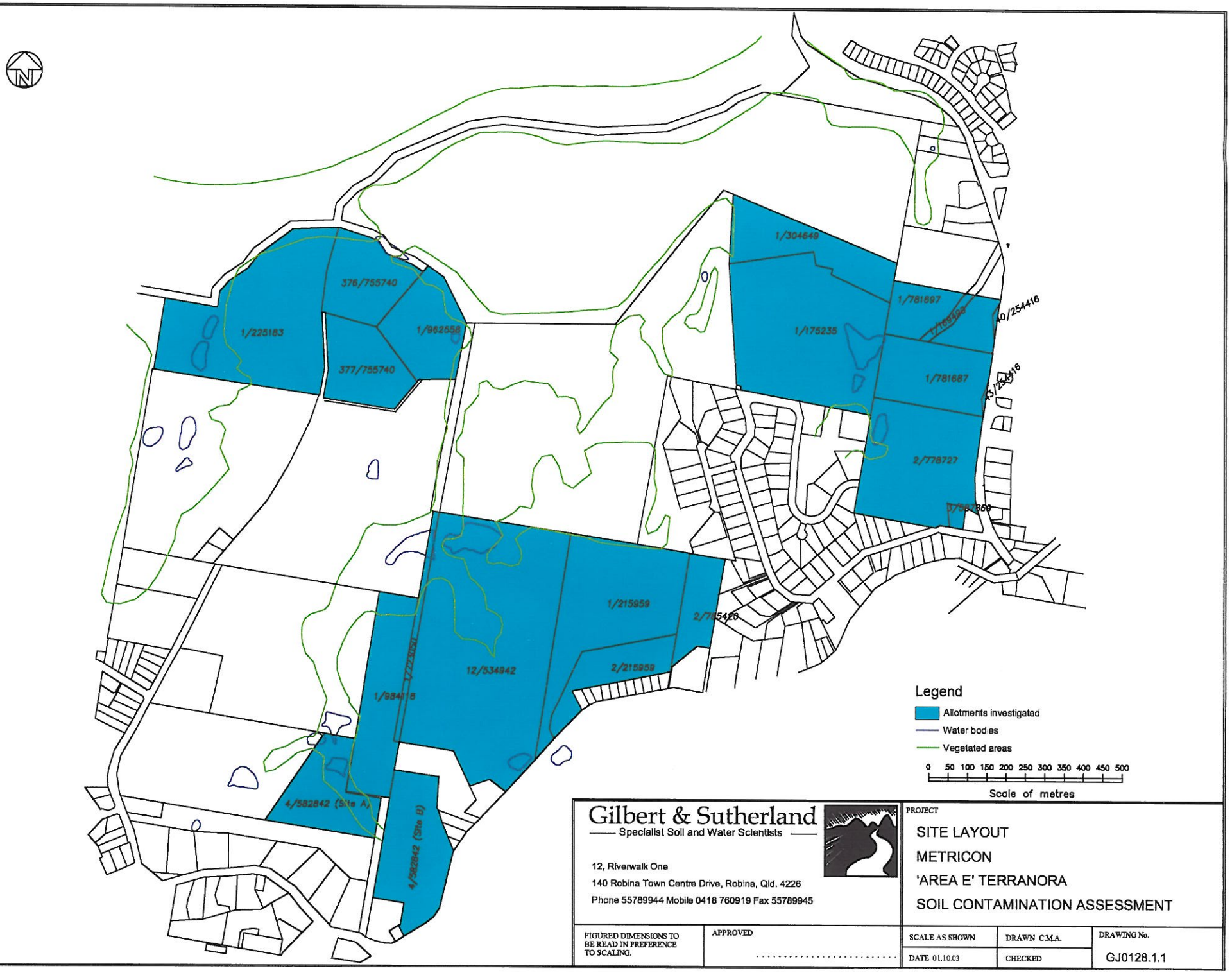
Table 1. Properties investigated for soil chemical residues.

Lot	DP	Ha	Current owner
2	785420	2.405	Cartwright, C. J. & J. M.
376	755740	4.429	Greber, D. W.
377	755740	4.047	Greber, D. W.
1	962558	4.047	Greber, D. W.
1	225183	12.780	Greber, G. L & A. M.
4 (Site A)	582842	4.4	James, G. R & L. J.
4 (Site B)	582842	5.84	James, G. R & L. J.
227	755740	51.900	Bolster, J.
1	215959	9.423	Nichols, B. I. O & D. J. (Est.)
2	215959	3.017	Nichols, B. I. O & D. J. (Est.)
12	534942	22.340	Nichols, B. I. O & D. J. (Est.)
1	723050	0.755	Nichols, B. I. O & D. J. (Est.)
1	984118	4.838	Nichols, B. I. O & D. J. (Est.)
3	587869	0.246	Abernathy, G. R.
1	169490	0.348	Abernathy, F.
1	175235	13.840	Abernathy, F.
40	254416	0.065	Abernathy, F.
43	254416	0.036	Abernathy, F.
1	304649	4.702	Abernathy, F.
2	778727	8.525	Abernathy, F.
1	781687	4.707	Abernathy, F.
1	781697	3.523	Abernathy, F.

The "site" properties are zoned rural and have been used for agriculture. To cater for urban expansion within the area, Metricon QLD Pty Ltd proposes to subdivide the subject properties into a number of smaller residential house blocks.

This soil contamination assessment was conducted in accordance with the following guidelines:

- Guidelines for Consultants Reporting on Contaminated Sites (NSW EPA 2000),
- Guidelines for Assessing Banana Plantation Sites (NSW EPA 1997),
- Contaminated Sites Sampling Design Guidelines (NSW EPA 1995),
- Assessment of Orchard and Market Garden Contaminated Sites Discussion Paper (NSW EPA 1995), and
- Guideline on the Investigation Levels for Soil and Groundwater Schedule B (1) (National Environment Protection Council).



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PROJECT

SITE LAYOUT
METRICON
'AREA E' TERRANORA
SOIL CONTAMINATION ASSESSMENT

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN C.M.A.
		DATE 01.10.03	CHECKED

DRAWING No. GJ0128.1.1

1.2 Scope of works

The following scope of works was conducted by Gilbert and Sutherland:

- identify potential contamination types,
- discuss the site condition,
- provide an assessment of the site contamination, and
- determine any need for further investigations.

1.3 Report structure

This report comprises three volumes and should only be referenced in its entirety.

2. Site history

A detailed site history assessment for several properties within "Area E" was undertaken on behalf of Gilbert & Sutherland by Glazebrook & Associates Pty Ltd in May 2003. The report is attached as Appendix A. The site history assessment was conducted by examining topographic maps, aerial photographs and by reviewing a report prepared previously by Wilkie Fleming & Associates Pty Ltd and Property Management Consultants "Assessment of Soil Chemical Residues and Agricultural Report, 1994".

In relation to the subject properties the site history report generally identified the following agricultural usages:

- banana plantations and possible stockyards were identified on various properties as early as 1935,
- presence of buildings, sheds and dams,
- broad clearance of land, and
- small crops including zucchini, sweet potatoes, tomatoes, peas, beans, paw-paw and passionfruit.

Low intensity cattle grazing was additionally observed across the lower slopes of some properties during the contamination sampling program undertaken by G&S.

The NSW EPA considerers all of the above listed uses to be potentially contaminating activities. Properties characterised by these uses generally require further assessment as part of the approval process prior to development application approval. A detailed soil contamination assessment was conducted for all site properties, with the exception of Lot 227 DP 755740 (Bolster). Lot 227 was not characterised by any of the above listed potentially contaminating activities.

3. Historical use of chemicals

As with all areas in the region, there appears to have been many chemicals applied to agricultural land within the site catchment. Given the nature and extensive period of use of these chemicals (approximately 60 to 80 years), it is possible that trace amounts of these chemicals may be present within the site soils. Some of these chemicals are known to persist in the environment whilst others leave little or no residues within the soil.

The likelihood of high residual contamination in the cultivated areas is relatively low given that the majority of the modern agricultural chemicals are not persistent in the environment. Additionally, the use of the more persistent chemicals has been restricted or prohibited from use since the mid 1980's. However, chemicals may have been applied at higher concentrations than recommended and the method of application may have varied from the manufacturers specifications. Contaminated "hot spots" may have resulted from spillage of chemicals within storage and mixing areas.

Brief descriptions of chemical residues most commonly used on agricultural lands, in accordance with Baird[1], are listed below:

Organochlorine pesticides (OC's)

- were first introduced in agriculture during the Second World War,
- have been used extensively in NSW i.e. small cropping and banana plantations,
- are stable against decomposition or degradation in the environment,
- have very low solubility in water and have high solubility in hydrocarbon-like environments and;
- have a relatively high toxicity to insects but low toxicity to humans.

Organophosphate pesticides (OP's)

- are generally nonpersistant in the environment,
- generally decompose within days or weeks of application and thus are seldom found in food chains,
- are more acutely toxic to humans than OC's and;
- exposure to OP's is typically percutaneous or by inhalation.

Arsenic (As)

- compounds of arsenic are used in weedicides, termicides and pesticides,
- is a known carcinogen in humans and;
- was replaced by OC's &OP's in the 1950's and 1960's however is still in limited use today.

[1] Baird, C. 2001. Environmental Chemistry. W. H. Freeman and Company. New York.

Cadmium (Cd)

- is a highly toxic, non-essential element with no known biological function,
- is an impurity in some phosphate fertilizers and;
- is bioavailable in soils.

Copper (Cu)

- is a constituent of many agricultural pesticides and fertilizers,
- is known to cause mucosal irritation of the eyes and;
- may in some instances cause pruritic dermatitis and allergic contact dermatitis in humans.

Lead (Pb)

- is a non-essential element with no known biological function,
- is comparatively less toxic and bioavailable than other heavy metals and;
- was historically applied in agriculture via the compound lead arsenate $Pb_3 (AsO_4)_2$.

Mercury (Hg)

- is a non-essential element with no known biological function,
- was used (alkyl-Hg's) to prevent fungal disease in germinating seeds resulting in the addition of large amounts of Hg to soils and;
- is a potent neurotoxin causing serious damage to the central nervous system.

Zinc (Zn)

- is a component and impurity in many agricultural fertilizers and;
- is commonly used as a rodenticide and pesticide.

4. Site description

4.1 Study area

The total assessment area is approximately 166.5 hectares. The property boundaries are generally defined by the Terranora Broadwater to the north, Terranora Road to the south, Fraser Drive to the east and Mahers Lane to the west.

4.2 Geology and soils

Based on observations made during the contamination sampling program, the predominant soil type was Ferrosol. Ferrosol is characteristically red brown with a light to medium silty clay texture. Alluvial and colluvial soils were observed across the lower areas of the site properties.

4.3 Topography and drainage

Site elevation ranges from approximately 0 to 130m AHD. The site is characterized by north facing slopes with grades ranging from level to > 25° (gently to steeply inclined).

4.4 Vegetation

Widespread clearance of native vegetation for the purpose of agricultural cropping is evident across much of the subject land. Small pockets of remnant vegetation can be observed across some of the steeply sloping areas, within gullies and across some of the lower areas of site. Weed infestation is prolific across areas left fallow and uncropped.

5. Subsurface investigation

5.1 Fieldwork

The sampling protocol adopted was based on the requirements specified within the EPA guidelines listed in Section 1.1 of this report. Similarly, the adopted sampling protocol is considered to be acceptable by Tweed Shire Council, which was confirmed by Tweed Shire Council staff[2] during briefings prior to the commencement of the field investigations.

The sampling was conducted across the subject lots by experienced environmental scientists from the Gilbert & Sutherland Robina office. All soil samples were collected from 0.0 – 0.15m depth near surface level (NSL) using a 60mm diameter push-tube sampler. The sampler was washed thoroughly using diluted Extran MA03 cleaner and re-rinsed in water prior to use. Upon recovery, all samples were stored in an ice-filled insulated container and placed out of direct sunlight. Approximately sixteen (16) samples were recovered for every one (1) hectare of property in accordance with the NSW EPA guidelines (refer Section 1.1).

The samples were composited prior to being sent for laboratory analysis. Equal masses of four (4) samples were combined to form a one (1) composite sample. Blind replicate and split samples were prepared for a number of samples for the purpose of quality assurance.

5.2 Laboratory analysis

The majority of composite samples were analysed by ALS for organochlorine and organophosphate pesticides, arsenic, cadmium, copper, lead, mercury and zinc. Where banana growing was determined to be the predominant former agricultural land use, organochlorine and organophosphate pesticides, arsenic, and lead were analysed. ALS is located at 32 Shand Street, Stafford, Brisbane, Queensland and is a National Association of Testing Authorities, Australia (NATA) registered laboratory.

[2] Brad Pearce, Mark Tunks.

6. Results

6.1 Soil investigation levels

The NEPM Level A Health Investigation Levels (HIL's) for frequently occurring substances are shown in Table 6.1.1 below. Consideration must be given to the future use of areas within the subject properties where the concentration/s of substances are found to exceed one or more of the HIL's described below.

Table 6.1.1 The NEPM HIL's for frequently occurring substances (mg/kg).

Analyte	Background ranges	HIL's	HIL's adjusted for composite sampling
Metals/Metalloids			
Arsenic	1 - 50	100	25
Cadmium	1	20	5
Copper	2 - 100	1000	250
Lead	1 - 200	300	75
Mercury (inorganic)	0.03	15	3.75
Zinc	10 - 300	7000	1750
Organics			
Aldrin + Dieldrin (A+D)	-	10	2.5
Chlordane	-	50	12.5
DDT + DDD + DDE	-	200	50

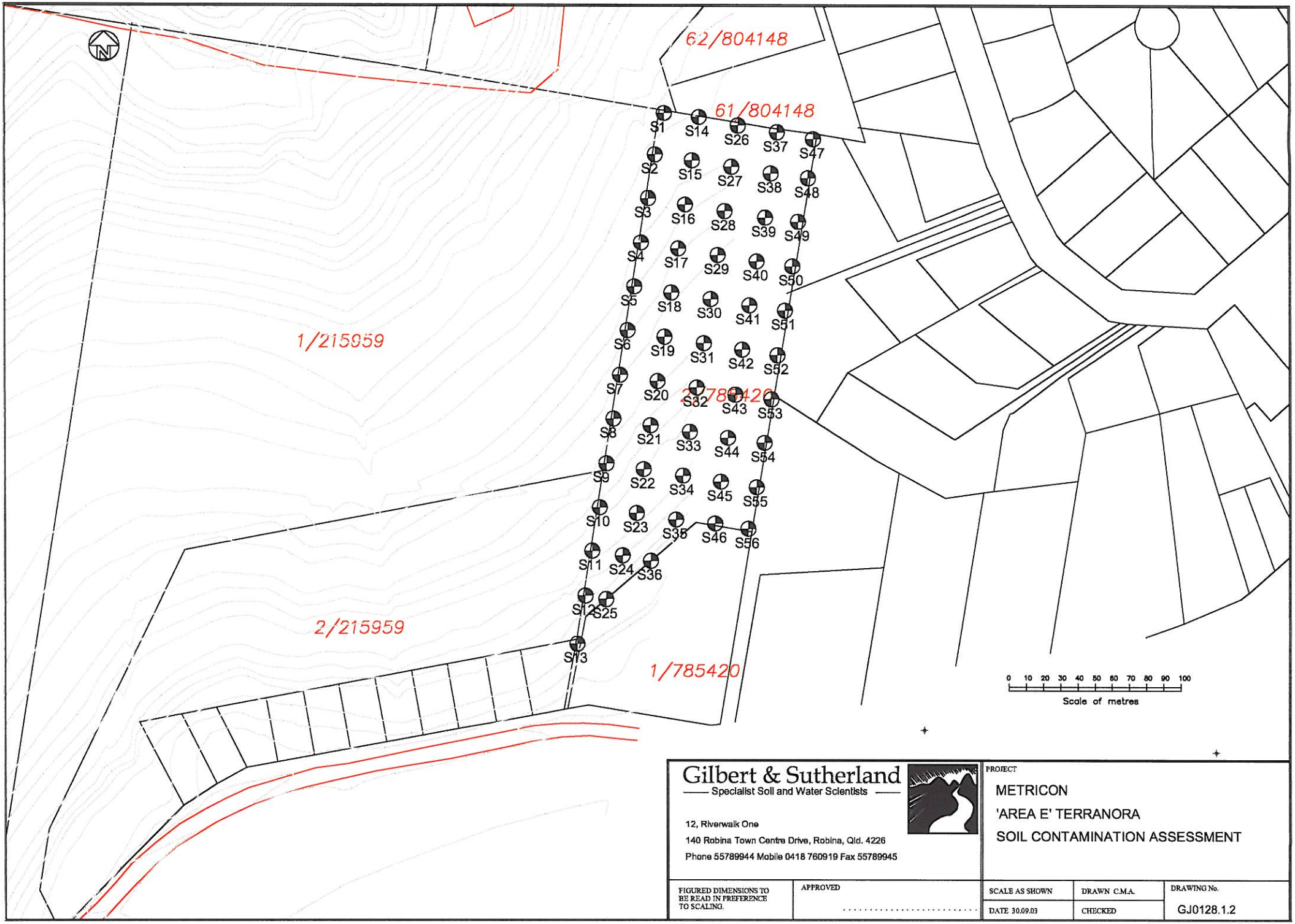
Summaries of the laboratory results for all properties investigated are shown in the sections below and the laboratory certificates are attached in Appendix B. Results exceeding the HIL' s are shown in bold type. This summary does not discuss the ALS results for detectable substances where HIL's were nonexistent (i.e. endosulfan).

6.2 Results for Lot 2 DP 785420 (Cartwright)

A summary of the analytical results for Lot 2 DP 785420 are shown in Table 6.2.1 below. The sample locations are shown on Drawing Number GJ0128.1.2.

Table 6.2.1. Summary of analytical results for Lot 2 DP 785420 (mg/kg).

Composite sample no.	Arsenic	Cadmium	Copper	Lead	Zinc	Mercury	Aldrin + Dieldrin	Chlordane	DDT+ DDD+ DDE
C1 (S1,S2,S3,S4)	23	<1	20	8	116	0.1	<0.1	<0.1	<0.3
C2 (S5,S6,S7,S8)	**34**	<1	22	8	113	0.1	<0.1	<0.1	<0.3
C3 (S9,S10,S11,S12)	**32**	<1	19	8	97	0.1	<0.1	<0.1	<0.3
C4 (S13,S14,S15,S16)	19	<1	22	7	116	0.1	<0.1	<0.1	<0.3
C5 (S17,S18,S19,S20)	8	<1	16	7	120	0.1	<0.1	<0.1	<0.3
C6 (S21,S22,S23,S24)	17	<1	18	8	87	0.1	<0.1	<0.1	<0.3
C7 (S25,S26,S27,S28)	5	<1	16	6	88	0.1	<0.1	<0.1	<0.3
C8 (S29,S30,S31,S32)	6	<1	20	8	102	0.2	<0.1	<0.1	<0.3
C9 (S33,S34,S35,S36)	20	<1	17	9	83	0.1	<0.1	<0.1	<0.3
C10 (S37,S38,S39,S40)	6	<1	26	7	118	0.1	<0.1	<0.1	<0.3
C11 (S41,S42,S43,S44)	3	<1	20	8	109	0.1	<0.1	<0.1	<0.3
C12 (S45,S46,S47,S48)	**28**	<1	23	9	142	0.1	<0.1	<0.1	<0.3
C13 (S49,S50,S51,S52)	**40**	<1	34	9	149	0.2	<0.1	<0.1	<0.3



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		DATE 30.09.03	CHECKED	GJ0128.1.2

Composite sample no.	Arsenic	Cadmium	Copper	Lead	Zinc	Mercury	Aldrin + Dieldrin	Chlordane	DDT+ DDD+ DDE
C14 (S53,S54,S55,S56)	**27**	<1	25	11	206	0.1	<0.1	<0.1	<0.3
Mean	19	<1	21	8	118	0.1	<0.1	<0.1	<0.3

Five (5) of the fourteen (14) composite samples (C2, C3, C12, C13 & C14) analysed exceeded the adjusted HIL of 25mg/kg for arsenic. The arsenic concentration of these composite samples was 34, 32, 28, 40 & 27 mg/kg respectively. The concentrations of lead, cadmium, copper, zinc, mercury and organochlorine compounds were below the adjusted HIL's within all fourteen (14) of the composite samples analysed.

The twenty (20) samples used to form composite samples C2, C3, C12, C13 & C14 were analysed for arsenic concentration. The analytical results for these samples are shown in Table 6.2.2 below.

Table 6.2.2. Arsenic results (mg/kg).

Sample no.	Arsenic	
	ALS Brisbane	ALS Newcastle
S5	37	32
S6	38	38
S7	34	32
S8	31	26
S9	29	24
S10	34	35
S11	39	32
S12	36	38
S45	3	4
S46	51	57
S47	61	69
S48	21	25
S49	18	19
S50	23	21
S51	24	33
S52	71	72
S53	41	44
S54	40	37
S55	13	18
S56	15	14
Mean	32.95	33.5

The concentration of arsenic was below the HIL of 100 mg/kg for all twenty (20) samples submitted to ALS Brisbane. To provide a check on the analytical proficiency of the Brisbane laboratory, twenty split samples representative of the samples analysed by ALS Brisbane, were forwarded to ALS Newcastle for analysis of arsenic. Similarly, the concentration of arsenic was below the HIL of 100 mg/kg for all twenty of the split samples analysed by ALS Newcastle.

Inferential testing was conducted to compare the results obtained by ALS Brisbane with those of ALS Newcastle across the distribution of results. A paired samples t-test confirmed that there was no significant difference (P= 0.964) between the distribution of results between the two laboratories, which demonstrates a satisfactory proficiency of the Brisbane laboratory.

6.3 Results for Lot 376 DP 755740 (Greber)

A summary of the analytical results for Lot 376 DP 755740 are shown in Table 6.3.1 below. The sample locations are shown on Drawing Number GJ0128.1.3.

Table 6.3.1. Summary of analytical results for Lot 376 DP 755740 (mg/kg).

Composite sample no.	Arsenic	Cadmium	Copper	Lead	Zinc	Mercury	Aldrin + Dieldrin	Chlordane	DDT + DDD + DDE
C1 (S1,S2,S3,S4)	7	<1	62	6	70	<0.1	<0.1	<0.1	<0.3
C2 (S5,S6,S7,S8)	6	<1	36	6	53	<0.1	<0.1	<0.1	<0.3
C3 (S9,S10,S11,S12)	7	<1	54	5	67	<0.1	<0.1	<0.1	<0.3
C4 (S13,S14,S15,S16)	9	<1	31	6	60	0.1	<0.1	<0.1	<0.3
C5 (S17,S18,S19,S20)	22	<1	62	7	72	0.1	<0.1	<0.1	<0.3
C6 (S21,S22,S23,S24)	14	<1	32	6	72	0.1	<0.1	<0.1	<0.3
C7 (S25,S26,S27,S28)	12	<1	35	10	88	0.1	<0.1	<0.1	<0.3
C8 (S29,S30,S31,S32)	14	<1	33	4	73	0.1	<0.1	<0.1	<0.3
C9 (S33,S34,S35,S36)	12	<1	47	8	92	0.1	<0.1	<0.1	<0.3
C10 (S37,S38,S39,S40)	19	<1	52	6	92	0.1	<0.1	<0.1	<0.3
C11 (S41,S42,S43,S44)	12	<1	40	7	86	0.1	<0.1	<0.1	<0.3
C12 (S45,S46,S47,S48)	18	<1	40	7	88	0.2	<0.1	<0.1	<0.3
Mean	13	<1	44	6	76	<0.1	<0.1	<0.1	<0.3

The concentrations of arsenic, cadmium, copper, lead, zinc, mercury and organochlorine compounds within all twelve (12) of the composite samples analysed, complied with the adjusted HIL's for each analyte.

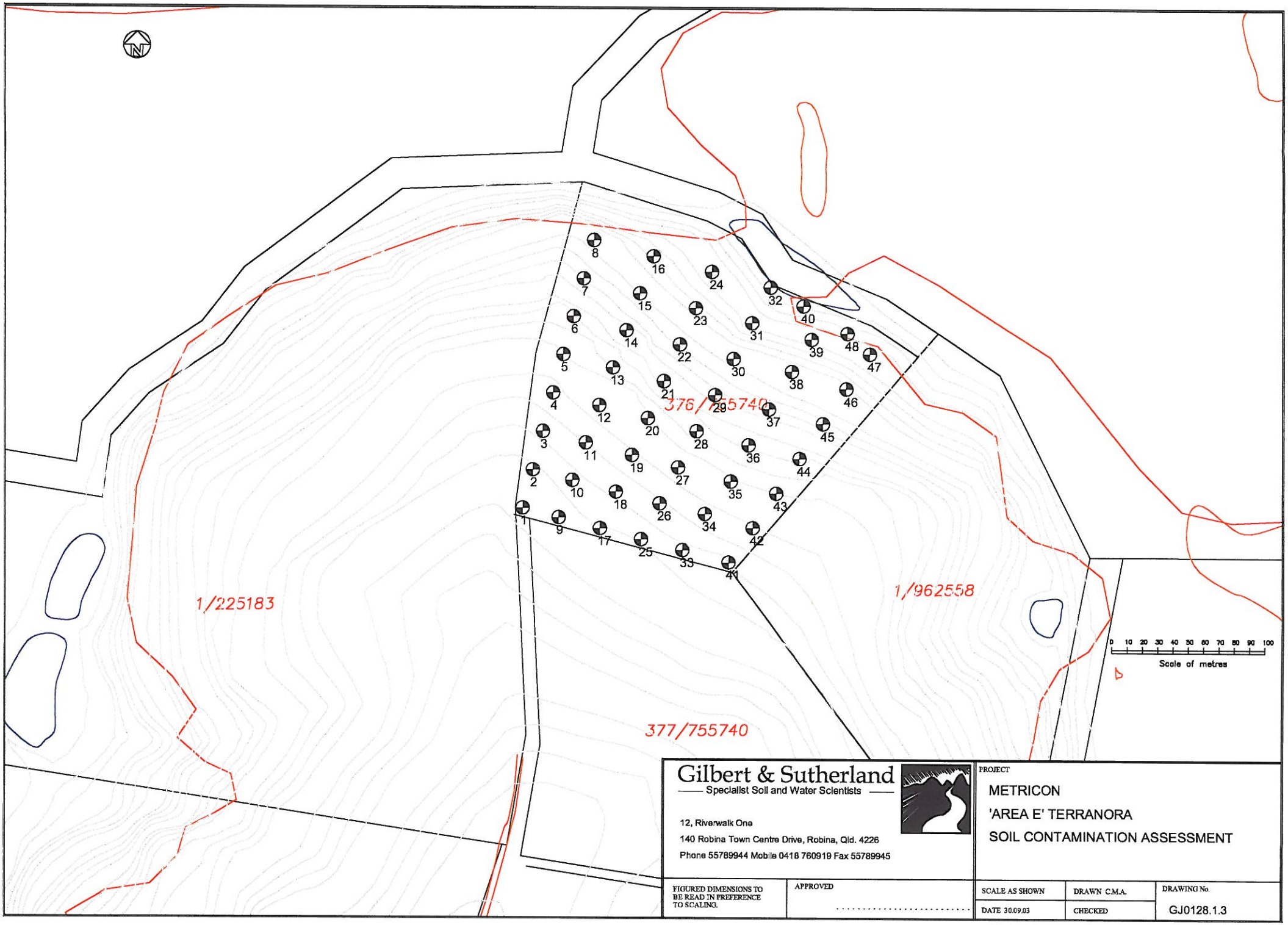
6.4 Results for Lot 377 DP 755740 (Greber)

A summary of the analytical results for Lot 377 DP 755740 are shown in Table 6.4.1 below. The sample locations are shown on Drawing Number GJ0128.1.4.

Table 6.4.1. Summary of analytical results for Lot 377 DP 755740 (mg/kg).

Composite sample no.	Arsenic	Cadmium	Copper	Lead	Zinc	Mercury	Aldrin+ Dieldrin	Chlordane	DDT + DDD + DDE
C1 (S1,S2,S3,S4)	5	<1	28	24	108	0.1	<0.1	<0.1	<0.3
C2 (S5,S6,S7,S8)	2	<1	34	7	75	0.1	<0.1	<0.1	<0.3
C3 (S9,S10,S11,S12)	4	<1	25	14	89	<0.1	<0.1	<0.1	<0.3
C4 (S13,S14,S15,S16)	3	<1	41	8	80	0.1	<0.1	<0.1	<0.3
C5 (S17,S18,S19,S20)	2	<1	29	8	76	0.1	<0.1	<0.1	<0.3
C6 (S21,S22,S23,S24)	4	<1	40	8	92	0.1	<0.1	<0.1	<0.3
C7 (S25,S26,S27,S28)	<1	<1	33	7	72	0.1	<0.1	<0.1	<0.3
C8 (S29,S30,S31,S32)	4	<1	32	7	75	<0.1	<0.1	<0.1	<0.3
C9 (S33,S34,S35,S36)	1	<1	54	8	79	0.1	<0.1	<0.1	<0.3
C10 (S37,S38,S39,S40)	4	<1	53	8	76	0.1	<0.1	<0.1	<0.3
C11 (S41,S42,S43,S44)	7	<1	47	8	69	0.1	<0.1	<0.1	<0.3
C12 (S45,S46,S47,S48)	4	<1	45	7	77	0.1	<0.1	<0.1	<0.3
Mean	<3	<1	38	10	81	<0.1	<0.1	<0.1	<0.3

The concentrations of arsenic, cadmium, copper, lead, zinc, mercury and organochlorine compounds within all twelve (12) of the composite samples analysed, complied with the adjusted HIL's for each analyte.



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