



Photo 7: Sample location SE070



Photo 8: Sample location SE103



Photo 9: Sample location BH107, west of boundary fence



Photo 10: Stockpile 4



Figure 11: 'Mercury Plug' MP001



Figure 12: 'Mercury Plug' MP002

Appendix C - Tables

Table C1: Soil and Stockpile Chemistry

				Inorganics	Metals										
				Moisture	Aluminium	Antimony	Arsenic	Cadmium	Chromium (III+VI)	Copper	Iron	Lead	Mercury	Nickel	Zinc
				%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL				1	50	5	5	1	2	5	50	5	0.1	2	5
NEPM 1999 EIL							20	3	1	100		600	1	60	200
NEPM 1999 HIL E							200	40	200	2000		600	30	600	14000
USEPA RES						310									
10 times HIL E/USEPA RES						3100	2000	400	2000	20,000		6000	300	6000	140,000
30 times HIL E/USEPA RES						9300	6000	1200	6000	60,000	0	18,000	900	18,000	420,000

Field_ID	LocCode	Sample Depth	Sampled Date												
BH007 0.0-0.1	BH007	0-0.1	11/12/2012	4.9	-	3140	1370	-	-	-	-	-	-	-	-
BH007 0.3-0.5	BH007	0.3-0.5	11/12/2012	8.6	-	37	21	-	-	-	-	-	-	-	-
BH085 0.0-0.1	BH085	0-0.1	10/12/2012	2.8	-	506	184	-	-	-	-	-	-	-	-
BH086 0.0 0.1	BH086	0.1	10/12/2012	3.3	-	767	171	-	-	-	-	-	-	-	-
BH087 0.0-0.1	BH087	0-0.1	10/12/2012	2.8	-	156	44	-	-	-	-	-	-	-	-
BH087 0.3-0.4	BH087	0.3-0.4	10/12/2012	3.4	-	75	20	-	-	-	-	-	-	-	-
BH102 0.0-0.1	BH102	0-0.1	11/12/2012	74.8	-	1830	30	-	-	-	-	-	-	-	-
BH102 0.3-0.5	BH102	0.3-0.5	11/12/2012	57.4	-	632	88	-	-	-	-	-	-	-	-
BH103 0.0-0.1	BH103	0-0.1	11/12/2012	59.4	3550	4120	343	<1	34	272	4440	40	4.2	<2	26
BH103 0.3-0.5	BH103	0.3-0.5	11/12/2012	24.6	6760	17	442	<1	38	161	131,000	31	8.4	<2	30
BH104 0.0-0.1	BH104	0-0.1	11/12/2012	14.6	-	169	24	-	-	-	-	-	-	-	-
BH104 0.3-0.5	BH104	0.3-0.5	11/12/2012	12.3	-	65	15	-	-	-	-	-	-	-	-
BH105 0.0-0.1	BH105	0-0.1	11/12/2012	40.7	8270	1190	279	<1	78	380	12,700	40	98.4	<2	27
BH105 0.3-0.5	BH105	0.3-0.5	11/12/2012	15.2	5970	134	18	<1	8	20	6430	11	22.2	3	32
BH106 0.0-0.1	BH106	0-0.1	11/12/2012	10.6	-	82	14	-	-	-	-	-	-	-	-
BH107 0.0-0.1	BH107	0-0.1	11/12/2012	13.2	-	60	23	-	-	-	-	-	-	-	-
BH107 0.2-0.3	BH107	0.2-0.3	11/12/2012	10.2	-	22	16	-	-	-	-	-	-	-	-
MP001A	Mercury Plug 1		11/12/2012	16.7	<50	39,100	956	<1	<2	8	970	<5	3800	<2	47
MP001B	Mercury Plug 1		11/12/2012	17.6	<50	41,900	521	<1	<2	<5	650	<5	5840	<2	32
MP002A	Mercury Plug 2		11/12/2012	10.4 - 11.2	<50	36,900	554	<1	<2	<5	590	<5	2440	<2	26
MP002B	Mercury Plug 2		11/12/2012	10.4 - 11.2	<50	41,000	1660	<1	<2	61	24,100	<5	4680	<2	99
SP004 0.0-0.1	Stockpile 4	0-0.1	10/12/2012	11.4	5350	565	241	<1	16	66	33,300	139	4.6	3	120
SP004 0.1-0.2	Stockpile 4	0.1-0.2	10/12/2012	7.2	5170	409	452	<1	11	77	19,200	50	4.1	4	143

Table C2: Sediment Chemistry

				Inorganics	Metals	
				Moisture	1M HCl Extractable Antimony	1M HCl Extractable Arsenic
				%	mg/kg	mg/kg
EQL				1	1	1
ANZECC (2000) Interim Sediment Quality Guidelines - High					25	70
ANZECC (2000) Interim Sediment Quality Guidelines - Low					2	20
10 times ANZECC (2000) Interim Sediment Quality Guidelines - High					250	700
30 times ANZECC (2000) Interim Sediment Quality Guidelines - High					750	2100

Field_ID	LocCode	Sample Depth	Sampled Date			
SE015_0.0-0.1	SE015	0-0.1	10/12/2012	76.8	211	20
SE023_0.0-0.1	SE023	0-0.1	10/12/2012	79.7	1590	96
SE023_0.1-0.25	SE023	0.1-0.25	10/12/2012	74.2	45.6	37.5
SE024_0.0-0.1	SE024	0-0.1	10/12/2012	76.7	95.2	29.1
SE034_0.0-0.15	SE034	0-0.15	10/12/2012	76.3	616	62.6
SE035_0.0-0.1	SE035	0-0.1	10/12/2012	79	1580	55.1
SE036_0.0-0.2	SE036	0-0.2	10/12/2012	85.8	413	23
SE044_0.0-0.05	SE044	0-0.05	10/12/2012	63.5	198	56.2
SE045_0.0-0.2	SE045	0-0.2	10/12/2012	75.7	240	17.8
SE069_0.0-0.15	SE069	0-0.15	10/12/2012	84.9	439	348
SE070_0.0-0.3	SE070	0-0.3	10/12/2012	74.4	394	27.9
SE071_0.0-0.15	SE071	0-0.15	10/12/2012	51.6	57.8	36.8
SE072_0.0-0.3	SE072	0-0.3	10/12/2012	85	682	25.8
SE103_0.05-0.1	SE103	0.05-0.1	10/12/2012	75.9	467	32.5
SE103_0.1-0.3	SE103	0.1-0.3	10/12/2012	43.1	87.6	3.5
SE104_0.0-0.1	SE104	0-0.1	10/12/2012	73.1	14.2	6.5

Table C3: QA/QC Results

SDG	ES1229225	ES1229225		ES1229225	ES1229225		ES1229225	ES1229225	
Field_ID	BH007_0.0-0.1	BHDUP 20	RPD	SE103_0.05-0.1	SEDUP 21	RPD	SE104_0.0-0.1	SEDUP 20	RPD
Sampled_Date-Time	11/12/2012	11/12/2012		10/12/2012	10/12/2012		10/12/2012	10/12/2012	

Chem_Group	ChemName	Units	EQL									
Inorganics	Moisture	%	1	4.9	6.2	23	75.9	80.0	5	73.1	70.6	3
Metals	Antimony	mg/kg	5	3140.0	3190.0	2						
	Antimony	mg/kg	1				467.0	1030.0	75	14.2	10.2	33
	Arsenic	mg/kg	5	1370.0	1420.0	4						
	Arsenic	mg/kg	1				32.5	40.6	22	6.5	2.0	106

*RPDs have only been considered where a concentration is greater than 1 times the EQL.

**High RPDs are in bold (Acceptable RPDs for each EQL multiplier range are: 50 (1-10 x EQL); 50 (10-30 x EQL); 50 (> 30 x EQL))

***Interlab Duplicates are matched on a per compound basis as methods vary between laboratories. Any methods in the row header relate to those used in the primary laboratory

Appendix D - Borelogs



BOREHOLE LOG

ENVIRONMENTAL - SOIL BORE

Bore No.: BH007

Page: 1 of 1

Client: NSW Catchment and Lands - Crown Land
Project: Urunga Antimony RAP
Project No.: 2216251
Location:
Date Drilled: 11/12/2012 to: 11/12/2012

Drill Co: GHD
Driller: BC
Rig Type: HA
Total Depth (m): 1
Diameter (mm): 50

Easting: 500858
Northing: 6625215
Grid Ref: GDA94_MGA_zone_56
Elevation: 0
Logged by: BC Checked by: BC

DRILLING						Moisture	Consistency	COMMENTS/ CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	Elevation / Depth (m)
Depth (m)	Drilling Method	PID (ppm)	Sample ID	Water	Graphic Log				
0.0	HA		BH007_0.0-0.1			D		BHDUP20	0.00
						M			-0.10
			BH007_0.3-0.5			M			-0.40
			BH007_0.5-0.7						0.40
			BH007_0.8-1.0						-1.00
1.0									1.00
2.0									
3.0									
4.0									

NOTES:

GHD Soil Classifications: The GHD Soil Classification is based on Australian Standards AS 1726-1993. This log is not intended for geotechnical purposes.

Drilling Abbreviations:

RW(x) Rotary Wash
RT(x) Rotary Triple Tube
PC(x) Percussion Cable Tool
PD(x) Percussion Down Hole
Where "x" is flushing medium: (W) Water, (M) Mud, (A) Air, (F) Foam.

PSC(x) Percussion Simultaneous Casing
AS Augering - Solid Flight
AH Augering - Hollow Flight
H Hand Augering

Moisture Abbreviations:

D Dry
M Moist
W Wet

Consistency:

Granular Soils
(VL) Very Loose (D) Dense
(L) Loose (VD) Very Dense
(MD) Medium Dense

Cohesive Soils
(VS) Very Soft
(S) Soft
(F) Firm

(ST) Stiff
(VST) Very Stiff
(H) Hard



BOREHOLE LOG

ENVIRONMENTAL - SOIL BORE

Bore No.: BH085

Page: 1 of 1

Client: NSW Catchment and Lands - Crown Land
Project: Urunga Antimony RAP
Project No.: 2216251
Location:
Date Drilled: 10/12/2012 to: 10/12/2012

Drill Co: GHD
Driller: BL
Rig Type: HA
Total Depth (m): 0.4
Diameter (mm): 50

Easting: 500907
Northing: 6625246
Grid Ref: GDA94_MGA_zone_56
Elevation: 0
Logged by: BL Checked by: BC

DRILLING					Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	Moisture	Consistency	COMMENTS/ CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	Elevation / Depth (m)
Depth (m)	Drilling Method	PID (ppm)	Sample ID	Water						
0.0	HA					Ground Surface:				0.00
			BH085_0.0-0.1			SAND Some gravel, trace silt, brown.	D		Trace roots.	0.00
						SILT Some sand, trace gravel, grey.	D			-0.10
			BH085_0.2-0.3							-0.40
										0.40
1.0										
2.0										
3.0										
4.0										

NOTES:

GHD Soil Classifications: The GHD Soil Classification is based on Australian Standards AS 1726-1993. This log is not intended for geotechnical purposes.

Drilling Abbreviations:				Moisture Abbreviations:	Consistency:	Cohesive Soils	
RW(x)	Rotary Wash	PSC(x)	Percussion Simultaneous Casing	D Dry	(VL) Very Loose	(D) Dense	(VS) Very Soft
RT(x)	Rotary Triple Tube	AS	Augering - Solid Flight	M Moist	(L) Loose	(VD) Very Dense	(ST) Stiff
PC(x)	Percussion Cable Tool	AH	Augering - Hollow Flight	W Wet	(MD) Medium Dense		(VST) Very Stiff
PD(x)	Percussion Down Hole	H	Hand Augering			(F) Firm	(H) Hard

Where "x" is flushing medium: (W) Water, (M) Mud, (A) Air, (F) Foam.

Drilling Abbreviations:			Moisture Abbreviations:	Consistency: Granular Soils	Cohesive Soils
RW(x)	Rotary Wash	PSC(x) Percussion Simultaneous Casing	D Dry	(VL) Very Loose	(VS) Very Soft
RT(x)	Rotary Triple Tube	AS Augering - Solid Flight	M Moist	(D) Dense	(ST) Stiff
PC(x)	Percussion Cable Tool	AH Augering - Hollow Flight	(L) Loose	(VD) Very Dense	(S) Soft
PD(x)	Percussion Down Hole	H Hand Augering	(MD) Medium Dense		(VST) Very Stiff
Where "x" is flushing medium: (W) Water, (M) Mud, (A) Air, (F) Foam.					(F) Firm
					(H) Hard



BOREHOLE LOG

ENVIRONMENTAL - SOIL BORE

Bore No.: BH087

Page: 1 of 1

Client: NSW Catchment and Lands - Crown Land
Project: Urunga Antimony RAP
Project No.: 2216251
Location:
Date Drilled: 10/12/2012 to: 10/12/2012

Drill Co: GHD
Driller: BL
Rig Type: HA
Total Depth (m): 0.7
Diameter (mm): 50

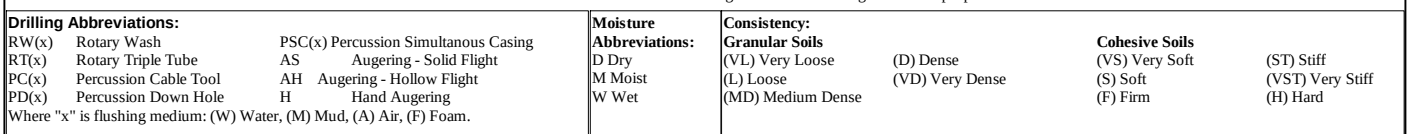
Easting: 500894
Northing: 6625217
Grid Ref: GDA94_MGA_zone_56
Elevation: 0
Logged by: BL Checked by: BC

DRILLING					Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	Moisture	Consistency	COMMENTS/ CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	Elevation / Depth (m)
Depth (m)	Drilling Method	PID (ppm)	Sample ID	Water						
0.0	HA		BH087_0.0-0.1			Ground Surface:				0.00
						SAND Some Gravel, trace silt, brown/white.	D			0.00
						SILT Some sand, trace gravel, brown.	D			-0.20 0.20
			BH087_0.3-0.4			silty CLAY Trace sand, orange.	M			-0.50 0.50
			BH087_0.5-0.6							-0.70 0.70
1.0										
2.0										
3.0										
4.0										

NOTES:

GHD Soil Classifications: The GHD Soil Classification is based on Australian Standards AS 1726-1993. This log is not intended for geotechnical purposes.

Drilling Abbreviations:				Moisture Abbreviations:	Consistency: Granular Soils	Cohesive Soils	
RW(x)	Rotary Wash	PSC(x)	Percussion Simultaneous Casing				
RT(x)	Rotary Triple Tube	AS	Augering - Solid Flight	D Dry	(VL) Very Loose	(D) Dense	(VS) Very Soft
PC(x)	Percussion Cable Tool	AH	Augering - Hollow Flight	M Moist	(L) Loose	(VD) Very Dense	(S) Soft
PD(x)	Percussion Down Hole	H	Hand Augering	W Wet	(MD) Medium Dense		(VST) Very Stiff
Where "x" is flushing medium: (W) Water, (M) Mud, (A) Air, (F) Foam.						(F) Firm	(H) Hard





BOREHOLE LOG

ENVIRONMENTAL - SOIL BORE

Bore No.: BH103

Page: 1 of 1

Client: NSW Catchment and Lands - Crown Land
Project: Urunga Antimony RAP
Project No.: 2216251
Location:
Date Drilled: 11/12/2012 to: 11/12/2012

Drill Co: GHD
Driller: BC
Rig Type: HA
Total Depth (m): 0.7
Diameter (mm): 50

Easting: 500828
Northing: 6625158
Grid Ref: GDA94_MGA_zone_56
Elevation: 0
Logged by: BC Checked by: BC

DRILLING						LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	Moisture	Consistency	COMMENTS/ CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	Elevation / Depth (m)
Depth (m)	Drilling Method	PID (ppm)	Sample ID	Water	Graphic Log					
0.0	HA		BH103_0.0-0.1			Ground Surface: SILT Dark brown.	M		Organic matter	0.00
						silty CLAY Grey/brown.	M			-0.10
			BH103_0.3-0.5			CLAY Trace silt, orange/white.	M			-0.30
			BH103_0.5-0.7							0.30
						Refusal on roots.				-0.70
1.0										0.70
2.0										
3.0										
4.0										

NOTES:

GHD Soil Classifications: The GHD Soil Classification is based on Australian Standards AS 1726-1993. This log is not intended for geotechnical purposes.

Drilling Abbreviations:				Moisture Abbreviations:		Consistency:		Cohesive Soils	
RW(x)	Rotary Wash	PSC(x)	Percussion Simultaneous Casing	D Dry	(VL) Very Loose	(D) Dense		(VS) Very Soft	(ST) Stiff
RT(x)	Rotary Triple Tube	AS	Augering - Solid Flight	M Moist	(L) Loose	(VD) Very Dense		(S) Soft	(VST) Very Stiff
PC(x)	Percussion Cable Tool	AH	Augering - Hollow Flight	W Wet	(MD) Medium Dense			(F) Firm	(H) Hard
PD(x)	Percussion Down Hole	H	Hand Augering						

Where "x" is flushing medium: (W) Water, (M) Mud, (A) Air, (F) Foam.



BOREHOLE LOG

ENVIRONMENTAL - SOIL BORE

Bore No.: BH104

Page: 1 of 1

Client: NSW Catchment and Lands - Crown Land
Project: Urunga Antimony RAP
Project No.: 2216251
Location:
Date Drilled: 11/12/2012 to: 11/12/2012

Drill Co: GHD
Driller: BC
Rig Type: HA
Total Depth (m): 0.5
Diameter (mm): 50

Easting: 500830
Northing: 6625194
Grid Ref: GDA94_MGA_zone_56
Elevation: 0
Logged by: BC Checked by: BC

DRILLING					Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	Moisture	Consistency	COMMENTS/ CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	Elevation / Depth (m)
Depth (m)	Drilling Method	PID (ppm)	Sample ID	Water						
0.0	HA		BH104_0.0-0.1			Ground Surface: SILT Trace gravel, trace clay, trace sand, brown.	D		Trace roots.	0.00
										0.00
			BH104_0.3-0.5							-0.50
						Refusal on roots.				0.50
1.0										
2.0										
3.0										
4.0										

NOTES:

GHD Soil Classifications: The GHD Soil Classification is based on Australian Standards AS 1726-1993. This log is not intended for geotechnical purposes.

Drilling Abbreviations:

RW(x) Rotary Wash
RT(x) Rotary Triple Tube
PC(x) Percussion Cable Tool
PD(x) Percussion Down Hole
Where "x" is flushing medium: (W) Water, (M) Mud, (A) Air, (F) Foam.

PSC(x) Percussion Simultaneous Casing
AS Augering - Solid Flight
AH Augering - Hollow Flight
H Hand Augering

Moisture Abbreviations:

D Dry
M Moist
W Wet

Consistency:

Granular Soils
(VL) Very Loose (D) Dense
(L) Loose (VD) Very Dense
(MD) Medium Dense

Cohesive Soils
(VS) Very Soft
(S) Soft
(F) Firm

(ST) Stiff
(VST) Very Stiff
(H) Hard



Bore No.: BH105

Page: 1 of 1

Client: NSW Catchment and Lands - Crown Land
Project: Urunga Antimony RAP
Project No.: 2216251
Location:
Date Drilled: 11/12/2012 to: 11/12/2012

Drill Co: GHD
Driller: BC
Rig Type: HA
Total Depth (m): 1
Diameter (mm): 50

Easting: 500828
 Northing: 6625152
 Grid Ref: GDA94_MGA_zone_56
 Elevation: 0
 Logged by: BC Checked by: BC

NOTES:

GHD Soil Classifications: The GHD Soil Classification is based on Australian Standards AS 1726-1993. This log is not intended for geotechnical purposes.

Drilling Abbreviations:		Moisture Abbreviations:		Consistency:		Granular Soils		Cohesive Soils	
RW(x)	Rotary Wash	PSC(x)	Percussion Simultaneous Casing	D Dry		(VL) Very Loose	(D) Dense	(VS) Very Soft	(ST) Stiff
RT(x)	Rotary Triple Tube	AS	Augering - Solid Flight	M Moist		(L) Loose	(VD) Very Dense	(S) Soft	(VST) Very Stiff
PC(x)	Percussion Cable Tool	AH	Augering - Hollow Flight	W Wet		(MD) Medium Dense		(F) Firm	(H) Hard
PD(x)	Percussion Down Hole	H	Hand Augering						
Where "x" is flushing medium: (W) Water, (M) Mud, (A) Air, (F) Foam.									



BOREHOLE LOG

ENVIRONMENTAL - SOIL BORE

Bore No.: BH106

Page: 1 of 1

Client: NSW Catchment and Lands - Crown Land
Project: Urunga Antimony RAP
Project No.: 2216251
Location:
Date Drilled: 11/12/2012 to: 11/12/2012

Drill Co: GHD
Driller: BC
Rig Type: HA
Total Depth (m): 0.5
Diameter (mm): 50

Easting: 500819
Northing: 6625186
Grid Ref: GDA94_MGA_zone_56
Elevation: 0
Logged by: BC Checked by: BC

DRILLING						Moisture	Consistency	COMMENTS/ CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	Elevation / Depth (m)
Depth (m)	Drilling Method	PID (ppm)	Sample ID	Water	Graphic Log				
0.0	HA		BH106_0.0-0.1			D			0.00
									0.00
									-0.30
			BH106_0.3-0.5						0.30
									-0.50
									0.50
1.0									
2.0									
3.0									
4.0									

NOTES:

GHD Soil Classifications: The GHD Soil Classification is based on Australian Standards AS 1726-1993. This log is not intended for geotechnical purposes.

Drilling Abbreviations:				Moisture Abbreviations:	Consistency: Granular Soils	Cohesive Soils	
RW(x)	Rotary Wash	PSC(x)	Percussion Simultaneous Casing				
RT(x)	Rotary Triple Tube	AS	Augering - Solid Flight	D Dry	(VL) Very Loose	(D) Dense	(VS) Very Soft
PC(x)	Percussion Cable Tool	AH	Augering - Hollow Flight	M Moist	(L) Loose	(VD) Very Dense	(S) Soft
PD(x)	Percussion Down Hole	H	Hand Augering	W Wet	(MD) Medium Dense	(F) Firm	(VST) Very Stiff
Where "x" is flushing medium: (W) Water, (M) Mud, (A) Air, (F) Foam.							(H) Hard



BOREHOLE LOG

ENVIRONMENTAL - SOIL BORE

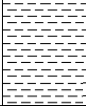
Bore No.: BH107

Page: 1 of 1

Client: NSW Catchment and Lands - Crown Land
Project: Urunga Antimony RAP
Project No.: 2216251
Location:
Date Drilled: 11/12/2012 to: 11/12/2012

Drill Co: GHD
Driller: BC
Rig Type: HA
Total Depth (m): 0.3
Diameter (mm): 50

Easting: 500823
Northing: 6625155
Grid Ref: GDA94_MGA_zone_56
Elevation: 0
Logged by: BC Checked by: BC

DRILLING					Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	Moisture	Consistency	COMMENTS/ CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	Elevation / Depth (m)
Depth (m)	Drilling Method	PID (ppm)	Sample ID	Water						
0.0	HA		BH107_0.0-0.1			Ground Surface:				0.00
						SILT Trace gravel, trace clay, trace sand, light brown.	D		Trace roots.	0.00
			BH107_0.2-0.3							-0.30
						Refusal on roots.				0.30
1.0										
2.0										
3.0										
4.0										

NOTES:

GHD Soil Classifications: The GHD Soil Classification is based on Australian Standards AS 1726-1993. This log is not intended for geotechnical purposes.

Drilling Abbreviations:

RW(x) Rotary Wash
RT(x) Rotary Triple Tube
PC(x) Percussion Cable Tool
PD(x) Percussion Down Hole
Where "x" is flushing medium: (W) Water, (M) Mud, (A) Air, (F) Foam.

PSC(x) Percussion Simultaneous Casing
AS Augering - Solid Flight
AH Augering - Hollow Flight
H Hand Augering

Moisture Abbreviations:

D Dry
M Moist
W Wet

Consistency:

Granular Soils
(VL) Very Loose (D) Dense
(L) Loose (VD) Very Dense
(MD) Medium Dense

Cohesive Soils
(VS) Very Soft
(S) Soft
(F) Firm

(ST) Stiff
(VST) Very Stiff
(H) Hard



BOREHOLE LOG

ENVIRONMENTAL - SOIL BORE

Bore No.: SE015

Page: 1 of 1

Client: NSW Catchment and Lands - Crown Land
Project: Urunga Antimony RAP
Project No.: 2216251
Location:
Date Drilled: 10/12/2012 to: 10/12/2012

Drill Co: GHD
Driller: BC
Rig Type: HA
Total Depth (m): 0.4
Diameter (mm): 50

Easting: 501017
Northing: 6625094
Grid Ref: GDA94_MGA_zone_56
Elevation: 0
Logged by: BC Checked by: BC

DRILLING					Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	Moisture	Consistency	COMMENTS/ CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	Elevation / Depth (m)
Depth (m)	Drilling Method	PID (ppm)	Sample ID	Water						
0.0	HA					Ground Surface:				0.00
			SE015_0.0-0.1			sandy SILT Brown.	W		Organic matter	0.00
			SE015_0.1-0.2			silty CLAY	W		Some organic matter	-0.10
			SE015_0.2-0.3			Trace sand, dark brown.	W			0.10
						CLAY	W			-0.20
						Trace silt, brown/grey.				0.20
						silty CLAY				-0.30
						Brown.				0.30
										-0.40
1.0										
2.0										
3.0										
4.0										

NOTES:

GHD Soil Classifications: The GHD Soil Classification is based on Australian Standards AS 1726-1993. This log is not intended for geotechnical purposes.

Drilling Abbreviations:				Moisture Abbreviations:	Consistency:	Cohesive Soils	
RW(x)	Rotary Wash	PSC(x)	Percussion Simultaneous Casing	D Dry	(VL) Very Loose	(D) Dense	(VS) Very Soft
RT(x)	Rotary Triple Tube	AS	Augering - Solid Flight	M Moist	(L) Loose	(VD) Very Dense	(ST) Stiff
PC(x)	Percussion Cable Tool	AH	Augering - Hollow Flight	W Wet	(MD) Medium Dense		(VST) Very Stiff
PD(x)	Percussion Down Hole	H	Hand Augering			(F) Firm	(H) Hard

Where "x" is flushing medium: (W) Water, (M) Mud, (A) Air, (F) Foam.



BOREHOLE LOG

ENVIRONMENTAL - SOIL BORE

Bore No.: SE023

Page: 1 of 1

Client: NSW Catchment and Lands - Crown Land
Project: Urunga Antimony RAP
Project No.: 2216251
Location:
Date Drilled: 10/12/2012 to: 10/12/2012

Drill Co: GHD
Driller: BC
Rig Type: HA
Total Depth (m): 0.7
Diameter (mm): 50

Easting: 500991
Northing: 6625137
Grid Ref: GDA94_MGA_zone_56
Elevation: 0
Logged by: BC Checked by: BC

DRILLING					Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	Moisture	Consistency	COMMENTS/ CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	Elevation / Depth (m)
Depth (m)	Drilling Method	PID (ppm)	Sample ID	Water						
0.0	HA					Ground Surface:				0.00
			SE023_0.0-0.1			sandy SILT Dark brown.	W		Organic matter	0.00
			SE023_0.1-0.25				W		Roots and organic matter.	
						silty CLAY Grey.	M			-0.25
			SE023_0.3-0.5			silty CLAY Dark brown.			Trace organic matter.	0.25
						CLAY Trace silt, brown.				-0.70
1.0										0.70
2.0										
3.0										
4.0										

NOTES:

GHD Soil Classifications: The GHD Soil Classification is based on Australian Standards AS 1726-1993. This log is not intended for geotechnical purposes.

Drilling Abbreviations:

RW(x) Rotary Wash
RT(x) Rotary Triple Tube
PC(x) Percussion Cable Tool
PD(x) Percussion Down Hole
Where "x" is flushing medium: (W) Water, (M) Mud, (A) Air, (F) Foam.

PSC(x) Percussion Simultaneous Casing
AS Augering - Solid Flight
AH Augering - Hollow Flight
H Hand Augering

Moisture Abbreviations:

D Dry
M Moist
W Wet

Consistency:

Granular Soils
(VL) Very Loose (D) Dense
(L) Loose (VD) Very Dense
(MD) Medium Dense

Cohesive Soils
(VS) Very Soft
(S) Soft
(F) Firm

(ST) Stiff
(VST) Very Stiff
(H) Hard

Drilling Abbreviations:			Moisture Abbreviations:	Consistency: Granular Soils	Cohesive Soils
RW(x)	Rotary Wash	PSC(x) Percussion Simultaneous Casing	D Dry	(D) Dense	(VS) Very Soft
RT(x)	Rotary Triple Tube	AS Augering - Solid Flight	M Moist	(L) Loose	(S) Soft
PC(x)	Percussion Cable Tool	AH Augering - Hollow Flight	W Wet	(VD) Very Dense	(VST) Very Stiff
PD(x)	Percussion Down Hole	H Hand Augering		(MD) Medium Dense	(F) Firm
Where "x" is flushing medium: (W) Water, (M) Mud, (A) Air, (F) Foam.					(H) Hard



BOREHOLE LOG

ENVIRONMENTAL - SOIL BORE

Bore No.: SE034

Page: 1 of 1

Client: NSW Catchment and Lands - Crown Land
Project: Urunga Antimony RAP
Project No.: 2216251
Location:
Date Drilled: 10/12/2012 to: 10/12/2012

Drill Co: GHD
Driller: BC
Rig Type: HA
Total Depth (m): 0.4
Diameter (mm): 50

Easting: 501011
Northing: 6625200
Grid Ref: GDA94_MGA_zone_56
Elevation: 0
Logged by: BC Checked by: BC

DRILLING						LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	Moisture	Consistency	COMMENTS/ CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	Elevation / Depth (m)
Depth (m)	Drilling Method	PID (ppm)	Sample ID	Water	Graphic Log					
0.0	HA					Ground Surface:				0.00
			SE034_0.0-0.15			silty CLAY Black.	W			0.00
			SE034_0.15-0.25			sandy CLAY Brown, fine grained sand.	W		Trace organic matter	0.15
			SE034_0.25-0.40			CLAY Mottled orange/grey/brown, firm.	M			-0.25
										-0.40
										0.40
1.0										
2.0										
3.0										
4.0										

NOTES:

GHD Soil Classifications: The GHD Soil Classification is based on Australian Standards AS 1726-1993. This log is not intended for geotechnical purposes.

Drilling Abbreviations:				Moisture Abbreviations:		Consistency:		Cohesive Soils	
RW(x)	Rotary Wash	PSC(x)	Percussion Simultaneous Casing	D Dry	(VL) Very Loose	(D) Dense	(VS) Very Soft	(ST) Stiff	
RT(x)	Rotary Triple Tube	AS	Augering - Solid Flight	M Moist	(L) Loose	(VD) Very Dense	(S) Soft	(VST) Very Stiff	
PC(x)	Percussion Cable Tool	AH	Augering - Hollow Flight	W Wet	(MD) Medium Dense		(F) Firm	(H) Hard	
PD(x)	Percussion Down Hole	H	Hand Augering						

Where "x" is flushing medium: (W) Water, (M) Mud, (A) Air, (F) Foam.



BOREHOLE LOG

ENVIRONMENTAL - SOIL BORE

Bore No.: SE035

Page: 1 of 1

Client: NSW Catchment and Lands - Crown Land
Project: Urunga Antimony RAP
Project No.: 2216251
Location:
Date Drilled: 10/12/2012 to: 10/12/2012

Drill Co: GHD
Driller: BC
Rig Type: HA
Total Depth (m): 0.5
Diameter (mm): 50

Easting: 501041
Northing: 6625167
Grid Ref: GDA94_MGA_zone_56
Elevation: 0
Logged by: BC Checked by: BC

DRILLING					Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	Moisture	Consistency	COMMENTS/ CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	Elevation / Depth (m)
Depth (m)	Drilling Method	PID (ppm)	Sample ID	Water						
0.0	HA		SE035_0.0-0.1			Ground Surface:				0.00
						sandy SILT Brown/grey.	W		Organic matter	0.00
							W		Some organic matter.	0.10
			SE035_0.15-0.25			silty CLAY Brown.	M		Trace organic matter.	-0.25
							M			0.25
			SE035_0.3-0.5			CLAY Brown/grey.				
						silty CLAY Dark brown.				-0.50
										0.50
1.0										
2.0										
3.0										
4.0										

NOTES:

GHD Soil Classifications: The GHD Soil Classification is based on Australian Standards AS 1726-1993. This log is not intended for geotechnical purposes.

Drilling Abbreviations:				Moisture Abbreviations:	Consistency: Granular Soils	Cohesive Soils	
RW(x)	Rotary Wash	PSC(x)	Percussion Simultaneous Casing				
RT(x)	Rotary Triple Tube	AS	Augering - Solid Flight	D Dry	(VL) Very Loose	(D) Dense	(ST) Stiff
PC(x)	Percussion Cable Tool	AH	Augering - Hollow Flight	M Moist	(L) Loose	(VD) Very Dense	(VST) Very Stiff
PD(x)	Percussion Down Hole	H	Hand Augering	W Wet	(MD) Medium Dense	(F) Firm	(H) Hard
Where "x" is flushing medium: (W) Water, (M) Mud, (A) Air, (F) Foam.							



BOREHOLE LOG

ENVIRONMENTAL - SOIL BORE

Bore No.: SE036

Page: 1 of 1

Client: NSW Catchment and Lands - Crown Land
Project: Urunga Antimony RAP
Project No.: 2216251
Location:
Date Drilled: 10/12/2012 to: 10/12/2012

Drill Co: GHD
Driller: BC
Rig Type: HA
Total Depth (m): 0.7
Diameter (mm): 50

Easting: 501082
Northing: 6625155
Grid Ref: GDA94_MGA_zone_56
Elevation: 0
Logged by: BC Checked by: BC

DRILLING						LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	Moisture	Consistency	COMMENTS/ CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	Elevation / Depth (m)
Depth (m)	Drilling Method	PID (ppm)	Sample ID	Water	Graphic Log					
0.0	HA					Ground Surface:				0.00
			SE036_0.0-0.2			sandy SILT Brown.	W		Organic matter.	0.00
			SE036_0.2-0.3			silty CLAY Brown.	W		Some organic matter	-0.20
			SE036_0.3-0.4			CLAY Trace silt, trace sand, brown/grey.	M		Trace organic matter	-0.30
						CLAY Trace silt, dark brown.	M			-0.40
										-0.70
										0.70
1.0										
2.0										
3.0										
4.0										

NOTES:

GHD Soil Classifications: The GHD Soil Classification is based on Australian Standards AS 1726-1993. This log is not intended for geotechnical purposes.

Drilling Abbreviations:

RW(x) Rotary Wash
RT(x) Rotary Triple Tube
PC(x) Percussion Cable Tool
PD(x) Percussion Down Hole
Where "x" is flushing medium: (W) Water, (M) Mud, (A) Air, (F) Foam.

PSC(x) Percussion Simultaneous Casing
AS Augering - Solid Flight
AH Augering - Hollow Flight
H Hand Augering

Moisture Abbreviations:

D Dry
M Moist
W Wet

Consistency:

Granular Soils
(VL) Very Loose (D) Dense
(L) Loose (VD) Very Dense
(MD) Medium Dense

Cohesive Soils
(VS) Very Soft
(S) Soft
(F) Firm

(ST) Stiff
(VST) Very Stiff
(H) Hard



BOREHOLE LOG

ENVIRONMENTAL - SOIL BORE

Bore No.: SE044

Page: 1 of 1

Client: NSW Catchment and Lands - Crown Land
Project: Urunga Antimony RAP
Project No.: 2216251
Location:
Date Drilled: 10/12/2012 to: 10/12/2012

Drill Co: GHD
Driller: BC
Rig Type: HA
Total Depth (m): 0.06
Diameter (mm): 50

Easting: 501068
Northing: 6625218
Grid Ref: GDA94_MGA_zone_56
Elevation: 0
Logged by: BC Checked by: BC

DRILLING						LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	Moisture	Consistency	COMMENTS/ CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	Elevation / Depth (m)
Depth (m)	Drilling Method	PID (ppm)	Sample ID	Water	Graphic Log					
0.0	HA		SE044_0.0-0.05			Ground Surface: silty CLAY Brown. CLAY Mottled orange/grey/brown, stiff.	W			0.00
1.0										
2.0										
3.0										
4.0										

NOTES:

GHD Soil Classifications: The GHD Soil Classification is based on Australian Standards AS 1726-1993. This log is not intended for geotechnical purposes.

Drilling Abbreviations:				Moisture Abbreviations:	Consistency:	Cohesive Soils	
RW(x)	Rotary Wash	PSC(x)	Percussion Simultaneous Casing	D Dry	(VL) Very Loose	(D) Dense	(VS) Very Soft
RT(x)	Rotary Triple Tube	AS	Augering - Solid Flight	M Moist	(L) Loose	(VD) Very Dense	(ST) Stiff
PC(x)	Percussion Cable Tool	AH	Augering - Hollow Flight	W Wet	(MD) Medium Dense		(VST) Very Stiff
PD(x)	Percussion Down Hole	H	Hand Augering			(F) Firm	(H) Hard

Where "x" is flushing medium: (W) Water, (M) Mud, (A) Air, (F) Foam.



BOREHOLE LOG

ENVIRONMENTAL - SOIL BORE

Bore No.: SE045

Page: 1 of 1

Client: NSW Catchment and Lands - Crown Land
Project: Urunga Antimony RAP
Project No.: 2216251
Location:
Date Drilled: 10/12/2012 to: 10/12/2012

Drill Co: GHD
Driller: BC
Rig Type: HA
Total Depth (m): 0.6
Diameter (mm): 50

Easting: 501097
Northing: 6625187
Grid Ref: GDA94_MGA_zone_56
Elevation: 0
Logged by: BC Checked by: BC

DRILLING					Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	Moisture	Consistency	COMMENTS/ CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	Elevation / Depth (m)
Depth (m)	Drilling Method	PID (ppm)	Sample ID	Water						
0.0	HA					Ground Surface:				0.00
			SE045_0.0-0.2			sandy SILT Brown.	W		Organic matter	0.00
						silty CLAY Trace sand, brown.	W		Trace organic matter	-0.20
			SE045_0.25-0.40			CLAY Trace silt, trace sand, grey/brown.	M		Trace organic matter	0.20
						silty CLAY Dark brown.			Some organic matter	-0.40
			SE045_0.4-0.6							0.40
										-0.60
										0.60
1.0										
2.0										
3.0										
4.0										

NOTES:

GHD Soil Classifications: The GHD Soil Classification is based on Australian Standards AS 1726-1993. This log is not intended for geotechnical purposes.

Drilling Abbreviations:

RW(x) Rotary Wash
RT(x) Rotary Triple Tube
PC(x) Percussion Cable Tool
PD(x) Percussion Down Hole
Where "x" is flushing medium: (W) Water, (M) Mud, (A) Air, (F) Foam.

PSC(x) Percussion Simultaneous Casing
AS Augering - Solid Flight
AH Augering - Hollow Flight
H Hand Augering

Moisture Abbreviations:

D Dry
M Moist
W Wet

Consistency:

Granular Soils
(VL) Very Loose (D) Dense
(L) Loose (VD) Very Dense
(MD) Medium Dense

Cohesive Soils
(VS) Very Soft
(S) Soft
(F) Firm

(ST) Stiff
(VST) Very Stiff
(H) Hard



BOREHOLE LOG

ENVIRONMENTAL - SOIL BORE

Bore No.: SE069

Page: 1 of 1

Client: NSW Catchment and Lands - Crown Land
Project: Urunga Antimony RAP
Project No.: 2216251
Location:
Date Drilled: 10/12/2012 to: 10/12/2012

Drill Co: GHD
Driller: BC
Rig Type: HA
Total Depth (m): 0.6
Diameter (mm): 50

Easting: 501101
Northing: 6625277
Grid Ref: GDA94_MGA_zone_56
Elevation: 0
Logged by: BC Checked by: BC

DRILLING						LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	Moisture	Consistency	COMMENTS/ CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	Elevation / Depth (m)
Depth (m)	Drilling Method	PID (ppm)	Sample ID	Water	Graphic Log					
0.0	HA					Ground Surface:				0.00
			SE069_0.0-0.15			sandy SILT Brown.	W		Organic matter	0.00
			SE069_0.15_0.3			silty CLAY Brown	W		Some organic matter.	-0.15
			SE069_0.3-0.4			CLAY	W			-0.30
						Some sand, trace silt, grey/brown. silty CLAY	W			0.30 -0.40 0.40
										-0.60 0.60
1.0										
2.0										
3.0										
4.0										

NOTES:

GHD Soil Classifications: The GHD Soil Classification is based on Australian Standards AS 1726-1993. This log is not intended for geotechnical purposes.

Drilling Abbreviations:

RW(x) Rotary Wash
RT(x) Rotary Triple Tube
PC(x) Percussion Cable Tool
PD(x) Percussion Down Hole
Where "x" is flushing medium: (W) Water, (M) Mud, (A) Air, (F) Foam.

PSC(x) Percussion Simultaneous Casing
AS Augering - Solid Flight
AH Augering - Hollow Flight
H Hand Augering

Moisture Abbreviations:

D Dry
M Moist
W Wet

Consistency:

Granular Soils
(VL) Very Loose (D) Dense
(L) Loose (VD) Very Dense
(MD) Medium Dense

Cohesive Soils
(VS) Very Soft
(S) Soft
(F) Firm

(ST) Stiff
(VST) Very Stiff
(H) Hard



BOREHOLE LOG

ENVIRONMENTAL - SOIL BORE

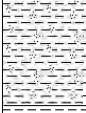
Bore No.: SE070

Page: 1 of 1

Client: NSW Catchment and Lands - Crown Land
Project: Urunga Antimony RAP
Project No.: 2216251
Location:
Date Drilled: 10/12/2012 to: 10/12/2012

Drill Co: GHD
Driller: BC
Rig Type: HA
Total Depth (m): 0.65
Diameter (mm): 50

Easting: 501117
Northing: 6625279
Grid Ref: GDA94_MGA_zone_56
Elevation: 0
Logged by: BC Checked by: BC

DRILLING					Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	Moisture	Consistency	COMMENTS/ CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	Elevation / Depth (m)
Depth (m)	Drilling Method	PID (ppm)	Sample ID	Water						
0.0	HA					Ground Surface:				0.00
			SE070_0.0-0.3			sandy SILT Brown.	W		Organic matter	0.00
			SE070_0.3-0.4			silty CLAY Brown.	W		Some organic matter	-0.30
			SE070_0.4-0.6			CLAY Trace silt, grey/brown Trace sand, brown.	M		Trace organic matter	0.40
										-0.50
										0.50
										-0.65
										0.65
1.0										
2.0										
3.0										
4.0										

NOTES:

GHD Soil Classifications: The GHD Soil Classification is based on Australian Standards AS 1726-1993. This log is not intended for geotechnical purposes.

Drilling Abbreviations:

RW(x) Rotary Wash
RT(x) Rotary Triple Tube
PC(x) Percussion Cable Tool
PD(x) Percussion Down Hole
Where "x" is flushing medium: (W) Water, (M) Mud, (A) Air, (F) Foam.

PSC(x) Percussion Simultaneous Casing
AS Augering - Solid Flight
AH Augering - Hollow Flight
H Hand Augering

Moisture Abbreviations:

D Dry
M Moist
W Wet

Consistency:

Granular Soils
(VL) Very Loose (D) Dense
(L) Loose (VD) Very Dense
(MD) Medium Dense

Cohesive Soils
(VS) Very Soft
(S) Soft
(F) Firm

(ST) Stiff
(VST) Very Stiff
(H) Hard



BOREHOLE LOG

ENVIRONMENTAL - SOIL BORE

Bore No.: SE071

Page: 1 of 1

Client: NSW Catchment and Lands - Crown Land
Project: Urunga Antimony RAP
Project No.: 2216251
Location:
Date Drilled: 10/12/2012 to: 10/12/2012

Drill Co: GHD
Driller: BC
Rig Type: HA
Total Depth (m): 0.4
Diameter (mm): 50

Easting: 501085
Northing: 6625265
Grid Ref: GDA94_MGA_zone_56
Elevation: 0
Logged by: BC Checked by: BC

DRILLING						LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	Moisture	Consistency	COMMENTS/ CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	Elevation / Depth (m)
Depth (m)	Drilling Method	PID (ppm)	Sample ID	Water	Graphic Log					
0.0	HA					Ground Surface:				0.00
			SE071_0.0-0.15			silty CLAY Dark brown.	W W			0.00
			SE071_0.15-0.3			CLAY Grey.			Trace organic matter	-0.15
						silty CLAY Brown.	W M			-0.30
						clayey SAND Grey.				0.30
						CLAY Mottled orange/grey/brown.				
1.0										
2.0										
3.0										
4.0										

NOTES:

GHD Soil Classifications: The GHD Soil Classification is based on Australian Standards AS 1726-1993. This log is not intended for geotechnical purposes.

Drilling Abbreviations:

RW(x) Rotary Wash
RT(x) Rotary Triple Tube
PC(x) Percussion Cable Tool
PD(x) Percussion Down Hole
Where "x" is flushing medium: (W) Water, (M) Mud, (A) Air, (F) Foam.

PSC(x) Percussion Simultaneous Casing
AS Augering - Solid Flight
AH Augering - Hollow Flight
H Hand Augering

Moisture Abbreviations:

D Dry
M Moist
W Wet

Consistency:

Granular Soils
(VL) Very Loose (D) Dense
(L) Loose (VD) Very Dense
(MD) Medium Dense

Cohesive Soils

(VS) Very Soft (ST) Stiff
(S) Soft (VST) Very Stiff
(F) Firm (H) Hard



BOREHOLE LOG

ENVIRONMENTAL - SOIL BORE

Bore No.: SE072

Page: 1 of 1

Client: NSW Catchment and Lands - Crown Land
Project: Urunga Antimony RAP
Project No.: 2216251
Location:
Date Drilled: 10/12/2012 to: 10/12/2012

Drill Co: GHD
Driller: BC
Rig Type: HA
Total Depth (m): 0.65
Diameter (mm): 50

Easting: 501100
Northing: 6625244
Grid Ref: GDA94_MGA_zone_56
Elevation: 0
Logged by: BC Checked by: BC

DRILLING						LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	Moisture	Consistency	COMMENTS/ CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	Elevation / Depth (m)
Depth (m)	Drilling Method	PID (ppm)	Sample ID	Water	Graphic Log					
0.0	HA					Ground Surface:				0.00
			SE072_0.0-0.3			sandy SILT Brown.	W		Organic matter	0.00
			SE072_0.3-0.4			silty CLAY Dark brown.	M		Trace organic matter	-0.30
			SE072_0.4-0.5			CLAY	M		Trace organic matter	-0.40
			SE072_0.5-0.65			Trace silt, grey/brown.	M/W		Some organic matter	-0.50
						silty CLAY Brown.				-0.65
										0.65
1.0										
2.0										
3.0										
4.0										

NOTES:

GHD Soil Classifications: The GHD Soil Classification is based on Australian Standards AS 1726-1993. This log is not intended for geotechnical purposes.

Drilling Abbreviations:				Moisture Abbreviations:	Consistency: Granular Soils	Cohesive Soils	
RW(x)	Rotary Wash	PSC(x)	Percussion Simultaneous Casing			(VS) Very Soft	(ST) Stiff
RT(x)	Rotary Triple Tube	AS	Augering - Solid Flight	D Dry	(VL) Very Loose	(D) Dense	(VST) Very Stiff
PC(x)	Percussion Cable Tool	AH	Augering - Hollow Flight	M Moist	(L) Loose	(VD) Very Dense	(H) Hard
PD(x)	Percussion Down Hole	H	Hand Augering	W Wet	(MD) Medium Dense	(F) Firm	

Where "x" is flushing medium: (W) Water, (M) Mud, (A) Air, (F) Foam.



BOREHOLE LOG

ENVIRONMENTAL - SOIL BORE

Bore No.: SE103

Page: 1 of 1

Client: NSW Catchment and Lands - Crown Land
Project: Urunga Antimony RAP
Project No.: 2216251
Location:
Date Drilled: 10/12/2012 to: 10/12/2012

Drill Co: GHD
Driller: BC
Rig Type: HA
Total Depth (m): 0.4
Diameter (mm): 50

Easting: 500858
Northing: 6625096
Grid Ref: GDA94_MGA_zone_56
Elevation: 0
Logged by: BC Checked by: BC

DRILLING						LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	Moisture	Consistency	COMMENTS/ CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	Elevation / Depth (m)
Depth (m)	Drilling Method	PID (ppm)	Sample ID	Water	Graphic Log					
0.0	HA					Ground Surface:				0.00
			SE103_0.05-0.1			sandy SILT Brown.	W		Organic matter	0.00
			SE103_0.1-0.3			CLAY Trace silt, brown	W		SEDUP21, trace organic matter. Some organic matter	
						Dark brown.				-0.30
										0.30
1.0										
2.0										
3.0										
4.0										

NOTES:

GHD Soil Classifications: The GHD Soil Classification is based on Australian Standards AS 1726-1993. This log is not intended for geotechnical purposes.

Drilling Abbreviations:				Moisture Abbreviations:	Consistency:	Cohesive Soils	
RW(x)	Rotary Wash	PSC(x)	Percussion Simultaneous Casing	D Dry	(VL) Very Loose	(D) Dense	(VS) Very Soft
RT(x)	Rotary Triple Tube	AS	Augering - Solid Flight	M Moist	(L) Loose	(VD) Very Dense	(ST) Stiff
PC(x)	Percussion Cable Tool	AH	Augering - Hollow Flight	W Wet	(MD) Medium Dense		(VST) Very Stiff
PD(x)	Percussion Down Hole	H	Hand Augering			(F) Firm	(H) Hard

Where "x" is flushing medium: (W) Water, (M) Mud, (A) Air, (F) Foam.



BOREHOLE LOG

ENVIRONMENTAL - SOIL BORE

Bore No.: SE104

Page: 1 of 1

Client: NSW Catchment and Lands - Crown Land
Project: Urunga Antimony RAP
Project No.: 2216251
Location:
Date Drilled: 10/12/2012 to: 10/12/2012

Drill Co: GHD
Driller: BC
Rig Type: HA
Total Depth (m): 0.4
Diameter (mm): 50

Easting: 500795
Northing: 6625090
Grid Ref: GDA94_MGA_zone_56
Elevation: 0
Logged by: BC Checked by: BC

DRILLING					Graphic Log	LITHOLOGICAL DESCRIPTION Soil Type (Classification Group Symbol); Particle Size; Colour; Secondary / Minor Components.	Moisture	Consistency	COMMENTS/ CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	Elevation / Depth (m)
Depth (m)	Drilling Method	PID (ppm)	Sample ID	Water						
0.0	HA		SE104_0.0-0.1			Ground Surface:				0.00
						sandy SILT Brown.	W		SEDUP20, Organic matter	0.00
						W				
						W				
			SE104_0.2-0.3			silty CLAY Brown.				-0.20
						CLAY Trace silt, grey/brown.			Trace organic matter.	0.20
						Dark Brown				-0.30
						CLAY				0.30
										-0.40
										0.40
1.0										
2.0										
3.0										
4.0										

NOTES:

GHD Soil Classifications: The GHD Soil Classification is based on Australian Standards AS 1726-1993. This log is not intended for geotechnical purposes.

Drilling Abbreviations:				Moisture Abbreviations:	Consistency: Granular Soils	Cohesive Soils	
RW(x)	Rotary Wash	PSC(x)	Percussion Simultaneous Casing				
RT(x)	Rotary Triple Tube	AS	Augering - Solid Flight	D Dry	(VL) Very Loose	(D) Dense	(ST) Stiff
PC(x)	Percussion Cable Tool	AH	Augering - Hollow Flight	M Moist	(L) Loose	(VD) Very Dense	(VST) Very Stiff
PD(x)	Percussion Down Hole	H	Hand Augering	W Wet	(MD) Medium Dense	(F) Firm	(H) Hard
Where "x" is flushing medium: (W) Water, (M) Mud, (A) Air, (F) Foam.							

Appendix E - Laboratory Reports

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: ES1229225	Page	: 1 of 11
Amendment	: 1		
Client	: GHD PTY LTD	Laboratory	: Environmental Division Sydney
Contact	: MR BEN LUFFMAN	Contact	: Angelene Kumar
Address	: 230 HARBOUR DRIVE PO Box 1340 COFFS HARBOUR NSW, AUSTRALIA 2450	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: ben_luffman@ghd.com	E-mail	: angelene.kumar@alsglobal.com
Telephone	: +61 02 6650 5600	Telephone	: +61 2 8784 8555
Facsimile	: +61 02 6652 6021	Facsimile	: +61 2 8784 8555
Project	: 2216251	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 12-DEC-2012
Sampler	: B CORK	Issue Date	: 08-JAN-2013
Site	: ----		
Quote number	: SY/270/12	No. of samples received	: 73
		No. of samples analysed	: 42

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results



NATA Accredited Laboratory 825

Accredited for compliance with
ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	Position	Accreditation Category
Evie.Sidarta	Inorganic Chemist	Sydney Inorganics
Raymond Commodor	Instrument Chemist	Sydney Inorganics
Shobhna Chandra	Metals Coordinator	Sydney Inorganics
Wisam Marassa	Inorganics Coordinator	Sydney Inorganics



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting

- **EG005: Poor precision was obtained for Antimony on sample ES1229225#19 due to sample heterogeneity. Results have been confirmed by re-extraction and reanalysis.**
- **EG005: Poor precision was obtained for Zinc and Lead on sample ES1229375#45 due to sample heterogeneity. Results have been confirmed by re-extraction and reanalysis**
- **EG005-SDH: Poor precision was obtained for Antimony and Arsenic on sample ES1229225#29 due to sample heterogeneity.**
- **EG005T: Poor precision and poor spike recovery was obtained for some elements on sample ES229225 #39 due to sample heterogeneity. Results have been confirmed by re-extraction and reanalysis**



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

				BH007_0.0-0.1	BH007_0.3-0.5	BH087_0.0-0.1	BH087_0.3-0.4	BH086_0.0_0.1
Client sampling date / time				11-DEC-2012 15:00	11-DEC-2012 15:00	10-DEC-2012 15:00	10-DEC-2012 15:00	10-DEC-2012 15:00
Compound	CAS Number	LOR	Unit	ES1229225-001	ES1229225-002	ES1229225-003	ES1229225-004	ES1229225-005
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	4.9	8.6	2.8	3.4	3.3
EG005T: Total Metals by ICP-AES								
Antimony	7440-36-0	5	mg/kg	3140	37	156	75	767
Arsenic	7440-38-2	5	mg/kg	1370	21	44	20	171



Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Client sample ID

Client sampling date / time

				BH085_0.0-0.1	BH102_0.0-0.1	BH102_0.3-0.5	BHDUP 20	BH103_0.0-0.1
				10-DEC-2012 15:00	11-DEC-2012 15:00	11-DEC-2012 15:00	11-DEC-2012 15:00	11-DEC-2012 15:00
Compound	CAS Number	LOR	Unit	ES1229225-006	ES1229225-007	ES1229225-008	ES1229225-009	ES1229225-010
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	2.8	74.8	57.4	6.2	59.4
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	----	----	----	----	3550
Antimony	7440-36-0	5	mg/kg	506	1830	632	3190	4120
Arsenic	7440-38-2	5	mg/kg	184	30	88	1420	----
Iron	7439-89-6	50	mg/kg	----	----	----	----	4440
Arsenic	7440-38-2	5	mg/kg	----	----	----	----	343
Cadmium	7440-43-9	1	mg/kg	----	----	----	----	<1
Chromium	7440-47-3	2	mg/kg	----	----	----	----	34
Copper	7440-50-8	5	mg/kg	----	----	----	----	272
Lead	7439-92-1	5	mg/kg	----	----	----	----	40
Nickel	7440-02-0	2	mg/kg	----	----	----	----	<2
Zinc	7440-66-6	5	mg/kg	----	----	----	----	26
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	----	----	----	----	4.2



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

Client sampling date / time

				BH103_0.3-0.5	BH104_0.0-0.1	BH104_0.3-0.5	BH105_0.0-0.1	BH105_0.3-0.5
				11-DEC-2012 15:00	11-DEC-2012 15:00	11-DEC-2012 15:00	11-DEC-2012 15:00	11-DEC-2012 15:00
Compound	CAS Number	LOR	Unit	ES1229225-011	ES1229225-012	ES1229225-013	ES1229225-014	ES1229225-015
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	24.6	14.6	12.3	40.7	15.2
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	6760	----	----	8270	5970
Antimony	7440-36-0	5	mg/kg	17	169	65	1190	134
Arsenic	7440-38-2	5	mg/kg	----	24	15	----	----
Iron	7439-89-6	50	mg/kg	131000	----	----	12700	6430
Arsenic	7440-38-2	5	mg/kg	442	----	----	279	18
Cadmium	7440-43-9	1	mg/kg	<1	----	----	<1	<1
Chromium	7440-47-3	2	mg/kg	38	----	----	78	8
Copper	7440-50-8	5	mg/kg	161	----	----	380	20
Lead	7439-92-1	5	mg/kg	31	----	----	40	11
Nickel	7440-02-0	2	mg/kg	<2	----	----	<2	3
Zinc	7440-66-6	5	mg/kg	30	----	----	27	32
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	8.4	----	----	98.4	22.2



Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Client sample ID

Client sampling date / time

				BH106_0.0-0.1	BH107_0.0-0.1	BH107_0.2-0.3	SE015_0.0-0.1	SE023_0.0-0.1
				11-DEC-2012 15:00	11-DEC-2012 15:00	11-DEC-2012 15:00	10-DEC-2012 15:00	10-DEC-2012 15:00
Compound	CAS Number	LOR	Unit	ES1229225-016	ES1229225-017	ES1229225-018	ES1229225-019	ES1229225-020
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	10.6	13.2	10.2	76.8	79.7
EG005-SDH: 1M HCl-Extractable Metals by ICPAES								
Antimony	7440-36-0	1.0	mg/kg	----	----	----	211	1590
Arsenic	7440-38-2	1.0	mg/kg	----	----	----	20.0	96.0
EG005T: Total Metals by ICP-AES								
Antimony	7440-36-0	5	mg/kg	82	60	22	----	----
Arsenic	7440-38-2	5	mg/kg	14	23	16	----	----



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

Client sampling date / time

				SE023_0.1-0.25	SE024_0.0-0.1	SE034_0.0-0.15	SE035_0.0-0.1	SE036_0.0-0.2
				10-DEC-2012 15:00	10-DEC-2012 15:00	10-DEC-2012 15:00	10-DEC-2012 15:00	10-DEC-2012 15:00
Compound	CAS Number	LOR	Unit	ES1229225-021	ES1229225-022	ES1229225-023	ES1229225-024	ES1229225-025
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	74.2	76.7	76.3	79.0	85.8
EG005-SDH: 1M HCl-Extractable Metals by ICPAES								
Antimony	7440-36-0	1.0	mg/kg	45.6	95.2	616	1580	413
Arsenic	7440-38-2	1.0	mg/kg	37.5	29.1	62.6	55.1	23.0



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

Client sampling date / time

				SE044_0.0-0.05	SE045_0.0-0.2	SE069_0.0-0.15	SE070_0.0-0.3	SE071_0.0-0.15
				10-DEC-2012 15:00	10-DEC-2012 15:00	10-DEC-2012 15:00	10-DEC-2012 15:00	10-DEC-2012 15:00
Compound	CAS Number	LOR	Unit	ES1229225-026	ES1229225-027	ES1229225-028	ES1229225-029	ES1229225-030
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	63.5	75.7	84.9	74.4	51.6
EG005-SDH: 1M HCl-Extractable Metals by ICPAES								
Antimony	7440-36-0	1.0	mg/kg	198	240	439	394	57.8
Arsenic	7440-38-2	1.0	mg/kg	56.2	17.8	348	27.9	36.8



Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Client sample ID

				SE072_0.0-0.3	SE103_0.05-0.1	SEDUP 21	SE103_0.1-0.3	SE104_0.0-0.1
Client sampling date / time				10-DEC-2012 15:00	10-DEC-2012 15:00	10-DEC-2012 15:00	10-DEC-2012 15:00	10-DEC-2012 15:00
Compound	CAS Number	LOR	Unit	ES1229225-031	ES1229225-032	ES1229225-033	ES1229225-034	ES1229225-035
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	85.0	75.9	80.0	43.1	73.1
EG005-SDH: 1M HCl-Extractable Metals by ICPAES								
Antimony	7440-36-0	1.0	mg/kg	682	467	1030	87.6	14.2
Arsenic	7440-38-2	1.0	mg/kg	25.8	32.5	40.6	3.5	6.5



Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Client sample ID

Client sampling date / time

				SEDUP 20	SP004_0.0-0.1	SP004_0.1-0.2	MP001A	MP002B
				10-DEC-2012 15:00	10-DEC-2012 15:00	10-DEC-2012 15:00	11-DEC-2012 15:00	11-DEC-2012 15:00
Compound	CAS Number	LOR	Unit	ES1229225-036	ES1229225-037	ES1229225-038	ES1229225-039	ES1229225-040
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	70.6	11.4	7.2	16.7	11.2
EG005-SDH: 1M HCl-Extractable Metals by ICPAES								
Antimony	7440-36-0	1.0	mg/kg	10.2	----	----	----	----
Arsenic	7440-38-2	1.0	mg/kg	2.0	----	----	----	----
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	----	5350	5170	<50	<50
Antimony	7440-36-0	5	mg/kg	----	565	409	39100	36900
Iron	7439-89-6	50	mg/kg	----	33300	19200	970	24100
Arsenic	7440-38-2	5	mg/kg	----	241	452	956	1660
Cadmium	7440-43-9	1	mg/kg	----	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	----	16	11	<2	<2
Copper	7440-50-8	5	mg/kg	----	66	77	8	61
Lead	7439-92-1	5	mg/kg	----	139	50	<5	<5
Nickel	7440-02-0	2	mg/kg	----	3	4	<2	<2
Zinc	7440-66-6	5	mg/kg	----	120	143	47	99
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	----	4.6	4.1	3800	2440



Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Client sample ID

Client sampling date / time

				MP001B	MP002B	----	----	----
				11-DEC-2012 15:00	11-DEC-2012 15:00	----	----	----
Compound	CAS Number	LOR	Unit	ES1229225-072	ES1229225-073	----	----	----
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	17.6	10.4	----	----	----
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	<50	<50	----	----	----
Antimony	7440-36-0	5	mg/kg	41900	41000	----	----	----
Iron	7439-89-6	50	mg/kg	650	590	----	----	----
Arsenic	7440-38-2	5	mg/kg	521	554	----	----	----
Cadmium	7440-43-9	1	mg/kg	<1	<1	----	----	----
Chromium	7440-47-3	2	mg/kg	<2	<2	----	----	----
Copper	7440-50-8	5	mg/kg	<5	<5	----	----	----
Lead	7439-92-1	5	mg/kg	<5	<5	----	----	----
Nickel	7440-02-0	2	mg/kg	<2	<2	----	----	----
Zinc	7440-66-6	5	mg/kg	32	26	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	5840	4680	----	----	----

Environmental Division

INTERPRETIVE QUALITY CONTROL REPORT

Work Order	: ES1229225	Page	: 1 of 6
Amendment	: 1		
Client	: GHD PTY LTD	Laboratory	: Environmental Division Sydney
Contact	: MR BEN LUFFMAN	Contact	: Angelene Kumar
Address	: 230 HARBOUR DRIVE PO Box 1340 COFFS HARBOUR NSW, AUSTRALIA 2450	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: ben_luffman@ghd.com	E-mail	: angelene.kumar@alsglobal.com
Telephone	: +61 02 6650 5600	Telephone	: +61 2 8784 8555
Facsimile	: +61 02 6652 6021	Facsimile	: +61 2 8784 8555
Project	: 2216251	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: ----		
C-O-C number	: ----	Date Samples Received	: 12-DEC-2012
Sampler	: B CORK	Issue Date	: 08-JAN-2013
Order number	: ----		
Quote number	: SY/270/12	No. of samples received	: 73
		No. of samples analysed	: 42

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Interpretive Quality Control Report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Parameter Frequency Compliance
- Brief Method Summaries
- Summary of Outliers

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extraction or analysis and precludes subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the analysis aliquot was taken. Elapsed period to analysis represents number of days from sampling where no extraction / digestion is involved or period from extraction / digestion where this is present. For composite samples, sampling date is assumed to be that of the oldest sample contributing to the composite. Sample date for laboratory produced leachates is assumed as the completion date of the leaching process. Outliers for holding time are based on USEPA SW 846, APHA, AS and NEPM (1999). A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL** Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis			
Container / Client Sample ID(s)		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
EA055: Moisture Content								
Soil Glass Jar - Unpreserved (EA055-103) BH087_0.0-0.1, BH086_0.0_0.1, SE015_0.0-0.1, SE023_0.1-0.25, SE034_0.0-0.15, SE036_0.0-0.2, SE045_0.0-0.2, SE070_0.0-0.3, SE072_0.0-0.3, SEDUP 21, SE104_0.0-0.1, SP004_0.0-0.1, BH087_0.3-0.4, BH085_0.0-0.1, SE023_0.0-0.1, SE024_0.0-0.1, SE035_0.0-0.1, SE044_0.0-0.05, SE069_0.0-0.15, SE071_0.0-0.15, SE103_0.05-0.1, SE103_0.1-0.3, SEDUP 20, SP004_0.1-0.2	10-DEC-2012	----	----	----	17-DEC-2012	24-DEC-2012	✓	
Soil Glass Jar - Unpreserved (EA055-103) BH007_0.0-0.1, BH102_0.0-0.1, BHDUP 20, BH103_0.3-0.5, BH104_0.3-0.5, BH105_0.3-0.5, BH107_0.0-0.1, MP001A, MP001B, BH007_0.3-0.5, BH102_0.3-0.5, BH103_0.0-0.1, BH104_0.0-0.1, BH105_0.0-0.1, BH106_0.0-0.1, BH107_0.2-0.3, MP002B, MP002B	11-DEC-2012	----	----	----	17-DEC-2012	25-DEC-2012	✓	



Matrix: **SOIL**

Evaluation: * = Holding time breach ; ✓ = Within holding time.

Method		Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG005-SDH: 1M HCl-Extractable Metals by ICPAES								
Soil Glass Jar - Unpreserved (EG005-SDH)		10-DEC-2012	17-DEC-2012	08-JUN-2013	✓	18-DEC-2012	08-JUN-2013	✓
SE015_0.0-0.1, SE023_0.1-0.25, SE034_0.0-0.15, SE036_0.0-0.2, SE045_0.0-0.2, SE070_0.0-0.3, SE072_0.0-0.3, SEDUP 21, SEDUP 20, SE104_0.0-0.1	SE023_0.0-0.1, SE024_0.0-0.1, SE035_0.0-0.1, SE044_0.0-0.05, SE069_0.0-0.15, SE071_0.0-0.15, SE103_0.05-0.1, SE103_0.1-0.3,							
EG005T: Total Metals by ICP-AES								
Soil Glass Jar - Unpreserved (EG005T)		10-DEC-2012	15-DEC-2012	08-JUN-2013	✓	17-DEC-2012	08-JUN-2013	✓
BH087_0.0-0.1, BH086_0.0_0.1, SP004_0.0-0.1,	BH087_0.3-0.4, BH085_0.0-0.1, SP004_0.1-0.2							
Soil Glass Jar - Unpreserved (EG005T)		11-DEC-2012	15-DEC-2012	09-JUN-2013	✓	17-DEC-2012	09-JUN-2013	✓
BH007_0.0-0.1, BH102_0.0-0.1, BHDUP 20, BH103_0.3-0.5, BH104_0.3-0.5, BH105_0.3-0.5, BH107_0.0-0.1, MP001A, MP001B,	BH007_0.3-0.5, BH102_0.3-0.5, BH103_0.0-0.1, BH104_0.0-0.1, BH105_0.0-0.1, BH106_0.0-0.1, BH107_0.2-0.3, MP002B, MP002B							
EG035T: Total Recoverable Mercury by FIMS								
Soil Glass Jar - Unpreserved (EG035T)		10-DEC-2012	15-DEC-2012	07-JAN-2013	✓	17-DEC-2012	07-JAN-2013	✓
SP004_0.0-0.1,	SP004_0.1-0.2							
Soil Glass Jar - Unpreserved (EG035T)		11-DEC-2012	15-DEC-2012	08-JAN-2013	✓	17-DEC-2012	08-JAN-2013	✓
BH103_0.0-0.1, BH105_0.0-0.1, MP001A, MP001B,	BH103_0.3-0.5, BH105_0.3-0.5, MP002B, MP002B							



Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(where) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: ✖ = Quality Control frequency not within specification ; ✔ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	Method	QC	Regular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
1M HCl Extractable Metals	EG005-SDH	2	18	11.1	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Moisture Content	EA055-103	6	57	10.5	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Mercury by FIMS	EG035T	2	20	10.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	4	39	10.3	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Laboratory Control Samples (LCS)							
1M HCl Extractable Metals	EG005-SDH	1	18	5.6	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Mercury by FIMS	EG035T	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	2	39	5.1	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
1M HCl Extractable Metals	EG005-SDH	1	18	5.6	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Mercury by FIMS	EG035T	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	2	39	5.1	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Matrix Spikes (MS)							
Total Mercury by FIMS	EG035T	1	20	5.0	5.0	✓	ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	2	39	5.1	5.0	✓	ALS QCS3 requirement



Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Moisture Content	EA055-103	SOIL	A gravimetric procedure based on weight loss over a 12 hour drying period at 103-105 degrees C. This method is compliant with NEPM (2010 Draft) Schedule B(3) Section 7.1 and Table 1 (14 day holding time).
1M HCl Extractable Metals	EG005-SDH	SOIL	APHA 21st ed., 3120; USEPA SW 846 - 6010. Metals are determined via ICPAES following weak acid extraction. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM (1999) Schedule B(3). LORs per NAGD.
Total Metals by ICP-AES	EG005T	SOIL	(APHA 21st ed., 3120; USEPA SW 846 - 6010) (ICPAES) Metals are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM (1999) Schedule B(3)
Total Mercury by FIMS	EG035T	SOIL	AS 3550, APHA 21st ed., 3112 Hg - B (Flow-injection (SnCl ₂)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion. Ionic mercury is reduced online to atomic mercury vapour by SnCl ₂ which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (1999) Schedule B(3)
Preparation Methods	Method	Matrix	Method Descriptions
Hot Block Digest for metals in soils sediments and sludges	EN69	SOIL	USEPA 200.2 Mod. Hot Block Acid Digestion 1.0g of sample is heated with Nitric and Hydrochloric acids, then cooled. Peroxide is added and samples heated and cooled again before being filtered and bulked to volume for analysis. Digest is appropriate for determination of selected metals in sludge, sediments, and soils. This method is compliant with NEPM (1999) Schedule B(3) (Method 202)
1M HCl Extraction for Metals in Sediments (1 hour)	EN71	SOIL	In house, Allen (1993) Mod. 1g of sample is leached at room temperature for 1 hour in 10% hydrochloric acid. The resultant extract is filtered and bulked for analysis of extracted metals.



Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged in the Quality Control (QC) Report. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). This report displays QC Outliers (breaches) only.

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **SOIL**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Duplicate (DUP) RPDs							
EG005-SDH: 1M HCl-Extractable Metals by ICPAES	ES1229225-029	SE070_0.0-0.3	Antimony	7440-36-0	21.2 %	0-20%	RPD exceeds LOR based limits
EG005-SDH: 1M HCl-Extractable Metals by ICPAES	ES1229225-019	SE015_0.0-0.1	Antimony	7440-36-0	103 %	0-20%	RPD exceeds LOR based limits
EG005-SDH: 1M HCl-Extractable Metals by ICPAES	ES1229225-029	SE070_0.0-0.3	Arsenic	7440-38-2	23.0 %	0-20%	RPD exceeds LOR based limits
EG005T: Total Metals by ICP-AES	ES1229225-010	BH103_0.0-0.1	Arsenic	7440-38-2	42.4 %	0-20%	RPD exceeds LOR based limits
EG005T: Total Metals by ICP-AES	ES1229225-010	BH103_0.0-0.1	Chromium	7440-47-3	36.1 %	0-20%	RPD exceeds LOR based limits
EG005T: Total Metals by ICP-AES	ES1229375-045	Anonymous	Lead	7439-92-1	39.2 %	0-20%	RPD exceeds LOR based limits
EG005T: Total Metals by ICP-AES	ES1229375-045	Anonymous	Zinc	7440-66-6	48.2 %	0-20%	RPD exceeds LOR based limits
Matrix Spike (MS) Recoveries							
EG005T: Total Metals by ICP-AES	ES1229225-039	MP001A	Arsenic	7440-38-2	Not Determined	----	MS recovery not determined, background level greater than or equal to 4x spike level.
EG005T: Total Metals by ICP-AES	ES1229225-010	BH103_0.0-0.1	Arsenic	7440-38-2	267 %	70-130%	Recovery greater than upper data quality objective
EG035T: Total Recoverable Mercury by FIMS	ES1229225-010	BH103_0.0-0.1	Mercury	7439-97-6	Not Determined	----	Matrix spike recovery not determined due to sample matrix interference.

- For all matrices, no Method Blank value outliers occur.
- For all matrices, no Laboratory Control outliers occur.

Regular Sample Surrogates

- For all regular sample matrices, no surrogate recovery outliers occur.

Outliers : Analysis Holding Time Compliance

This report displays Holding Time breaches only. Only the respective Extraction / Preparation and/or Analysis component is/are displayed.

- No Analysis Holding Time Outliers exist.

Outliers : Frequency of Quality Control Samples

The following report highlights breaches in the Frequency of Quality Control Samples.

- No Quality Control Sample Frequency Outliers exist.



CHAIN OF CUSTODY

ALS Laboratory: please tick →

Sydney 277 Woodpeck Rd. Smithfield NSW 2176
Ph 02 4784 8555 F samples.sydney@als.com.au
Newcastle 5 Ridgeman Rd. Wynterok NSW 2304
Ph 02 4922 9433 L samples.newcastle@als.com.au

Brisbane 32 Shand St. Stafford QLD 4053
Ph 07 3243 7222 E samples.brisbane@als.com.au
Townsville 14-15 Down Ct. Ballo QLD 4810
Ph 07 4796 0001 E samples.townsville@als.com.au

Melbourne 24 Westall Rd. Springvale VIC 3171
Ph 03 8549 6661 E samples.melbourne@als.com.au
Adelaide 21 Burns Rd. Parafield SA 5045
Ph 08 8359 1850 E samples.adelaide@als.com.au

Perth 10 Hord Way, Mirrabooka WA 6055
Ph 08 9209 7855 E samples.perth@als.com.au
Launceston 27 Wellington St. Launceston TAS 7250
Ph 03 6331 2150 E samples.launceston@als.com.au

CLIENT: GLD	TURNAROUND REQUIREMENTS: ☒ Standard TAT (List due date):		FOR LABORATORY USE ONLY (Circle) Sample received: _____ Sample stored: _____ Sample analysed: _____ Random Sample: _____ Other: _____
OFFICE: Coffs Harbour	(Standard TAT may be longer for some tests e.g. Ultra Trace Organics) ☐ Non Standard or urgent TAT (List due date):		
PROJECT: 2216251	ALS QUOTE NO.: SY/270/12	COC SEQUENCE NUMBER (Circle) COC: ① 2 3 4 5 6 7 OF: 1 2 3 4 5 ⑥ 7	
ORDER NUMBER:			
PROJECT MANAGER: Ben Luffman	CONTACT PH: 02 6650 5613	RELINQUISHED BY: B. Cork	RECEIVED BY: David
SAMPLER: B. Cork	SAMPLER MOBILE:	DATE/TIME: 12/12/12	DATE/TIME: 12/12 0815
OC emailed to ALS? (YES / NO) (NO)	EDD FORMAT (or default):		
Email Reports to (will default to PM if no other addresses are listed): ben.luffman@glc.com			
Email Invoice to (will default to PM if no other addresses are listed):			

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

LABS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).										Additional Information		
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	Antimony	Arsenic	As	As	As	As	As	As	As	As	As	As	Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	BH007-0.0-0.1	11/12/12	Soil		1	✓	✓											
2	BH007-0.3-0.5	↓	↓		↓	✓	✓											
(41)	BH007-0.5-0.7	↓	↓		↓													
(42)	BH007-0.8-1.0	↓	↓		↓													
3	BH090-0.0-0.1	10/12/12	↓		↓	✓	✓											
4	BH090-0.3-0.4	↓	↓		↓	✓	✓											
(43)	BH090-0.5-0.6	↓	↓		↓													
5	BH091-0.0-0.1	↓	↓		↓	✓	✓											
6	BH092-0.0-0.1	↓	↓		↓	✓	✓											
(44)	BH092-0.2-0.3	↓	↓		↓													
7	BH102-0.0-0.1	11/12/12	↓		↓	✓	✓											
8	BH102-0.3-0.5	↓	↓		↓	✓	✓											
TOTAL																		

Environmental Division
Sydney
Work Order
ES1229225



Telephone : +61-2-8784 8555

Environmental Division
Sydney

Work Order

ES1229225

Telephone: +61-2-8784 8555

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airfreight Unpreserved Plastic
 V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
 Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.



CHAIN OF CUSTODY

ALS Laboratory: please tick →

1 Sydney 277 Woodpark Rd. Smithfield NSW 2176
Ph 02 8784 8945 F samples@sydney.als.com.au
1 Newcastle 4 Ryegum Rd. Wyndham NSW 2314
Ph 02 4967 9433 F samples@newcastle.als.com.au

1 Brisbane 32 Shind St. St. Andrew QLD 4053
Ph 07 3243 7222 F samples@brisbane.als.com.au
1 Townsville 14-15 Deane Ct. Balak QLD 4818
Ph 07 4798 0001 F samples@townsville.als.com.au

1 Melbourne 2-4 Westall Rd. Springvale VIC 3171
Ph 03 9549 9500 F samples@melbourne.als.com.au
1 Adelaide 21 Gunga Rd. Port Adelaide SA 5015
Ph 08 8359 4890 F samples@adelaide.als.com.au

1 Perth 10 Hurl Way, Midvale WA 6100
Ph 08 9209 7655 F samples@perth.als.com.au
1 Launceston 27 Wellington St. Launceston TAS 7250
Ph 03 6331 2158 F samples@launceston.als.com.au

CLIENT: GHD		TURNAROUND REQUIREMENTS: ☒ Standard TAT (List due date):		FOR LABORATORY USE ONLY (Circle)	
OFFICE: Coffs Harbour		(Standard TAT may be longer for some tests e.g., Ultra Trace Organics)			
PROJECT: 2216251		ALS QUOTE NO.: SY/270/12		COC SEQUENCE NUMBER (Circle)	
ORDER NUMBER:				COC: 1 2 3 4 5 6 7	
PROJECT MANAGER: Ben Huffman		CONTACT PH: 02 6650 5613		OF: 1 2 3 4 5 6 7	
AMPLER:		SAMPLER MOBILE:		RECEIVED BY: David	
COC emailed to ALS? (YES / NO)		EDD FORMAT (or default):		RELINQUISHED BY:	
Email Reports to (will default to PM if no other addresses are listed): ben.huffman@ghd.com				DATE/TIME: 12/12/12	
Email Invoice to (will default to PM if no other addresses are listed):				DATE/TIME: 12/12/12	

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

SAMPLE DETAILS MATRIX: Solid(S) Water(W)				CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottles required) or Dissolved (field filtered bottles required).				Additional information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	Antimony	Arsenic	11 metals	total	Comments on likely contaminant levels, dilutions, or samples requiring specific analysis etc.
43	BH102-0.8-1.0	11/12/12	Soil		1					
9	BHDUP 20					✓	✓			
10	BH103-0.0-0.1							✓		
11	BH103-0.3-0.5							✓		
46	BH103-0.5-0.7								✓	
12	BH104-0.0-0.1					✓	✓			
13	BH104-0.3-0.5					✓	✓			
14	BH105-0.0-0.1							✓		
15	BH105-0.3-0.5							✓		
47	BH105-0.7-0.9								✓	
16	BH106-0.0-0.1					✓	✓			
48	BH106-0.3-0.5								✓	
TOTAL										

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottle; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.



CHAIN OF CUSTODY

ALS Laboratory: please tick →

1 Sydney 277 Woodpark Rd. Smithfield NSW 2126
Ph 02 8784 8555 E samples@sydney.als.com.au
1 Newcastle 4 Rusque Rd. Warburton NSW 2314
Ph 02 4929 9413 E samples@newcastle.als.com.au

1 Brisbane 32 Shand St. St. Albans QLD 4153
Ph 07 3243 7222 E samples@brisbane.als.com.au
1 Townsville 14-15 Deane Ct. Balke QLD 4810
Ph 07 4796 0608 E samples@townsville.als.com.au

1 Melbourne 24 Westall Rd. Springvale VIC 3171
Ph 03 8549 5600 E samples@melbourne.als.com.au
1 Adelaide 21 Banna Rd. Pooraka SA 5005
Ph 08 8358 9890 E samples@adelaide.als.com.au

1 Perth 10 Hind Way, Malaga WA 6090
Ph 08 9209 7655 E samples@perth.als.com.au
1 Launceston 27 Wellington St. Launceston TAS 7250
Ph 03 6331 2158 E samples@launceston.als.com.au

CLIENT: GHF	TURNAROUND REQUIREMENTS: ☐ Standard TAT (List due date):		FOR LABORATORY USE ONLY (Circle) Custom Seal (Impressions) Physical (2) and Chemical (2) Impressions Random Sample (Impressions) Other (Impressions)
OFFICE: Coffs Harbour	(Standard TAT may be longer for some tests e.g. Ultra Trace Organics) ☐ Non Standard or urgent TAT (List due date):		
PROJECT: 2216251	ALS QUOTE NO.: SY/270/12	COC SEQUENCE NUMBER (Circle) COC: 1 2 3 4 5 6 7 OF: 1 2 3 4 5 6 7	
ORDER NUMBER:	PROJECT MANAGER: Ben Huffman	CONTACT PH: 02 6650 5613	
SAMPLER:	SAMPLER MOBILE:	RELINQUISHED BY: B. Cork	RECEIVED BY: Dani
OC emailed to ALS? (YES / NO)	EDD FORMAT (or default):	DATE/TIME: 12/12/12	DATE/TIME: 12/12 0815
Email Reports to (will default to PM if no other addresses are listed): ben.huffman@ghd.com		DATE/TIME:	
Email Invoice to (will default to PM if no other addresses are listed):		DATE/TIME:	

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

SAMPLE DETAILS MATRIX: Solid(S) Water(W)				CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (filtered bottle required).					Additional Information	
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	Antimony	Arsenic	Extractable Sb	Extractable As	hold	Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.	
17	BH107-0.0-0.1	11/12/12	Soil		1	✓	✓					
18	BH107-0.2-0.3	↓	↓			✓	✓					
19	SE015-0.0-0.1	10/12/12	Sed					✓	✓			
(49)	SE015_0.1-0.3									✓		
(50)	SE015_0.2-0.3									✓		
20	SE023_0.0-0.1							✓	✓			
21	SE023_0.1-0.25							✓	✓			
(51)	SE023_0.3-0.5							✓	✓	✓		
22	SE024_0.0-0.1									✓		
(52)	SE024_0.1-0.2									✓		
(53)	SE024_0.2-0.25									✓		
(54)	SE024_0.3-0.5									✓		
TOTAL												

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airfreight Unpreserved Plastic
 V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
 Z = Zinc Acetate Preserved bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Solids; B = Unpreserved Bag.



CHAIN OF CUSTODY

ALS Laboratory: please tick →

1 Sydney 277 Woodpark Rd. Smithfield NSW 2176
Ph 02 4784 8595 F samples@sydney.als.com.au
1 Newcastle 5 Roseglen Rd. Warminster NSW 2314
Ph 02 4962 9433 E samples@newcastle.als.com.au

1 Brisbane 32 Strand St. St. Lawrence QLD 4153
Ph 07 3243 7222 E samples@brisbane.als.com.au
1 Townsville 14-15 Downs Ct. Bulimba QLD 4810
Ph 07 4776 0600 E samples@townsville.als.com.au

1 Melbourne 24 Westall Rd. Springvale VIC 3171
Ph 03 8549 9600 E samples@melbourne.als.com.au
1 Adelaide 21 Burns Rd. Pooraka SA 5095
Ph 08 8356 0300 E samples@adelaide.als.com.au

1 Perth 10 Hat Way, Malaga WA 6055
Ph 08 9209 7655 E samples@perth.als.com.au
1 Launceston 27 Wellington St. Launceston TAS 7250
Ph 03 6331 7450 E samples@launceston.als.com.au

CLIENT: GHD	TURNAROUND REQUIREMENTS: ☒ Standard TAT (List due date):		FOR LABORATORY USE ONLY (Circle) Custody Sealed () Preserved () Random Sample () Other ()
OFFICE: Coffs Harbour	(Standard TAT may be longer for some tests e.g., Ultra Trace Organics) ☐ Non Standard or urgent TAT (List due date):		
PROJECT: 22/6.25.1	ALS QUOTE NO.: 54/270/12	COC SEQUENCE NUMBER (Circle) COC: 1 2 3 4 5 6 7 OF: 1 2 3 4 5 6 7	
ORDER NUMBER:	PROJECT MANAGER: Ben Huffman	CONTACT PH: 02 6650 5613	
SAMPLER:	SAMPLER MOBILE:	RELINQUISHED BY: B. Cork	RECEIVED BY: Don
COC emailed to ALS? (YES / NO)	EDD FORMAT (or default):	DATE/TIME: 12/12/12	DATE/TIME: 12/12 0811
Email Reports to (will default to PM if no other addresses are listed): ben.huffman@ghd.com		DATE/TIME:	DATE/TIME:
Email Invoice to (will default to PM if no other addresses are listed):		DATE/TIME:	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

LABORATORY USE ONLY		SAMPLE DETAILS MATRIX: Solid(S) Water(W)		CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).					Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	Extractable Sb	Extractable As	hold			Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
23	SE034-0.0-0.15	10/12/12	Seal		1	✓	✓	✓	✓	✓	
(53)	SE034-0.15-0.25							✓			
(58)	SE034-0.25-0.40					✓	✓				
24	SE035-0.0-0.1							✓			
(55)	SE035-0.15-0.25							✓			
(58)	SE035-0.3-0.5							✓			
25	SE036-0.0-0.2					✓	✓				
(54)	SE036-0.2-0.3							✓			
(60)	SE036-0.3-0.4							✓			
26	SE044-0.0-0.05					✓	✓				
27	SE045-0.0-0.2					✓	✓				
(61)	SE045-0.25-0.40							✓			
(62)	SE045-0.4-0.6							✓			
TOTAL											

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottle; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Solids; B = Unpreserved Bag.



CHAIN OF CUSTODY

ALS Laboratory: please tick →

Sydney: 277 Woodpark Rd. Smithfield NSW 2176
Ph: 02 4704 6565 E: samples@als.com.au
Newcastle: 6 Rivington Rd. Whitetask NSW 2304
Ph: 02 4907 9433 E: samples@newcastle.als.com.au

Brisbane: 32 Strand St. St. Lawrence QLD 4053
Ph: 07 3243 7222 E: samples@brisbane.als.com.au
Townsville: 14-15 Deanna Ct. Balda QLD 4810
Ph: 07 4796 0000 E: samples@townsville.als.com.au

Melbourne: 2-4 Wexford Rd. Springvale VIC 3171
Ph: 03 8549 9600 E: samples@melbourne.als.com.au
Adelaide: 21 Bunn Rd. Pineside SA 5066
Ph: 08 8354 0890 E: samples@adelaide.als.com.au

Perth: 10 Hnd Way, Malaga WA 6090
Ph: 08 9240 7655 E: samples@perth.als.com.au
Launceston: 27 Wellington St. Launceston TAS 7250
Ph: 03 1331 2158 E: samples@launceston.als.com.au

CLIENT: CHD	TURNAROUND REQUIREMENTS: ☒ Standard TAT (List due date): (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)		FOR LABORATORY USE ONLY (Circle) Client Name: _____ Client Address: _____ Client Contact: _____ Random Samples Impassable to Review Other: _____
OFFICE: Coffs Harbour	☐ Non Standard or urgent TAT (List due date):		
PROJECT: 2216251	ALS QUOTE NO.: SY/270/12	COC SEQUENCE NUMBER (Circle) COC: 1 2 3 4 5 6 7 OF: 1 2 3 4 5 6 7	
ORDER NUMBER:			
PROJECT MANAGER: Ben Luffman	CONTACT PH: 02 6650 5613		
SAMPLER:	SAMPLER MOBILE:	RELINQUISHED BY: B. Cork	RECEIVED BY: Den J
COC emailed to ALS? (YES / NO)	EDD FORMAT (or default):	DATE/TIME: 12/12/12	DATE/TIME: 12/12 0815
Email Reports to (will default to PM if no other addresses are listed): ben.luffman@chd.com		DATE/TIME:	
Email Invoice to (will default to PM if no other addresses are listed):		DATE/TIME:	

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

SAMPLE DETAILS MATRIX: Solid(S) Water(W)				CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (acid filtered bottle required)					Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	Antimony	Arsenic	Extractable Sb	Extractable As	hold	Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
28	SE069_0.0-0.15	10/12/12	Sed					✓	✓	✓	Potentially
(63)	SE069_0.15-0.3									✓	V. High Contain
(64)	SE069_0.3-0.4									✓	
29	SE070_0.0-0.3							✓	✓	✓	
(65)	SE070_0.3-0.4									✓	
(66)	SE070_0.4-0.6							✓	✓	✓	
30	SE071_0.0-0.15									✓	
(67)	SE071_0.15-0.3							✓	✓	✓	
31	SE072_0.0-0.3									✓	
(68)	SE072_0.3-0.4									✓	
(69)	SE072_0.4-0.5									✓	
(70)	SE072_0.5-0.65									✓	
TOTAL:											

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airfreight Unpreserved Plastic
 V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
 Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Solids; B = Unpreserved Bag.



CHAIN OF CUSTODY

ALS Laboratory, please tick →

Sydney 277 Woodpark Rd. Smithfield NSW 2176
Ph 02 3784 8655 F samples@sydney.als.com.au
Newcastle 6 Rossington Rd. Waratah NSW 2314
Ph 017 4587 9433 F samples@newcastle.als.com.au

Brisbane 32 Strand St. St. Lawrence QLD 4053
Ph 07 3243 7222 E samples@brisbane.als.com.au
Townsville 14-16 Devon Ct. Bahra QLD 4818
Ph 07 4796 0601 E samples@townsville.als.com.au

Melbourne 2-4 Westall Rd. Springvale VIC 3171
Ph 03 8549 9600 E samples@melbourne.als.com.au
Adelaide 2 1 Guano Rd. Pooraka SA 5005
Ph 08 8359 0890 E samples@adelaide.als.com.au

Perth 10 Hind Way, Mirrabooka WA 6006
Ph 08 9200 7655 E samples@perth.als.com.au
Launceston 27 Wellington St. Launceston TAS 7250
Ph 03 6331 2158 E samples@launceston.als.com.au

CLIENT: GHD	TURNAROUND REQUIREMENTS: ☒ Standard TAT (List due date):	FOR LABORATORY USE ONLY (Circle) COC SEQUENCE NUMBER (Circle) COC: 1 2 3 4 5 6 7 OF: 1 2 3 4 5 6 7
OFFICE: Coffs Harbour	(Standard TAT may be longer for some tests e.g., Ultra Trace Organics) ☐ Non Standard or urgent TAT (List due date):	
PROJECT: 2216251	ALS QUOTE NO.: SY/270/12	
ORDER NUMBER:		
PROJECT MANAGER: Ben Luffman	CONTACT PH: 02 6650 5613	
SAMPLER:	SAMPLER MOBILE:	RELINQUISHED BY: B. Cork
DOC emailed to ALS? (YES / NO)	EDD FORMAT (or default):	RECEIVED BY: David
Email Reports to (will default to PM if no other addresses are listed): ben.luffman@ghd.com		DATE/TIME: 12/12/12
Email Invoice to (will default to PM if no other addresses are listed):		DATE/TIME: 12/12 09:55

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

SAMPLE DETAILS MATRIX: Solid(S) Water(W)				CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).						Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	Antimony	Arsenic	11 metals	Extractable Sb	Extractable As	hold	Comments on likely contaminant levels, dilutions, or samples requiring specific QA analysis etc.
32	SE103_0-05-0-1	10/12/12	Seed		1				✓	✓		Potentially high Contaminated
33	SEDUP21	↓	↓		↓				✓	✓		
34	SE103_0-1-0-3	↓	↓		↓				✓	✓		
35	SE104_0-0-0-1	↓	↓		↓				✓	✓		
36	SEDUP20	↓	↓		↓				✓	✓		
37	SP004_0-0-0-1	↓	Soil		↓			✓			✓	
38	SP004_0-1-0-2	↓	↓		↓			✓				V. High Contam
39	MP001	11/12/12	↓		↓			✓				V. High Contam
40	MP002	↓	↓		↓			✓				Possibly Mercury.
TOTAL												

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

GHD

230 Harbour Drive

Coffs Harbour NSW 2450

T: (02) 6650 5600 F: (02) 6650 5601 E: cfsmail@ghd.com.au

© GHD 2013

This document is and shall remain the property of GHD. The document may only be used for the purpose for which was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

G:\22\16251\WP\15479.docx

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
A	B. Cork	B. Luffman	<i>B. Luffman</i>	I. Gregson	<i>I. Gregson</i>	24.01.13
0	B. Cork	B. Luffman	<i>Ben</i>	I. Gregson	<i>[Signature]</i>	11.02.13

www.ghd.com



Appendix E Remediation Action Plan



NSW Trade and Investment - Crown Lands
Former Antimony Processing Plant- Urunga NSW
Remedial Action Plan
Revision 1

September 2014

Abbreviations

ASSMAC	Acid Sulfate Soils Management Advisory Committee
ASSMP	Acid Sulfate Soils Management Plan
As	Arsenic
BSC	Bellingen Shire Council
CEMP	Construction Environmental Management Plan
CLM Act	Contaminated Land Management Act
CSM	Conceptual Site Model
COC	Contaminant of Concern
CQA	Construction Quality Assurance
Cr	Chromium
DECCW	NSW Department of Environment, Climate Change and Water (former, now the OEHL)
DLWC	Department of Land and Water Conservation
EIL	Environmental Investigation Level
EMP	Environmental Management Plan
EPA	NSW Environment Protection Authority
HIL	Health Investigation Level
ISQG	Interim Sediment Quality Guideline
m	Metres
mbgs	Metres below ground surface
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Litre
NATA	National Association of Testing Authorities
NEPM	National Environmental Protection Measure
NSW	New South Wales
OCP	Organochlorine Pesticides
OEHL	Office of Environment and Heritage
PAHs	Polynuclear Aromatic hydrocarbons
PASS	Potential Acid Sulfate Soil
Pb	Lead
PBIL	Phytotoxicity Based Investigation Levels

PCBs	Polychlorinated Biphenyls
PMF	Probable Maximum Flood
PQL	Practical Quantitation Limit
RAP	Remedial Action Plan
RPD	Relative Percent Difference
SOP	Standard Operating Procedure
QA	Quality Assurance
QC	Quality Control
Sb	Antimony
SCS	Soil Conservation Service
SEPP	State Environmental Planning Policy
SWMP	Soil and Water Management Plan
SWMS	Safe Work Method Statement
TCLP	Toxicity Characteristic Leaching Procedure
TPH	Total petroleum hydrocarbons
WHS	Workplace Health and Safety
XRF	X-Ray Fluorescence

Table of contents

1.	Introduction	1
1.1	Project background	1
1.2	Objectives and scope	4
1.3	Contact details	4
2.	Background.....	6
2.1	Previous investigations.....	6
2.2	Conceptual site model.....	6
2.3	Site description.....	7
2.4	Contaminants of concern.....	8
2.5	Contaminant delineation.....	9
2.6	Estimated volume of impacted soil and sediment.....	10
2.7	Contaminant concentration/time relationship.....	10
2.8	Other site features.....	10
3.	Treatment trials	15
4.	Remediation options assessment	16
4.1	General	16
4.2	Remediation objectives	17
4.3	Areas requiring remediation.....	18
4.4	Technical and policy considerations.....	26
4.5	Identified remediation options	26
4.6	Remediation constraints and limitations	28
4.7	Cost estimate	38
4.1	Remediation option summary	40
4.2	Recommended remediation option	41
5.	Remediation methodology.....	42
5.1	Overview of remediation methodology	42
5.2	Site establishment.....	42
5.3	Water management.....	43
5.4	Excavation	43
5.5	Treatment.....	44
5.6	Containment cell.....	45
5.7	Backfill and landforming.....	46
5.8	Disposal of soils, mercury plugs and refuse	46
5.9	Environmental monitoring and ongoing management.....	48
6.	Assessment criteria	49
6.1	Framework	49
6.2	Soil assessment criteria.....	50
6.3	Sediment assessment criteria.....	54

6.4	Water assessment criteria	55
6.5	Imported fill	56
7.	Validation	57
7.1	Decision process	57
7.2	Validation methodology	59
7.3	QA/QC requirements	62
7.4	Material Treatment and Containment Cell Verification	64
8.	Remediation works management	65
8.1	Responsibilities	65
8.2	Site control	65
8.3	Recommended personal protective equipment	66
8.4	Acid sulfate soils	67
8.5	Erosion/sediment control and run-off control	67
8.6	Contingency plan (unexpected finds)	67
8.7	Review of RAP	68
9.	Protection of the environment and community	69
10.	Health and safety	70
11.	Community consultation	71
12.	Regulatory requirements	72
12.1	State Environmental Planning Policy (State and Regional Development) 2011	72
12.2	State Environmental Planning Policy No 55 – Remediation of Land	72
12.3	State Environmental Planning Policy No 14—Coastal Wetlands	73
12.4	Environmental Planning and Assessment Act	74
12.5	Protection of the Environment Operations (POEO) Act 1997	74
12.6	Water Management (WM) Act 2000	75
12.7	Fisheries Management Act 1994	75
13.	Conclusions and recommendations	77
13.1	Conclusions	77
13.2	Recommendations	78
14.	Limitations	79
15.	References	81

Table index

Table 4-1	Remediation areas	20
Table 4-2	Volume and mass of antimony by remediation area	24
Table 4-3	Remediation option comparison.....	30
Table 4-4	Risk assessment of on-site containment options.....	33
Table 4-5	Cost estimate summary.....	39
Table 6-1	Adopted Soil Assessment Criteria.....	54
Table 6-2	Adopted sediment assessment criteria.....	55
Table 6-3	Adopted Water Assessment Criteria	55

Figure index

Figure 1-1	Site Location	2
Figure 1-2	Site Features.....	3
Figure 2-1	Estimated area and volume of impacted soil	11
Figure 2-2	Estimated area and volume of impacted sediment	12
Figure 2-3	Surface water sampling locations	13
Figure 2-4	Groundwater sampling locations.....	14
Figure 4-1	Remediation areas	23
Figure 4-2	Proportion of antimony removed compared to the volume of material removed	25
Figure 5-1	Containment cell location.....	47

Appendices

Appendix A Summary Results

Appendix B Remediation Concepts

Appendix C Risk Assessment

1. Introduction

The Soil Conservation Service (SCS) has been engaged by NSW Catchment & Lands - Crown Lands (Crown Lands) to project manage the rehabilitation of a former antimony processing facility located at Hillside Drive, Urunga, NSW (the Site). GHD has been engaged to undertake a series of tasks relating to that project including:

- A Preliminary Investigation Report, which has previously been completed (GHD 2012a).
- Detailed Investigation Reports, which have previously been completed (GHD 2012b and GHD 2013).
- A Remedial Action Plan (RAP), which is this document.

1.1 Project background

The Site is located at Urunga, NSW, to the south east of the Pacific Highway and adjoining a State Environmental Planning Policy (SEPP) 14 wetland as illustrated in Figure 1-1 and Figure 1-2. The Site comprises part of Lot 1 and Lot 2 DP 874874, part of Lot 7062 DP 1108434 and part of Lot 253 DP 46013. All lots are Crown land.

The Site was a former antimony processing plant, which operated between 1969 and 1974, and was abandoned in 1974 without clean up or remedial work. Tailings and mill waste water were discharged onto the wetland foreshore area during the plant operations. A tailings deposit approximately 1 hectare (ha) in extent fans out into the adjoining wetland. The tailings and adjoining environment are contaminated by a range of heavy metals, particularly arsenic, antimony and mercury. A belt of dead *Melaleuca* trees characterises the periphery of the tailings deposit. The tailings area is devoid of vegetation, and is periodically inundated by flood water and/or surface runoff.

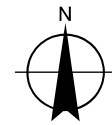
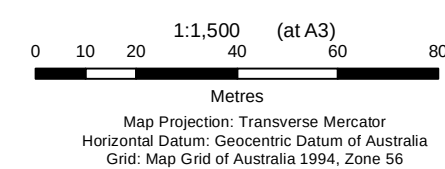
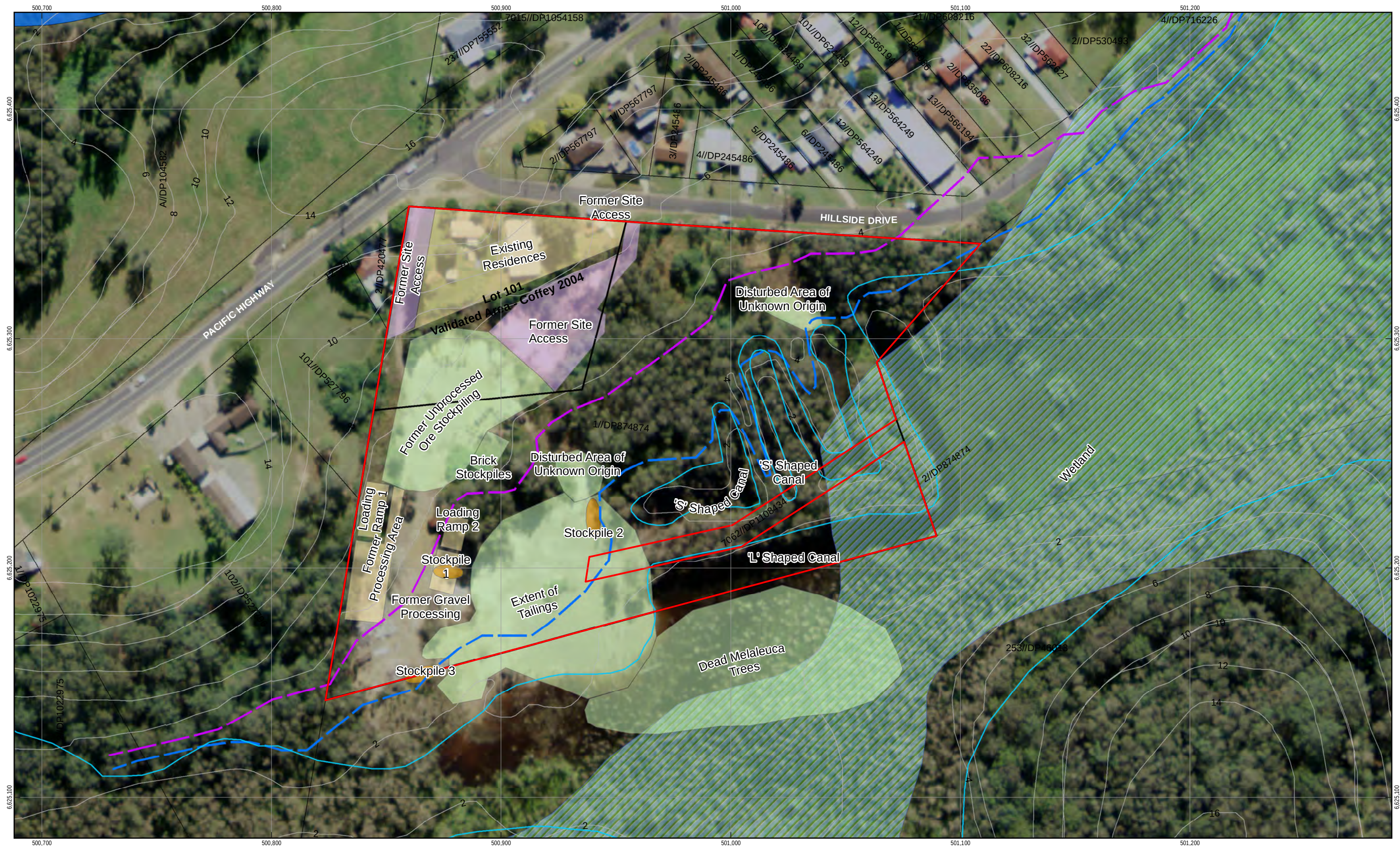
A partial clean-up of surface debris and waste materials on the former antimony processing site has been carried out by Entech Industries (Entech) in 2011, however no remediation or management of soil or tailings contamination has occurred.

A series of canals lies to the east of the tailings area. The wetland discharges into Station Creek, and Urunga Lagoon at the mouth of the Kalang River in Urunga.

Under the provisions of the Contaminated Land Management Act 1997 (CLM Act), a Management Order (No. 20111405) applies to Lot 253 DP 46013 (NSW EPA 2011). A Declaration of remediation site (No. 21020, Area 1089) applies to Lot 1 and Lot 2, DP 874874 and Lot 253 DP46013 (NSW EPA 2002). A portion of Lot 1 DP 874874 was removed from remediation area 1089 by means of a Notice to End Remediation Declaration in November 2005 (NSW EPA 2005). This was reflected in a Notice to Amend Management Order issued on 22 May 2012 (NSW EPA 2012a) which applied to the entire site (i.e. Part of Lot 1 in DP874874, Lot 2 in DP874874 and Lot 253 in DP46013) following the land transfer from Harry Ross Tickner to the State (Crown Lands). The dates for each milestone of the Management Order were successively revised in further Notices to Amend Management Order issued on 26 September 2012 (NSW EPA 2012b) and 21 May 2014 (NSW EPA 2014).

It is evident from previous investigations and the additional data obtained by GHD that significant contaminant impact is present in soils (including tailings and waste stockpiles) on the Site, sediment in adjoining areas, groundwater on the Site and surface water on and adjoining the Site. Section 1.3.4 summarises the extent, nature, exposure pathways and impacts relevant to the identified contamination. The remaining questions dealt with in this RAP are the extent and means of remediation or management that will be applied to minimise the future impact of the contaminants.





- LEGEND**
- Flood Levels - BSC Flood Risk Maps (2008)**
- 100 Year
 - Probable Maximum Flood (PMF)
 - Waters Edge (August 2012)
- Lidar Contours
 - Lot
 - SEPP14 Wetland
 - Site Boundary



NSW Catchment and Lands- Crown Lands
Former Antimony Processing Plant, Urunga NSW

Job Number 22-16251
Revision 2
Date 7 Apr 2014

**Site Location
Features - Detailed**

Figure 1-2

Remediation requirements and options have been discussed previously, including in:

- *Part 2 Urunga Contaminated Site Remediation Options* (DLWC 1997a).
- A Site visit and inception meeting that was held on 9 May 2012 and attended by representatives from:
 - GHD
 - NSW Environmental Protection Authority (EPA)
 - Bellingen Shire Council (BSC)
 - Crown Lands
 - Soil Conservation Service
- Urunga Antimony Processing Plant Contaminated Site - Project Application & Preliminary Environmental Assessment (SCS, 2012).

1.2 Objectives and scope

The objectives of the remediation are to:

- Achieve compliance with the Management Order 20111405.
- Remediate the contamination at the Site so that any further impact on the adjacent wetland and receiving environment is minimised, and to allow the Site to be opened to public access without unacceptable risk to human health.

The specific objectives of the RAP as presented in EPA Management Order 20111405 and corresponding scope include:

- Prepare a RAP to remediate the harm caused and being caused by the significant contamination of the land. The RAP must:
 - Provide a detailed consideration of the remedial options nominated by the EPA from those outlined in the investigation report plus any other options put forward in writing by the EPA.
 - Nominate the preferred remedial option and provide reasoning.
 - Provide sufficient detail in the RAP to enable it to be implemented by a remediation contractor. This should include but not be limited to:
 - An estimation of the volume of material required for remediation.
 - Detailed characterisation of the nature of the material requiring remediation.
 - Figures, maps and/or plans showing with precision the locations of the material requiring remediation and the methods and design of any remedial system.
 - Detailed descriptions of any remedial technologies to be utilised.
 - A contingency plan, should the nominated remedial method fail.

Submit the RAP to the EPA for review and approval.

1.3 Contact details

Listed below are the various parties involved in the remediation, and their respective contact details.

1.3.1 Project manager

Responsible, as Owner's Representative, for funding and directing remediation towards the agreed goals.

Name: Clayton Colmer
Company: Soil Conservation Service
Telephone: 02 6650 3143
Mobile: 0437 013 126

1.3.2 Site manager

Represents the remediation contractor. Responsible for the required civil works, including all measures required to protect worker and public health and the environment during the works.

Name: TBC
Company: TBC
Telephone: TBC
Mobile: TBC

1.3.3 Environmental representative

May be engaged by the remediation contractor. Responsible for overall direction of environmental work associated with the remediation. Responsible for monitoring of work areas for environmental purposes and advising the Project Manager and site manager of appropriate actions on the basis of observations, sampling and analysis.

Name: TBC
Company: TBC
Telephone: TBC
Mobile: TBC

1.3.4 Environmental consultant

Independent from contractor. Responsible for guidance on the extent of remediation works, collection and analysis of validation and characterisation samples and advising the Project Manager of appropriate actions on the basis of observations, sampling and analysis.

Name: TBC
Company: TBC
Telephone: TBC
Mobile: TBC

2. Background

2.1 Previous investigations

Previous investigations undertaken at the Site include:

- DMR 1977. *Urunga Mineral Processing Plant Investigation*. Department of Mineral Resources Mines Inspection Branch.
- SPCC 1984. *Water Quality in the Bellingen and Kalang Rivers*. State Pollution Control Commission, Northern Rivers Study No. 2.
- Hicks 1993, *Investigation of Trace Metal Concentrations in Urunga Lagoon*. Bachelor Degree Thesis, The University of New England- Northern Rivers.
- DLWC 1995. *Assessment of Contaminated Crown Land at Urunga*. Department of Land and Water Conservation.
- DLWC 1997a. *Part 1 Urunga Contaminated Site Background and Results*. Department of Land and Water Conservation.
- DLWC 1997b. *Part 2 Urunga Contaminated Site Remediation Options*. Department of Land and Water Conservation.
- DLWC 2002 *Wasteland to Wetland. Evaluation of Options for Remediation of the Former Antimony Processing Plant at Urunga, NSW*. NSW Department of Land and Water Conservation, Resource Analysis Unit North Coast.
- Repath, P and Body, M 2003. *Flora and Fauna Evaluation for the Urunga Antimony Contaminated Site: An inventory assessment for an EIS*.
- Coffey 2004. *Validation Assessment of Stripped Area*.
- DMR 2004, NSW. *Abandoned Minesite Database. Urunga Mineral Preparation Plant*. Department of Mineral Resources.
- NSW EPA 2008. *Former Antimony Processing Plant Soil Sampling Results*. Environmental Protection Authority.
- SCS 2012. *Urunga Antimony Processing Plant. Contaminated Site - Project Application & Preliminary Environmental Assessment* Prepared for NSW Department of Planning. Soil Conservation Service.
- GHD (July, 2012a). *Former Antimony Processing Plant, Urunga, NSW – Preliminary Investigation Report*.
- GHD (December, 2012b). *Former Antimony Processing Plant, Urunga, NSW – Detailed Investigation Report*.
- GHD (February, 2013). *Former Antimony Processing Plant, Urunga, NSW – Detailed Investigation Report Addendum One – Supplementary Sampling Results*.

2.2 Conceptual site model

A conceptual site model (CSM) was presented in the Detailed Investigation Report (GHD, 2012b) and, where relevant to remediation, is summarised in the following subsections.

2.3 Site description

Site features are presented in Figure 1-2. In general, the Site consists of:

- A disturbed area incorporating the various features associated with the former antimony processing facility that is largely devoid of vegetation.
- A tailings area of approximately one hectare that is devoid of vegetation, extending from the former processing area into an adjacent, SEPP 14 wetland (no. 354).
- A generally forested area adjacent to the SEPP 14 wetland that contains at least 24 endangered or vulnerable fauna species.
- Surface material consisting of imported fill and tailings.
- Some remaining infrastructure consisting mainly of foundations of the former processing facility and loading ramps.
- Several remaining stockpiles of ore, rubbish and bricks.
- An 'L' shaped canal that has apparently been excavated from the wetland.
- A series of 'S' shaped canals.
- Visually impacted *melaleuca* trees in the wetland area, adjacent to the tailings deposit.

2.3.1 Soils

Reference to the Macksville Nambucca 1:100,000 Soil Landscape Map indicates the bedrock slopes above the mill at the site are in the Pine Creek (pn) landscape being gravelly red kurosols. The low footslopes above the tailings area are mottled grey red clays of the Bowra Creek (ba) soil landscape. The wetland area below the tailings is predominantly permeable acid peats and impermeable grey humic clays of the Charmont (ch) soil landscape group (typically wetlands). This soil type generally contains high sulphide content presumably in both organic and inorganic forms (SCS, 2012).

The soils in the vicinity of the tailing deposit are considered to be acid sulfate soils. The preparation of a detailed management plan and development consent would be required for works that disturb the soil in that area. Acid sulfate soils generate acid where pyritic material is exposed to oxygen. Increased acidity may, in turn, exacerbate the mobilisation of metal contaminants.

In general, the lithology in the vicinity of the tailings consists of silty sand (tailings) to approximately 1.5 m depth overlaying approximately 1 m of clayey silt (described by DLWC as peat) and then silty clay from approximately 2.5 m below ground surface (bgs).

2.3.2 Hydrology

The Site sits between the footslope of a small ridge to the north and west and the SEPP 14 wetland to the south and east. Several small drainage lines meander through the site from the small catchment. Flood waters (BSC 2008) are shown to periodically inundate the Site (Figure 1-2) with the Probable Maximum Flood (PMF) level inundating the tailings, former gravel processing area and the canal systems. The PMF level does not cover the full extent of the former processing area. No tidal influence was noted during the field investigation program; however long period tidal influences may periodically inundate portions of the tailings during different hydrological conditions. Aerial photographs and anecdotal evidence from different times of the year indicate a significant seasonal fluctuation in the water level in the wetland.

2.3.3 Hydrogeology

Groundwater onsite ranged from approximately 0.4 to 1.4 m below ground surface (mbgs) and is interpreted to discharge into the wetland. Groundwater has only been investigated within the tailings area. The tailings material and underlying peat are expected to be highly permeable and hence the contaminants are likely to have high groundwater connectivity. Characteristics of deeper groundwater or groundwater flow into the site are not known.

2.4 Contaminants of concern

Several potential contaminant sources have been identified at the site including the tailings deposits, ore stockpiles, incidental contaminants, fill material, excavated sediments (from the creation of the canals) and any exposed, acid sulfate soils.

Based on a comparison of the historic results (compiled in GHD 2012a) and current analyte concentrations (from GHD 2012b and GHD 2013) with the adopted assessment criteria:

- Antimony and arsenic were evident as the key Contaminants of Concern (COCs). In nearly all cases, where one of the less significant COCs was present in significant concentrations, more significant concentrations of either antimony or arsenic were present. As a result, these analytes were deemed to be representative indicator analytes and the governing contaminants.
- Elevated aluminium and iron concentrations were noted throughout the site, including background samples. Due to the lack of applicable assessment criteria and elevated background levels, these analytes were not considered COCs.
- Chromium and nickel concentrations exceeded the adopted threshold criteria in sediment and groundwater. They were deemed to be COCs but are unlikely to govern remediation.
- Zinc concentrations were less than the adopted threshold criteria in soil, sediment and surface water but exceeded criteria for some of the groundwater sampling locations. Due to the relatively low concentrations and conservative assessment criteria, zinc was not considered a COC.
- Copper and lead concentrations were noted to exceed the adopted assessment criteria in the sediment, surface water and groundwater. They were deemed to be COCs but are unlikely to govern remediation.
- Elevated mercury concentrations were noted in all media and were noted to generally correlate with antimony and arsenic concentrations. Mercury is considered to be a COC.
- Cyanide was noted to be relatively low in soil, slightly elevated in some sediments and groundwater but absent in the surface water. Cyanide is hence considered a COC but is unlikely to govern remediation.
- Incidental contaminants may also be present on the Site (especially in the residual stockpiles), including:
 - Total Petroleum Hydrocarbons (TPH).
 - Polynuclear, Aromatic Hydrocarbons (PAH).
 - Organochlorine Pesticides (OCP).
 - Polychlorinated Biphenyls (PCB).
 - Asbestos.

A summary of the results is presented in the tables in Appendix A.

2.5 Contaminant delineation

2.5.1 Lateral extent

The interpreted extent of the contamination in the soil and sediment is presented in Figure 2-1 and Figure 2-2. The extent of impact in the surface water and groundwater is presented in Figure 2-3 and Figure 2-4, respectively. The data indicate considerable impact in the tailings and sediments, moderate contamination in the groundwater (given limited data) and a lesser degree of impact to the surface water quality.

The lateral extent of the impact in the soil can be summarised as:

- Roughly correlating with the absence of vegetation.
- Including the tailings deposit, former processing area and portions of the former unprocessed ore stockpiling area.
- Extending into the SW corner of the site, near the wetland, however the extent of this impact has not been fully delineated. Delineation would entail further sampling in the neighbouring property.
- Extending along the embankment in the vicinity of the 'L' shaped canal, at a depth of 1 to 1.7 mbgs. It is possible that impacted sediment and soil was excavated from the location of the 'L' shaped canal during canal and embankment construction. Clean soil from deeper within the profile beneath the 'L' shaped canal may have been placed over the impacted/ excavated sediment.
- Not extending into the NE portion of the site with the exception of an area of unknown disturbance, to the north of the 'L' Shaped canal. This area showed elevated antimony, arsenic and copper concentrations to a depth of approximately 1 mbgs.
- Not extending to the southern side of the wetland.

The lateral extent of the impact in the sediment can be summarised as:

- Showing highest levels of impact adjacent to the tailings deposit, extending approximately 50 m downstream of the tailing deposit and adjacent to the north eastern portion of the 'L' shaped canal. This is interpreted to reflect the distribution of sediment that would be expected from flood events transporting sediment downstream. The impacted sediments to the north east of the 'L' shaped canal may be as a result of deposition in an 'eddy' that would be present during high flow events, or may have been deposited by a former flow path prior to construction of the 'L' shaped canal, or dumped there during construction of the 'L' shaped canal.
- Including the western portion of the 'S' shaped canals.
- Including the south eastern portion of the 'S' shaped canals, suggesting a possible impact from the area of unknown disturbance in the vicinity of the NE portion of the site.

Insufficient data was available to accurately delineate sediment impact to the south east of the site, adjacent to the southern shore of the wetland. This data gap is deemed unlikely to affect decisions regarding the extent of remediation as the technical and commercial feasibility of remediation in that area would be limited, and the net environmental benefit (i.e. marginal degree of improvement vs extent of disturbance required) would be low.

2.5.2 Vertical extent

The interpreted vertical extent of the impact in the soil is presented in Figure 2-1. Depths vary from approximately 0.8 mbgs to 2.5 mbgs, as follows:

- The depth of contaminated soil extended to 1.2 mbgs in the NW portion of the Site.
- In the location of the former processing plant on the western boundary of the site, contaminated soil extended to a depth of 0.5 mbgs.
- Within the tailings deposit the depth of contaminated soil ranged from 1 mbgs to 3 mbgs.
- The north east area of unknown disturbance contained contaminated soil to a depth of 1 mbgs.
- The bund adjacent to the 'L' shaped canal had contaminated soil at a depth of between 1 mbgs and 2.5 mbgs, however, from the surface to 1 mbgs, the concentration of contaminants was less than the adopted criteria. This suggests contaminated soil, excavated from the 'L' shaped canal, was covered by clean soil.

As shown in Figure 2-2, impacts in the sediment range from about 0.5 mbgs near the tailings to 0.1 mbgs on the south of the wetland. The greatest antimony and arsenic concentrations were generally noted in the surface sediment (0-0.1 mbgs).

2.6 Estimated volume of impacted soil and sediment

Estimated volumes of impacted soil and sediment are shown in Table 4-2. It is conservatively estimated that approximately 28,175 m³ of material has been impacted and 286 tonnes of antimony (and a similar mass of arsenic) is remaining onsite. Approximately 84% of the antimony and a similar proportion of arsenic is within the tailings deposit. The basis of these calculations is discussed in Section 4.3.

2.7 Contaminant concentration/time relationship

Concentrations of COCs in the soil recorded in this investigation were within a similar order of magnitude (given differences in sampling and analysis methods) as those recorded in the historical investigations. This implies concentrations have remained relatively constant over the sampling period.

2.8 Other site features

2.8.1 Stockpiles

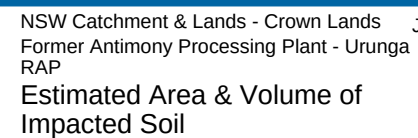
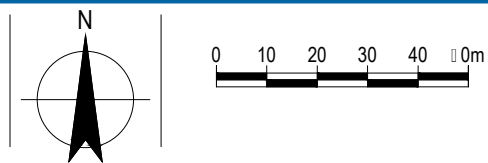
The stockpiles consisted mainly of ore material and soil with some debris including metal and potential asbestos containing material. The metal and COCs concentrations in the stockpiles were similar to those found in the tailings deposit.

2.8.2 Bricks

The bricks stockpiled in the northern portion of the site did not contain metal concentrations beyond background levels and no metal concentrations exceeded the thresholds for general solid waste. The bricks could hence be disposed as general solid waste or reused.

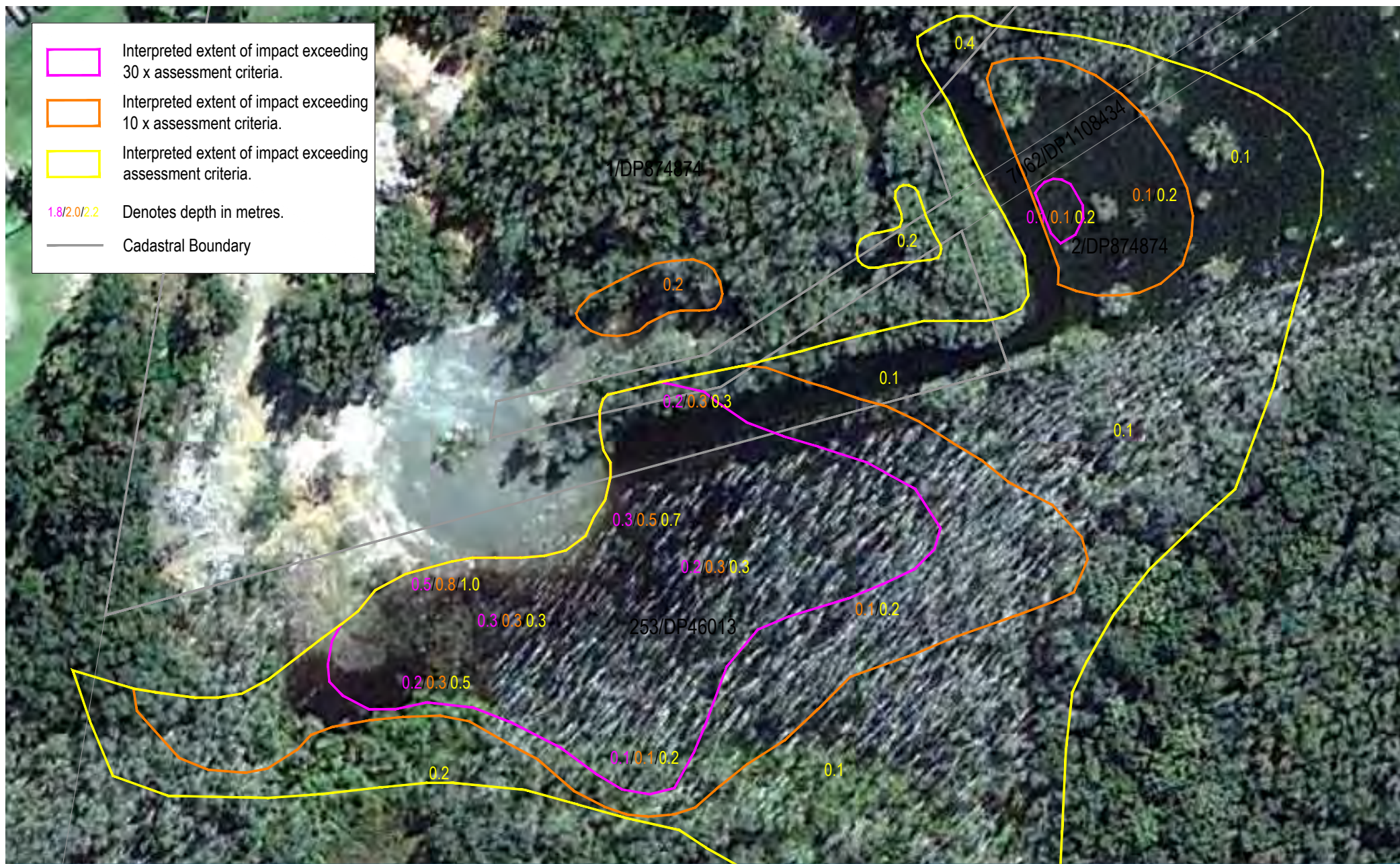
2.8.3 Mercury plugs

Two 'mercury plugs' were identified immediately west of the processing area. The analytical results show the mercury plugs to contain elevated concentrations of antimony, mercury and arsenic. Soil downgradient of these 'plugs' was moderately impacted by antimony and arsenic with one exceedance of the adopted assessment criteria for mercury to a depth of approximately 0.3 mbgs.

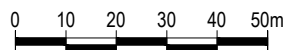
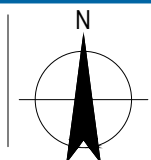


Job Number	22-16251
Revision	A
Date	NOV.2013

Figure 2-1



- Interpreted extent of impact exceeding 30 x assessment criteria.
- Interpreted extent of impact exceeding 10 x assessment criteria.
- Interpreted extent of impact exceeding assessment criteria.
- 1.8/2.0/2.2 Denotes depth in metres.
- Cadastral Boundary

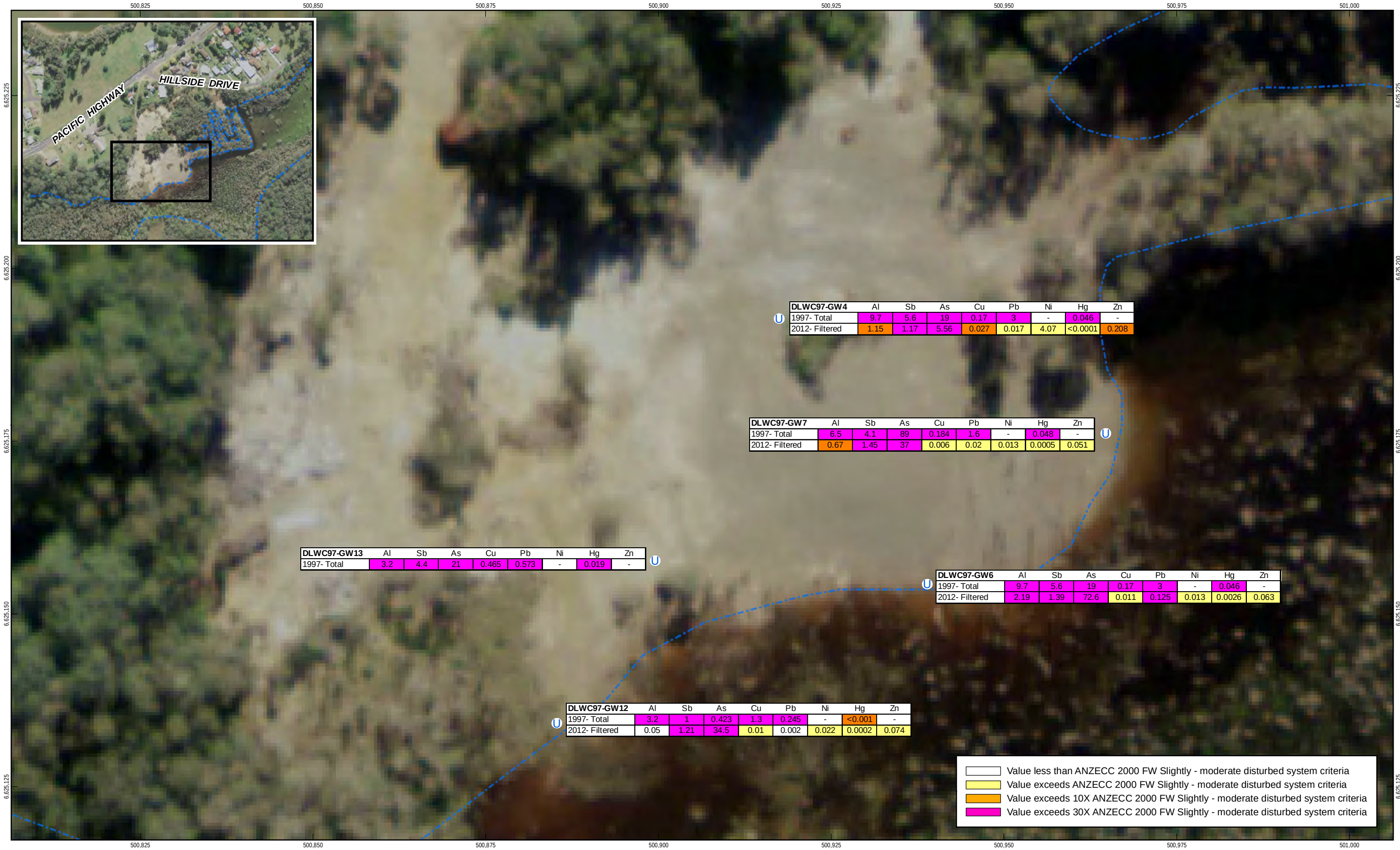


NSW Catchment & Lands - Crown Lands
Former Antimony Processing Plant - Urunga
RAP
Estimated Area & Volume
of Impacted Sediment

Job Number | 22-16251
Revision | A
Date | NOV.2013

Figure 2-2





3. Treatment trials

Hazmat Services Pty Ltd (Hazmat) and Bairad (Prescience) Pty Ltd have completed treatment trials on nine samples from different areas of the Site. The treatment trials indicated that the material could be immobilised and achieve pH stabilisation appropriate for long term landfill disposal.

Full details of the treatment trials were not available to GHD, and GHD has been advised that the exact reagent regime and treatment methodology are proprietary and commercial in confidence. It is understood that the treatment for off-site disposal (if required) would be subject to a Specific Immobilisation Approval (SIA) approved by the EPA. The EPA has confirmed that they will review and approve an appropriate treatment process and methodology for on-site containment. This will be described in the Quality Control Plan that will be submitted prior to works commencing (see Section 5.5).

4. Remediation options assessment

4.1 General

A contaminated site, as defined by the “Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites” (ANZECC/NHMRC, 1992), is a site at which hazardous substances occur at concentrations above background levels, and where assessment (with reference to appropriate criteria) indicates it poses, or is likely to pose, an immediate or long term hazard to human health or the environment. ANZECC/NHMRC (1992) describes a number of principles of contaminated site management, including the following:

- Contaminated site management strategies should reflect the need to protect all segments of the environment both biological and physical.
- The fundamental goal of contaminated site clean-up should be to render a site acceptable and safe for a long term continuation of its existing use and to maximise to the extent practicable the potential future uses of the site.
- Wherever human health is at risk, either on or off-site, or the off-site environment is at risk, a contaminated site should be cleaned up to the extent necessary in order to minimise such risks in both the short and long terms. However, in cases where there is no threat to human health and the environment is not at risk, it may be appropriate to clean-up the site to some lesser degree, and in some cases to accept a strategy of containing contaminants on the site or using planning controls to limit site use. Considerations of technical feasibility and of net social benefit should always play a part in influencing the clean up strategy for a particular site.
- Clean-up should not proceed if the process is likely to create a greater adverse effect than leaving the site undisturbed.

Environmental and Human Health Risk is based on exposure to potential hazards and is defined as:

- $\text{Risk} = \text{Hazard} \times \text{Exposure}$.
- The elimination of risk can be achieved by the removal of the hazard and/or the exposure pathway. Remediation commonly involves removal of the hazard, while risk management involves removal of the exposure pathway but the hazard may remain. Exposure pathways to contaminated material can be managed by any physical action and/or management plan which prevents exposure to contaminants, such as planning controls, management controls, and/or site remediation.
- A planning control is any means to control future change of end use and associated demolition/construction activities, and could take the form of leasing/selling arrangements to specific planning legislation controls. For example if contaminated soil is buried/capped in a particular zone, that zone may be designated to have a particular land use e.g. public open space or roadways. This enables the material to be placed in less sensitive land use areas (e.g. under roadways) within land used for more sensitive purposes such as residential.

A risk based remediation/management strategy consistent with the strategy outlined in ANZECC/NHMRC (1992) is considered appropriate for the remediation of contaminated soils and sediments on the site. The general objective of the remediation will be to remove, manage or remediate areas of contamination that present an unacceptable risk to human health or the environment under the proposed land use scenarios.

Where contaminated material is to be removed, it will be remediated to the extent practical, subject to consideration of risk and economic factors and consistent with the net environmental benefits of the overall site remediation. Assessment of the risk associated with remaining contamination will be based on the assessment criteria described in Section 6 of this RAP.

GHD notes that the scope of previous assessments and this RAP have not allowed for a site-specific risk assessment, and the assessment criteria described in Section 6 are investigation levels, which the NEPM 1999 (NEPC 2013) describes as the concentrations of a contaminant above which further appropriate investigation and evaluation are required. The NEPM (Schedule B1) notes that investigation and screening levels are not clean-up or response levels, and the use of investigation and screening levels as default remediation criteria may result in unnecessary remediation and increased development costs, unnecessary disturbance to the site and local environment, and potential waste of valuable landfill space.

The NEPM 1999 (NEPC 2013) Schedules B4 and B5 note that exceedance of investigation levels would typically prompt a site-specific risk assessment and the development of site-specific risk-based criteria for comparison with site data. The processes for health risk assessment (HRA) and ecological risk assessment (ERA) are similar, differing primarily in the pathways and receptors involved. The NEPM 1999 (NEPC 2013) acknowledges that more detailed stages of risk assessment are more time consuming and costly, and notes that where no further assessment is proposed, a clear and transparent explanation should be provided.

In this instance, it is considered that the main function of a site specific risk assessment would be to establish concentrations of the COCs that would result in a particular level of impact/species protection at the periphery of the areas of contamination. Concentrations of COCs in the most significantly impacted areas of the Site are clearly above the relevant assessment criteria and are having an evident impact on the environment (and hence clearly require remediation or management). Even with site specific risk assessment, there would still be some uncertainty as to acceptable concentrations of COCs at the periphery of the impacted area, and other factors such as the cost and net environmental benefit of extending the area of remediation are likely to have greater influence on the decision process than a more precise understanding of the level of risk. This RAP has therefore concentrated primarily on evaluating the most appropriate remediation methodology to manage the most significant areas of impact, with decisions on the subsequent extent of remediation in peripheral areas to be made in consultation with the stakeholders. Decisions are to be based on a range of factors that will influence the remediation works as described further in the following sections of this RAP.

4.2 Remediation objectives

The intention of Crown Lands is to use the site as Public Open Space. Considering this proposed land use and the location of the site (adjoining a SEPP 14 wetland and upstream of Urunga Lagoon), the following remediation objectives should be met:

- Remediation should enable the site to be safely opened to public access, without unacceptable risk to health from contamination.
- Remediation should result in final landforms that facilitate beneficial use of the site as public open space, and satisfy relevant stakeholders to the maximum practical extent.
- Remaining contamination should not present any unacceptable risks to the environment.
- Remediation works should not cause greater environmental or health impacts than would occur if the contamination is left in place.
- Concentrations of contaminants should be below appropriate health-based assessment criteria in surface soils and soils likely to be disturbed during use of the site (taking into account potential redevelopment works).

- Concentrations of contaminants exceeding ecological investigation levels must not be placed in a location or manner that could reasonably be expected to exacerbate existing risks of potential impact to ecological receptors.
- Remediation must be able to be completed within the funding available for the work.
- Remediation must meet the requirements of EPA Management Order 20111405.

The adopted remediation activity must also:

- Be cost effective to ensure maximum reduction in bio-available contaminants over the long term.
- Consider the latest approaches to stabilisation of the key contaminants of concern.
- Allow for the impact of periodic flooding and tidal influence at the site.
- Favour solutions that separate contaminated material from water within the hydrological zones.
- Effectively manage acid sulfate soils (ASS).
- Be in compliance with all relevant Commonwealth, State and Local legislation.

The decision process governing remediation should also consider the final land form and land use. For instance, management measures or institutional controls may be an effective means of controlling risks in some areas, if these are compatible with long-term beneficial use of the area. These considerations are likely to be specific to each particular area of the Site. GHD considers that effective planning and a clear vision of the final land form and use will result in the most cost effective remediation as well as the best outcome for rehabilitation of the site. The involvement of key stakeholders at the remediation planning stage will be essential to this outcome.

For the purposes of this RAP, the primary target for remediation is the tailings deposit. Consideration will be given to remediation of sediments and other areas of contamination, if practical.

Further details as to how the contamination will physically be removed from excavations, including details on shoring/battering and dewatering of excavations will be included in a Construction Environmental Management Plan (CEMP) to be prepared prior to construction activities.

Details of the remediation works required to achieve these objectives are described in Section 5.

4.3 Areas requiring remediation

Figure 2-1 and Figure 2-2 show the interpreted extent of significant contamination on the site that has been identified by investigations to date. There are some isolated areas outside the interpreted extent of impact where contamination exceeds the adopted criteria by less than 10 times, however these areas are considered to present a relatively low risk to health or the environment, and existing impact is not evident in these areas (eg. vegetation is healthy). Given the remediation objectives and constraints, it is not considered that remediation of such areas is warranted.

Conversely, there are some areas (eg. former ore stockpiling / site access in the northern portion of the site) where significant contamination has not been identified but remaining impacts are evident. These areas will require some form of rehabilitation if only for aesthetic reasons, although remediation per se (eg. to prevent unacceptable health risks) is not required.

Within the interpreted extent of impact, a balance will be required to address the remediation objectives. The cost of remediation and the impacts incurred during the remediation works will need to be weighed up against the impacts and risks of leaving areas of contamination in place. Without prejudicing the decisions for any particular area, as general guidance it is proposed that areas will not warrant remediation where the following conditions apply:

- Contamination is present at concentrations less than relevant health investigation levels (on a statistical basis for the subject area) and/or the potential for exposure is acceptably low.
- Contamination concentrations are nominally less than 10 times the ecological investigation levels, or higher exceedences are relatively isolated in extent and in an area where there would be a high risk of ecological impact by remediation activities.
- The area is physically stable and has a good cover of viable vegetation.
- Extensive disturbance of the area would be required to remove or treat the contamination.

A discussion of areas potentially requiring remediation is presented in Table 4-1 along with conservative estimates of the volume of material contaminated and the mass of antimony in each area. The locations of the areas defined in the table are presented in Figure 4-1. Table 4-2 presents the volumes and mass of antimony¹ in more detail, along with the cumulative volume and mass of antimony removed by remediating the areas in order of the greatest mass (generally corresponding to the highest contaminant concentrations) to the least. Figure 4-2 illustrates the cumulative effect and the diminishing returns after the main areas of contamination have been remediated.

'Conservative' and 'optimistic' estimates of volumes of material and mass of antimony were calculated for each area as a basis for reviewing options with the stakeholders. The volumes of material with concentrations greater than 30 times and greater than 10 times the guideline have also been calculated for areas A and B, as shown in Table 4-2. The conservative volumes have been calculated by assuming the identified impact extends to the depth identified as having a lower concentration (e.g. where concentrations of 30 times and 10 times the guideline were identified at depths of 1.5 and 2.0 m respectively, the soil with 30 times impact was assumed to extend to a depth of 2.0 m). The optimistic estimate has been calculated by assuming the identified impact extended only to the minimum depth of identified impact (e.g. where concentrations of 30 times and 10 times the guideline were identified at depths of 1.5 and 2.0 m respectively, the soil with 30 times impact was considered to extend only to a depth of 1.5 m). The conservative and optimistic depths of impact were then multiplied by the area to provide the volume. The volumes were multiplied by the average contaminant concentration from the samples from within each area and sub area (i.e. greater than 30x and greater than 10x the guideline) to give the mass of antimony.

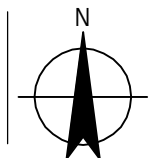
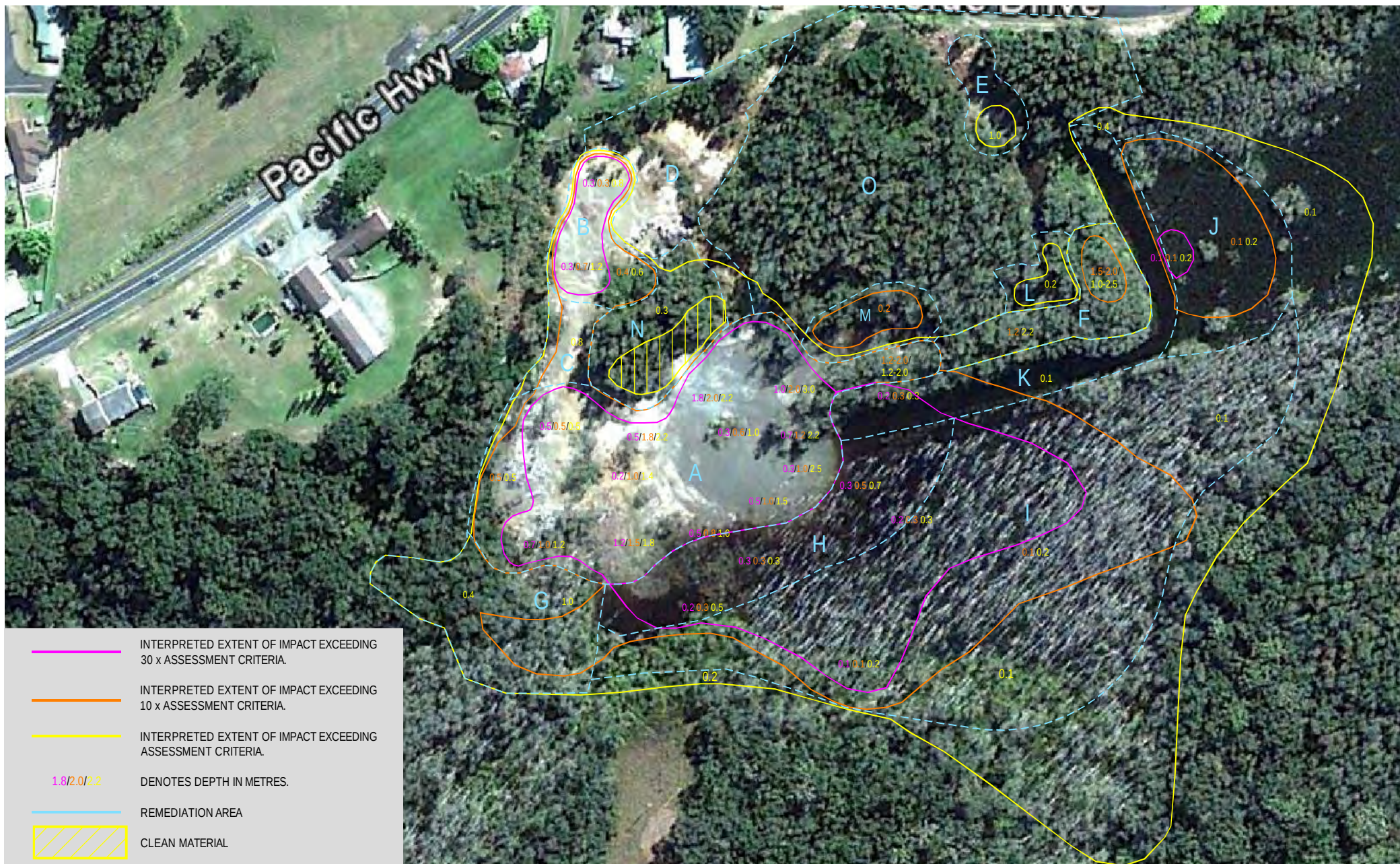
¹ For simplicity, only antimony data has been illustrated; however the arsenic concentrations and mass are closely related to those of antimony, and are adequately illustrated by the antimony data.

Table 4-1 Remediation areas

Area	Description	Characteristics	Area (m ²)	Estimated Contaminated Volume (m ³)	Estimated Mass of Antimony (tonnes)	Comment
A	Main tailings and former processing area	Significant contamination, exceeding 30 x HIL E in most of area. Contains tailings, remnant stockpiles and miscellaneous contamination / waste materials. Little or no vegetation. Groundwater exceeds ANZECC criteria by more than 30 times.	10,300	19,000	240	Requires remediation. Extent is relatively insensitive to selected clean-up levels, as there is a relatively quick cut-off to lower levels at boundaries of area.
B	Former ore stockpile area	Significant contamination, exceeding 30 x HIL E. Level area with little or no vegetation.	1,730	1,170	13	Requires remediation. Extent may vary somewhat, but not expected to have significant effect on overall volumes or remediation strategy.
C	Between ore stockpile and process area	Level area with little or no vegetation.	700	580	2	Requires remediation. The extent is relatively shallow and may vary laterally, but not expected to have significant effect on overall volumes or remediation strategy.
D	Former site access area	Relatively well characterised, no significant contamination. Little vegetation, likely because area has been excavated to bedrock.	3,430	<1	<1	Will require rehabilitation for aesthetic reasons.
E	North eastern disturbed area	Some contamination less than 10 x HIL E, XRF data indicates significant lead and zinc contamination. No vegetation. Drainage pathway. Likely source of impact to north end of S shaped canals and north end of L shaped canal (elevated zinc).	900	200	<1	Likely to require remediation subject to further characterisation. Will require rehabilitation for aesthetic reasons.
F	Panhandle adjoining L shaped canal	Contamination exceeds 10 x HIL E at some locations, at former ground level generally beneath at least 0.5 m 'clean' soil. Vegetation is healthy. Boundary between Area A and Area F to	1,950	970	5	Low risk to health or environment due to relatively limited extent (likely previously impacted natural soils) and lack of exposure to contamination. Could be managed by installing a boardwalk through this area, also making use of the physical

Area	Description	Characteristics	Area (m ²)	Estimated Contaminated Volume (m ³)	Estimated Mass of Antimony (tonnes)	Comment
		be determined.				characteristics for beneficial future use of the site.
G	South west of processing plant and tailings area.	Contamination exceeds criteria and extends into adjacent property. Extend of contamination extends to at least 0.5 mbgs and additional work required to delineate lateral extent. Area is extensively vegetated.	3,400	280	<1	Remediation likely to be required, subject to further delineation to define extent and degree of contamination, including on adjacent property. Extent of remediation will need to be determined.
H	Wetland adjoining south of tailings area.	Significant impact exceeding 30 x HIL E and 30 x sediment criteria. Surface water exceeds ANZECC criteria by more than 10 times. Significant impact to vegetation apparent. Boundary between Area H and Area I to be determined. Further delineation of extent and degree and ecology / ecotoxicology studies (eg. field survey) recommended to aid decisions on extent of remediation.	4,000	1,930	11	Remediation considered to be required, extent will require consideration of cost, impacts during remediation vs risks associated with leaving contamination in place. Boundary between Area H and Area I to be determined.
I	Southern side of wetland.	Significant impact exceeding 30 x sediment criteria, but vegetation does not show as significant impact as Area H.	18,800	2,280	10	May not warrant remediation due to considerations of cost and impacts during remediation vs risks associated with leaving contamination in place.
J	Wetland east of L shaped canal.	Significant impact exceeding 30 x sediment criteria. Vegetation does not show significant impact. Further delineation of extent and degree and ecology / ecotoxicology studies recommended to aid decisions on extent of remediation.	3,800	350	1	May not warrant remediation due to considerations of cost and impacts during remediation vs risks associated with leaving contamination in place.
K	L shaped canal	Areas of contamination adjacent to tailings but less than adjacent wetland sediments. Significant depth likely to limit potential exposure.	3,300	520	2	Likely no remediation. Uncertainties subject to further sampling and possibly ecotox survey.

Area	Description	Characteristics	Area (m ²)	Estimated Contaminated Volume (m ³)	Estimated Mass of Antimony (tonnes)	Comment
L	SE corner of S shaped canal	Elevated As, Sb and Zn with respect to sediment criteria and EILs, but not significantly above HIL E. No apparent impact, well vegetated, low potential for migration offsite.	660	60	<1	No remediation proposed.
M	Western end of S shaped canals.	Adjoins tailings area, apparent impact from migration of sediments from tailings area. Sb and As greater than 10 times HIL E and sediment criteria, little vegetation, potential for exposure.	1,125	120	<1	Remediate in conjunction with Area A.
N	Vegetated area between ore stockpile area and tailings area.	The extent of impact was noted to extend into the north western portion of the vegetated area. Contamination extended to approximately 0.2 mbgs.	2,140	635	1	Remediate the northern western portion in conjunction with Area B and C.
O	North eastern portion of site.	Mainly densely vegetated, no significant signs of impact, relatively well characterised, contaminant concentrations less than 10 x HIL E and in most cases less than EILs.	15,550	0	0	No remediation proposed.



NSW Catchment & Lands - Crown Lands
Former Antimony Processing Plant - Urunga
RAP
REMEDIAION AREAS

Job Number | 22-16251
Revision | A
Date | NOV.2013

Figure 4-1

Table 4-2 Volume and mass of antimony by remediation area

Area	Estimated Volume of Soil (m ³)	Estimated Mass of Antimony (tonnes)	Cumulative Volume of Soil (m ³)	Cumulative Mass of Antimony (tonnes)	Cumulative Mass of Antimony Removed (% of overall mass of Antimony identified onsite)
A (30x) ¹	9854	189	9854	189	66
A (10x) ²	4910	44	14764	233	82
A (>Guideline) ³	4319	7	19083	240	84
B (30x) ¹	474	9	19557	249	87
B (10x) ²	692	4	20249	253	89
C	579	2	20828	255	89
D	<1	<1	20828	255	89
H	1929	11	22757	266	93
I	2280	10	25037	276	97
E	202	<1	25239	276	97
G	280	<1	25519	277	97
M	119	<1	25638	277	97
F	969	5	26607	282	99
N	635	1	27424	283	99
K	517	2	27759	285	100
J	353	1	28112	286	100
L	63	<1	28175	286	100
O	<1	<1	28175	286	100

¹ This relates to material that has a concentration of antimony 30 times or greater than the guidelines.

² This relates to material that has a concentration of antimony between 10 times and 30 times greater than the guidelines.

³ This relates to material that has a concentration of antimony between the guideline and 10 times greater than the guidelines.

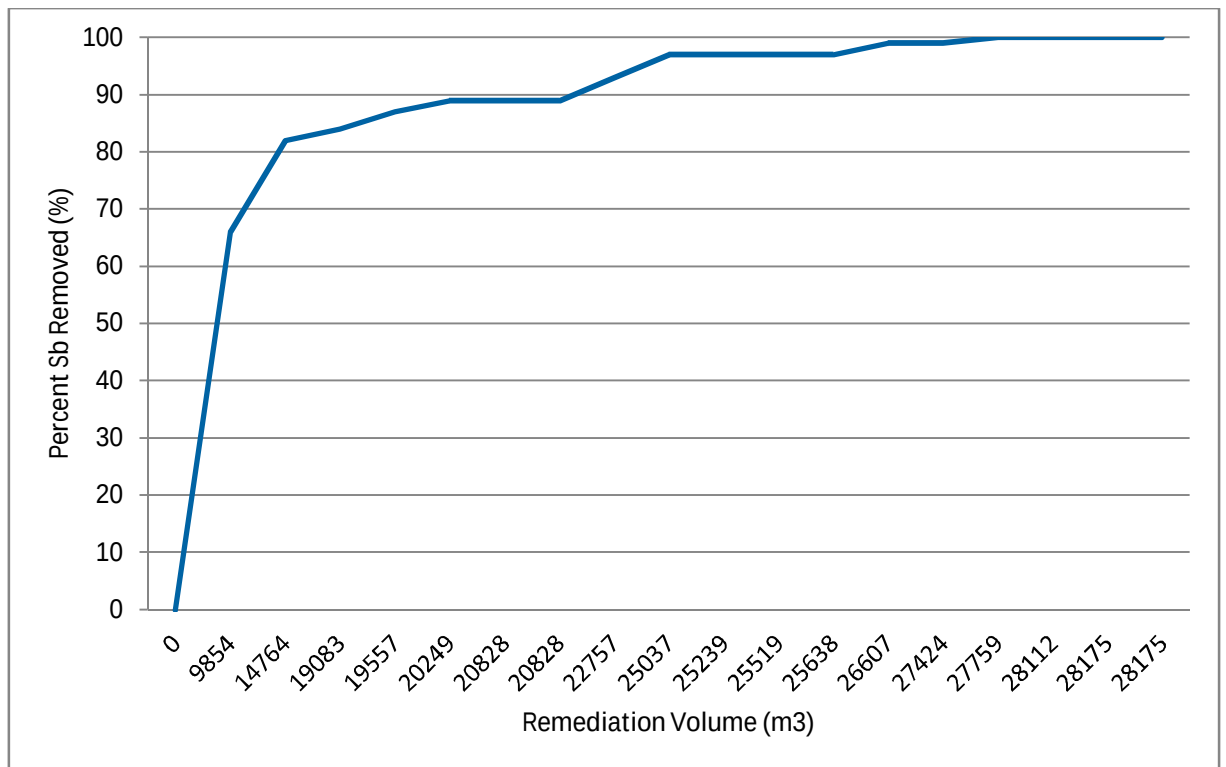


Figure 4-2 Proportion of antimony removed compared to the volume of material removed

4.3.1 Summary

In summary, Area A is considered the priority for remediation due to the concentration and mass of contamination plus its proximity to the edge of the wetland. Remediating this area would remove approximately 84% of the overall amount of contamination identified onsite. Extending the remediation area to include Areas B, C and H would increase the overall mass of antimony removed from the site to 266 tonnes or 93% of the total amount identified onsite. These areas could be remediated relatively easily and with minimal impact. Area I also has a relatively large volume and mass of contamination but access would be difficult and the impact of remediation versus the benefit needs to be considered.

Contamination exists at Areas F, J, K, M and N but there is limited volume and most areas are covered in vegetation or under water. Area M could be relatively easily remediated but the cost and damage caused by remediating the other areas may be greater than the benefits.

Area G is not as contaminated as other areas and is heavily vegetated, but may require remediation because part of the area is offsite.

It is also recommended that Areas D and E be rehabilitated during the remediation because access is readily available and it would improve the aesthetics of the site.

No remediation is considered necessary at Areas L and O.

4.4 Technical and policy considerations

The EPA's preferred order of options for site remediation and management, in accordance with policy described in ANZECC/NHMRC (1992) and DEC (2006), is as follows:

- On-site treatment of the soil so that the contaminant is either destroyed or the associated hazard is reduced to an acceptable level.
- Off-site treatment of excavated soil so that the contaminant is either destroyed or the associated hazard is reduced to an acceptable level, after which the soil is returned to the site.

If these options cannot be implemented, then other options that should be considered include:

- Removal of contaminated soil to an approved site or facility, followed, where necessary, by replacement with clean fill.
- Consolidation and isolation of the soil on-site by containing within a properly designed barrier.

The NEPC (2013) reverses the preferred order of the last two points. Considerations of sustainability and the Waste Avoidance and Resource Recovery (WARR) Act (1997) also support avoiding off-site disposal.

For on-site containment of contamination, whether in a dedicated cell or as part of site development, the EPA requires containment to achieve the following:

- Maximise the long-term engineering security of the works, and, where applicable, minimise the potential for leachate formation and/or volatilisation.
- Exclude the erection of structures on the capped or contained area that may result in risk of harm to the public health or the environment.
- Include a notification mechanism to ensure that the capped or contained areas are protected from any unintentional or uncontrolled disturbance that could breach the integrity of the physical barrier.

4.5 Identified remediation options

Four broad options for remediating the site have currently been identified. The remediation options relate to those areas identified for remediation in Table 4-1 and Figure 4-1.

The four remediation options are briefly explained below and illustrated in Appendix B.

While a single remediation strategy may be selected for the overall works, it is likely that a combination of strategies may be applicable to some areas of the site (i.e. outside the main remediation area), particularly in areas where a management, rather than intrusive remediation approach, is considered to be more appropriate (following the considerations described elsewhere in this report). For instance, there will be some off-site disposal (of miscellaneous materials) regardless of the overall preferred option; potentially some contaminated sediments could be capped in situ to minimise disturbance; and management of contaminated land adjoining the site may be appropriate for Area G.

The option of 'Do Nothing' was not considered appropriate due to the identified, current impact resulting in a lack of vegetation in the vicinity of the tailings deposit and potential risk associated with further, potential mobilisation of impacted soil, sediment and water. However, this may apply to "fringe" areas of the site, as noted above.

4.5.1 Option 1 - Off-site reprocessing or disposal without treatment

This option would involve the removal of source material, long haul transport, and off-site reprocessing and disposal at an appropriate ore processing facility. The processing facility considered during the assessment was Hillgrove Mine (near Armidale NSW) because it is the closest antimony processing area to the Site hence minimising transport cost. Hillgrove Mine has infrastructure to process similar minerals, although the tailings dam at the facility would likely need to be upgraded to accommodate the additional material.

An alternative option i.e. Option 1B, is the disposal of the untreated material at an appropriately licenced landfill able to accept the untreated material. The landfills investigated were in south-east Queensland because NSW does not have landfills licenced to accept much of the untreated material.

The main tasks involved with these options, would include:

- Site and access establishment.
- Removing existing infrastructure and rubbish.
- Installing environmental management controls (eg water, soil, clearing limits).
- Excavation of material.
- Haulage of material to reprocessing site or landfill.
- Reprocessing or disposal at landfill.
- Rehabilitation of excavation area.

4.5.2 Option 2 - Off-site disposal

The off-site disposal option would involve removal of source material, treatment on-site or off-site, long haul transport, and disposal to a licensed facility (Grafton Landfill) within a containment cell or isolated (segregated) portion of the landfill.

The main tasks involved in this option would include:

- Site and access establishment.
- Removing existing infrastructure and rubbish.
- Installing environmental management controls (eg water, soil, clearing limits).
- Excavation of material.
- Treatment of material.
- Possible establishment of a containment cell at the landfill.
- Haulage to landfill.
- Rehabilitation of excavation area.

4.5.3 Option 3 - On-site disposal

The onsite disposal option would involve removal of source material, possible treatment on-site (Option 3A) or onsite containment without treatment (Option 3B), short haul transport for disposal to a containment cell on-site.

The main tasks involved in this option would include:

- Additional investigations to better define design constraints / parameters for this option.
- Site and access establishment.

- Removing existing infrastructure and rubbish.
- Installing environmental management controls (eg water, soil, clearing limits).
- Excavation of material.
- Possible treatment of material.
- Establishment of an on-site containment cell.
- Placement of material in containment cell.
- Rehabilitation of excavation area.
- Monitoring of groundwater and surface water quality.

4.5.4 Option 4 - In-situ containment

In-situ containment would involve leaving the source material in place (Option 4A), possibly with stabilisation or treatment (Option 4B), and construction of a containment system in-situ to prevent direct exposure or mobilisation and separate contaminated material from surface and ground waters.

The main tasks involved in this option would include:

- Additional investigations to better define design constraints / parameters for this option.
- Site and access establishment.
- Removing existing infrastructure and rubbish.
- Installing environmental management controls (eg water, soil, clearing limits).
- Possible treatment of material.
- Establishment in-situ containment cell.
- Monitoring of groundwater and surface water quality.

4.6 Remediation constraints and limitations

Remediation activities will be constrained by factors including:

- Long term feasibility.
- Technical feasibility.
- Data gaps.
- Cost.
- Site characteristics.
- Availability of Appropriate Disposal Sites (for excavation and off-site disposal).
- Implementation timeframe.
- Contractor availability.
- Resource availability (e.g. backfill).
- Legislative requirements.
- Ongoing monitoring requirements.
- Ongoing liabilities.
- WHS requirements.

- Community acceptance.
- Environmental considerations.

4.6.1 Remediation option comparison

A preliminary evaluation of these factors for the various remediation options is presented in Table 4-3.

Table 4-3 Remediation option comparison

Constraint	Off-site Reprocessing	Off-site Disposal	On-site Disposal	In-situ Containment
Long term reliability (in relation to the site)	Good – material permanently removed from site	Good – material permanently removed from site	Moderate – depends on containment design	Low – Moderate – depends on containment design
Technical feasibility	Good – proven technologies	Good – established methodology	Moderate – reasonably established methodology	Moderate– reasonably established methodology
Data gaps (excluding those relating to extent of remediation)	Whether material is cost effective to reprocess	Minimal (based on successful completion of immobilisation trials)	Geotechnical and groundwater data at disposal site	Geotechnical and groundwater data at disposal site
Relative cost	Low – High – reprocessing is relatively low but transport and disposal costs make disposal at hazardous waste landfill a high cost option.	High – particularly if landfill levies apply. Also treatment and transport costs.	Moderate – depends on treatment and containment design.	Low - Moderate– depends on treatment and containment design.
Site Characteristics	Moderate – requires replacement fill	Moderate – requires replacement fill	Low – Moderate – space on site is limited for a containment cell, still requires replacement fill	Moderate – siting not ideal for in-situ containment, but no replacement fill required
Disposal site availability	Unknown – depends on reprocessing site	Satisfactory	Good (available, subject to other constraints)	Good (available, subject to other constraints)
Resource availability (eg backfill)	Good if timing coincides with major transport civil works	Good if timing coincides with major transport civil works	Good if timing coincides with major transport civil works	Good – less backfill required
Contractor Availability	Potential issues due to lack of processing facilities in a position to accept the material	Good	Good	Good
Legislative requirements	Satisfactory if existing processing plant can accept	Satisfactory – existing waste management regulatory framework	Potential Issues associated with long term liability and management.	Potential Issues associated with long term liability and management.
Timeframe	Satisfactory	Satisfactory	Satisfactory	Satisfactory
Ongoing Monitoring or management requirements	Minimal for site. Liability passes to reprocessing site's disposal facility. (High off-site)	Minimal for site. Disposal facility managed in conjunction with requirements for rest of disposal site.	Moderate to High – to maintain and monitor integrity of containment.	High– to maintain and monitor integrity of containment.
Ongoing liability	Minimal for site. Liability	Minimal for site. Disposal facility	Moderate – High –	Moderate – High–

Constraint	Off-site Reprocessing	Off-site Disposal	On-site Disposal	In-situ Containment
	passes to reprocessing site's disposal facility. (Moderate - High for off-site).	managed in conjunction with requirements for rest of disposal site. (Low for off-site).	contaminated material remains on site.	contaminated material remains on site.
WHS	Moderate risk – limited to civil works on site	Moderate – High – civil works and treatment on site.	Moderate – High – civil works and treatment on site.	Moderate – High – civil works and treatment on site.
Likely Community acceptance	Low – strong community concerns in relation to any re-processing, due to publicised impacts from mining areas	Good	Low – Moderate – depending on containment design.	Low – Moderate – depending on containment design.
Potential short-term environmental impacts from remediation (surface water, groundwater, ecological, air quality, noise, traffic, visual amenity, heritage)	Moderate negative impact due to site disturbance, transport.	Moderate negative impact due to site disturbance, transport.	Low - Moderate negative impact due to site disturbance, containment cell construction, reduced transport.	Low negative impact due to reduced site disturbance, reduced transport.
Potential long-term environmental impacts (surface water, groundwater, ecological, air quality, noise, traffic, visual amenity, heritage)	Low risk on site. Need assurance that reprocessing site will be appropriately managed.	Low risk – contamination removed from site, to managed waste disposal facility.	Moderate risk – depending on containment design.	Moderate to high risk – depending on containment design.
Sustainability	Good (recovery of minerals, treatment of contaminated material, but off-set by haulage requirements).	Low - Moderate (treatment, use of landfill space, moderate haulage requirements).	Moderate (minimal haulage, greater containment cell construction requirements, moderate risk of future requirements).	Moderate (minimal disturbance, minimal haulage, higher risk of future requirements).

Note: The governing / main differentiating constraints for each option are highlighted in yellow (negative constraints) or green (positive constraints / differentiators).

4.6.2 Remediation options summary

Essentially, all options can be designed to meet the remediation objectives, with the main differences (apart from cost) being whether the most-contaminated material is removed from site (and liability for long-term management passes to other parties), or whether it remains on site, and the degree of certainty that it will be securely contained on site with no unacceptable adverse long term impacts.

The risks associated with on-site containment options are further examined in Table 4-4 below, with comparison against the existing situation as a “baseline” risk scenario. The basis of assigning risks is described in Appendix C.

Table 4-4 Risk assessment of on-site containment options

Scenario	Status Quo			In-situ containment without treatment			In-situ containment with treatment			Engineered Containment Cell with treatment			Engineered Containment Cell without treatment		
Direct Exposure to Contamination	Currently no control to direct exposure. Significant on-site impacts are evident which require major works to restore function of site. Rectification works >\$1M.			Cap would prevent exposure except in exceptional circumstances. Untreated waste could result in significant consequence if contamination is exposed.			Cap would prevent exposure except in exceptional circumstances. Treated waste would result in less serious (eg. moderate) consequence if contamination is exposed.			Cap would prevent exposure except in exceptional circumstances. Treated waste would result in less serious (eg. moderate) consequence if contamination is exposed.			Cap would prevent exposure except in exceptional circumstances. Untreated waste could result in significant consequence if contamination is exposed.		
	A	1	V	E	2	M	E	3	L	E	3	L	D	2	M
Leachate migration direct from material, via surface water or via groundwater	Currently no control on generation or migration of leachate. Significant effects are present (contributions by leachate unknown but likely to dissipate through dilution – sediment migration likely more critical), regulatory action required.			Without treatment, the material would still be highly leachable, and migration to some degree is likely to occur. Potential migration would be limited by the capping and underlying geology. Impacts could possibly be moderate. More detailed hydrogeological investigations may increase confidence in a lower risk, subject to design and construction details.			Treatment of the material will reduce the chance of leachate migration, although migration to some degree could still occur. Potential migration would be limited by the capping and underlying geology. Impacts unlikely to be as high as moderate. (Possibly minor – same risk ranking). More detailed hydrogeological investigations may increase confidence in a lower risk, subject to design and construction details.			The material would be treated, and in an engineered containment system. Any more than insignificant migration would be highly unlikely to occur except in system failure – further examined below.			Without treatment, the material would still be highly leachable, and migration to some degree may occur. Potential migration would be limited by containment in the engineered cell.		
	A	2	V	C	3	M	D	3	M	E	4	L	D	3	M

Scenario	Status Quo	In-situ containment without treatment	In-situ containment with treatment	Engineered Containment Cell with treatment	Engineered Containment Cell without treatment
Migration of contaminated tailings / sediments through direct erosion or release	Currently occurring, no protective measures. Impacts considered Significant to Severe (main impacts presumably from past migration, but almost certainly ongoing).	Containment will prevent migration of contaminated material. Failure mechanisms examined separately below. If discharge of untreated sediments occurred, consequences could be significant.	Containment will prevent migration of contaminated material. Failure mechanisms examined separately below. Discharge of treated sediments unlikely to exceed moderate.	Containment will prevent migration of contaminated material. Failure mechanisms examined separately below. Discharge of treated sediments unlikely to exceed minor given further distance of containment cell from wetland.	Containment will prevent migration of contaminated material. Failure mechanisms examined separately below. Discharge of treated sediments unlikely to exceed minor given further distance of containment cell from wetland.
	A 1 V	E 2 M	L 3 L	E 4 L	E 4 L
Loss of containment	No present containment. Situation captured above.	Mechanisms captured below.	Mechanisms captured below.	Mechanisms captured below.	Mechanisms captured below.
Stabilisation is or becomes ineffective	No present stabilisation. Situation captured above.	No stabilisation. Risks taken as equivalent to worst case above.	Stabilisation is expected to be effective for geological periods.	Stabilisation is expected to be effective for geological periods.	No stabilisation. Risks taken as equivalent to worst case above.
		C 3 M	E 3 L	E 3 L	C 3 M
Failure of leachate collection systems	No present containment. Situation captured above.	No leachate collection system	No leachate collection system	Failure of leachate collection system could result in a built up of leachate and greater risk if released. Failure unlikely if properly designed and installed.	Failure of leachate collection system could result in a built up of leachate and greater risk if released. Failure unlikely if properly designed and installed.
				E 3 L	E 3 L
Release of leachate through liner.	No present containment. Situation captured above.	No liner. Situation captured by leachate migration scenario above.	No liner. Situation captured by leachate migration scenario above.	Assuming leachate collection system does not fail. Some release likely, but consequence expected to be negligible.	Assuming leachate collection system does not fail. Some release likely, and consequence could be greater because of the lack of treatment.
				B 5 L	B 4 M

Scenario	Status Quo	In-situ containment without treatment			In-situ containment with treatment			Engineered Containment Cell with treatment			Engineered Containment Cell without treatment		
Failure of cap – small scale leaks	No present containment. Situation captured above.	Small scale leaks / infiltration likely, causing leachate. Risk of migration as above. Untreated waste increases likely consequence to moderate (depending on hydrogeology and design – see leachate migration scenario above).			Small scale leaks / infiltration likely, causing leachate. Risk of migration as above. Treated waste reduces likely consequence to minor (depending on hydrogeology and design – see leachate migration scenario above).			Small scale leaks / infiltration likely, causing leachate, but will be captured by liner / leachate system reducing likely consequence. Treated waste also reduces likely consequence to minor.			Small scale leaks / infiltration likely, causing leachate, but will be captured by liner / leachate system reducing likely consequence.		
		C	3	M	C	4	M	D	4	L	D	3	M
Failure of cap – large scale erosion	No present containment. Situation captured above.	Containment cell within flood zone. Large scale erosion unlikely, but consequence could be significant. Hydrology study / capping design may reduce risk.			Containment cell within flood zone. Large scale erosion unlikely, but consequence could be significant. Hydrology study / capping design may reduce risk.			Containment cell above flood zone, insignificant catchment. Damage highly unlikely, although if it occurred, consequence could be significant.			Containment cell above flood zone, insignificant catchment. Damage highly unlikely, although if it occurred, consequence could be significant.		
		D	2	M	D	2	M	E	2	M	E	2	M
Unplanned disturbance to cell	No present containment. Situation captured above.	Unlikely with adequate site management. Exposure to untreated contamination could result in moderate impact.			Unlikely with adequate site management. Exposure to treated contamination more likely to result in minor impact.			Unlikely with adequate site management. Exposure to treated contamination more likely to result in minor impact.			Unlikely with adequate site management. Exposure to untreated contamination could result in moderate impact.		
		D	3	M	D	2	L	D	2	L	D	3	M
Flood damage to containment	No present containment. Situation captured above.	As above.			As above.			As above.			As above.		

Scenario	Status Quo	In-situ containment without treatment			In-situ containment with treatment			Engineered Containment Cell with treatment			Engineered Containment Cell without treatment		
Batter instability	No present containment. Situation captured above.	Cell situated in area of low potential energy (eg. low elevation). Instability highly unlikely, with appropriate geotech input to design and construction.			Cell situated in area of low potential energy (eg. low elevation). Instability highly unlikely, with appropriate geotech input to design and construction.			Larger batter required to contain volume of waste. Instability unlikely with proper geotech input to design and construction. Consequence could be moderate to significant if failure occurred.			Larger batter required to contain volume of waste. Instability unlikely with proper geotech input to design and construction. Consequence could be moderate to significant if failure occurred.		
		E	3	L	E	3	L	D	3	M	D	3	M
Mass movement – slumping	No present containment. Situation captured above.	Cell situated in area of low potential energy (eg. low elevation). Slumping unlikely, subject to geotech review.			Cell situated in area of low potential energy (eg. low elevation). Slumping highly unlikely, subject to geotech review. (Treated mass more stable).			Cell situated in area of higher potential energy. Slumping highly unlikely, subject to geotech review. (Treated mass more stable).			Cell situated in area of higher potential energy. Slumping highly unlikely, subject to geotech review.		
		D	3	M	E	3	L	E	3	L	E	3	L
Mass movement – sliding	No present containment. Situation captured above.	Cell situated in area of low potential energy (eg. low elevation). Sliding unlikely, subject to geotech review. Has nowhere to slide, consequences minor.			Cell situated in area of low potential energy (eg. low elevation). Sliding highly unlikely, subject to geotech review. (Treated mass more stable).			Cell situated in area of higher potential energy. Sliding unlikely, subject to geotech review. (Treated mass more stable). Has further to slide – consequences moderate.			Cell situated in area of higher potential energy. Sliding unlikely, subject to geotech review. Has further to slide – consequences moderate.		
		D	4	L	E	4	L	D	3	M	D	3	M
Liquifaction (eg seismic)	No present containment. Situation captured above. (Unlikely to be any worse).	Possible for untreated contamination. Consequences unlikely to be higher than moderate.			Highly unlikely for treated contamination, subject to geotech review. Consequences unlikely to be higher than moderate.			Highly unlikely for treated contamination, subject to geotech review. Consequences be significant given higher elevation of site.			Possible for untreated contamination. Consequences could be significant given higher elevation of site.		
		C	3	M	E	3	L	E	2	M	C	2	H

Scenario	Status Quo	In-situ containment without treatment			In-situ containment with treatment			Engineered Containment Cell with treatment			Engineered Containment Cell without treatment		
Mass movement – settlement	No present containment. Situation captured above.	Untreated sediment possibly will settle, resulting in cap damage / maintenance requirements			Treated sediment unlikely to settle (subject to placement), resulting in cap damage / maintenance requirements. Geotech review may reduce to highly unlikely.			Treated sediment unlikely to settle (subject to placement), resulting in cap damage / maintenance requirements. Geotech review may reduce to highly unlikely.			Untreated sediment will possibly settle, resulting in cap damage / maintenance requirements		
		C	3	M	D	3	M	D	3	M	C	3	M
Effects on local hydrology (flooding)	No present containment. Situation captured above.	Capping likely to increase elevation of contaminated area, possible it may have some effect on local hydrology – subject to flood study.			Capping likely to increase elevation of contaminated area, possible it may have some effect on local hydrology – subject to flood study.			Cell above flood zone, highly unlikely to have any effect on local hydrology.			Cell above flood zone, highly unlikely to have any effect on local hydrology.		
		C	4	M	C	4	M	E	4	L	E	4	L

4.6.3 Onsite containment options summary

Table 4-4 indicates the “Status Quo” option presents a “very high” risk to direct exposure, migration, human health and the environment. This option is considered unacceptable, as is reflected by the EPA having issued a management order for the site.

“In-situ containment without treatment” reduces the risk to “medium” for most of the scenarios considered, with some risks reduced to “low”. The risk level for some scenarios may be reduced further subject to the outcome of more detailed investigations and design. Due to the nature of the material (unconsolidated, leachable and toxic) and its exposure to the local hydrology (i.e. groundwater and flooding), this option still presents some “medium” risks to direct exposure, migration, human health and the environment.

The “in-situ containment with treatment” option reduces the risks further, as a result of treatment decreasing the leachability and increasing the physical stability of the material. Most scenarios are considered to present a low risk, although there are some scenarios that are still considered to present a “medium” risk due to the exposure of the material to the local hydrology (i.e. groundwater and flooding).

The “engineered containment cell without treatment” also reduces the risk compared to the “in-situ containment without treatment” but presents a slightly greater risk than the “in-situ containment with treatment option”. This is mainly due to the instability of an engineered containment cell and the untreated material combined with the potentially severe consequence caused by the release of untreated material or leachate.

The “engineered containment cell with treatment” presents the lowest risk option for on-site management of the contaminated material. This option would stabilise the material and reduce its exposure to the local hydrology. However, this option does still present some “medium” risk scenarios which are associated with potential failure of the engineered cell. It is considered that these risks can be reduced to “low” with appropriate detailed design of the containment cell.

4.7 Cost estimate

The project has limited funding available to undertake the remediation works. To better understand the costs associated with each option, a detailed cost estimate was prepared by SCS. The cost estimate included all four main options plus their sub options. It also looked at a further five scenarios where 100%, 99%, 97%, 84% and 66% of contamination was removed. Table 4-5 provides a summary of the cost estimate (based on conservative quantity calculations as described in Section 4.3) and also presents how many tonnes of antimony are removed per million dollars. This provides an indication of the value for money.

The scenarios with less than 100% removal of contamination acknowledge that some areas of contamination would remain onsite. For scenarios approaching 97% or greater removal, the areas to remain onsite are considered to pose limited risk and remediation would not be practical due to access constraints and potential environmental damage.

GHD notes that these costs have been developed by SCS and are not warranted by GHD. The potential exists for remediation costs to be greater than the estimates provided, due to factors such as the heterogeneous nature of contamination distribution at the site, the inherent difficulties in defining quantities of contamination and the possibility of contamination being uncovered during remediation that was not apparent from the site investigations. GHD understands that the cost estimates have been compiled from estimated quantities (including time / productivity data) and available unit rates known to SCS or considered reasonably applicable, and the scope has not been costed by commercial tender. Tendered costs may vary from these estimates.

Table 4-5 Cost estimate summary

Option	Description	100% Removal (all Areas)		99% Removal (As 97% plus Areas F & N)		97% Removal (Areas A, B, C, D, E, G, H, I, M)		84% Removal (All Area A)		66% Removal (Area A 30x)	
		\$M	t/\$M	\$M	t/\$M	\$M	t/\$M	\$M	t/\$M	\$M	t/\$M
1A	Isolate, excavate, long haul transport, disposal at mining facility at Hillgrove	\$6.4	44.7	\$6.1	46.4	\$5.9	46.9	\$4.3	55.8	\$3.0	63.0
1B	Isolate, excavate, long haul transport, treatment & disposal at hazardous waste landfill Ipswich	\$20.5	14	\$19.7	14.4	\$18.7	14.8	\$13.5	17.8	\$7.7	24.5
2	Isolate, excavate, treatment, long haul transport, disposal as general waste landfill with leach ate control, Grafton	\$24.2	11.8	\$23.2	12.2	\$21.1	13.1	\$16.1	14.9	\$9.2	20.5
3A	Isolate, excavate, treatment, short haul, monocell onsite	\$9.0	31.8	\$8.4	33.7	\$8.1	34.2	\$6.2	38.7	\$4.4	43.0
3B	Isolate, excavate, short haul, hazardous waste monocell onsite	\$6.3	45.4	\$5.8	48.8	\$5.7	48.6	\$4.5	53.3	\$3.4	55.6
4A	Isolate, construct containment cell in-situ	\$4.3	66.5	\$4.1	69.0	\$4.0	69.3	\$3.0	80.0	\$2.4	78.8
4B	Isolate, construct containment cell in-situ, treat and dispose in-situ	\$7.3	39.2	\$7.0	40.4	\$6.7	41.3	\$5.2	46.2	\$3.7	51.1

Orange highlighting indicates highest cost and lowest mass of contamination removed per dollar.

Green highlighting indicates lowest cost and greatest mass of contamination removed per dollar.

4.7.1 Summary

The remediation costs presented in Table 4-5 range from approximately \$2.4 million to over \$24 million. Costs for all options are directly related to volumes remediated, and exhibit diminishing returns as illustrated in Figure 4-2. Option 4A (insitu containment without treatment) is the cheapest for all scenarios, followed by Option 1A (disposal at Hillgrove Mine) and Option 3B (onsite disposal without treatment). Options 4B (insitu containment with treatment) and 3A (onsite disposal with treatment) are the next least expensive options respectively.

In regards to cost per tonne of contamination removed, the 84% removal scenario for Option 4A presents the best value for money. With the exception of the 84% scenario for Option 4A, value for money decreases with the greater volumes remediated (by reason of greater areas of disturbance and lower concentrations of contamination as volumes remediated are increased). Option 4A provides the best value for money for all scenarios and even when remediating 100% of the contamination, this option provides better value (i.e. greater mass of contamination managed per \$) than any of the other options, for all the scenarios presented.

4.8 Remediation option summary

4.8.1 Option 1 - Off-site reprocessing

Option 1A – Off-site reprocessing

Off-site reprocessing was considered a desirable outcome because it would remove the contamination from the site, and would recover resources (eg. gold and antimony) from the contaminated material that could be sold to offset the costs of processing. While the concentration of valuable metals available for extraction is not sufficient to justify the cost of transport and processing, the cost of this option is reasonable compared to the other options.

However, due to the limited resource recovery potential, no processor has been found that is willing to take the material. The on-going off-site liability relating to the management of the residual contaminated material inherited by the reprocessing plant is also considered undesirable. There were also strong community concerns and public opinion against any reprocessing facilities receiving the material, arising in part from previous discharges to the environment from off-site antimony mining and processing facilities.

Option 1B – Off-site disposal at hazardous waste landfill

The transport and disposal of the material to a hazardous waste landfill at Ipswich was assessed. This option was initially considered a possibility because it removed the material from Site to a contained location but ultimately the transport and disposal costs combined to make this the second most expensive option.

4.8.2 Option 2 - Off-site disposal

Off-site disposal provides the advantages of limiting the on-going liability and risk. It would remove the contamination from the site using an established waste management process and facilities, and thus offers a high level of reliability and is also likely to be acceptable to the community. The cost associated with this option is its most significant disadvantage, particularly if landfill levies apply (although these levies may be considered representative of the costs of cell construction and ongoing monitoring that are borne by the landfill facility). The cost of extraction, treatment, transport and disposal means this option is the most expensive. Depending on funding, the cost of this option would limit the area that can be remediated.

4.8.3 Option 3 - On-site disposal

Option 3A – Treat and dispose on-site

On-site disposal is technically similar to the off-site disposal option, however the contamination would remain on site, and there would be on-going liability and risks which may not be acceptable to the community. The site constraints and technical feasibility, especially in the long term, are also limitations associated with this option. The main advantage of this option, compared to off-site disposal, is the lower cost because it would avoid the transport and disposal fees. However the construction costs (which would be related to the degree of on-going liability and risk) as well as the on-going management and monitoring required for this option would offset some of the cost savings of the remediation works. Further understanding of site conditions (groundwater and geotechnical) would be required for a robust design of on-site containment.

Option 3B – On-site disposal without treatment

The advantages and disadvantages of this option are similar to Option 3A. It is less expensive than Option 3A but also presents more risks because the material is not treated.

4.8.4 In-situ containment

Option 4A – In-situ containment without treatment

In-situ containment is considered to be the lowest cost and best value for money option, with the least impact during remediation and requiring the least off-site resources, but would also entail the greatest on-going liability and risk. This option may not be favourable due to the associated risk. Additional investigations (in particular groundwater and geotechnical) would be required to determine the viability of this option and the technical details required for adequate in-situ containment. The additional investigations, combined with the greater on-going management and monitoring required for this option would offset some of the cost savings of the remediation works. This option may also be considered a medium term solution until more funding is available in the future or new technologies provide more cost effective, onsite treatment options.

Option 4B – In-situ containment with treatment

The “in-situ containment with treatment” option would be similar to Option 4A but treating the material reduces the risks. However, this option would be more expensive than Option 4A and a similar cost as Options 3A and 3B which have a similar or lower risk.

4.1 Recommended remediation option

Option 3A – Treat and Dispose Onsite for the 97% scenario, was agreed to as the preferred option by the stakeholders including BSC, Crown Lands, EPA and SCS. This option would remove the material, immobilise the most leachable materials and place it in a containment cell onsite. This option was considered to be the most appropriate form of remediation when considering the above constraints, especially:

- Cost
- Long term reliability
- Site characteristics
- Ongoing liability
- Ongoing management
- Environmental impact

More details on the recommended remediation methodology, including contingencies for contaminated material remaining on-site, are outlined below in Section 5.

5. Remediation methodology

5.1 Overview of remediation methodology

As mentioned above, the adopted remediation option is 3A – Onsite Disposal with Treatment. Treatment requirements would vary depending on the degree of contamination, leachability and physical characteristics (eg. soil type) of the excavated material. The 97% scenario adopted would remove the contamination from Areas A, B, C, D, E, G (part), H, I (part) and M, as shown on Figure 4-1. The extent of excavation within Areas I and G would be limited to where healthy vegetation commences. This is consistent with the decision process for selecting remediation areas as discussed in Section 4.3. The nominated extent of remediation totals approximately 2.8 hectares in area and 25,000 m³ in volume.

An overview of remediation methodology was completed by SCS (2012) and is summarised in the following subsections.

5.1.1 Disturbance activities

Remediation will involve the following activities that will result in disturbance to the environment:

- Excavating contaminated material within the wetland for the purpose of bulk removal.
- Construction of the containment cell.
- Landform earthworks across the site to divert uncontaminated clean water away from the site and control the flow of surface water across the contaminated site.
- Importing clean material for engineering purposes including construction of impervious containment cell, surface capping, void filling, land reshaping or habitat purposes.
- Dewatering of surface or groundwater which enters the excavation works.
- Installing groundwater bores for the purpose of monitoring before and after the remediation works.
- Clearing and re-use or disposal of vegetation (both native regeneration and weeds), for the purpose of extracting underlying contaminated material.

5.2 Site establishment

The remediation works would be subject to key management plans including:

- Occupational Health and Safety Management Plan.
- Construction Environmental Management Plan (CEMP).
- Soil and Water Management Plan (SWMP).
- Traffic Management Plan (TMP).
- Waste Management Plan (WMP).
- Acid Sulfate Soil Management Plan (ASSMP).

Site establishment would also require:

- Establishing access to, from and within the site.
- Setup site compound.
- Full perimeter of security fencing (to water's edge).
- Appropriate warning signs related to construction and hazardous waste.

- Disposal of residual building waste including old processing mill structures and stockpiles.

5.3 Water management

Stormwater and groundwater management will be required including:

- Implement erosion and sediment controls in accordance with Urban Stormwater Manual Volume 1 7 2 (Blue Book) and IECA Guidelines.
- Install perimeter controls of contaminated area in the wetland.
- Separation and diversion of uncontaminated stormwater away or through the site.
- Management of stormwater and dewatering from the remediation areas which will include a sediment basin to allow treatment before discharge (if required). Discharge of water from the remediation or treatment areas will be avoided if possible, with water to be managed within the remediation areas by return to excavations where dewatering is no longer required, or used for dust suppression / moisture control of stockpiles and material to be placed in the containment cell.
- Setup washdown bay that drains to sediment basin.
- Remediation design to allow for flooding and expected climate change water level increases.
- Minimising inflow groundwater into sections of excavations, using temporary barriers (eg. sheet piling), if required.
- Locating any on-site containment areas away from groundwater influences.

More detail on the water management would be provided in the CEMP.

5.4 Excavation

5.4.1 Excavation extent

Decisions regarding the lateral extent of the excavation will be based on factors considered in Section 4.3 and site observations of ecological conditions. The decision will be made by the Project Manager, in consultation with an experienced ecologist and independent consultant. The decision making process will be documented to demonstrate that a sensible, transparent and defensible decision making process has been applied. Factors governing the decision making process will include the following:

- Previously identified levels of impact
- Vegetation cover extent and condition
- Human health considerations (access, depth, likelihood of dust creation)
- Proximity to water including groundwater, surface water, drainage paths, the wetland and potential flood inundation areas
- Ability of environmental controls to contain potential negative environmental impacts (e.g. sedimentation)
- Net environmental benefit (i.e. benefit vs impacts of the additional extent of excavation).

If areas of contamination not previously identified are found during the works, consultation with the EPA may be required and procedures followed as outlined in Section 8.6.

Excavation limits will be set up using a digital terrain model for upload to construction plant.

5.4.2 Excavation methodology

Excavators or backhoes will be used for all excavation operations involving contaminated soil.

All excavations undertaken within the contaminated areas will be conducted under supervision of a suitably qualified environmental representative to ensure all contamination and remediation works is appropriately managed. An independent environmental consultant will guide and verify the extent of remediation works, as discussed in Section 1.3.

Staging of the remediation works across the site will be detailed in the CEMP but the following sequence of steps should be followed prior to commencing the excavation operations in areas of identified contamination:

- The environmental consultant will brief the Site Manager in the field on the following:
 - The boundaries of the area to be excavated.
 - The expected depth of excavation.
 - The manner in which excavation works will be monitored and verified.
- The Site Manager, in consultation with the Project Manager, environmental representative and environmental consultant, will reach agreement on the following:
 - Environmental protection / management measures to be put in place.
 - The manner in which materials are to be excavated.
 - The area where stockpiling of material can take place.
- Prior to commencement of excavations within the wetland foreshores, the Site Manager shall ensure that a suitable barrier is installed around the perimeter of the works to separate clean and dirty water. Further details on sediment controls around excavations will be provided in the CEMP.
- The Site Manager shall ensure that at all times the sides of the excavation are stable, and provide support to the surrounding ground and infrastructure.
- The Site Manager shall ensure all excavation works are undertaken in a manner that will minimise the mixing of different material types, i.e. contaminated and clean material.
- Based on the known hydrogeological characteristics of the site it is expected that groundwater seepage will be encountered for all works in the wetland foreshores (including the main tailings dump) , and localised dewatering may be required. Any dewatering activities must be undertaken in accordance with the CEMP prepared for the site including specific requirements of the ASSMP and the SWMP. Excavations will continue beneath the water table to the extent practical, if required.
- Prior to demobilisation of any plant, the Site Manager shall ensure that plant and equipment is cleaned and decontaminated.

5.4.3 Validation sampling

The validation sampling protocol for the remedial operations is detailed in Section 7.

5.5 Treatment

The most leachable materials will be immobilised and there will be some treatment / stabilisation of less contaminated materials. The material to be treated would principally be those areas greater than 10 times the assessment criteria, shown on Figure 4-1, with consideration of soil type and leachability characteristics.

The treatment would be based on the results of the treatment trials. The remediation contractor shall utilise the initial stages of the full scale treatment process to verify the effectiveness of the treatment methodology.

The treatment process is likely to involve:

- Preparation of a drainage pad to assist in dewatering excavated material prior to treatment. Leachate would be directed to the sediment basin.
- Stockpiling excavated material according to the concentration of contamination.
- Blending of reagents with the contaminated material in layers using appropriate plant.
- Verification sampling and analysis.

The contractor shall undertake process control / verification testing, at a sufficient rate (to be agreed with the environmental consultant and EPA) to verify the representativeness of sampling (including batch control), and compliance with immobilization requirements, including ASLP (water leachability) and MEP (multiple extraction procedure) testing. The environmental consultant may take quality control samples.

Treatment and testing shall be carried out in accordance with a quality control plan, to be provided by the Site Manager prior to commencement of works, for review and agreement by the EPA.

5.6 Containment cell

A containment cell will be constructed on site approximately in the location shown on Figure 5-1. The configuration of the containment cell would be confirmed during detailed design but the objectives would be to:

- Provide secure long-term containment of contaminated material without unacceptable environmental impact or health risk.
- Minimise ongoing management requirements by the land holder (eg. avoid long-term leachate management requirements).
- Provide a final containment cell landform that is appropriate for the future use of the site.
- Provide the most cost-effective containment that will meet the above objectives, to maximise the budget that is available for remediation (eg. excavation, treatment and containment) of contamination at the site.

Construction of the containment cell is likely to consist of:

- Excavation and installation of diversion drains. The excavated material, if suitable, may be used to backfill the excavation remaining from the removal of the contaminated material.
- Construction of impermeable layer, possibly including synthetic liner and leachate drain.
- Filling with contaminated material.
- Construction of an impermeable cap, possibly including synthetic liner.
- Reshape and revegetate the surface to be consistent with the surrounding area.

The EPA has confirmed that they will review and approve an appropriate methodology for on-site containment. This will be described in the final design and Construction Quality Assurance (CQA) Plan that will be submitted prior to works commencing.

5.7 Backfill and landforming

Excavations may be left as voids (or be partially filled) if this is consistent with the original bathymetry of the site and is not detrimental to the final landform. Other excavations will require backfill with soil that is deemed suitable for the final land use. Where materials are to be imported, they will be tested to verify classification as Virgin Excavated Natural Material (VENM) or Excavated Natural Material (ENM).

On completion of the excavation and subsequent validation approval, the excavation will be backfilled with validated material. Validation requirements are detailed in Section 7.

Earth materials will require placement in accordance with engineering specifications, landscaping plans and erosion and sediment control.

5.8 Disposal of soils, mercury plugs and refuse

Where soil and refuse wastes are to be removed from site, they must be classified for waste disposal purposes, and disposed in accordance with the requirements of the *Protection of the Environment Operations Amendment (Scheduled Activities and Waste) Regulation 2008* made under the *POEO Act 1997*, and *NSW DECC, 2009*.

An experienced environmental professional should be engaged to oversee the classification of the waste and minimise the potential for cross contamination of waste streams. The Site Manager shall ensure its transport and disposal at an appropriately licensed landfill.

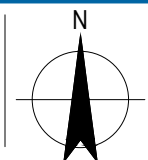
Further details regarding material handling and disposal will be documented in the CEMP including measures to:

- Minimise cross contamination by any arsenic and antimony contaminated material (soil, sediments, tails, ores and dusts) with any remediated or clean materials (validated areas, imported fill, existing vegetation, surface water or treated materials).
- Minimise the quantity of materials to be removed from the site.
- Decontaminate and validate any material to be removed from site for recycling or reuse.
- Minimise the potential for imported fill to require offsite disposal.

The Site Manager shall ensure that wastes arising from the works are removed and disposed of in accordance with the requirements of the NSW EPA and WorkCover Authority, together with the relevant legislative requirements, namely:

- Work Health and Safety Act, 2011 and Regulations, 2011.
- Contaminated Land Management Act, 1997 and Regulations, 2008.
- Protection of the Environment Operations Act, 1997 and Regulations, 2008.

Building and demolition waste generated from the project (e.g. bricks, concrete, metal, and timber) is expected to classify as General Solid Waste (non-putrescible). These materials will be recycled or re-used where possible. This waste should be stockpiled separately from other waste and further advice sought prior to off-site disposal to landfill if required.



0 20 40 60m
SCALE 1:2000 AT ORIGINAL SIZE



NSW Catchment & Lands - Crown Lands
Former Antimony Processing Plant - Urunga
Detailed Investigation Report
CONTAINMENT CELL LOCATION

Job Number 22-16251
Revision A
Date MAR 2014

Figure 5-1

5.9 Environmental monitoring and ongoing management

Option 3A will result in contaminated material remaining onsite. This will present some environmental risks that will need to be assessed, monitored and managed. The requirements of the ongoing monitoring and management of the site will be documented in a Long Term Environmental Management Plan (EMP). The Long Term EMP will be a stand-alone document that includes, as a minimum:

- Site Description
- Site History
- Description of Remediation and Containment
- Risk Assessment
- Management
 - Leachate management
 - Erosion control
 - Revegetation
- Monitoring:
 - Groundwater
 - Surface Water
 - Revegetation
- Contingency Plan

6. Assessment criteria

6.1 Framework

The framework for contamination assessment is based on guidelines “made or approved”, by the NSW EPA under Section 105 of the *Contaminated Land Management Act, 1997*. These guidelines include, but are not limited to the following:

- NSW OEH, Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites, 2011.
- DECC, Contaminated Sites: Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997, June 2009.
- DEC, Contaminated Sites: Guidelines for the Assessment and Management of Groundwater Contamination, 2007.
- DEC, Contaminated Sites: Guidelines for NSW Site Auditor Scheme. 2006.
- ANZECC, National Water Quality Management Strategy, Paper No. 4, Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), 2000.
- NEPC, National Environment Protection (Assessment of Site Contamination) Measure (NEPM), 1999, as amended by the National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1), herein referred to as the NEPM.
- NSW EPA, Contaminated Sites: Sampling Design Guidelines, 1995.
- ANZECC/NHMRC, Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites, 1992.

Additional regulatory guidelines used for classification of waste material for off-site disposal (including the bricks) includes:

- DECCW 2009, Waste Classification Guidelines, December 2009.

Where relevant criteria were not contained in the above guidelines, reference was made to other guideline documents, including the following:

- MHSPE 1994, Environmental Quality Objectives in the Netherlands.
- USEPA 2004, Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual.
- USEPA 2014, Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites.

The assessment criteria (thresholds) against which the project analytical data have been compared are outlined in the following subsections.

As noted in Section 4.1, investigation and screening levels (i.e. the assessment criteria described below) are not clean-up or response levels, and the use of investigation and screening levels as default remediation criteria may result in unnecessary remediation and increased development costs, unnecessary disturbance to the site and local environment, and potential waste of valuable landfill space.

6.2 Soil assessment criteria

The adopted soil assessment criteria are presented in Table 6-1. The rationale for the criteria is provided in the Detailed Investigation Report and is summarised as follows.

Health based criteria

Health-based soil Investigation Levels (HILs) are provided for a range of different exposure settings, which are based on the nature of the use(s) for which the site is currently used and/or its approved use(s). As the future use of the Site is likely to be as a reserve, the most applicable default exposure setting is considered to be NEHF E- Parks, Recreational, Open space as published in NSW DEC (2006). These criteria correspond with NEPM HIL (C) from NEPC (2013) and are herein referred to as HIL (C).

Ecological investigation levels

Ecological Investigation Levels (EILs) are presented in NEPC (2013). The EILs have been developed by CSIRO using data from various Australasian databases, the Australian National Biosolids Research Program and supplemented by data from the US EPA ecotoxicology database where necessary. The methodology is based on a species sensitivity distribution (SSD) approach, which considers the physicochemical properties of soil and contaminants and the capacity of the local ecosystem to accommodate increases in contaminant levels (referred to as the 'added contaminant limit' or ACL) above ambient background. Where insufficient data is available for the SSD method to be used, a more conservative method using an assessment factor approach may be adopted.

EILs have been developed for three generic land use settings:

- areas of ecological significance.
- urban residential areas and public open space.
- commercial and industrial land uses.

The EILs have also been given, where sufficient data permitted, for sites with fresh (<2 years) and aged (≥2 years) contamination.

DEC 2006 includes Provisional Phytotoxicity Based Investigation Levels (PBILs) which relate to the potential uptake of contaminants that may result in adverse, phytotoxic impacts on sensitive plant species. These are generally equivalent to the NEPC (2013) EILs. NSW DEC 2006 notes, however that the PBILs have significant limitations because phytotoxicity depends on soil and species parameters in ways that are not fully understood.

The EILs provided in Table 6-1 below are for aged contamination in areas of ecological significance. They are intended for use as a screening guide only and may be assumed to apply to sandy loam soils, or soils of a similar texture, for pH 6-8.

Antimony

No criteria are given in NEPC 2013 for antimony. As outlined in the Preliminary Investigation Report, the following assessment criteria have been used for the assessment of antimony concentrations:

- ANZECC/NH&MRC (1992) Environmental Investigation level - 20 mg/kg.
- USEPA (2004) Residential - 310 mg/kg.

It is noted that the 'USEPA (2004) Residential' criterion as referred to above is actually a typographical error (the value should have been 31 mg/kg), which was inadvertently adopted (instead of the USEPA 2004 Industrial criterion of 410 mg/kg or an intermediate site specific

criterion) at the Preliminary Investigation stage of the investigations. GHD has subsequently reviewed the antimony criteria in consultation with the EPA to assess the implications of this error, as discussed below.

The current (2014) USEPA Regional Screening Levels (RSLs) are essentially the same as the 2004 Preliminary Remediation Goals (PRGs), except the industrial RSL is now 470 mg/kg. A residential criterion (31 mg/kg) is considered inappropriately conservative for the site exposure setting as it is now and as it will be following the proposed remediation.

Similar to HILs as described in the NEPM, the USEPA notes that RSLs are used for site "screening" and as initial clean-up goals, if applicable, and that RSLs are not de facto clean-up standards and should not be applied as such. The RSL's role in site "screening" is to help identify areas, contaminants, and conditions that require further federal [USEPA] attention at a particular site. Generally, at sites where contaminant concentrations fall below RSLs, no further action or study is warranted under the USEPA Superfund program, so long as the exposure assumptions at a site match those taken into account by the RSL calculations. Chemical concentrations above the RSL would not automatically designate a site as "dirty" or trigger a response action; however, exceeding a RSL suggests that further evaluation of the potential risks by site contaminants is appropriate.

Giving due consideration to the above, GHD has used the NEPM spreadsheet tool (NEPC 2013) to derive site specific criteria for antimony as summarised below.

Key input parameters were as follows:

- Toxicity Oral Reference Dose 0.0004 mg/kg/d (USEPA IRIS – consistent with that used by USEPA 2014).
- Gastro intestinal (GI) Absorption factor 0.15 (USEPA 2014). Antimony is reported to be slow at absorption in the gastrointestinal system.
- Background intake 0%. The WHO publishes information on antimony in the environment and indicates that exposure through food is very low, and domestic water (based on analysis of waste water) is practically free of antimony (WHO 2014).
- No dermal absorption factor published, therefore exposure through dermal pathway is not deemed significant (see below).
- No inhalation toxicity reference value published, therefore exposure through dust inhalation pathway is not deemed significant (see below).

Exposure through dermal exposure (skin) and inhalation of dust do not significantly contribute to the overall risk and therefore may be excluded from the calculation of the HIL. As an example, zinc is a similar situation where the dermal absorption factor (DAF) is 0.001 (typical of most metals) and the air toxicity is the same as the oral toxicity, adjusted for an inhalation rate of 20 m³/day and body weight of 70 kg for an adult. The HIL Spreadsheet shows that the pathway-specific HIL for the oral pathway in this example is 36 times more stringent than the dermal pathway, and nearly 10000 times more stringent than the inhalation pathway. On this basis it may be concluded that the dermal and inhalation exposure routes do not significantly contribute to health risk for exposure to antimony.

Using the HIL Spreadsheet, with the standard assumptions for the HIL C exposure setting (open space, recreational), the derived antimony health-based criterion is 120 mg/kg.

It must be understood that the NEPM definition of HIL C includes a variety of exposure scenarios such as parks and playgrounds (including sandpits), recreational areas and playing fields that are fully accessible to the public and where the public may potentially spend a significant amount of time. This land use scenario assumes that the open space areas are in

areas where young children may have supervised access and use the area outside of the home environment for frequent short periods of time (up to 2 hours a day, 7 days a week). Other users may include older children and adults who may visit the area frequently for a range of recreational purposes. These open space areas may contain lawns, gardens, vegetated areas and walkways, with some limited areas of hardstand and some areas of exposed soil.

The NEPM notes that Scenario HIL C does not directly apply to undeveloped public open space such as urban bushland and reserves, where the potential for exposure (and frequency of exposure) is lower and which should be subject to a site-specific assessment.

The default HIL C exposure scenario is considered overly conservative for Urunga, which will be more of a passive recreational area (eg. no playgrounds, likely to be infrequent use, children would be under supervision due to natural hazards from ticks, snakes, waterways etc.). A report prepared for the US Army Corps of Engineers, *Remedial Investigation Report, Iron Mountain Road Ranges* (Shaw Environmental, May 2009) which deals with antimony contamination (a co-contaminant with lead at many firing ranges) presents the following basis for exposure in open space areas at that site, where the nature of the likely open space use is considered to be generally similar to that at Urunga:

- Adult and young child under supervision: In December 2008 the US Army and its contractor, U.S. Fish and Wildlife Service, EPA, and the Alabama Department of Environmental Management (ADEM) and its contractor, judged that a youth would have more opportunity for recreational activities, than an adult with adult responsibilities or a young child (0- through 6-year-old) who is likely to be dependent on an adult caretaker. It was therefore judged that a young child is likely to visit a similar recreational site much less than older individuals.

On this basis, two scenarios have been considered in the derivation of appropriate investigation criteria for antimony at the Urunga site:

- Scenario 1. Adults and young child (0-6 years old) under supervision. Exposure occurs during weekends (2 hours per day, 2 days per week).
- Scenario 2. Older child (8-11 years old) with no supervision who enters the site every day (2 hours per day, 7 days per week).

Scenario 2 differs from the default HIL C in that the body weight for the older child is higher than for the young child. The default body weight of the young child represents a 2-3 year old of 15 kg. The Australian Exposures Handbook (EnHealth, 2012) Section 2.2 presents weight ranges for different age groups. For older children 8 to 11 years, a mean body weight of 37 kg is presented.

The derived criteria for antimony are as follows:

- Scenario 1 (adult and young child): 420 mg/kg
- Scenario 2 (older child): 300 mg/kg.

The limiting scenario for this exposure setting is the older child exposed every day, with a derived criterion of 300 mg/kg.

On the basis of this derivation, GHD considers an appropriate health investigation level for antimony in soil at the Urunga site is 300 mg/kg, which is essentially the same as the 310 mg/kg criterion which was adopted in the preceding stages of investigation and assessment.

At the request of the EPA and NSW Health, GHD also considered the implications of adopting a more conservative criterion of 120 mg/kg, equivalent to the default HIL C exposure setting. Examination of all investigation data for samples which exceeded 120 mg/kg but didn't exceed 310 mg/kg, and also for samples which exceeded or didn't exceed ten times this criteria

(corresponding to the factors used in the previous assessments and development of remediation areas and volumes) found that consideration of the lower HIL C of 120 mg/kg for antimony has no effect on the exceedence boundaries illustrated on the figures, and no significant effect on the proposed extent or volumes of remediation. Only one location (BH100 – adjoining the west of Area B/C, and which may be encompassed by the containment cell works) lies outside a nominated remediation area, and the only area where the extent of remediation may be affected is Area G, where further delineation is already noted as being required (see Table 4-1), and contamination may extend past the western boundary of the site.

On the basis of these considerations, GHD has adopted the following antimony criteria for the remediation and validation of the site (noting again that use of investigation levels is a conservative measure, as discussed previously):

- ANZECC/NH&MRC (1992) Environmental Investigation level - 20 mg/kg.
- HIL for 'bushland' open space / recreational area' – 300 mg/kg (essentially the same as the HIL of 310 used in previous investigations and assessment), which is considered applicable to the majority of the site.
- HIL C – 120 mg/kg in areas where there is a particular potential for more frequent exposure by young children.

Acid sulfate soils

Potential acid sulfate soils were assessed by comparison with criteria outlined in:

- *Acid Sulfate Soils Assessment (ASSMAC) Guidelines* (Ahern et al. 1998).
- *Queensland Acid Sulfate Soil Technical Manual- Soil Management Guidelines* (Dear et al. 2002).

Table 6-1 Adopted Soil Assessment Criteria

Analyte	Units	NEPM 2013 HIL C	NEPM 2013 EIL
Antimony ⁽¹⁾	mg/kg	120 - 310	20
Arsenic	mg/kg	300	40
Cadmium	mg/kg	90	-
Chromium (III+VI) ⁽²⁾	mg/kg	300	60-130 ⁴
Cyanide Total ⁽³⁾	mg/kg	240	-
Copper	mg/kg	17,000	30-270
Lead	mg/kg	600	470
Manganese	mg/kg	19,000	-
Mercury ⁵	mg/kg	80	-
Nickel	mg/kg	1,200	5-95

¹ Previously adopted criteria for antimony were 20 mg/kg (ANZECC/NH&MRC 1992) and 310 mg/kg (incorrect adoption of USEPA Res (2004)). Site specific criteria have been developed equivalent to HIL C of 120 mg/kg (applicable to areas where significant exposure by children is plausible) and 300 mg/kg (essentially the same as the previously used 310 mg/kg) for a bushland recreational setting considered more applicable to the majority of the site.

² Chromium analysed as Total Chromium. Criteria for Cr (VI) used as a conservative screening measure, although chromium is considered unlikely to be present in hexavalent form.

³ HIL for free cyanide used as a conservative measure.

⁴ Range depending on pH and cation exchange capacity

⁵ Inorganic mercury

6.3 Sediment assessment criteria

The adopted sediment assessment criteria for selected analytes are presented in Table 6-2. As outlined in the Preliminary Investigation Report, the criteria for most analytes were from the ANZECC /ARMCANZ (2000) Sediment Quality Guidelines (ISQG).

No criteria was available from ANZECC /ARMCANZ (2000) for cyanide. The Dutch intervention values (MHSPE 1994) for sediment of 20 mg/kg for free cyanide and 50 mg/kg for complex cyanides, have been adopted in this case.

The influence of site-specific conditions on contaminant bioavailability and toxicity to benthic invertebrates is a key consideration in the environmental risk assessment process. This is particularly relevant for contaminants with complex speciation chemistries such as arsenic (Irving et al 2008). However, Irving et al (2008) found sublethal toxicities of both arsenite (As(III)) and arsenate (As(V)) to be similar and not significantly affected by changes in DO. Accordingly, total arsenic concentrations were considered to be relevant for the site assessment.

Following an assessment of the results presented in the Detailed Investigation Report (GHD, 2012b), it was deemed that extractable and/or leachable concentrations were more applicable in a comparison with the assessment criteria as it provides a greater indication of the bioavailability of the contaminants of concern (COC).

Total organic carbon (TOC) was also used to normalise the amount of COC per gram of organic-carbon.

Table 6-2 Adopted sediment assessment criteria

Analyte	Units	ISQG- Low	ISQG- High
Antimony	mg/kg	2	25
Arsenic	mg/kg	20	70
Cadmium	mg/kg	1.5	10
Chromium	mg/kg	80	370
Copper	mg/kg	65	270
Cyanide	mg/kg	20	50
Lead	mg/kg	50	220
Mercury	mg/kg	0.15	1
Nickel	mg/kg	21	52
Zinc	mg/kg	200	410

6.4 Water assessment criteria

For the purpose of the RAP, surface and groundwater quality will be compared to the assessment criteria outlined in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC 2000). Although limited, the data indicates the receiving environment contains freshwater (brackish water is considered to have an EC of 800-1600 uS/cm (Environment Australia, 2002)), hence the guidelines for Freshwater were applied.

As the Site is deemed to be a 'slightly to moderately disturbed system', the 95% level of protection of species has been identified as being applicable in conjunction with the 99% level for selected analytes deemed to have a bioaccumulative effect.

Table 6-3 Adopted Water Assessment Criteria

Analyte	Units	ANZECC 2000 Fresh Water Slightly-moderate disturbed system
Aluminium	mg/L	0.05
Antimony	mg/L	0.009
Arsenic	mg/L	0.013
Cadmium	mg/L	0.0002
Chromium (III) ¹	mg/L	0.00331
Chromium (VI)	mg/L	0.001
Copper	mg/L	0.0014
Cyanide Total	mg/L	0.007
Lead	mg/L	0.0034
Mercury (inorganic) ²	mg/L	0.00006
Mercury (methyl)	Mg/L	ID2
Nickel	mg/L	0.011

1 A moderate reliability trigger value for chromium (III) of 3.3 µg/L for freshwater was derived, using the statistical distribution method with 95% protection and an ACR of 77.6.

2 There were Insufficient Data (ID) to derive trigger values for methyl mercury. The 99% protection levels for organic mercury are recommended for slightly-moderately disturbed systems as a precaution for bioaccumulation.

6.4.1 Water Quality Monitoring During Remediation

As explained in Section 5.3, the water will be managed via a series of detention basins and will be treated to achieve the below requirements:

- Total Suspended Solids - 50mg/L
- pH - 6.5-8.5
- Oil and grease – visible

Surface water quality will be monitored adjoining and downgradient of remediation work areas using field parameters and observations (including turbidity) to monitor the effectiveness of the sediment and surface water control measures implemented during the remediation works.

Details of the monitoring program will be provided in the CEMP.

6.5 Imported fill

Imported fill will be certified clean fill (e.g. Virgin Excavated Natural Material – VENM or Excavated Natural Material – ENM) validated suitable for use as fill material in accordance with section 4.1.2 of the Sampling Design Guidelines (EPA 1995). Samples shall be collected and analysed at a rate equivalent to that specified in the ENM exemption 2012, and at least three samples from any particular fill source.

In order to avoid importation of contamination to the site, fill judged suitable for use will have TPH, BTEX, heavy metals, OCP/PCBs and PAHs concentrations below the criteria in the Excavated Natural Material exemption 2012.

7. Validation

Adoption of the Option 3A and 97% scenario for remediation acknowledges that some contaminated material will remain *insitu*. Therefore “validation” of the remediation works will be based more on verification that the extent of remediation is consistent with the principles for nominating the remediation areas (as described in Section 4.3), rather than a traditional process of sampling and analysis to verify compliance with the adopted assessment criteria. The basis for this is that the site has been sufficiently characterised so that the areas of contamination are relatively accurately delineated and the extent of remediation can be largely predetermined prior to excavation. The relatively small volumes of contamination that would be addressed by iterative validation sampling and excavation are expected to be relatively insignificant, and the remediation works will be more efficient without this process, allowing more remediation to be undertaken for the available budget. This will also minimise the duration the excavations must remain open, and minimise dewatering and water treatment requirements.

Due to the above mentioned considerations, the following approach will be used to guide the extent of remediation.

- Excavation works will be supervised by an appropriately qualified and experienced independent environmental consultant, familiar with the characteristics of the site.
- Vertical limits of excavation will be based primarily on consideration of previous data, particularly the depth of contaminated soil in the respective identified areas, relationship between soil type (observable characteristics such as texture and colour) and field screening limits of excavation with a portable XRF (based on relationships established in GHD 2012b).
- Lateral limits of excavation as discussed in Section 5.4.1.

A “validation” process per se is not proposed; rather decisions will be made during the works based on these procedures, and in consultation with SCS and the EPA where required. For the nominated remediation areas, previous data and field screening data will be compared with the decision process described below, subject to practical limitations to excavation extent.

As noted in Sections 4.1 and 6.1, the assessment criteria described in Section 6 are not clean-up or response levels, but have been used as an initial basis for assessment of the extent and degree of contamination. The basis for the proposed extent of remediation is described in Section 4.3, and consistent with these principles, the following decision process will be used for guidance within the remediation areas.

7.1 Decision process

7.1.1 Soils

The HIL C and EIL assessment criteria for the contaminants of potential concern on the site are listed in Table 6-1.

Subject to the considerations described in Section 4.3 and above, areas of contamination will be deemed to be successfully remediated if:

- The arithmetic average² 95% UCLAVG concentration for contamination in soils remaining after excavation is less than the HIL C assessment criteria and nominally less than 10

² Note: it is not proposed to use the 95% UCLav concentration in this decision process because of the inherent conservatism of the assessment criteria, and as sufficient samples may not be available in each remediation area to provide meaningful statistical data.

times the EILs. Given the considerations noted above, the target clean-up levels will be 300 mg/kg for antimony and arsenic, and 80 mg/kg for mercury (the latter based on previous data).

- No single sample concentration is greater than 2.5 times the relevant criteria.

In areas where there is a significant potential for more frequent exposure to soils by young children, consideration will also be given to the HIL C of 120 mg/kg for antimony, on the same basis as above.

These criteria will be applied to the base and walls of each area of active remediation, noting that there are likely to be areas of the Site where evidence (XRF or aesthetic data) suggests that contamination remains and an ongoing management approach will be required.

The minimum target depths to which remediation and validation apply for each area will be set out in the CEMP.

7.1.2 Sediments

Remediation of areas of deeper aqueous sediments is not proposed. Areas of wetland adjoining the tailings area are known to be seasonally dry, and it would be inconsistent to attempt to remediate these areas to a lower clean-up level than the source areas, given the additional impact on the environment that would be incurred if this was the case (i.e. through physical disturbance of a large area of the wetland).

Subject to the considerations described in Section 4.3 and above, it is therefore proposed to adopt a target clean-up level of approximately 10 times the ISQG-High shown in Table 6-2, which is generally equivalent to the 300 mg/kg target for antimony and arsenic, but with a lower target of 10 mg/kg for mercury (the latter based on previous data).

7.1.3 Environmental risk

Use of the nominated clean-up levels described above is considered to be protective of human health, but may leave some residual risk to the localised environment. Hence some more sensitive species may not be fully protected, however the reduced contaminant load is expected to result in a net improvement to the surrounding environment, in particular as a reduction in migration of contaminants via sediment, surface water or groundwater.

As discussed in Section 5.4.1, the lateral extent of the excavation will be identified for easy detection by the operators. Decisions in regard to the extent will be based on factors considered in Section 4.3 and site observations of ecological conditions including potential phytotoxicity effects and vegetation quality. As discussed in Section 4.3, extending remediation areas to remove contamination exceeding EILs / ISQGs would not represent an effective balance to address the remediation objectives. In these areas of secondary impact, the physical stability and cover of viable vegetation will be considered adequate to prevent further impact. In the areas that will be excavated, if concentrations significantly exceeding EILs / ISQGs will be left in situ, supplementary remediation measures (such as covering with a layer of clean soil) would be considered to address potential ecological impacts, if relevant to the final land form.

Potential migration of soils or sediments during the remediation will be managed by erosion control measures.

7.1.4 Aesthetic criteria

Aesthetic considerations (odours, staining, vegetation cover) will also be taken into account when validating areas of remediation. Areas exhibiting objectionable odours or absence of viable vegetation cover relating to site contamination will not be considered satisfactorily remediated.

7.2 Validation methodology

7.2.1 Sample identification

As explained above, in addition to use of existing data and field observations of soil characteristics, the vertical extent or base of the excavation and the lateral extent or walls of the excavation will be screened on site to characterise the material remaining.

Validation samples will be identified using a "V" suffix. The depth will also be recorded as part of the sample number (e.g. 1V-0.0), where the depth component represents the shallowest part of the sample interval. Any imported materials will be identified with a "C" suffix for characterisation samples.

A detailed sample register will be kept, recording the sample number, date sampled, location, depth interval, field observations (including soil description) and field measurements (e.g. XRF measurements). Duplicate samples will be recorded in the register, as will subsequent validation samples where these are needed to re-validate an area which has not met the assessment criteria and has had further remediation.

Field sketches will be prepared showing the area and locations sampled.

7.2.2 Validation of excavations

Sampling procedures

XRF procedures will be used to assist in assessing any residual contamination present in an excavation. XRF procedures will be detailed in the CEMP.

Validation sampling will be undertaken by an appropriately qualified environmental consultant to verify that the site has been remediated in accordance with the principles described in this RAP.

All fieldwork will be undertaken in general accordance with GHD's Standard Field Operating Procedures (SOP). The following procedures will be followed for all sampling work:

- New disposable nitrile gloves will be used for the collection of each sample.
- Samples will be placed in laboratory-supplied bottles appropriate for the analysis required.
- Samples will be stored in a dedicated container for transport to the project analytical laboratory with chain of custody documentation. Where required for appropriate preservation of samples prior to laboratory analysis, ice will be used.
- Samples will be submitted to the project laboratory to enable sufficient time for extraction and analysis within specified holding times.
- All sampling equipment will be thoroughly decontaminated (in accordance with written procedures) to mitigate cross contamination occurs between sampling locations. Sampling equipment will be washed with Decon 90 (or an equivalent solution) and then rinsed in tap water and then deionised water prior to and after the collection of each individual sample.
- QA/QC sampling as outlined in Section 7.3. Duplicate samples will be used to assess the precision and accuracy of results. Rinsate blanks will be used to assess the adequacy of decontamination and potential for cross contamination of samples due to sampling methodology, and trip blanks will be used to assess the potential for cross contamination from containers, transportation or laboratory methodology.

Sampling frequency

Validation sampling will generally involve the following:

- One sample per 10 linear metres from the sides of each excavation, with at least one sample from each side of any single excavation.
- One sample per 100 m² from the base of each excavation (based on a 10 x 10 m grid, or at least one sample per 10 linear metres of trench), with at least one base sample from any single excavation.
- Aesthetic considerations will be based on observations (e.g. odour, discolouration, vegetation) made by the environmental consultant during excavations.
- Photographic evidence will be taken of validation prior to backfilling.

Field logbook and sample documentation

Written logs will be maintained for all field activities. These logs will cover general field observations and give an account of daily works and events.

General notes will include:

- Works completed including start and end time.
- Weather conditions, including wind direction.
- Any background odour.
- Presence of dust.
- Results of any field testing.
- Data and rationale in regard to the lateral and vertical extent of the excavation.
- Instrument calibration results.
- Sample details including: time and date, sample, identification number and location, procedures used in sample collection, and instrument readings.
- Any on-site calibration checks.
- Description of conditions surrounding the sampling location.
- Observable characteristics of samples taken.
- Decontamination procedures and health and safety monitoring.

A register of all samples will be maintained. Depending on the level of detail required (generally related to depth of sampling), sample descriptions will either be recorded on the sample register or on specific field logs for each sampling location.

A copy of the field logbooks, sample registers and log sheets will be retained in the hard and electronic job file.

Sample labels

Samples will be labelled on adhesive labels using indelible ink. The following information will be included on the sample labels:

- Job number.
- Sample identification number.
- Date (and time, for water samples) of sampling.

Each sample will be assigned an individual sample identification number with the following format:

VA_001_0.5-0.7, where

- V = Validation.
- A = Excavation area.
- 001 = Sample number.
- 0.5-0.7 = The sampling depth or interval at which the sample was taken below the ground surface.

Quality control sample labelling system to be used is as follows:

- Field duplicate samples: VDUP001, VDUP002 etc.
- Inter laboratory duplicate sample: LABDUP001, LABDUP002 etc.
- Trip blanks: TB001, TB002, etc.
- Rinsate blanks: RB001, RB002, etc.

Chain of custody forms

Chain of custody procedures are used to track samples, discourage tampering, and provide a sampling summary. Chain of custody forms include general information about the location of the activity and the members of the sampling team, as well as specific information about the type of sample, sample location, number of sample containers from each station and comments.

Chain of custody forms will be completed in the field and used in conjunction with investigation logs to confirm the samples collected.

Chain of custody documentation will include:

- Site identification.
- Name of the sampler.
- Sample numbers.
- Nature of the sample.
- Collection date.
- Signature of sampler or field manager.
- Departure time from site.
- Dispatch courier(s).

Samples will be checked against the sample register and the Chain of custody prior to dispatch from the site. A copy of the Chain of custody will be retained by GHD and is sent to file as a record of samples sent and analyses requested.

7.2.3 Analytical test methods and detection limits

In general, laboratory analysis will be conducted in accordance with the standard test methods outlined in Schedule B(3) of the NEPM (2013) for soils. The practical quantitation limits (PQLs) will be set at a level below the relevant assessment criteria.

The above documents describe the methods preferred by the NSW EPA. However, laboratories in Australia may not all follow these methods precisely. In particular the sample preparation methods may be significantly different. Some analysis methodology may also be slightly different for some of the analyses.

In all cases, the selected laboratories will be required to be NATA registered for the analyses performed, and NATA registration will take precedence over the laboratory's ability to perform the analyses precisely to the methodology described in the above documents.

7.3 QA/QC requirements

7.3.1 Field programme QA/QC

All fieldwork will be conducted in general accordance with GHD's SOP, which are aimed at collecting environmental samples using uniform and systematic methods, as required by GHD's QA system. Key requirements of these procedures are as follows:

- Appropriately trained and experienced staff will conduct and document site activities using photographs and notes on standard field forms such as daily site records and sampling logs.
- Decontamination procedures - including the use of new disposable gloves for the collection of each sample, decontamination of sampling equipment between each sampling location (using DECON 90/N) and the use of dedicated sampling containers provided by the laboratory.
- Logging procedures - all samples are described using a recognised system.
- Calibration procedures - all field monitoring equipment is appropriately calibrated.
- Documentation and Chain of Custody information as outlined in section 7.2.2.
- Collection of samples for laboratory analysis at an approximate rate of 10% of field screening samples, to verify the relationship between screening and laboratory analysis.
- Collection of duplicate and triplicate samples for QA/QC purposes. GHD proposes 5% split duplicates and 5% blind replicate samples on the basis of the NEPM (2013). This is also consistent with requirements of ANZECC / ARMCANZ 2000 Australian Guidelines for Water Quality Monitoring and Reporting. This would apply for all samples collected for laboratory analysis. Where possible, both blind and split samples would be collected from the same location as the primary sample (e.g. duplicate and triplicate) to enable further evaluation of variability at the one location.

Field quality control procedures to be used during the project include the collection and analysis of the following:

- Field Duplicates: Comprise a single sample that is divided into two separate sampling containers. Both samples are sent anonymously to the project laboratory. Blind duplicates provide an indication of the analytical precision of the laboratory, but are inherently influenced by other factors such as sampling techniques and sample media heterogeneity.

Field duplicate samples are to be collected at a rate of at least 5%.

- Inter-laboratory duplicates: Identical to a blind duplicate, except that the primary sample is sent to the primary project laboratory and the duplicate is sent to a secondary (check) laboratory.

Inter laboratory (triplicate) samples are to be collected at a rate of at least 5%.

- Rinsate Blank: Final rinse water used in the decontamination of equipment will be collected and submitted for analysis. Rinsate blanks provide an indication of efficiency of the decontamination methodology and techniques employed in the decontamination of sampling equipment between each sampling event, and are an indicator of potential cross contamination between sampling locations.

One rinsate blank sample will be collected per day as required.

- Trip Blank: A sample of laboratory supplied deionised water is bottled and accompanies the other samples over the course of the fieldworks and submitted to the laboratory for analyses. Trip blanks provide an indication of contamination introduced during sample transport and handling (including by sample containers), and also whether the testing laboratory is reporting “false positives”.

One trip blank sample will be collected for each batch during the investigation, and will be submitted to the primary testing laboratory.

7.3.2 Laboratory programme QA/QC

All analyses will be carried out by NATA accredited laboratories, using analytical methodology consistent with the requirements of relevant guidelines. Where practical, analytical methodology will be selected that provides a Practical Quantitation Limit (PQL) low enough for comparison with the adopted assessment criteria.

The primary project laboratory will use its internal procedures and NATA accredited methods in accordance with their quality assurance system. GHD will ensure that the laboratory analytical methods and limits of reporting are acceptable for analysis required.

Laboratory quality control procedures used during the project will include:

- Laboratory duplicate samples: Duplicate sub samples collected by the laboratory from one sample submitted for analytical testing at a rate equivalent to one in twenty samples per analytical batch, or one sample per batch if less than twenty samples are analysed in a batch. A laboratory duplicate provides data on the analytical precision and reproducibility of the test result.
- Spiked Samples: An authentic field sample is spiked by adding an aliquot of known concentration of the target analyte(s) prior to sample extraction and analysis. A spike documents the effect of the sample matrix on the extraction and analytical techniques. Spiked samples are to be analysed for each batch where samples are analysed for organic chemicals of concern.
- Certified Reference Standards: A reference standard of known (certified) concentration is analysed along with a batch of samples. The Certified Reference Standard (CRS) or Laboratory Control Spike provides an indication of the analytical accuracy and the precision of the test method and is used for inorganic analyses.
- Surrogate Standard/Spikes: These are organic compounds which are similar to the analyte of interest in terms of chemical composition, extractability, and chromatographic conditions (retention time), but which are not normally found in environmental samples. These surrogate compounds are spiked into blanks, standards and samples submitted for organic analyses by gas-chromatographic techniques prior to sample extraction. Surrogate Standard/Spikes provide a means of checking that no gross errors have occurred during any stage of the test method leading to significant analyte loss.
- Laboratory Blank: Usually an organic or aqueous solution that is as free as possible of analytes of interest to which is added all the reagents, in the same volume, as used in the preparation and subsequent analysis of the samples. The reagent blank is carried through the complete sample preparation procedure and contains the same reagent concentrations in the final solution as in the sample solution used for analysis. The reagent blank is used to correct for possible contamination resulting from the preparation or processing of the sample.

The individual testing laboratories will conduct an assessment of the laboratory QC program, internally; however the results will also be independently reviewed and assessed by GHD.

Laboratory duplicate samples should return RPDs within the NEPM acceptance criteria of $\pm 30\%$. Percent recovery is used to assess spiked samples and surrogate standards. Percent recovery; although dependent on the type of analyte tested, concentrations of analytes and sample matrix; should normally range from about 70-130%. Method (laboratory) blanks should return analyte concentrations as 'not detected'.

7.4 Material treatment and containment cell verification

As discussed in Section 5.5, a quality control plan will be developed to verify the treatment of contaminated materials prior to placement in the containment cell. Testing will incorporate QA/QC measures as described above.

As part of final design of the containment cell, a Construction Quality Assurance Plan (CQA Plan) will be developed to verify that construction of the containment cell is undertaken in accordance with the design and specifications.

Verification of the treatment process and construction of the containment cell will be included in a Remediation and Validation report documenting the works undertaken.

8. Remediation works management

8.1 Responsibilities

Those responsible for the implementation of the RAP have been outlined in Section 1.3 and are as follows:

- Project Manager (PM).
- Site Manager (SM).
- Environmental Representative (ER).
- Environmental Consultant (EC).

The following requirements are intended to be read in conjunction with a CEMP that will be prepared prior to remediation activities, as discussed in Section 9.

8.2 Site control

8.2.1 Site access

The SM shall ensure that the site is securely fenced and designated work areas (excavation, stockpiles and treatment areas) are adequately controlled to prevent unauthorised persons from accessing the work areas. This includes preventing access to excavations or stockpiles, and subsequently gaining direct access to contaminated soils, or to areas of operating machinery.

Before entering the site, all personnel must report to the SM. All personnel within the site will be required to meet the applicable personal protective equipment (PPE) requirements (refer to Section 8.3), and all workers must have undertaken Occupational Health and Induction Training.

All visitors and on-site workers will be required to complete a site safety and environmental induction and consequently acknowledge understanding of the site Health, Safety and Environmental Management procedures prior to commencement of any activity on the site.

8.2.2 Notification

All persons entering the site must be made aware that a CEMP and RAP exist in relation to the contaminated soil and waste material present on-site. This should be included during the general site induction process.

Anyone ordering or requiring intrusive works or disturbance of the site including vehicular access, must notify the staff member or subcontractor concerned of the CEMP and RAP and the requirement that the staff member or subcontractor complete the site ground works induction form.

Subcontractors should be provided with a copy of this RAP and the CEMP when quotes or tenders are sought from them for works that may cause site disturbance.

8.2.3 Induction

It is the responsibility of the PM to ensure that all visitors and on-site workers complete a site specific induction as discussed in Section 8.2.1. In regard to issues associated with contaminated soil and waste materials, the induction process should address the requirements of this RAP including (but not limited to) the following topics:

- Identification of the type and locations (area and depth) of identified contamination.

- Identification of hazards associated with contaminated soil and waste materials and risk control measures.
- Regulatory requirements or codes of practice relevant to identified hazards.
- Site specific safety rules for contamination and hazardous building materials.
- Accident, emergency and evacuation procedures for incidents involving contamination and hazardous building materials, and knowledge of any associated equipment on-site.

8.2.4 Records

For each person likely to be exposed to a hazardous substance, records must be kept for the following:

- All risk assessment reports indicating a need for atmospheric monitoring or health surveillance, and records of the results of any atmospheric monitoring or health surveillance—for at least 30 years after the date of the last entry in them.
- A record of all induction or other training.
- A copy of relevant statements of WHS induction training, or a statement indicating that the PM is satisfied that the relevant WHS induction training has been undertaken.
- A brief description of the site-specific training undertaken by the person.

8.2.5 Control of subcontractors

Subcontractors whose work will be performed on-site, or who otherwise could be exposed to health and safety hazards, will be required to adopt the provisions of this RAP and the CEMP and will be advised of potential safety and environmental issues on-site during site-specific induction training. This induction will include the environmental and occupational health and safety responsibilities, requirements and controls for all subcontractors working on-site. All subcontractor activities will be monitored by the PM to ensure compliance with the requirements of this plan.

Subcontractors shall be solely responsible for the health and safety of their employees and shall comply with all applicable laws and regulations. All contractors and subcontractors are responsible for:

- Providing their own personal protective equipment.
- Preparing site specific safe work method statements for work they are undertaking.
- Training their employees in accordance with applicable laws.
- Providing health and medical surveillance and obtaining medical approvals for their employees.
- Ensuring their employees are advised of and meet the minimum requirements of the RAP, the CEMP and any other additional measures required by their site activities.
- Designating their own Site Safety Representative.

8.3 Recommended personal protective equipment

All personnel will be required to wear appropriate PPE when working on the site. In relation to contamination, the following items of PPE are recommended:

- Long Sleeve Drill Shirt.
- Long Drill Pants.

- Disposable coveralls (when working in direct contact with contaminated soils/groundwater).
- Chemical Resistant Safety Boots.
- Disposable Nitrile Gloves (when working in direct contact with contaminated soils/groundwater).
- Safety glasses/goggles.
- Dust mask (during dust generating activities).

Disposable gloves and coveralls should be disposed of after use or when deemed necessary. Heavily stained work clothes and other items of PPE should also be disposed or laundered by an appropriate industrial laundering facility. Potentially contaminated clothing will not be taken home for laundering.

Further site specific PPE may be identified as a requirement for site workers following the completion of site safety assessment.

8.4 Acid sulfate soils

Any works that involves the disturbance of acid sulphate soils (ASS) must be undertaken in accordance with the ASSMP prepared for the Site.

8.5 Erosion/sediment control and run-off control

All site works shall be undertaken in accordance with the Soil and Water Management Plan (SWMP) prepared for the Site. The PM shall provide the specific details of the erosion and sediment control measures, and will be responsible for their implementation and maintenance throughout the construction works.

8.6 Contingency plan (unexpected finds)

The presence of previously unidentified types of contaminants, may be identified during works by observation of any unusual physical/sensory characteristics of the impacted soil or groundwater.

The following outlines some of the unexpected situations that may arise:

- Unexpected discovery of hazardous building materials (HBMs) such as asbestos containing materials.
- Contaminants in addition to the type already identified on-site may be encountered (e.g.drums and material with visual or olfactory evidence of contamination).
- Contaminated material in addition to the type already identified on-site may fail the NSW EPA Waste Classification Guidelines, and not be acceptable for disposal.
- Side effects of site works such as unacceptable levels of odour, noise, dust, and surface runoff may be generated.

The PM should be notified if such impacts are noted. Should any unexpected situations be encountered, the following procedures should be followed:

- Stop work and make the area secure
- Notify the PM (who will consult with the EPA, if required)
- Follow the procedures listed below:

If potential asbestos containing material is observed, then the excavation area should be isolated and managed as per the procedures listed in Section 5.

If this can be carried out in a manner consistent with the RAP, potentially contaminated material may be excavated and placed into leak-proof skip bins or separately stockpiled in a secure location on strong impermeable plastic sheeting to prevent the contamination of the underlying soils and covered with plastic sheeting, which should be securely fitted. The stockpile should be surrounded by adequate sedimentation control to collect runoff and prevent overland stormwater flow from affecting the base of the stockpile. Potentially contaminated materials from different parts of the site should not be mixed, but should be segregated into separate stockpiles for each type of material excavated. Access to the stockpiles of potentially contaminated material should be limited by keeping within the existing site fences or alternatively temporary fencing be placed around the stockpiles. Stockpiles or skip bins should be covered to prevent rainfall from saturating the material and/or generating leachate.

When the potentially contaminated material has been removed, the area from which this material was excavated should also be isolated. Further excavation or other construction work should not occur in that area until advice from a suitably qualified environmental consultant is provided confirming that any contaminated material has been removed and that the area has been suitably remediated.

The location from which potentially contaminated materials is excavated and the location of the stockpile of excavated material should be recorded on a site plan. This should include an outline of the lateral and vertical extent of the potentially contaminated materials (i.e. area and depth) and the volume of material excavated should be estimated and recorded.

A suitably qualified environmental consultant should assess the potentially contaminated material and prepare a report advising whether the material is contaminated at levels exceeding the NSW EPA endorsed guidelines for reuse on-site and/or whether the material needs to be disposed of as waste, and the classification of that waste.

When the contaminated material is assessed as being unsuitable for reuse on the site, then the area where the material was excavated will require validation by the environmental consultant to demonstrate that no unsuitable material remains in the excavated area. If the laboratory analysis of the validation samples collected from the excavated area reports concentrations of contaminants above that suitable for the proposed land use (i.e. open space), then additional contaminated material will need to be removed until the excavation is validated as suitable, or alternative management means uses will need to be determined.

8.7 Review of RAP

This RAP will require review and updating following any significant changes in characteristics of the site, including those resulting from unexpected finds. The RAP should be reviewed and updated if required should these works be significantly delayed or postponed.

9. Protection of the environment and community

A major factor of the remediation operation shall involve the installation and maintenance of environmental protection and pollution control measures. These measures shall be designed to achieve the following objectives:

- Protection of the surrounding environment during all phases of remediation works.
- Protection of the local community during all phases of the remediation works.
- The containment of all contaminated and potentially contaminated materials (soils, sludges, run-off etc) to the site.

The CEMP will be prepared to address and incorporate these measures as applicable to all active remediation works. The CEMP shall include the following activities:

- Hours of Operation.
- Containing Contaminated Material.
- Soil and Water Management.
- Stockpiles.
- Vehicle Access.
- Dewatering.
- Noise.
- Vibration.
- Air Quality.
- Dust and Particulate Control.
- Odour Control.
- Environmental Protection and Pollution Control Contingency Plan.

10. Health and safety

Workplace Health and Safety (WH&S) is a necessity on all remediation projects to ensure the health and safety of all personnel working/visiting the site. Therefore work shall be carried out in accordance with a Site Specific Health and Safety Plan. The Site Manager shall prepare a site specific WH&S Plan for the remediation works, addressing as a minimum the requirements of this RAP, and shall appoint a Site Safety Officer for the duration of the works.

It is the responsibility of the contractor to take all necessary practicable actions to safeguard the safety and health of all employees and subcontractors while they are on the site. The aim of the WH&S Plan shall be to provide and maintain safety standards and practices, which offer the highest practical degree of personal protection, based on current knowledge.

All work undertaken shall be performed in accordance with the provisions of the relevant legislation, and any other relevant regulations or directions issued by regulatory authorities.

The Site Specific Health and Safety Plan shall cover the following aspects:

- Induction of personnel.
- Hazard locations and identification.
- Description of exposure pathways and personnel protection requirements.
- Location of all underground/aboveground services.
- Work practice procedures, within the designated contaminated zones.
- Monitoring protocols to identify a potentially hazardous practice.
- Emergency response information and procedures.
- Incident reporting.

A number of exposure pathways exist which could potentially result in on-site workers/visitors to the site or surrounding residences being exposed to the contamination. These potential exposure pathways include:

- Inhalation of contaminants in the form of dust or vapours.
- Ingestion of contaminated soil.
- Dermal absorption of contaminants through skin contact.

The Site Safety Officer shall ensure that these and any other potential exposure pathways are controlled.

11. Community consultation

Consultation with the community has been undertaken at various phases throughout the site investigation. Consultation activities have included:

- A public meeting held at the Urunga Golf Club.
- Meetings with interested community groups (e.g. Urunga Chamber of Commerce, Community Groups, Bellingen Environment Centre, Bellingen Shire Council).
- Media releases which were then converted to newspaper articles.
- Direct liaison (meetings and written correspondence) with relevant stakeholders.

In general, community feedback indicated there was very little opposition to the Proposal as a remediation project is considered to offer significant benefits to the community through reduced potential health risks, improved environmental conditions, short term employment opportunities and restored recreational and visual amenity.

Community consultation would continue throughout the Environmental Impact Statement (EIS) process and the remediation works.

Any enquires made by members of the public to worker on site during remediation should be directed to the PM.

12. Regulatory requirements

This RAP has been prepared with consideration of relevant guidelines and policy, in particular:

- Guidelines for Consultants Reporting on Contaminated Sites (OEH 2011).
- Protection of the Environment Operations Act 1997.
- Protection of the Environment (Waste) Regulations 2005.
- Other guidelines made or approved by EPA under s.51 of the CLM Act 1997 have been referred to in this RAP, as listed in Section 4.4.

Other relevant regulatory requirements are outlined below. The PM shall be responsible for ensuring the remediation works are carried out in accordance with regulatory requirements.

12.1 State Environmental Planning Policy (State and Regional Development) 2011

The aims of this Policy are as follows:

- (a) to identify development that is State significant development,*
- (b) to identify development that is State significant infrastructure and critical State significant infrastructure, and*
- (c) to confer functions on joint regional planning panels to determine development applications.*

Schedule 1 (Clause 24) of the Policy describes the types of remediation that are considered state significant.

Clause 24 'Remediation of contaminated land':

- (1) Development for the purpose of remediation of land that is category 1 remediation work on significantly contaminated land if the work is required to be carried out under the Contaminated Land Management Act 1997 by a management order that requires:*
 - (a) the taking of action of the kind referred to in section 16 (d) or (g) of that Act, or*
 - (b) the preparation of a plan of management that provides for the taking of any such action.*

The proposed remediation is subject to this Policy by virtue of Management Order 20111405, which requires the remediation of the site. The Minister is, therefore, the determining authority.

12.2 State Environmental Planning Policy No 55 – Remediation of Land

The aims and objectives of *State Environmental Planning Policy No. 55 – Remediation of Land* (SEPP 55) are to provide a state-wide planning approach to potentially contaminated land. It also promotes the remediation of contaminated land to reduce the risk of harm.

SEPP 55 aims to promote the remediation of contaminated land for the purpose of reducing the risk of harm to human health or any other aspect of the environment.

Clause 8 of SEPP 55 outlines the types of remediation that requires consent and those that do not. Category 1 remediation works require consent. Pursuant to Clause 9, a category 1 remediation work is a remediation work (not being a work to which clause 14 (b) applies) that is:

- (a) designated development, or*

- (b) carried out or to be carried out on land declared to be a critical habitat, or*
- (c) likely to have a significant effect on a critical habitat or a threatened species, population or ecological community, or*
- (d) development for which another State environmental planning policy or a regional environmental plan requires development consent, or*
- (e) carried out or to be carried out in an area or zone to which any classifications to the following effect apply under an environmental planning instrument:*
 - (i) coastal protection,*
 - (ii) conservation or heritage conservation,*
 - (iii) habitat area, habitat protection area, habitat or wildlife corridor,*
 - (iv) environment protection,*
 - (v) escarpment, escarpment protection or escarpment preservation,*
 - (vi) floodway,*
 - (vii) littoral rainforest,*
 - (viii) nature reserve,*
 - (ix) scenic area or scenic protection,*
 - (x) wetland, or*
- (f) carried out or to be carried out on any land in a manner that does not comply with a policy made under the contaminated land planning guidelines by the council for any local government area in which the land is situated (or if the land is within the unincorporated area, the Western Lands Commissioner).*

According to Clause 9 of the SEPP, the proposed remediation is considered Category 1 remediation works as it will be undertaken within an environmental protection zone pursuant to Bellingen LEP 2010, hence consent is required.

12.3 State Environmental Planning Policy No 14—Coastal Wetlands

The aim of SEPP 14 is to ensure that the coastal wetlands are preserved and protected in the environmental and economic interests of the State.

Clause 7(1) requires consent for the following activities on land mapped as SEPP 14:

- a) Clearing*
- b) constructing a levee*
- c) draining*
- d) filling*

The Proposal is located adjacent to, and may include some works within a SEPP 14 wetland (no. 354). As the Proposal includes clearing, drainage and potentially filling, consent is required from the consent authority. As the proposal is considered State significant development the Minister would be the consent authority.

12.4 Environmental Planning and Assessment Act

The provisions of the EP&A Act govern development within the State of NSW. The approval pathway for assessment and determination of development is dependent on which part of the Act applies.

The Proposal falls under Part 4 of the EP&A Act, through the application of Clause 9 of *State Environmental Planning Policy No 55 (Remediation of Land)* and therefore development consent is required. The development is also considered State Significant Development according to Clause 8 of *State Environmental Planning Policy (State and Regional Development)*. Accordingly, the Minister is the consent authority.

An Environmental Impact Statement is required to provide the Minister and other determining authorities with information on matters affecting or likely to affect the environment and to comply with the requirements of the EP&A Act. Contaminated Land Management (CLM) Act 1997.

The CLM Act 1997 is administered by the EPA and local Councils. It provides a regime for investigation and, where appropriate remediation of land affected by contamination that poses a significant risk of harm to human health or the environment. The CLM Act specifies responsibilities for managing contaminated land and the role of the EPA in the assessment of contamination and the supervision of the investigation, remediation and management of contaminated sites. NSW has a comprehensive suite of guidelines relating to assessment and management of contamination, administered under the CLM Act 1997 and the *Protection of the Environment Operations* (POEO) Act 1997.

Under Section 14 of the CLM Act, the EPA has issued a Management Order 20111405 for the remediation of the site.

12.5 Protection of the Environment Operations (POEO) Act 1997

The requirements of the POEO Act 1997, and associated schedules and regulations, are relevant to the remedial phase of the project. The objectives of the Act include to protect, restore and enhance the quality of the environment in NSW, having regard to the need to maintain ecologically sustainable development (ESD).

The POEO Act includes requirements not to pollute waters, to prevent or minimise air pollution, to maintain and operate plant in a proper and efficient condition/manner and to deal with materials in a proper and efficient manner to minimise noise impacts, and to minimise and manage wastes. The Act also requires notification to the EPA when a pollution incident occurs that causes or threatens material harm to the environment.

The provisions of the POEO Act relating to the pollution of waters and waste disposal are particularly relevant to the proposal and would need to be considered during the remediation work.

Environmental Protection Licences are issued under the POEO Act. Under Schedule 43 'Types of licences' of the POEO Act:

'Environment protection licences may be issued for the following purposes:

- (a) to authorise the carrying out of scheduled development work at any premises, as required under section 47,*
- (b) to authorise the carrying out of scheduled activities at any premises, as required under section 48,*
- (c) to authorise the carrying out of scheduled activities not related to premises, as required under section 49,*

(d) to control the carrying out of non-scheduled activities for the purpose of regulating water pollution resulting from any such activity, as referred to in section 122.'

Schedule 1 'Scheduled Activities', Clause 15 'Contaminated soil treatment' of the POEO Act states:

(1) This clause applies to contaminated soil treatment, meaning the on site or off site treatment of contaminated soil (including, in either case, incineration or storage of contaminated soil but excluding excavation for treatment at another site).

(2) The activity to which this clause applies is declared to be a scheduled activity if:

(a) in any case, it has the capacity to treat more than 1,000 cubic metres per year of contaminated soil received from off site, or

(b) where it treats contaminated soil originating exclusively on site, it has a capacity:

–(i) to incinerate more than 1,000 cubic metres per year of contaminated soil, or

–(ii) to treat (otherwise than by incineration) and store more than 30,000 cubic metres of contaminated soil, or

–(iii) to disturb more than an aggregate area of 3 hectares of contaminated soil.

As the Proposal includes the excavation of less than 30,000 cubic metres of contaminated soil and would disturb less than 3 hectares of contaminated land, an EPL is not required.

12.6 Water Management (WM) Act 2000

The WM Act 2000 aims to provide for the sustainable and integrated management of the water sources of the State for the benefit of both present and future generations.

The WM Act also provides for the preparation of water management plans, which contain much of the detail necessary for the operation of the Act. Water Management Plans address matters such as water sharing, water use, drainage and floodplain management and water source protection. The Site is located within the *Water Sharing Plan for the Bellinger River Area Unregulated and Alluvial Water Sources 2008*.

A Controlled Activity Approval (CAA) under the WM Act is required for certain types of developments and activities that are carried out in or near a river, lake or estuary. In accordance with clause 39A of the *Water Management Regulations 2004*, Public authorities and local councils are exempt from a CAA, pursuant to Section 344 (1) (a) of the WM Act in relation to all controlled activities that they carry out in, on or under waterfront land. Accordingly, a CAA would not be required for the Project.

12.7 Fisheries Management Act 1994

The *Fisheries Management Act 1994* (FM Act) is administered by the Department of Primary Industries and its objectives are to conserve, develop and share the fishery resources of the State for the benefit of present and future generations.

Pursuant to Section 199 of the FM Act, 'a public authority (other than a local government authority) must, before it carries out or authorises the carrying out of dredging or reclamation work:

(a) give the Minister written notice of the proposed work, and

(b) consider any matters concerning the proposed work that are raised by the Minister within 28 days after the giving of the notice (or such other period as is agreed between the Minister and the public authority).'

Written notice of the proposed remediation would need to be given to the Minister because the Proposal involves excavating material from water land.

Part 7A of the FM Act provides for threatened species conservation including measures to:

- Conserve biological diversity of fish and marine vegetation
- Prevent the extinction and promote the recovery of threatened species
- Provide for the listing of threatened species for the purposes of this Part

Threatened species, populations are listed in Schedules 4, 4a and 5 of the FM Act.

13. Conclusions and recommendations

13.1 Conclusions

As a result of former antimony ore processing activities at the site, significant contaminant impact is present in soils (including tailings and waste stockpiles) on the site, sediment in adjoining areas, groundwater on the site and surface water on and adjoining the site. Antimony and arsenic have been identified as the key contaminants of concern and govern remediation requirements. Other metals (including mercury) were identified as less significant contaminants of concern, but are unlikely to govern remediation requirements.

There are lesser quantities of incidental contaminants on the site which also need to be addressed as part of the remediation works, primarily associated with residual stockpiles and waste materials in the former processing area.

The areas of most significant impact have been identified by previous investigations. A set of remediation objectives has been agreed with key stakeholders (SCS, Crown Lands, EPA and BSC), to define the desired outcomes and constraints of the remediation works. Based on achieving a balance between the cost of remediation and the impacts incurred during the remediation works against the impacts and risks of leaving areas of contamination in place, areas have been identified for remediation. The nominated extent of remediation totals approximately 2.8 hectares in area and 25,000 m³ in volume.

The costs, risks and benefits of a number of remediation options were examined, including off-site reprocessing of tailings, off-site disposal to licensed landfill, on-site containment in an engineered containment cell, and on-site in situ containment. Based on a review of feasible remediation options by the key stakeholders, the preferred remediation option is on-site treatment and disposal which will remove the material from the most impacted areas, immobilise the most leachable material and place it in a containment cell onsite.

While this approach will entail long-term management of the contaminated material on the site, the lower cost compared with the off-site disposal options will enable a greater area and volume of the impacted areas to be remediated. There will also be less impacts associated with transport of contaminated material from the site. The most significant areas of contamination will be removed and isolated from potential exposure and the risks of ongoing migration of contaminants will be minimised.

It is estimated that approximately 97% of the mass of contamination can be remediated and managed by means of this remediation approach, within the budget that is understood to be available for the works. The remaining areas of contamination are considered to present a relatively low risk to health or the environment, and existing impact is not evident in these areas (eg. vegetation is healthy). Given the remediation objectives and constraints (including the high risk of ecological impact that would be incurred by remediation activities in these areas for relatively little gain in removal of contamination), it is not considered that remediation of the remaining areas is warranted.

An EIS (GHD 2014) has been prepared as the remediation falls under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act), through the application of Clause 9 of *State Environmental Planning Policy No 55 (Remediation of Land)*. Development consent is therefore required. The Proposal is also considered State Significant Development under Section 89C of the EP&A Act by virtue of Clause 8 of *State Environmental Planning Policy (State and Regional Development) 2011*. Pursuant to Section 78A(8A) of EP&A Act, an EIS is required to accompany a development application to the Minister for Planning and Infrastructure for the Proposal.

13.2 Recommendations

The following information is required prior to the commencement of remediation works:

- The EIS (GHD 2014) which contains details relating to:
 - The Director Generals requirements.
 - Required agency approvals.
 - Community and agency consultation.
 - Mitigation measures.
- A Construction Environmental Management Plan (CEMP) detailing the remediation methodology and work sequence and incorporating an acid sulphate management plan (ASSMP), soil and water management plan (SWMP), traffic management plan (TMP) and waste management plan (WMP). The CEMP should be prepared by the parties responsible for carrying out the remediation works, and subject to approval by the appropriate regulators.
- An Occupational Health and Safety management plan for the remediation works.
- A treatment process for contaminated materials approved by the EPA, and a quality control plan to verify the treatment of contaminated materials.
- Geotechnical and hydrogeological investigations of the containment cell area.
- Detailed design of the containment cell and a Construction Quality Assurance (CQA) Plan for construction of the cell.

The remediation works should be guided and verified by an independent environmental consultant, who should prepare a Remediation and Validation report documenting the works that are carried out.

A long term environmental management plan (EMP) will be required for the ongoing management and maintenance of the containment cell.

14. Limitations

This Remedial Action Plan (RAP) for the Former Antimony Processing Plant - Urunga NSW (the "Report"):

- has been prepared by GHD Pty Ltd ("GHD") for NSW Trade and Investment - Crown Lands
- may be used and relied on by NSW Trade and Investment - Crown Lands
- may be used by and provided to the NSW EPA and the relevant planning authority for the purpose of meeting statutory obligations in accordance with the relevant sections of the CLM Act 1997 or the Environment Planning and Assessment (EP&A) Act 1979
- may only be used for the purpose as stated in Section 1.2 of the Report (and must not be used for any other purpose)

GHD and its servants, employees and officers otherwise expressly disclaim responsibility to any person other than NSW Trade and Investment - Crown Lands arising in connection with this report. To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by GHD and the RAP are excluded unless they are expressly stated to apply in this RAP.

The services undertaken by GHD in connection with preparing this Report:

- were limited to those specifically detailed in Section 1.2 of this Report and GHD proposal "Urunga Antimony Contaminated Site – Remedial Action Plan – Fee Proposal. 2 May 2012. 22\0906390\WP\15134.doc".
- were undertaken in accordance with current professional practice and by reference to relevant environmental regulatory authority and industry standards, guidelines and assessment criteria in existence as at the date of this RAP and any previous site investigation and assessment reports referred to in the RAP.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by various third parties. GHD has not independently verified or checked beyond the agreed scope of work and does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

This RAP is based solely on the investigations and findings contained in the reports referenced in the RAP (Section 15) and on the conditions encountered and information reviewed at the time of each referenced report. This RAP should be read in conjunction with the referenced reports. It is also subject to all the limitations and recommendations in the referenced reports.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

This Report should be read in full and no excerpts are taken to be representative of the findings of this Report.

15. References

- Ahern, C.R., Stone, Y. and Blunden, B. (1998) *Acid Sulfate Soils Assessment Guidelines*, Acid Sulfate Soil Management Advisory Committee, Wollongbar, NSW, Australia.
- ANZECC (2000). *National Water Quality Management Strategy, Paper No. 4, Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, October 2000, Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ).
- ANZECC/NH&MRC (1992). *Guidelines for the Australian and New Zealand Assessment and Management of Contaminated Sites*. Australian and New Zealand Environmental and Conservation Council and the National Health and Medical Research Council.
- BSC (2008). Flood Risk Maps, map 12. Bellingen Shire Council
http://www.bellingen.nsw.gov.au/images/documents/bellingen/mig/3366-Flood_Map_12.pdf
- Coffey (2004). *Validation Assessment of Stripped Area*.
- Dear SE, Moore NG, Dobos SK, Watling KM and Ahern CR (2002). Soil Management Guidelines. In Queensland Acid Sulfate Soil Technical Manual. Department of Natural Resources and Mines, Indooroopilly, Queensland, Australia.
- DECCW, (2009). *Waste Classification Guidelines*. Department of Environment, Climate Change and Water, Sydney.
- DLWC (1995). *Assessment of Contaminated Crown Land at Urunga*. Department of Land and Water Conservation.
- DLWC (1997a). *Part 1 Urunga Contaminated Site Background and Results*. Department of Land and Water Conservation.
- DLWC (1997b). *Part 2 Urunga Contaminated Site Remediation Options*. Department of Land and Water Conservation.
- DLWC (2002). *Wasteland to Wetland. Evaluation of Options for Remediation of the Former Antimony Processing Plant at Urunga, NSW*. NSW Department of Land and Water Conservation, Resource Analysis Unit North Coast.
- DMR (1977). *Urunga Mineral Processing Plant Investigation*. Department of Mineral Resources Mines Inspection Branch.
- DMR (2004). NSW. *Abandoned Minesite Database. Urunga Mineral Preparation Plant*. Department of Mineral Resources.
- EnHealth (2012). *Australian Exposures Handbook*.
- GHD (2012a). *Former Antimony Processing Plant, Urunga, NSW – Preliminary Investigation Report*.
- GHD (2012b). *Former Antimony Processing Plant, Urunga, NSW – Detailed Investigation Report*.
- GHD (2013). *Former Antimony Processing Plant, Urunga, NSW – Detailed Investigation Report Addendum One – Supplementary Sampling Results*.
- GHD (2014) *Former Antimony Processing Plant- Urunga NSW, Environmental Impact Assessment for Remediation Activities*
- Hicks (1993). *Investigation of Trace Metal Concentrations in Urunga Lagoon*. Bachelor Degree Thesis, The University of New England- Northern Rivers.

Irving, Lowell, Culp, Liber, Xie and Kerrich (2008). *Effects of Arsenic Speciation and Low Dissolved Oxygen Condition on the Toxicity of Arsenic to a Lotic Mayfly*. Paper in Environmental Toxicology and Chemistry, Vol 27, No. 3. 2008.

MHSPE (1994). [*Intervention values and target values - soil quality standards*](#). The Ministry of Housing, Spatial Planning and Environment. Directorate-General for Environmental Protection. Department of Soil Protection (625).

NEPC (2013). *National Environment Protection (Assessment of Site Contamination) Measure*, National Environment Protection Council (NEPC).

NSW DEC (2006). *Guidelines for the NSW Site Auditor Scheme*, Department of Environment and Conservation, April 2006.

NSW EPA (2002). *Declaration of Remediation Site*. Declaration Number 21020. Area 1089 Environmental Protection Authority.

NSW EPA (2005). *Notice to End Remediation Declaration*. Notice Number 22004. Area Number 1089. Environmental Protection Authority.

NSW EPA (2008). *Former Antimony Processing Plant Soil Sampling Results*. Environmental Protection Authority.

NSW EPA (2012a). *Notice to Amend Management Order*. Notice Number 20124407. Area Number 1089. May 22, 2012. Environmental Protection Authority.

NSW EPA (2012b). *Notice to Amend Management Order*. Notice Number 20124422. Area Number 1089. September 26, 2012. Environmental Protection Authority.

NSW EPA (1995). *Contaminated Sites: Sampling Design Guidelines*. Environmental Protection Authority.

NSW EPA (2011). *Management Order* Number 20111405, Declaration Number 21020. Area Number 1089. Environmental Protection Authority.

NSW EPA (2014). *Notice to amend Management Order (Section 44 of the Contaminated Land Management Act 1997)* Notice Number 20144421; Area Number 1089. Dated 21 May 2014.

OEH (2011). *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites*. Office of Environment and Heritage.

Repath, P and Body, M (2003). *Flora and Fauna Evaluation for the Urunga Antimony Contaminated Site: An inventory assessment for an EIS*.

SCS (2012). *Urunga Antimony Processing Plant. Contaminated Site - Project Application & Preliminary Environmental Assessment*. Soil Conservation Service. 12 June 2012.

Shaw Environmental (2009), *Remedial Investigation Report, Iron Mountain Road Ranges*, prepared for the US Army Corps of Engineers.

SPCC (1984). *Water Quality in the Bellingen and Kalang Rivers*. State Pollution Control Commission, Northern Rivers Study No. 2.

U.S. EPA. 2004. *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)*, Final. EPA/540/R/99/005. Office of Solid Waste and Emergency Response, Washington, DC. PB99-963312.

USEPA 2014. *Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites* as accessed from <http://www.epa.gov/region9/superfund/prg/>.

WHO 2014, Antimony in Drinking Water, as accessed from
http://www.who.int/water_sanitation_health/dwq/chemicals/0304_74/en/index5.html

Appendices

Appendix A Summary Results

Soil Chemistry

	Unassigned		Inorganics											Metals																									
	CEC	Sulphuric Acid	Cyanide Total	Electrical conductivity *(lab)	Exchangeable Calcium	Exchangeable Magnesium	Exchangeable Potassium	Exchangeable Sodium	Moisture	pH (Lab)	Redox	Sulphur as S	TOC	Aluminium	Leachable Aluminium	Antimony	Leachable Antimony	Arsenic	Leachable Arsenic	Cadmium	Leachable Cadmium	Chromium (III+VI)	Leachable Chromium (III+VI)	Cobalt	Copper	Leachable Copper	Iron	Lead	Leachable Lead	Manganese	Mercury	Leachable Mercury	Nickel	Leachable Nickel	Selenium	Silver	Vanadium	Zinc	Leachable Zinc
EQI	meq/100g	mg/kg	mg/kg	uS/cm	meq/100g	meq/100g	meq/100g	meq/100g	%	pH Units	mV	mg/kg	mg/kg	mg/kg	mg/L	mg/kg	mg/L	mg/kg	mg/L	mg/kg	mg/L	mg/kg	mg/L	mg/kg	mg/L	mg/kg	mg/kg	mg/L	mg/kg	mg/kg	mg/L	mg/kg	mg/L	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/L
NEPM 1999 EIL	0.1	0.001	0.1	1000	0.1	0.1	0.1	0.1	0.5	0.1	1	0.005	0.02	1	0.1	1	0.1	0.5	0.1	0.1	0.05	0.3	0.1	0.5	0.1	50	0.5	0.1	0.5	0.05	0.001	0.5	0.1	0.5	1	2	0.5	0.1	
USEPA RES												600					20		3		50			100			600		500	1		60				50	200		
NEPM 1999 HIL E			1000												310			200		40		200		200	2000		600		3000	30		600					14000		
10 times HIL E/ USEPA RES															3100		2000		400		2000		2000	20,000		6000		30,000	300		6000								
30 times HIL E/ USEPA RES															9300		6000		1200		6000		6000	60,000		18,000		90,000	900		18,000								

Field_ID LocCode Sample Sample Date Source
Depth

DLWC 1995																																								
1/0-10	DLWC95-S1	0-0.1	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	9020	-	2671	-	0.3	-	5	-	-	23	-	-	150	-	35	-	-	-	-	-	40	-	
1/40-50	DLWC95-S1	0.4-0.5	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	7059	-	3596	-	0.4	-	6	-	-	36	-	-	290	-	25	-	-	-	-	-	-	27	-
1/60-70	DLWC95-S1	0.6-0.7	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	9020	-	4897	-	0.4	-	3.4	-	-	23	-	-	555	-	188	-	-	-	-	-	-	42	-
2/0-10	DLWC95-S2	0-0.1	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	7843	-	3527	-	0.5	-	5	-	-	22	-	-	125	-	30	-	-	-	-	-	-	20	-
2/20-30	DLWC95-S2	0.2-0.3	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	5784	-	3048	-	0.5	-	12	-	-	21	-	-	110	-	63	-	-	-	-	-	-	27	-
2/40-50	DLWC95-S2	0.4-0.5	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	10,490	-	3022	-	0.8	-	77	-	-	142	-	-	920	-	315	-	-	-	-	-	-	50	-
2/50-55	DLWC95-S2	0.5-0.55	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	48	-	45	-	0.4	-	12	-	-	7	-	-	12	-	17	-	-	-	-	-	6	-	
2/80-100	DLWC95-S2	0.8-1	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	15	-	485	-	0.9	-	27	-	-	17	-	-	34	-	225	-	-	-	-	-	21	-	
3/110-120	DLWC95-S3	1.1-1.2	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	69	-	37	-	0.8	-	33	-	-	25	-	-	45	-	454	-	-	-	-	-	136	-	
3/20-30	DLWC95-S3	0.2-0.3	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	2745	-	1194	-	25.5	-	452	-	-	3448	-	-	3550	-	70	-	-	-	-	-	7477	-	
3/65-75	DLWC95-S3	0.65-0.75	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	7647	-	306	-	5.2	-	63	-	-	150	-	-	395	-	766	-	-	-	-	-	1290	-	
3/80-85	DLWC95-S3	0.8-0.85	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	549	-	332	-	3.7	-	94	-	-	119	-	-	200	-	507	-	-	-	-	-	4626	-	
4/0-10	DLWC95-S4	0-0.1	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	11,670	-	2910	-	0.9	-	23	-	-	704	-	-	480	-	55	-	-	-	-	-	137	-	
4/40-48	DLWC95-S4	0.4-0.48	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	1863	-	655	-	0.6	-	96	-	-	172	-	-	160	-	77	-	-	-	-	-	41	-	
4/80-90	DLWC95-S4	0.8-0.9	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	9118	-	1557	-	1.8	-	1540	-	-	1710	-	-	935	-	619	-	-	-	-	-	178	-	
5/0-10	DLWC95-S5	0-0.1	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	2010	-	197	-	1.6	-	363	-	-	2716	-	-	500	-	89	-	-	-	-	-	294	-	
6/0-10	DLWC95-S6	0-0.1	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	6569	-	2869	-	0.8	-	25	-	-	31	-	-	110	-	24	-	-	-	-	-	32	-	
6/15-20	DLWC95-S6	0.15-0.2	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	3137	-	738	-	0.8	-	29	-	-	33	-	-	49	-	5	-	-	-	-	-	25	-	
6/40-50	DLWC95-S6	0.4-0.5	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	17,160	-	1229	-	1.8	-	81	-	-	399	-	-	170	-	349	-	-	-	-	-	383	-	
7/0-10	DLWC95-S7	0-0.1	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	549	-	184	-	1.6	-	72	-	-	1293	-	-	75	-	1194	-	-	-	-	-	51	-	
7/20-30	DLWC95-S7	0.2-0.3	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	169	-	82	-	3.3	-	105	-	-	3376	-	-	75	-	3164	-	-	-	-	-	110	-	
7/60-70	DLWC95-S7	0.6-0.7	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	11,180	-	266	-	1.5	-	25	-	-	254	-	-	150	-	676	-	-	-	-	-	83	-	
7/70-80	DLWC95-S7	0.7-0.8	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	6275	-	504	-	1.5	-	15	-	-	158	-	-	220	-	676	-	-	-	-	-	64	-	
8/30-36	DLWC95-S8	0.3-0.36	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	7157	-	4262	-	0.6	-	6	-	-	9	-	-	43	-	49	-	-	-	-	-	14	-	
8/70-80	DLWC95-S8	0.7-0.8	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	1029	-	279	-	0.8	-	9	-	-	19	-	-	74	-	349	-	-	-	-	-	58	-	
9/0-10	DLWC95-S9	0-0.1	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	7843	-	5041	-	0.4	-	10	-	-	55	-	-	200	-	30	-	-	-	-	-	33	-	
10/0-10	DLWC95-S10	0-0.1	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	10,590	-	7582	-	0.7	-	5	-	-	30	-	-	180	-	26	-	-	-	-	-	20	-	
10/20-30	DLWC95-S10	0.2-0.3	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	5882	-	6352	-	0.6	-	19	-	-	22	-	-	120	-	46	-	-	-	-	-	35	-	
10/70-80	DLWC95-S10	0.7-0.8	14/03/1995	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	1186	-	3648	-	1	-	65	-	-	52	-	-	935	-	721	-	-	-	-	-	84	-	
DLWC 1997																																								
1/4	DLWC97-S1	1.7-1.8	30/04/1997	Historic- Lab	-	0.156	<0.1	22,000	-	-	-	-	-	-	-	-	-	1	-	2.5	-	<0.5	-	13	-	-	2.4	-	-	7.4	-	2.5	<0.05	-	-	-	-	-	4	-
1/5	DLWC97-S1	3.6-3.7	30/04/1997	Historic- Lab	-	0.156	<0.1	17,000	-	-	-	-	-	-	-	-	-	<1	-	<0.5	-	<0.5	-	8.5	-	-	2.5	-	-	7.4	-	2.5	<0.05	-	-	-	-	-	2	-
2/1	DLWC97-S2	0.15-0.25	30/04/1997	Historic- Lab	-	0.94	<0.1	64,000	-	-	-	-	-	-	-	-	-	3410	-	478	-	<0.5	-	3.6	-	-	142	-	-	31	-	13	8.3	-	-	-	-	-	10	-
3/1	DLWC97-S3	0.2-0.3	30/04/1997	Historic- Lab	-	6.72	0.7	170,000	-	-	-	-	-	-	-	-	-	6150	-	6250	-	<0.5	-	2.1	-	-	3.2	-	-	87	-	7.4	44	-	-	-	-	-	9	-
3/3	DLWC97-S3	0.8-0.9	30/04/1997	Historic- Lab	-	23.59	1.5	317,000	-	-	-	-	-	-	-	-	-	6550	-	3610	-	<0.5	-	6.5	-	-	88	-	-	107	-	6.4	25	-	-	-	-	31	-	
3/5	DLWC97-S3	1.9-2	30/04/1997	Historic- Lab	-	0.625	<0.1	78,000	-	-	-	-	-	-	-	-	-	2	-	6.6	-	<0.5	-	21	-	-	17	-	-	19	-	30	0.1	-	-	-	-	10	-	
4/1	DLWC97-S4	0.28-0.38	30/04/1997	Historic- Lab	-	5.94	1.3	246,000	-	-	-	-	-	-	-	-	-	6780	-	5950	-	<0.5	-	2	-	-	5.8	-	-	128	-	6	41	-	-	-	-	-	11	-
4/2	DLWC97-S4	1.1-1	30/04/1997	Historic- Lab	-	37.81	2.2	182,000	-	-	-	-	-	-	-	-	-	9020	-	6970	-	<0.5	-	10	-	-	39	-	-	180	-	161	51	-	-	-	-	46	-	
4/4	DLWC97-S4	1.2-1.3	30/04/1997	Historic- Lab	-	13.75	<0.1	112,000	-	-	-	-	-	-	-	-	-	3110	-	1980	-	<0.5	-	16	-	-	40	-	-	176	-	255	35	-	-	-	-	32	-	
5/1	DLWC97-S5	0.07-0.17	30/04/1997	Historic- Lab	-	13.13	0.8	694,000	-	-	-	-	-	-	-	-	-	4980	-	8740	-	<0.5	-	1.8	-	-	17	-	-	143	-	8.3	37	-	-	-	-	18	-	
5/2	DLWC97-S5	0.5-0.6	30/04/1997	Historic- Lab	-	16.56	1.6	155,000	-	-	-	-	-	-	-	-	-	5170	-	3340	-	<0.5	-	5	-	-	15	-	-	211	-	100	39	-	-	-	-	30	-	
5/3	DLWC97-S5	1-1.1	30/04/1997	Historic- Lab	-	23.91	5.8	227,000	-	-	-	-	-	-	-	-	-	5920	-	2130	-	<0.5	-	21	-	-	364	-	-	512	-	382	65	-	-	-	-	65	-	
6/1	DLWC97-S6	0.24-0.34	30/04/1997	Historic- Lab	-	3.44	2.1	68,000	-	-	-	-	-	-	-	-	-	4.4	324	0.11	0.9	-	<0.5	-	15	-	-	18	-	-	93	-	15	5.9	-	-	-	10	-	
6/2	DLWC97-S6	0.55-0.65	30/04/1997	Historic- Lab	-	18.59	18	227,000	-	-	-	-	-	-	-	-	-	4.9	72	0.595	3.7	-	<0.5	-	3.8	-	-	134	-	-	544	-	356	49	-	-	-	37	-	
6/3	DLWC97-S6	0.9-1	30/04/1997	Historic- Lab	-	22.66	8.8	215,000	-	-	-	-	-	-	-	-	-	6.1	136	0.73	9.7	-	<0.5	-	19	-	-	23	-	-	144	-	165	5.6	-	-	-	15	-	
7/1	DLWC97-S7	0.27-0.37	30/04/1997	Historic- Lab	-	1.875	2.5	40,000	-	-</																														

	Unassigned		Inorganics											Metals																										
	CEC	Sulphuric Acid	Cyanide Total	Electrical conductivity *(lab)	Exchangeable Calcium	Exchangeable Magnesium	Exchangeable Potassium	Exchangeable Sodium	Moisture	pH (Lab)	Redox	Sulphur as S	TOC	Aluminium	Leachable Aluminium	Antimony	Leachable Antimony	Arsenic	Leachable Arsenic	Cadmium	Leachable Cadmium	Chromium (III+VI)	Leachable Chromium (III+VI)	Cobalt	Copper	Leachable Copper	Iron	Lead	Leachable Lead	Manganese	Mercury	Leachable Mercury	Nickel	Leachable Nickel	Selenium	Silver	Vanadium	Zinc	Leachable Zinc	
	meq/100g	mg/kg	mg/kg	uS/cm	meq/100g	meq/100g	meq/100g	meq/100g	%	pH Units	mV	mg/kg	mg/kg	mg/kg	mg/L	mg/kg	mg/L	mg/kg	mg/L	mg/kg	mg/L	mg/kg	mg/L	mg/kg	mg/L	mg/kg	mg/L	mg/kg	mg/L	mg/kg	mg/L	mg/kg	mg/L	mg/kg	mg/L	mg/kg	mg/L	mg/kg	mg/L	
	EQL	0.1	0.001	0.1	1000	0.1	0.1	0.1	0.1	0.5	0.1	1	0.005	0.02	1	0.1	1	0.1	0.5	0.1	0.1	0.05	0.3	0.1	0.5	0.5	0.1	50	0.5	0.1	0.5	0.05	0.001	0.5	0.1	0.5	1	2	0.5	0.1
NEPM 1999 EIL												600				310		20		3		50			100		600		500	1		60					50	200		
USEPA RES																																								
NEPM 1999 HIL E			1000															200		40		200		200	2000		600		3000	30		600							14000	
10 times HIL E/ USEPA RES															3100	2000		400		2000		2000	20,000			6000		30,000	300		6000									
30 times HIL E/ USEPA RES															9300	6000		1200		6000		6000	60,000			18,000		90,000	900		18,000									

Field_ID

LocCode

Sample Depth

Sample Date

Source

Coffey 2004

A4	Coffey04-SA4	0-0.15	7/01/2004	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3	-	<1	-	5	-	-	9	-	-	8	-	-	<0.1	-	<1	-	-	-	-	22	-
A5	Coffey04-SA5	0-0.15	7/01/2004	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	1	-	2	-	<1	-	6	-	-	10	-	-	5	-	-	<0.1	-	<1	-	-	-	-	29	-
A6	Coffey04-SA6	0-0.15	7/01/2004	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	2	-	4	-	<1	-	15	-	-	13	-	-	11	-	-	<0.1	-	<1	-	-	-	-	38	-
A7	Coffey04-SA7	0-0.15	7/01/2004	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	2	-	4	-	<1	-	10	-	-	17	-	-	10	-	-	<0.1	-	<1	-	-	-	-	41	-
B5	Coffey04-SB5	0-0.15	7/01/2004	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	7	-	10	-	<1	-	18	-	-	39	-	-	10	-	-	<0.1	-	1	-	-	-	-	37	-
B6	Coffey04-SB6	0-0.15	7/01/2004	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	6	-	10	-	<1	-	19	-	-	87	-	-	8	-	-	0.13	-	2	-	-	-	-	17	-
B7	Coffey04-SB7	0-0.15	7/01/2004	Historic- Lab	-	-	-	-	-	-	-	-	-	-	-	-	7	-	10	-	<1	-	11	-	-	22	-	-	9	-	-	0.15	-	<1	-	-	-	-	42	-

DECC 2008

001	DECC08May-S001	0-0.01	29/05/2008	Historic-XRF	-	-	-	-	-	-	-	-	-	-	-	-	6813	-	1866	-	-	-	-	-	-	-	-	69	-	-	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-----	----------------	--------	------------	--------------	---	---	---	---	---	---	---	---	---	---	---	---	------	---	------	---	---	---	---	---	---	---	---	----	---	---	----	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

GHD 2012 Boreholes

BH001 0.0-0.2	BH001	0-0.2	16/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	12.250	-	3416	-	<21.12	-	<143	-	-	616.1	-	-	21.91	-	-	43.46	-	<54.05	-	-	-	-	36.73	-	
BH001 0.3-0.5	BH001	0.3-0.5	16/08/2012	Lab	-	-	-	<1	-	-	-	5.4	3.6	-	-	-	2970	-	3660	-	1520	-	<1	-	7	-	-	630	-	-	18	-	-	38.3	-	2	-	-	-	30	-	
BH001 0.3-0.5	BH001	0.3-0.5	16/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11.720	-	2913	-	<19.75	-	<144.1	-	-	598.3	-	-	24.32	-	-	51.42	-	<53.16	-	-	-	44.63	-	
BH001 0.7-0.9	BH001	0.7-0.9	16/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<415	-	26.86	-	<36.88	-	<112.8	-	-	<122.7	-	-	<8.68	-	-	<5.72	-	<36.29	-	-	-	11.82	-	
BH001 0.7-0.9	BH001	0.7-0.9	16/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<415	-	26.86	-	<36.88	-	<112.8	-	-	<122.7	-	-	<8.68	-	-	<5.72	-	<36.29	-	-	-	11.82	-	
BH001 1.0-1.2	BH001	1-1.2	16/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	239.4	-	200.3	-	<14.83	-	<108.9	-	-	41.2	-	-	<6.9	-	-	<6.13	-	<34.59	-	-	-	15.12	-	
BH002 0.0-0.2	BH002	0-0.2	16/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2053	-	264.9	-	<14.83	-	<114.3	-	-	25.19	-	<5.59	-	-	<5.98	-	<35.93	-	-	-	57.09	-		
BH002 0.5-0.7	BH002	0.5-0.7	16/08/2012	Lab	-	-	-	-	-	-	-	16.8	-	-	-	-	-	-	<5	-	<5	-	<1	-	11	-	-	7	-	-	6	-	-	<0.1	-	<2	-	-	-	13	-	
BH002 0.5-0.7	BH002	0.5-0.7	16/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<17.61	-	33.72	-	<39.22	-	<111	-	-	14.82	-	-	<6.87	-	-	<5.8	-	<78.24	-	-	-	28.05	-	
BH002 1.0-1.2	BH002	1-1.2	16/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20.62	-	14.48	-	<14.07	-	<111.5	-	-	<15.81	-	-	<6.34	-	-	<5.45	-	<33.91	-	-	-	13.82	-	
BH003 0.0-0.2	BH003	0-0.2	16/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9378	-	1152	-	<20.37	-	<153.9	-	-	384.7	-	-	263.2	-	-	15.95	-	<50.24	-	-	-	213	-	
BH003 0.5-0.7	BH003	0.5-0.7	16/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<16.78	-	8.01	-	<15.36	-	<762.3	-	-	<16.67	-	-	<5.34	-	-	<5.54	-	<35.4	-	-	-	26.57	-	
BH003 1.0-1.2	BH003	1-1.2	16/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<15.62	-	<3.5	-	<13.32	-	<106.8	-	-	<14.75	-	-	7.92	-	-	<4.82	-	<31.9	-	-	-	15.66	-	
BH004 0.0-0.2	BH004	0-0.2	16/08/2012	Lab	-	-	-	-	-	-	-	9.2	-	-	-	-	-	-	4700	-	1950	-	<1	-	18	-	-	136	-	-	150	-	-	61.2	-	<2	-	-	-	47	-	
BH004 0.0-0.2	BH004	0-0.2	16/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11.570	-	3931	-	<20.36	-	<145.5	-	-	113.3	-	-	151.9	-	-	48.49	-	<50.18	-	-	-	59.34	-	
BH004 0.5-0.7	BH004	0.5-0.7	16/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<17.01	-	<3.8	-	<114.54	-	<119.5	-	-	<16.95	-	-	8.14	-	-	<5.65	-	<35.11	-	-	-	12.42	-	
BH004 1.0-1.2	BH004	1-1.2	16/08/2012	Lab	-	-	-	-	-	-	-	28.6	-	-	-	-	-	-	2050	-	1160	-	<1	-	16	-	-	166	-	-	116	-	-	28.9	-	5	-	-	-	95	-	
BH004 1.0-1.2	BH004	1-1.2	16/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5323	-	84.85	-	<17.48	-	<130.1	-	-	<19.81	-	-	34.53	-	-	<7.2	-	<41.87	-	-	-	52.87	-	
BH004 1.5-1.7	BH004	1.5-1.7	16/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	218.6	-	76.3	-	<12.75	-	<99.18	-	-	<15.35	-	-	<4.93	-	-	<4.67	-	<27.08	-	-	-	18.78	-	
BH004 2.0-2.2	BH004	2-2.2	16/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	56.49	-	43.78	-	<42.01	-	<115.7	-	-	<16.06	-	-	<5.45	-	-	<5.39	-	<34.64	-	-	-	24.95	-	
BH005 0.0-0.2	BH005	0-0.2	14/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<19.47	-	19.09	-	<15.06	-	<101.1	-	-	5706	-	-	<6.06	-	-	<6.29	-	<35	-	-	-	54.56	-	
BH005 0.0-0.2	BH005	0-0.2	14/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<19.47	-	19.09	-	<15.06	-	<101.1	-	-	5706	-	-	<6.06	-	-	<6.29	-	<35	-	-	-	54.56	-	
BH005 0.3-0.5	BH005	0.3-0.5	14/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3312	-	372.6	-	<14.96	-	<114.7	-	-	<17.58	-	-	18.6	-	-	<6	-	<36.71	-	-	-	29.47	-	
BH005 1.0-1.2	BH005	1-1.2	14/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4206	-	278.9	-	<15.61	-	<117.4	-	-	<18.07	-	-	43.46	-	-	<6.16	-	<38.91	-	-	-	47.33	-	
BH005 1.5-1.8	BH005	1.5-1.8	14/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1197	-	367.6	-	<12.9	-	<92.14	-	-	54.34	-	-	<4.94	-	-	<4.73	-	<29.05	-	-	-	24.57	-	
BH005 2.0-2.2	BH005	2-2.2	14/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	99.63	-	149.6	-	<13.07	-	<98.43	-	-	<14.23	-	-	<5.84	-	-	<4.79	-	<30.75	-	-	-	12.28	-	
BH006 0.0-0.3	BH006	0-0.3	3/08/2012	Lab	-	-	-	-	-	-	-	36.2	-	-	-	-	-	-	1950	-	702	-	-	-	-	-	-	-	-	-	-	-	-	2.3	-	-	-	-	-	-	-	
BH006 0.0-0.3	BH006	0-0.3	13/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	847.6	-	164.8	-	<35.73	-	<105.5	-	-	458	-	-	<7.21	-	-	<6.12	-	<37.94	-	-	-	58.68	-	
BH006 0.0-0.3	BH006	0-0.3	13/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	847.6	-	164.8	-	<35.73	-	<105.5	-	-	458	-	-	<7.21	-	-	<6.12	-	<37.94	-	-	-	58.68	-	
BH010 0.0-0.2	BH010	0-0.2	14/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	509.1	-	191.6	-	<15.44	-	<102.7	-	-	1006	-	-	10.84	-	-	<6.55	-	<36.3	-	-	-	32.82	-	
BH010 0.3-0.5	BH010	0.3-0.5	14/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4479	-	83.45	-	<16.12	-	<119.4	-	-	444.5	-	-	39.39	-	-	<6.76	-	<39.39	-	-	-	194.3	-	
BH010 1.0-1.2	BH010	1-1.2	14/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<16.01	-	3.82	-	<14.71	-	<116.4	-	-	17.35	-	-	<6.07	-	-	<5.16	-	<33.67	-	-	-	<9.16	-	
BH010 1.5-1.8	BH010	1.5-1.8	14/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<15.5	-	6.05	-	<13.35	-	<112.9	-	-	30.41	-	-	7.43	-	-	<4.91	-	<31.97	-	-	-	13.6	-	
BH012 0.0-0.1	BH012	0-0.1	16/08/2012	Lab	-	-	-	-	-	-	-	41.2	-	-	-	-	13.100	-	<5	-	16	-	<1	-	15	-	-	12	-	-	25.400	12	-	-	-	-	5	-	-	-	8	-
BH012 0.0-0.1	BH012	0-0.1	16/08/2012	Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	-	847.6	-	164.8	-	<35.73	-	<105.5	-	-	458	-	-	<7.21	-	-	<6.12	-	<37.94	-	-	-	58.68	-	
BH014 0.0-0.1	BH014	0-0.1	15/08/2012	Lab	1	-	-	2	-	-	0.2	0.5	<0.1	0.2	34.8	4.7	-	-	7	-	7	-	<0.1	-	<0.1	-	<0.05	-	<0.1	-	-	<0.1	-	-	<0.001	-	<0.1	-	-	-	0.9	-
BH014 0.0-0.1	BH014	0-0.1	15/08/2012	Lab	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.2	-	<0.1	-	<0.1	-	<0.05	-	<0.1	-	<0.1	-	-	<0.1	-	-	<0.001	-	<0.1	-	-	-	0.4	-
BH020 0.0-0.2	BH020	0-0.2	16/08/2012	Lab	-	-	-	-	-	-	-	13.6	-	-	-	-	7520	-	59	-	58	-	11	-	12	-	-	724	-	27.400	25	-	-	-	-	4	-	-	-	695	-	
BH020 0.0-0.2	BH020	0-0.2	16/08/2012	Lab	-	-	-	-	-	-	-	-	-	-	-	1.5	-	-	<0.1	-	<0.1	-	<0.05	-	<0.1	-	-	1.1	-	-	<0.1	-	-	<0.001	-	<0.1	-	-	-	1.2	-	
BH020 0.0-0.2	BH020	0-0.2	16/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<16.99	-	42.56	-	<13.97	-	<275.6	-	-	174.7	-	-	<5.48	-	-	<5.52	-	<34.14	-	-	-	43.91	-	
BH020 0.3-0.5	BH020	0.3-0.5	16/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	35.69	-	56.2	-	<13.59	-	<213.6	-	-	88.42	-	-	<5.03	-	-	<5.46	-	<33.05	-	-	-	38.02	-	
BH020 1.0-1.2	BH020	1-1.2	16/08/2012	XRF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<16.19	-	4.51	-	<13.85	-	<113	-	-	<16	-	-	<6.27	-	-	<5.4	-	<33.55	-	-				

[illegible]

[illegible]

[illegible]

Table C01_Soil Chemistry_all data_V10_OK , 5/12/2012

Soil and Sediment XRF/Laboratory Result Comparison Table

	Antimony (LAB)		RPD/Comment	Arsenic (LAB)		RPD/Comment	Cadmium (LAB)		RPD/Comment	Chromium (III-VI) (LAB)		RPD/Comment	Copper (LAB)		RPD/Comment	Lead (LAB)		RPD/Comment	Mercury (LAB)		RPD/Comment	Nickel (LAB)		RPD/Comment	Zinc (LAB)		RPD/Comment
	mg/kg	mg/kg		mg/kg	mg/kg		mg/kg	mg/kg		mg/kg	mg/kg		mg/kg	mg/kg		mg/kg	mg/kg		mg/kg	mg/kg		mg/kg	mg/kg		mg/kg	mg/kg	
EQL	1	1	(%)	0.5	0.5	(%)	0.1	0.1	(%)	0.5	0.5	(%)	0.5	0.5	(%)	0.5	0.5	(%)	0.05	0.05	(%)	0.5	0.5	(%)	0.5	0.5	(%)
Field ID																											
BH001 0.3-0.5	3660	11,720	-105	1520	2913	-63	<1	<19.75	Both Non detect	7	<144.1	Lab low, XRF non detect	630	598.3	5	18	24.32	-30	38.3	51.42	-29	2	<53.16	Lab low, XRF non detect	30	44.63	-39
BH002 0.5-0.7	<5	<17.61	Both non detect	<5	33.72	Both Low	<1	<39.22	Both Non detect	11	<111	Lab low, XRF non detect	7	14.82	-72	6	<6.87	Both Low	<0.1	<5.8	Both Non detect	<2	<78.24	Both non detect	13	28.05	-73
BH004 0.0-0.2	4700	11,570	-84	1950	3931	-67	<1	<20.36	Both Non detect	18	<145.5	Lab low, XRF non detect	136	113.3	18	150	151.9	-1	61.2	48.49	23	<2	<50.18	Both non detect	47	59.34	-23
BH004 1.0-1.2	2050	5323	-89	1160	84.85	173	<1	<17.48	Both Non detect	16	<130.1	Lab low, XRF non detect	166	<19.81	Inconsistent	116	34.53	108	28.9	<7.2	Both Low	5	<41.87	Both low	95	52.87	57
BH006 0.0-0.3	1950	847.6	79	702	164.8	124	-	<35.73	Both Non detect	-	<105.5	-	-	458	-	-	<7.21	-	2.3	<6.12	Both Low	-	<37.94	-	-	58.68	-
BH020 0.0-0.2	59	<16.99	Both low	58	42.56	31	11	<13.97	Both Non detect	12	<275.6	Lab low, XRF non detect	724	174.7	122	25	<5.48	Lab low, XRF non detect	0.6	<5.52	Lab low, XRF non detect	4	<34.14	Lab low, XRF non detect	695	43.91	176
BH022 0.5-0.7	544	489.7	11	132	71.58	59	<1	<14.08	Both Non detect	9	<106.8	Lab low, XRF non detect	29	140.3	-131	23	<5.48	Lab low, XRF non detect	0.3	<5.53	Lab low, XRF non detect	<2	<31.71	Both non detect	13	28	-73
BH023 0.0-0.2	13,200	4277	102	6860	1453	130	-	<15.44	-	-	<22.85	-	-	<17.18	-	-	35.57	-	146	28.26	135	-	<38.88	-	-	<10.02	-
BH023 0.5-0.7	8650	4260	68	4110	1461	95	-	<15.48	-	-	<121.2	-	-	<17.71	-	-	38.38	-	42.8	22.23	63	-	<37.35	-	-	9.74	-
BH024 0.3-0.5	6640	9228	-33	4050	2431	50	-	<19.08	Both Non detect	-	<128.2	-	-	531.6	-	-	656.7	-	-	42.34	-	-	<45.27	-	-	96.67	-
BH024 1.0-1.2	192	677.5	-112	130	652.5	-134	-	<13.95	Both Non detect	-	<102.8	-	-	2318	-	-	184.9	-	-	14.61	-	-	<31.07	-	-	35.7	-
BH024 2.0-2.2	31	<15.95	Both Low	33	78.47	-82	-	<13.55	Both Non detect	-	<102.8	-	-	96.38	-	-	11.15	-	-	<5.03	-	-	<31.61	-	-	30.73	-
BH028 0.0-0.2	12,600	-	-	5000	5259	-5	<1	-	-	3	<24.81	Lab low, XRF non detect	23	55.87	-83	11	25.02	-78	47.3	44.15	7	<2	209	Inconsistent	27	51.08	-62
BH028 0.3-0.5	978	-	-	599	1185	-66	<1	-	-	7	<32.19	Lab low, XRF non detect	8	27.82	-111	10	<10.23	Lab low, XRF non detect	30.6	<12.08	Lab low, XRF non detect	<2	83.61	Inconsistent	8	<13.71	Lab low, XRF non detect
BH031 1.0-1.2	9670	4932	65	5280	3832	32	<1	<16.9	Both Non detect	9	<131.9	Lab low, XRF non detect	21	<20.17	Both Low	133	75.71	55	58.3	35.54	49	9	<41.52	Lab low, XRF non detect	24	26.78	-11
BH032 0.3-0.5	6070	2482	84	3620	1086	108	<1	<14.56	Both Non detect	34	<115.3	Lab low, XRF non detect	231	354.8	-42	996	251.4	119	78.8	28.4	94	<2	<35.12	Both non detect	39	26.89	37
BH053 0.3-0.5	5320	14,470	-92	3560	3007	17	<1	<22.98	Both Non detect	11	<143.8	Lab low, XRF non detect	26	<24.94	Lab low, XRF non detect	329	216.4	41	35.8	32.35	10	3	<53.36	Lab low, XRF non detect	19	32.09	-51
BH053 1.5-1.7	150	670.5	-127	1330	596.7	76	<1	<11.74	Both Non detect	18	<81.96	Lab low, XRF non detect	22	<11.67	Both Low	25	36.05	-36	1.2	<5.28	Both Low	9	<25.01	Lab low, XRF non detect	14	<7.34	Both Low
BH053 3.2-3.5	23	<16.29	Both Low	80	69.44	14	<1	<13.75	Both Non detect	11	<112.1	Lab low, XRF non detect	<5	21.66	Both Low	14	<5.11	Both Low	0.4	<5.56	Both Low	<2	<33.03	Both non detect	<5	14.26	Both Low
BH056 0.3-0.5	<5	<16.2	Both non detect	<5	5.5	Both Low	-	<14.92	Both Non detect	-	<116.9	-	-	<14.96	-	-	<6.22	-	<0.1	<5.24	Both Low	-	<33.44	-	-	8.35	-
BH060 0.0-0.2	160	26.59	143	66	50.17	27	-	<12.83	Both Non detect	-	<98.01	-	-	37.3	-	-	<4.67	-	1.1	<5.01	Both Low	-	<29.94	-	-	29.61	-
BH064 0.0-0.2	<5	<16.42	Both non detect	<5	4.62	Both Low	-	<21.08	Both Non detect	-	<114.9	-	-	18.4	-	-	<5.3	-	<0.1	<5.39	Both Non detect	-	<33.86	-	-	26.72	-
BH064 0.3-0.5	<5	<17.29	Both non detect	7	11.22	-46	-	<14.76	Both Non detect	-	<109.7	-	-	26.54	-	-	<5.65	-	<0.1	<5.76	Both Non detect	-	<35.48	-	-	36.88	-
BH071 0.5-0.7	<5	<16.35	Both non detect	<5	13.55	Both Low	<1	<20.17	Both Non detect	4	<105.2	Lab low, XRF non detect	<5	<15.22	Both non detect	8	<5.33	Both Low	<0.1	<5.3	Both Non detect	<2	<33.97	Both non detect	8	12.04	-40
BH073 0.0-0.2	295	447.9	-41	496	<69.91	Inconsistent	-	<19.62	Both Non detect	-	<594.3	-	-	947.6	-	-	15580.00	-	47.5	14.96	104	-	<36.26	-	-	7674	-
BH073 0.5-0.7	405	30.15	172	416	282.2	38	-	<19.7	Both Non detect	-	<117.9	-	-	480.6	-	-	2746	-	57.8	8.8	147	-	<34.68	-	-	1004	-
BH073 1.0-1.2	72	<15.96	Both low	13	76.23	-142	<1	<13.76	Both Non detect	11	<112.8	Lab low, XRF non detect	120	171.8	-36	518	623.5	-18	0.8	<5.57	Lab low, XRF non detect	<2	<32.28	Both non detect	305	406.5	-29
BH074 0.8-1.0	<5	<15.49	Both non detect	<5	<2.69	Both non detect	-	<14.36	Both Non detect	-	<112.9	-	-	<14.63	-	-	<5.87	-	<0.1	<4.98	Both Non detect	-	<31.94	-	-	6.64	-
BH075 1.8-2.0	36	<12.93	Both Low	129	32.4	120	3	<11.61	Both Non detect	10	<82.77	Lab low, XRF non detect	30	<12.25	Both Low	17	<3.77	Both Low	0.2	<4.02	Both Low	3	<25.15	Lab low, XRF non detect	76	17.27	126
BH077 0.0-0.2	388	22.4	178	432	107.3	120	<1	<13.05	Both Non detect	10	<103.2	Lab low, XRF non detect	19	<14.92	Lab low, XRF non detect	80	<5.01	Both Low	2	<5.13	Lab low, XRF non detect	2	<29.99	Lab low, XRF non detect	10	12.26	-20
BH077 0.3-0.5	93	<13.7	Both Low	157	212	-30	<1	<11.72	Both Non detect	15	<84.81	Lab low, XRF non detect	28	22.28	23	24	38.87	47	0.8	<4.14	Both Low	5	<24.94	Lab low, XRF non detect	9	7.28	21
BH077 1.0-1.2	36	93.58	-89	156	477.1	-101	<1	<13.83	Both Non detect	14	<111.3	Lab low, XRF non detect	10	17.09	-52	17	31.15	-59	0.6	<6.22	Both Low	3	<33.46	Lab low, XRF non detect	11	23.39	-72
BH077 1.5-1.7	882	107	157	2130	543.3	119	<1	<11.81	Both Non detect	17	<84.79	Lab low, XRF non detect	51	<12.56	Both Low	170	41.75	121	5.4	<4.87	Both Low	8	<25.19	Lab low, XRF non detect	33	7.55	126
BH077 2.0-2.2	144	<12.24	Inconsistent	165	39.13	123	<1	<10.89	Both Non detect	20	<76.76	Lab low, XRF non detect	22	<11.27	Lab low, XRF non detect	21	<3.85	Lab low, XRF non detect	0.8	<3.67	Lab low, XRF non detect	18	<22.64	Lab low, XRF non detect	15	<5.95	Lab low, XRF non detect
BH082 1.5-1.7	92	71.09	26	1510	139.2	166	-	<11.41	-	-	<79.09	-	-	<12.35	-	-	27.7	-	1.3	<4.11	Lab low, XRF non detect	-	<24.46	-	-	8.9	-
BH084 1.0-1.2	2730	550.2	133	518	105.7	132	-	<13.43	Both Non detect	-	<104.8	-	-	26.5	-	-	62.46	-	5.1	<5.45	Both Low	-	<32.04	-	-	19.28	-
BH084 1.5-1.7	3220	645.5	133	387	116.6	107	-	<11.62	Both Non detect	-	<80.22	-	-	<11.75	-	-	15.22	-	<0.1	<4.1	Both Non detect	-	<24.79	-	-	24.71	-
BH091 0.0-0.1	<5	<13.59	Both non detect	5	10.04	-67	-	<12.15	Both Non detect	-	<95.89	-	-	<13.59	-	-	<4.58	-	0.1	<4.3	Both low	-	<27.2	-	-	15.66	-
BH101 0.0-0.2	5400	664.8	156	2540	128.7	181	<1	<13	Both Non detect	34	<96.62	Lab low, XRF non detect	272	151.8	57	474	17.65	186	343	<5.1	Inconsistent	<2	<29.46	Both non detect	47	22.9	69
SE002 0.0-0.1	3060	1750	54	141	35.82	119	<1 - 0.3	<12.37	Both Non detect	61.8 - 1450	<91.97	Inconsistent	735	760.1	-3	1090	412	90	87.6	15.64	139	1.2 - 4	<27.61	Lab low, XRF non detect	99	50.5	65
SE002 0.3-0.5	1200	<12.75	Inconsistent	295	135.6	74	3	<10.88	Both Non detect	253	<75.91	Lab low, XRF non detect	1100	20.95	193	216	<3.69	Inconsistent	9.8	<3.57	Both Low	13	<22.82	Lab low, XRF non detect	140	93.63	40
SE102 0.0-0.2	744	117.1	146	18	<3.64	Both Low	<1	<11.06	Both Non detect	17	<78.58	Lab low, XRF non detect	708	230.8	102	74	57.83	25	0.3	<3.72	Both Low	11	<23.39	Lab low, XRF non detect	39	<6.73	Both Low

RPD >150%

Concentration exceeds adopted threshold

Concentration exceeds 10 x adopted threshold

Concentration exceeds 30 x adopted threshold

Note: Highlighted cells with a '<' symbol may not necessarily constitute an assessment criteria exceedance

Particle Size Analysis- Soil and Sediment

					Particle Sizing								Soil Classification							
					+75um	+150um	+300um	+425um	+600um	+1180um	+2.36mm	+4.75mm	+9.5mm	+19.0mm	+37.5mm	+75.0mm	Clay (<2 um)	Silt (2-60 um)	Cobbles (>6cm)	Gravel (>2mm)
EQL					%	%	%	%	%	%	%	%	%	%	%	%	%			
					1	1	1	1	1	1	1	1	1	1	1	1	1			

Field_ID	LocCode	Matrix	Sample Depth	Sample Date																				
BH014_0.0-0.1	BH014	Soil	0-0.1	15/08/2012	72	69	32	12	7	5	4	2	<1	<1	<1	<1	14	13	<1	4	69	clayey SAND	silty SAND	
BH023_0.0-0.1	BH023	Soil	0-0.1	15/08/2012	77	73	26	6	1	<1	<1	<1	<1	<1	<1	<1	14	7	<1	<1	79	clayey SAND	SAND	
BH031_0.0-0.2	BH031	Soil	0-0.2	15/08/2012	76	53	25	14	8	2	<1	<1	<1	<1	<1	<1	9	14	<1	<1	77	silty SAND	silty SAND	
BH031_0.5-0.7	BH031	Soil	0.5-0.7	15/08/2012	72	47	20	10	5	<1	<1	<1	<1	<1	<1	<1	9	17	<1	<1	74	silty SAND	silty SAND	
BH031_1.8-2.0	BH031	Soil	1.8-2	15/08/2012	20	12	6	4	2	1	<1	<1	<1	<1	<1	<1	36	44	<1	1	19	clayey SILT	clayey SILT	
SE002_0.5-0.7	SE002	Sediment	0.5-0.7	14/08/2012	22	10	3	1	1	<1	<1	<1	<1	<1	<1	<1	36	41	<1	<1	23	clayey SILT	sandy CLAY	
SE003_0.2-0.4	SE003	Sediment	0.2-0.4	16/08/2012	18	6	2	1	<1	<1	<1	<1	<1	<1	<1	<1	28	47	<1	<1	25	clayey SILT	SILT	
SE004_0.2-0.3	SE004	Sediment	0.2-0.3	16/08/2012	20	11	3	2	1	<1	<1	<1	<1	<1	<1	<1	36	44	<1	<1	20	clayey SILT	silty CLAY	
SE004_0.4-0.6	SE004	Sediment	0.4-0.6	16/08/2012	14	7	2	1	<1	<1	<1	<1	<1	<1	<1	<1	39	47	<1	<1	14	clayey SILT	SILT	
SE011_0.7-0.9	SE011	Sediment	0.7-0.9	14/08/2012	12	8	5	5	4	3	<1	<1	<1	<1	<1	<1	63	25	<1	1	11	silty CLAY	CLAY, some silt	
SE033_0.0-0.05	SE033	Sediment	0-0.05	15/08/2012	11	8	7	6	5	4	3	<1	<1	<1	<1	<1	55	30	<1	3	12	silty CLAY	silty CLAY	
SE033_0.2-0.4	SE033	Sediment	0.2-0.4	15/08/2012	23	11	2	2	1	<1	<1	<1	<1	<1	<1	<1	24	54	<1	<1	22	clayey SILT	silty CLAY	
SE033_0.4-0.6	SE033	Sediment	0.4-0.6	15/08/2012	9	8	6	5	5	3	1	<1	<1	<1	<1	<1	80	11	<1	1	8	silty CLAY	SILT	
SE063_0.0-0.1	SE063	Sediment	0-0.1	15/08/2012	14	12	11	10	9	6	3	<1	<1	<1	<1	<1	68	12	<1	3	17	silty CLAY	SILT	
SE063_0.2-0.3	SE063	Sediment	0.2-0.3	15/08/2012	6	4	2	2	2	1	<1	<1	<1	<1	<1	<1	57	36	<1	1	6	silty CLAY	sandy CLAY	
SE063_0.4-0.6	SE063	Sediment	0.4-0.6	15/08/2012	9	8	7	6	6	4	2	<1	<1	<1	<1	<1	64	27	<1	2	7	silty CLAY	SILT	

Acid Sulfate Soil Analysis

		pH					Acidity Trail						Sulfur Trail				Calcium Values					Magnesium Values					Retained Acidity				Acid Base Accounting							
		pH KCl (23A)	pH OX (23B)	pH (F)	pH (Fox)	Reaction Rate	Titratable Actual Acidity (23F)	Titratable Peroxide Acidity (23G)	Titratable Sulfidic Acidity (23H)	sulfidic - Titratable Actual Acidity (s-23F)	sulfidic - Titratable Peroxide Acidity (s-23G)	sulfidic - Titratable Sulfidic Acidity (s-23H)	KCl Extractable Sulfur (23Ce)	Peroxide Sulfur (23De)	Peroxide Oxidisable Sulfur (23E)	acidity - Peroxide Oxidisable Sulfur (a-23E)	KCl Extractable Calcium (23Vn)	Peroxide Calcium (23Wh)	Acid Reacted Calcium (23X)	acidity - Acid Reacted Calcium (a-23X)	sulfidic - Acid Reacted Calcium (s-23X)	KCl Extractable Magnesium (23Sm)	Peroxide Magnesium (23Tm)	Acid Reacted Magnesium (23U)	Acidity - Acid Reacted Magnesium (a-23U)	sulfidic - Acid Reacted Magnesium (s-23U)	HCl Extractable Sulfur (20Be)	Net Acid Soluble Sulfur (20Je)	acidity - Net Acid Soluble Sulfur (a-20J)	sulfidic - Net Acid Soluble Sulfur (s-20J)	ANC Fineness Factor	Net Acidity (sulfur units)	Net Acidity (acidity units)	Liming Rate				
		pH Units	pH units	pH units	pH units	-	mole H+ / t	mole H+ / t	mole H+ / t	% pyrite S	% pyrite S	% pyrite S	% S	% S	% S	mole H	% Ca	% Ca	% Ca	mole H+ / t	% S	% Mg	% Mg	% Mg	mole H+ / t	% S	% S	% S	mole H+ / t	% pyrite S	-	% S	mole H+ / t	kg CaCO3/t				
EQL		0.01	0.01	0.01	0.01	1	2	2	2	0.02	0.02	0.02	0.02	0.02	0.02	10	0.02	0.02	0.02	10	0.02	0.02	0.02	0.02	10	0.02	0.02	0.02	0.02	10	0.02	0.02	10	0.02	0.5	0.02	10	1
Field ID	Sample Date	4.0	2.1	3.4	2.5	3	32	64	31	0.05	0.10	0.05	<0.02	0.05	0.05	29	<0.02	<0.02	<0.02	<10	<0.02	<0.02	<0.02	<10	<0.02	0.02	0.02	11	<0.02	1.5	0.12	73	5					
BH031 0.0-0.2	15/08/2012	4.8	1.9	3.8	0.9	3	12	547	536	<0.02	0.88	0.86	<0.02	0.84	0.84	522	<0.02	<0.02	<0.02	<10	<0.02	<0.02	<0.02	<10	<0.02	-	-	-	-	-	1.5	0.86	534	40				
BH031 0.5-0.7	15/08/2012	4.5	2.1	6.9	1.4	4	85	702	617	0.14	1.12	0.99	0.04	0.85	0.81	504	0.14	0.17	0.02	12	<0.02	0.03	0.04	<0.02	13	0.02	-	-	-	-	-	1.5	0.94	589	44			
BH031 1.8-2.0	15/08/2012	4.6	3.2	5.9	2.3	2	19	153	<2	0.03	0.24	<0.02	<0.02	0.06	0.06	39	<0.02	<0.02	<0.02	<10	<0.02	<0.02	<0.02	<10	<0.02	-	-	-	-	-	1.5	0.09	58	4				
BH032 0.0-0.2	14/08/2012	4.4	2.6	6.3	1.4	2	38	151	<2	0.06	0.24	<0.02	<0.02	0.19	0.19	118	<0.02	<0.02	<0.02	<10	<0.02	<0.02	<0.02	<10	<0.02	-	-	-	-	-	1.5	0.32	199	15				
BH032 1.0-1.2	14/08/2012	5.5	2.7	7.1	1.5	2	18	352	334	0.03	0.56	0.54	0.03	0.50	0.48	297	0.14	0.18	0.03	16	0.02	0.08	0.09	<0.02	11	<0.02	0.09	0.09	43	0.07	1.5	0.50	315	24				
BH054 0.0-0.2	14/08/2012	-	-	6.5	2.9	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
BH054 0.7-0.9	14/08/2012	-	-	6.9	1.7	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
BH054 1.0-1.2	14/08/2012	-	-	6.7	1.2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
SE001 0.0-0.1	16/08/2012	-	-	6.7	1.9	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
SE003 0.2-0.4	16/08/2012	4.5	2.4	-	-	-	56	356	300	0.09	0.57	0.48	<0.02	0.22	0.22	141	0.05	0.06	<0.02	<10	<0.02	0.04	0.05	<0.02	<10	<0.02	-	-	-	-	-	1.5	0.32	197	15			
SE003 0.2-0.4	16/08/2012	-	-	5.9	1.8	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
SE004 0.0-0.1	16/08/2012	-	-	5.9	1.8	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
SE011 0.3-0.5	16/08/2012	-	-	5.7	1.8	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
SE013 0.3-0.5	16/08/2012	4.4	3.2	-	-	-	260	1010	746	0.42	1.61	1.20	0.03	0.54	0.50	313	0.10	0.12	<0.02	<10	<0.02	0.04	0.05	<0.02	<10	<0.02	0.08	0.04	20	0.03	1.5	0.95	594	44				
SE013 0.3-0.5	16/08/2012	-	-	6.6	1.6	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
SE031 0.5-0.7	16/08/2012	4.5	2.3	6.6	1.5	3	87	712	625	0.14	1.14	1.00	<0.02	0.43	0.43	268	0.13	0.15	0.02	12	<0.02	0.09	0.10	<0.02	<10	<0.02	-	-	-	-	-	1.5	0.57	355	27			
SE050 0.0-0.1	16/08/2012	-	-	5.4	2.2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
SE050 0.2-0.4	16/08/2012	-	-	5.4	2.2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
SE054 0.1-0.3	16/08/2012	-	-	6.5	1.6	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				

Surface Water Chemistry

			Field					Inorganics							Alkalinity						Major Ions													
			Dissolved Oxygen (Field)	Electrical Conductivity (Field)	Oxygen Redox Potential (Field)	pH (Field)	Temp (Field)	Cyanide Total	Electrical conductivity *(lab)	pH (Lab)	Redox	TOC	Total Dissolved Solids	Total Suspended Solids	Alkalinity (total) as CaCO3	Alkalinity (Bicarbonate as CaCO3)	Alkalinity (Carbonate as CaCO3)	Alkalinity (Hydroxide) as CaCO3	Bicarbonate	Hardness as CaCO3	Calcium	Calcium (Filtered)	Chloride	Magnesium	Magnesium (Filtered)	Potassium	Potassium (Filtered)	Sodium	Sodium (Filtered)	Sulphate	Anions Total	Cations Total		
EQL			0.1	100		0.01		0.004	1000	0.1	1	1	5	2	1	1	1	1	1	0.5	0.1	1	1	0.1	1	0.1	1	0.1	1	0.1	1	0.01	0.01	
ANZECC 2000 FW Slightly-moderate disturbed system								0.007																										
10 times ANZECC 2000 FW Slightly-moderate disturbed system								0.07																										
30 times ANZECC 2000 FW Slightly-moderate disturbed system								0.21																										
ANZECC 2000 MW Slightly-moderate disturbed system								0.004																										
Field ID	LocCode	Sample Date																																
1	DLWC97-SW1	30/04/1997	0.4	171	-	6.25	-	0.027	146	6	311	18	94	10	18	-	-	-	18	23	3.5	-	31	3.6	-	0.6	-	18	-	2	-	-		
2	DLWC97-SW2	30/04/1997	1.2	117	-	6.01	-	0.009	94	5.7	314	29	68	47	16	-	-	-	16	21	3.3	-	18	3.2	-	1.3	-	17	-	<1	-	-		
3	DLWC97-SW3	30/04/1997	3.5	146	-	5.94	-	0.013	139	5	335	10	90	8	3	-	-	-	3	16	2.8	-	32	2.3	-	2.2	-	22	-	10	-	-		
4	DLWC97-SW4	30/04/1997	4.4	102	-	6.19	-	0.018	95	6.1	308	15	73	6	10	-	-	-	10	14	2.3	-	18	2.2	-	2	-	16	-	4	-	-		
5	DLWC97-SW5	30/04/1997	5.1	103	-	6.1	-	<0.005	90	6	305	16	96	6	10	-	-	-	10	16	2.2	-	19	2.5	-	1.8	-	17	-	4	-	-		
6	DLWC97-SW6	30/04/1997	3.9	121	-	6.12	-	0.038	93	5.9	316	15	74	6	9	-	-	-	9	13	2	-	19	2	-	1.5	-	14	-	8	-	-		
7	DLWC97-SW7	30/04/1997	1	102	-	6.08	-	0.033	101	6.1	314	16	70	7	10	-	-	-	10	15	2.1	-	20	2.4	-	2.2	-	19	-	3	-	-		
8	DLWC97-SW8	30/04/1997	3	100	-	6.08	-	0.044	90	6	324	15	80	9	9	-	-	-	9	16	2.4	-	18	2.4	-	2.3	-	17	-	8	-	-		
9	DLWC97-SW9	30/04/1997	3	104	-	6.32	-	0.007	91	6	317	15	81	17	10	-	-	-	10	15	2.3	-	18	2.3	-	2.3	-	17	-	7	-	-		
10	DLWC97-SW10	30/04/1997	3.2	113	-	6.4	-	<0.005	95	5.8	307	14	70	11	10	-	-	-	10	15	2.5	-	18	2.2	-	2	-	17	-	4	-	-		
11	DLWC97-SW11	30/04/1997	1.8	105	-	5.98	-	0.02	96	6	332	15	86	8	9	-	-	-	9	14	2.1	-	20	2.1	-	2.1	-	17	-	10	-	-		
12	DLWC97-SW12	30/04/1997	1.9	116	-	5.94	-	0.029	105	6	309	15	92	14	11	-	-	-	11	16	2.3	-	22	2.4	-	2.7	-	20	-	4	-	-		
13	DLWC97-SW13	30/04/1997	5.4	149	-	6.09	-	0.038	123	6	304	20	115	10	11	-	-	-	11	17	2.6	-	29	2.6	-	3	-	24	-	2	-	-		
14	DLWC97-SW14	30/04/1997	4.5	158	-	6.18	-	0.011	142	5.7	310	12	108	8	10	-	-	-	10	16	2.3	-	34	2.4	-	1.9	-	25	-	2	-	-		
15	DLWC97-SW15	30/04/1997	0.9	229	-	6.04	-	0.013	218	5.7	312	9	128	7	13	-	-	-	13	16	2.3	-	54	2.6	-	0.8	-	44	-	4	-	-		
16	DLWC97-SW16	30/04/1997	1.7	214	-	6.15	-	0.016	198	5.4	318	7	122	17	5	-	-	-	5	15	1.9	-	54	2.5	-	0.9	-	36	-	4	-	-		
17	DLWC97-SW17	30/04/1997	0.9	256	-	5.95	-	0.012	249	5.9	290	11	162	3	12	-	-	-	12	28	3.6	-	67	4.5	-	1.6	-	46	-	3	-	-		
18	DLWC97-SW18	30/04/1997	1.1	266	-	5.95	-	0.008	240	6.3	268	11	169	4	14	-	-	-	14	29	4	-	65	4.7	-	1.7	-	45	-	3	-	-		
SW001	SW001	22/08/2012	2.46	168	241	5.4	12.8	<0.004	-	-	-	-	129	43	8	8	<1	<1	-	-	-	3	48	-	3	-	1	-	24	<1	1.51	1.47		
SW002	SW002	22/08/2012	6.58	177	222	6.9	21.2	<0.004	-	-	-	-	126	9	9	9	<1	<1	-	-	-	3	44	-	3	-	1	-	23	<1	1.42	1.42		
SW003	SW003	22/08/2012	6.8	137	207	5.5	19.6	<0.004	-	-	-	-	107	9	4	4	<1	<1	-	-	-	2	33	-	2	-	1	-	18	2	1.05	1.07		
SW004	SW004	22/08/2012	6.96	128	198	6	16	<0.004	-	-	-	-	106	<5	4	4	<1	<1	-	-	-	2	32	-	2	-	1	-	18	2	1.02	1.07		
SW005	SW005	22/08/2012	-	131	191	5.9	15.4	<0.004	-	-	-	-	104	6	4	4	<1	<1	-	-	-	2	32	-	2	-	1	-	18	2	1.02	1.07		
SW006	SW006	22/08/2012	5.27	139	132	6.1	14.8	<0.004	-	-	-	-	105	8	7	7	<1	<1	-	-	-	2	36	-	2	-	1	-	20	2	1.2	1.16		
SW007	SW007	22/08/2012	5.87	141	150	6.8	14.5	<0.004	-	-	-	-	112	8	6	6	<1	<1	-	-	-	2	36	-	2	-	1	-	20	1	1.16	1.16		
SW008	SW008	22/08/2012	5.65	320	257	4.9	14	<0.004	-	-	-	-	194	15	<1	<1	<1	<1	-	-	-	4	101	-	6	-	1	-	48	5	2.95	2.81		
SW009	SW009	22/08/2012	1.54	247	202	5.2	12.9	<0.004	-	-	-	-	157	6	1	1	<1	<1	-	-	-	5	67	-	6	-	2	-	36	20	2.33	2.36		

Note: Highlighted cells with a '<' symbol may not necessarily constitute an assessment criteria exceedance

Surface Water Chemistry

			Metals																						
			Aluminium	Aluminium (Filtered)	Antimony	Antimony (Filtered)	Arsenic	Arsenic (Filtered)	Cadmium	Cadmium (Filtered)	Chromium (III+VI)	Chromium (III+VI) (Filtered)	Copper	Copper (Filtered)	Iron	Iron (Filtered)	Lead	Lead (Filtered)	Manganese	Mercury	Mercury (Filtered)	Nickel	Nickel (Filtered)	Zinc	Zinc (Filtered)
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQL			0.01	0.01	0.001	0.001	0.001	0.001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.05	0.05	0.001	0.001	0.005	0.001	0.0001	0.001	0.001	0.005	0.005
ANZECC 2000 FW Slightly-moderate disturbed system			0.055	0.055	0.009	0.009	0.013	0.013	0.0002	0.0002	0.001	0.001	0.0014	0.0014			0.0034	0.0034	1.9	0.00006	0.00006	0.011	0.011	0.008	0.008
10 times ANZECC 2000 FW Slightly-moderate disturbed system			0.55	0.55	0.09	0.09	0.13	0.13	0.002	0.002	0.01	0.01	0.014	0.014			0.034	0.034	19	0.0006	0.0006	0.11	0.11	0.08	0.08
30 times ANZECC 2000 FW Slightly-moderate disturbed system			1.65	1.65	0.27	0.27	0.39	0.39	0.006	0.006	0.03	0.03	0.042	0.042			0.102	0.102	57	0.0018	0.0018	0.33	0.33	0.24	0.24
ANZECC 2000 MW Slightly-moderate disturbed system					0.27	0.27	0.0045	0.0045	0.0007	0.0007	0.0044	0.0044	0.0013	0.0013			0.0044	0.0044	0.08	0.0001	0.0001	0.007	0.007	0.015	0.015
Field ID	LocCode	Sample Date																							
1	DLWC97-SW1	30/04/1997	0.38	-	<0.01	-	0.005	-	-	-	-	<0.005	-	8.4	-	<0.01	-	0.132	<0.001	-	-	-	-	-	-
2	DLWC97-SW2	30/04/1997	0.85	-	<0.01	-	0.014	-	-	-	-	<0.005	-	15	-	<0.01	-	0.098	<0.001	-	-	-	-	-	-
3	DLWC97-SW3	30/04/1997	0.16	-	0.15	-	0.705	-	-	-	-	0.029	-	2.7	-	<0.01	-	0.13	<0.001	-	-	-	-	-	-
4	DLWC97-SW4	30/04/1997	0.25	-	0.26	-	0.456	-	-	-	-	0.08	-	2.9	-	0.006	-	0.037	<0.001	-	-	-	-	-	-
5	DLWC97-SW5	30/04/1997	0.25	-	0.21	-	0.276	-	-	-	-	0.055	-	2.6	-	<0.01	-	0.037	<0.001	-	-	-	-	-	-
6	DLWC97-SW6	30/04/1997	0.26	-	0.22	-	0.405	-	-	-	-	0.101	-	2.9	-	0.007	-	0.041	<0.001	-	-	-	-	-	-
7	DLWC97-SW7	30/04/1997	0.19	-	0.09	-	0.117	-	-	-	-	0.009	-	1.8	-	<0.01	-	0.025	<0.001	-	-	-	-	-	-
8	DLWC97-SW8	30/04/1997	0.24	-	0.2	-	0.294	-	-	-	-	0.122	-	2.3	-	0.008	-	0.044	<0.001	-	-	-	-	-	-
9	DLWC97-SW9	30/04/1997	0.25	-	0.2	-	0.394	-	-	-	-	0.142	-	3.2	-	0.009	-	0.047	<0.001	-	-	-	-	-	-
10	DLWC97-SW10	30/04/1997	0.22	-	0.1	-	0.236	-	-	-	-	0.055	-	2.8	-	0.009	-	0.032	<0.001	-	-	-	-	-	-
11	DLWC97-SW11	30/04/1997	0.21	-	0.17	-	0.194	-	-	-	-	0.014	-	2.1	-	<0.01	-	0.039	<0.001	-	-	-	-	-	-
12	DLWC97-SW12	30/04/1997	0.14	-	0.11	-	0.128	-	-	-	-	0.008	-	1.9	-	<0.01	-	0.042	<0.001	-	-	-	-	-	-
13	DLWC97-SW13	30/04/1997	0.16	-	0.03	-	0.058	-	-	-	-	0.005	-	1.8	-	<0.01	-	0.032	<0.001	-	-	-	-	-	-
14	DLWC97-SW14	30/04/1997	0.11	-	0.02	-	0.048	-	-	-	-	0.009	-	1.9	-	<0.01	-	0.019	<0.001	-	-	-	-	-	-
15	DLWC97-SW15	30/04/1997	<0.05	-	<0.01	-	0.021	-	-	-	-	0.008	-	3.5	-	<0.01	-	0.04	<0.001	-	-	-	-	-	-
16	DLWC97-SW16	30/04/1997	0.09	-	<0.01	-	0.053	-	-	-	-	<0.005	-	4.4	-	<0.01	-	0.092	<0.001	-	-	-	-	-	-
17	DLWC97-SW17	30/04/1997	<0.05	-	<0.01	-	0.037	-	-	-	-	0.005	-	3.5	-	<0.01	-	0.111	<0.001	-	-	-	-	-	-
18	DLWC97-SW18	30/04/1997	<0.05	-	<0.01	-	0.031	-	-	-	-	<0.005	-	3.2	-	<0.01	-	0.097	<0.001	-	-	-	-	-	-
SW001	SW001	22/08/2012	0.36	0.09	0.022	0.01	0.008	<0.001	<0.0001	<0.0001	0.001	<0.001	0.021	0.001	5.38	0.54	0.001	<0.001	-	-	<0.0001	<0.001	<0.001	0.016	0.018
SW002	SW002	22/08/2012	0.19	0.11	0.171	0.145	0.077	0.028	<0.0001	<0.0001	0.001	<0.001	0.011	0.008	2.94	1.05	0.002	<0.001	-	-	<0.0001	<0.001	<0.001	0.016	0.018
SW003	SW003	22/08/2012	0.25	0.19	0.139	0.12	0.171	0.118	<0.0001	<0.0001	<0.001	<0.001	0.017	0.012	1.72	1.21	0.005	0.003	-	-	<0.0001	<0.001	<0.001	0.026	0.032
SW004	SW004	22/08/2012	0.22	0.19	0.116	0.139	0.104	0.073	<0.0001	<0.0001	<0.001	<0.001	0.013	0.012	1.57	1.09	0.005	0.003	-	-	<0.0001	<0.001	<0.001	0.03	0.028
SW005	SW005	22/08/2012	0.22	0.21	0.151	0.133	0.092	0.071	<0.0001	<0.0001	<0.001	<0.001	0.014	0.012	1.52	1.15	0.004	0.003	-	-	<0.0001	<0.001	<0.001	0.032	0.031
SW006	SW006	22/08/2012	0.24	0.18	0.083	0.073	0.063	0.043	<0.0001	<0.0001	<0.001	<0.001	0.013	0.01	1.74	1.05	0.006	0.003	-	-	<0.0001	<0.001	<0.001	0.048	0.047
SW007	SW007	22/08/2012	0.2	0.13	0.07	0.061	0.056	0.038	<0.0001	<0.0001	<0.001	<0.001	0.012	0.008	1.48	0.97	0.004	0.002	-	-	<0.0001	<0.001	<0.001	0.041	0.025
SW008	SW008	22/08/2012	0.09	0.06	0.244	0.155	0.069	0.04	<0.0001	<0.0001	<0.001	<0.001	0.007	0.008	0.54	0.32	0.002	0.002	-	-	<0.0001	0.003	0.003	0.114	0.124
SW009	SW009	22/08/2012	0.05	0.03	0.018	0.012	0.016	0.002	0.0006	0.0005	0.001	<0.001	0.016	0.01	0.81	0.13	<0.001	<0.001	-	-	<0.0001	<0.001	<0.001	0.848	0.82

Note: Highlighted cells with a '<' symbol may not necessarily constitute an assessment criteria exceedance

Groundwater Chemistry

	Field					Inorganics							Alkalinity							Major Ions														
	Dissolved Oxygen (Field)	Electrical Conductivity (Field)	Oxygen Redox Potential (Field)	pH (Field)	Temp (Field)	Cyanide Total	Electrical conductivity *(lab)	pH (Lab)	Redox	TOC	Total Dissolved Solids	Total Suspended Solids	Alkalinity (total) as CaCO3	Alkalinity (Bicarbonate as CaCO3)	Alkalinity (Carbonate as CaCO3)	Alkalinity (Hydroxide) as CaCO3	Bicarbonate	Carbonate	Hardness as CaCO3	Calcium	Calcium (Filtered)	Chloride	Magnesium	Magnesium (Filtered)	Potassium	Potassium (Filtered)	Sodium	Sodium (Filtered)	Sulphate	Anions Total	Cations Total	Ionic Balance		
	mg/L	uS/cm	mV	pH Units	oC	mg/L	uS/cm	pH Units	mV	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	%	
EQL						0.004	1	0.1	1	1	5	2	1	1	1	1	1		0.5	0.1	0.1	0.05	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.01	0.01	0.01		
ANZECC 2000 FW Slightly-moderate disturbed system						0.007																												
10 times ANZECC 2000 FW Slightly-moderate disturbed system						0.07																												
30 times ANZECC 2000 FW Slightly-moderate disturbed system						0.21																												
ANZECC 2000 MW Slightly-moderate disturbed system						0.004																												
Field_ID	WellCode	Sample Date																																
4	DLW97-GW4	1/05/1997	-	-	-	-	-	0.184	1160	6.4	164	86	858	14,300	267	-	-	-	267	-	130	14	-	213	23	-	8.5	-	222	-	12	-	-	-
6	DLW97-GW6	1/05/1997	-	-	-	-	-	0.184	1160	6.4	164	86	858	14,300	267	-	-	-	267	-	130	14	-	213	23	-	8.5	-	222	-	12	-	-	-
7	DLW97-GW7	1/05/1997	-	-	-	-	-	0.104	541	6.2	238	59	604	12,900	70	-	-	-	70	-	70	8.6	-	89	12	-	7	-	111	-	28	-	-	-
12	DLW97-GW12	1/05/1997	-	-	-	-	-	<0.005	382	6.3	246	65	321	19,400	91	-	-	-	91	-	108	20	-	73	14	-	1	-	57	-	<1	-	-	-
13	DLW97-GW13	1/05/1997	-	-	-	-	-	0.01	-	-	-	-	-	-	-	-	-	-	-	103	15	-	-	16	-	8.2	-	86	-	-	-	-	-	
GW004	DLW97-GW4	22/08/2012	1.12	387	163.6	4.46	16.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
GW006	DLW97-GW6	22/08/2012	0.68	1144	-50.8	6.28	17.8	0.597	-	-	-	-	970	1190	285	285	<1	<1	347.7	<1.2	-	-	12	184	-	20	-	8	-	194	<10	10.9	10.9	0.02
GW007	DLW97-GW7	22/08/2012	0.13	784	-37	6.32	15.3	0.06	-	-	-	-	560	356	172	172	<1	<1	209.8	<1.2	-	-	9	150	-	14	-	7	-	132	<1	7.67	7.52	0.99
GW013	DLW97-GW12	22/08/2012	0.71	755	-64	6.53	19	<0.004	-	-	-	-	412	408	160	160	<1	<1	195.2	<1.2	-	-	12	78	-	14	-	6	-	71	<1	5.4	5.22	1.6

Note: Highlighted cells with a '<' symbol may not necessarily constitute an assessment criteria exceedance

Groundwater Chemistry

			Metals																						
			Aluminium	Aluminium (Filtered)	Antimony	Antimony (Filtered)	Arsenic	Arsenic (Filtered)	Cadmium	Cadmium (Filtered)	Chromium (III+VI)	Chromium (III+VI) (Filtered)	Copper	Copper (Filtered)	Iron	Iron (Filtered)	Lead	Lead (Filtered)	Manganese	Mercury	Mercury (Filtered)	Nickel	Nickel (Filtered)	Zinc	Zinc (Filtered)
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQL			0.005	0.001	0.001	0.001	0.001	0.001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.005	0.005	0.001	0.001	0.005	0.0001	0.0001	0.001	0.001	0.001	0.001
ANZECC 2000 FW Slightly-moderate disturbed system			0.055	0.055	0.009	0.009	0.013	0.013	0.0002	0.0002	0.001	0.001	0.0014	0.0014			0.0034	0.0034	1.9	0.00006	0.00006	0.011	0.011	0.008	0.008
10 times ANZECC 2000 FW Slightly-moderate disturbed system			0.55	0.55	0.09	0.09	0.13	0.13	0.002	0.002	0.01	0.01	0.014	0.014			0.034	0.034	19	0.0006	0.0006	0.11	0.11	0.08	0.08
30 times ANZECC 2000 FW Slightly-moderate disturbed system			1.65	1.65	0.27	0.27	0.39	0.39	0.006	0.006	0.03	0.03	0.042	0.042			0.102	0.102	57	0.0018	0.0018	0.33	0.33	0.24	0.24
ANZECC 2000 MW Slightly-moderate disturbed system					0.27	0.27	0.0045	0.0045	0.0007	0.0007	0.0044	0.0044	0.0013	0.0013			0.0044	0.0044	0.08	0.0001	0.0001	0.007	0.007	0.015	0.015
Field_ID	WellCode	Sample Date																							
4	DLW97-GW4	1/05/1997	9.7	-	5.6	-	19	-	-	-	-	-	0.17	-	27	-	3	-	0.923	0.046	-	-	-	-	-
6	DLW97-GW6	1/05/1997	9.7	-	5.6	-	19	-	-	-	-	-	0.17	-	27	-	3	-	0.923	0.046	-	-	-	-	-
7	DLW97-GW7	1/05/1997	6.5	-	4.1	-	89	-	-	-	-	-	0.184	-	21	-	1.6	-	0.31	0.048	-	-	-	-	-
12	DLW97-GW12	1/05/1997	3.2	-	1	-	0.423	-	-	-	-	-	1.3	-	30	-	0.245	-	1.7	<0.001	-	-	-	-	-
13	DLW97-GW13	1/05/1997	3.2	-	4.4	-	21	-	-	-	-	-	0.465	-	17	-	0.573	-	0.781	0.019	-	-	-	-	-
GW004	DLW97-GW4	22/08/2012	-	1.15	-	1.17	-	5.56	-	0.0001	-	0.132	-	0.027	-	9.05	-	0.017	-	-	<0.0001	-	4.07	-	0.208
GW006	DLW97-GW6	22/08/2012	-	2.19	-	1.39	-	72.6	-	<0.0001	-	0.014	-	0.011	-	37.4	-	0.125	-	-	0.0026	-	0.013	-	0.063
GW007	DLW97-GW7	22/08/2012	-	0.67	-	1.45	-	37	-	<0.0001	-	0.006	-	0.006	-	29.3	-	0.02	-	-	0.0005	-	0.013	-	0.051
GW013	DLW97-GW12	22/08/2012	-	0.05	-	1.21	-	34.5	-	<0.0001	-	0.011	-	0.01	-	90.5	-	0.002	-	-	0.0002	-	0.022	-	0.074

Note: Highlighted cells with a '<' symbol may not necessarily constitute an assessment criteria exceedance

Brick Analysis

	Antimony	Arsenic	Cadmium	Chromium (III+VI)	Copper	Lead	Mercury	Nickel	Zinc
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL									
NEPM 1999 EIL (bold)		20	3	1	100	600	1	60	200
NEPM 1999 HIL E		200	40	200	2000	600	30	600	14000
NSW 2008 General Solid Waste (No Leaching)		100	20	100		100	4	40	
NSW 2008 Restricted Solid Waste (No Leaching)		400	80	400		400	16	160	
USEPA RES	310								

Field ID	LocCode	Sample Date	Data Source									
Brick001	Brick Stockpile	16/08/2012	XRF	<17.87	<8.74	<15.23	<123.8	<22.66	<5.76	<6.34	<38.12	94.18
Brick001	Brick Stockpile	16/08/2012	XRF	<17.56	<2.65	<14.85	<125.2	<17.61	<6.55	<5.84	<37.29	17.05
Brick001	Brick Stockpile	17/08/2012	XRF	<16.89	12.21	<14.39	<130.8	<17.43	<6.33	<5.68	<36.71	21.79
Brick001	Brick Stockpile	17/08/2012	Lab	<5	<5	<1	6	<5	<5	3	10	-
Brick002	Brick Stockpile	16/08/2012	XRF	<17.31	18.55	<14.6	<125.3	<17.51	8.71	<5.97	<37.15	35.6
Brick002	Brick Stockpile	17/08/2012	Lab	<5	7	<1	11	6	6	6	14	-
Brick003	Brick Stockpile	16/08/2012	XRF	<17.3	12.56	<14.56	<114.6	<17.55	5.87	<6.15	<37.42	45.21
Brick004	Brick Stockpile	16/08/2012	XRF	<18.31	10.91	<15.4	<129.9	<19	<7.06	<6.45	<40.03	31.49
Brick005	Brick Stockpile	16/08/2012	XRF	<16.25	4.45	<13.86	<115.3	<16.2	<4.81	<5.4	<34.19	19.1
Brick006	Brick Stockpile	16/08/2012	XRF	<17.8	10.24	<15.12	<136	<18.15	<6.79	<6.06	<38.65	16.28
Brick007	Brick Stockpile	16/08/2012	XRF	<17.69	9.44	<14.9	<145.5	<18.34	<5.49	<6.06	<37.45	24.34
Brick008	Brick Stockpile	16/08/2012	XRF	<16.74	10.46	<14.31	<124.4	<17.52	<5.08	<5.89	<36.18	17.61
Brick009	Brick Stockpile	16/08/2012	XRF	<17.81	<3.81	<15.16	192.9	15.43	<6.78	<6.38	<38.59	35.76
Brick010	Brick Stockpile	16/08/2012	XRF	<16.47	<3.5	<14.09	<122.8	<16.74	<6.27	<5.6	<34.81	24.22
Brick011	Brick Stockpile	16/08/2012	XRF	<17.98	9.18	<15.27	<118.5	15.95	<7.18	<6.34	<38.63	60.31
Brick012	Brick Stockpile	16/08/2012	XRF	<17.7	7.86	<15.04	151.3	18.29	<5.51	<6.13	<38.03	35.3
Brick013	Brick Stockpile	16/08/2012	XRF	<16.53	<2.29	<14.09	<125.4	<16.33	<5.24	<5.4	<35.03	7.82
Brick014	Brick Stockpile	16/08/2012	XRF	<16.92	4.26	<14.44	<124.1	<16.79	<6.31	<5.69	<35.33	27.31
Brick015	Brick Stockpile	16/08/2012	XRF	<17.25	5.9	<14.63	<128.3	<17.62	<6.04	<5.82	<36.8	15.45
Brick016	Brick Stockpile	16/08/2012	XRF	<18.18	7.22	<15.39	<135.9	23.65	9.38	<6.45	<38.79	43.9
Brick017	Brick Stockpile	16/08/2012	XRF	<17.34	6.31	<14.75	<129.7	<17.58	<5.41	<6.06	<36.67	28.39
Brick018	Brick Stockpile	16/08/2012	XRF	<16.78	6.09	<14.26	<128.8	<17.08	<6.32	<5.74	<35.77	18.31
Brick019	Brick Stockpile	16/08/2012	XRF	<17.22	5.58	<14.68	<128.4	<17.23	<6.52	<5.84	<36.71	25.23
Brick020	Brick Stockpile	16/08/2012	XRF	<18.16	9.05	<15.28	<130	17.7	<5.57	<6.43	<39.31	70.24
Brick021	Brick Stockpile	16/08/2012	XRF	<17.68	5.11	<15.01	<130.1	<18.41	<6.49	<5.95	<37.63	28.21
Brick022	Brick Stockpile	16/08/2012	XRF	<16.45	6.46	<14.1	<117	<16.46	<6.23	<5.5	<34.4	50.22
Brick023	Brick Stockpile	16/08/2012	XRF	<17.87	8.74	<15.23	<123.8	22.66	<5.76	<6.34	<38.12	94.18

Note: Highlighted cells with a '<' symbol may not necessarily constitute an assessment criteria exceedance

SOIL QA/QC Data

[illegible]

*RPDs have only been considered where a concentration is greater than 1 times the EQL

**High RPDs are in bold (Acceptable RPDs for each EQL multiplier range are: 50 (1-10 x EQL); 50 (10-30 x EQL); 50 (> 30 x EQL))

***Interlab Duplicates are matched on a per compound basis as methods vary between laboratories. Any methods in the row header relate to those used in the primary laboratory

Trip Blanks

	Antimony	Arsenic
	mg/kg	mg/kg
EQL	5	5
ANZECC (2000) Interim Sediment Quality Guidelines - High	25	70
NEPM 1999 HILE		200
USEPA RES	310	

Field ID	Sampled Date-Time	Matrix	Description	
TB01	6/08/2012	soil		<5
TB02	6/08/2012	soil		<5

Rinsate Samples

	Antimony	Arsenic
	mg/L	mg/L
EQL	0.001	0.001

Field ID	Sampled Date-Time		
RB01	15/08/2012	1.64	2.35
RB02	15/08/2012	1.24	3.59
RB03	16/08/2012	0.028	0.009
RB04	15/08/2012	0.013	0.005
RB05	16/08/2012	0.01	0.004

SOIL QA/QC Data

		SDG		ES1223935			ES1223935			ES1223935			ES1223935			ES1220305			ES1220305			ES1220305			ES1220305			ES1220305			ES1220305			ES1220305					
		Field_ID		BH032_0.3-0.5			BHDUP01			BH012_0.0-0.1			BHDUP08			BH075_1.8-2.0			BHLABDUP01			BH004_0.0-0.2			BHLABDUP02			BH031_1.0-1.2			BHLABDUP03			SE050_0.0-0.1			SELABDUP01		
		Sampled_Date		14/08/2012			14/08/2012			16/08/2012			16/08/2012			15/08/2012			15/08/2012			16/08/2012			16/08/2012			15/08/2012			15/08/2012			15/08/2012					
				RPD			RPD			RPD			RPD			RPD			RPD			RPD			RPD			RPD			RPD			RPD					
Method_Type		ChemName	Units	EQL																																			
1M HCl Extractable Metals	Aluminium	mg/kg	50																																				
	Antimony	mg/kg	1																																				
	Arsenic	mg/kg	1																																				
	Cadmium	mg/kg	0.1																																				
	Chromium (III+VI)	mg/kg	1																																				
	Cobalt	mg/kg	0.5																																				
	Copper	mg/kg	1																																				
	Iron	mg/kg	50																																				
	Lead	mg/kg	1																																				
	Manganese	mg/kg	10																																				
	Nickel	mg/kg	1																																				
	Silver	mg/kg	1																																				
	Vanadium	mg/kg	2																																				
	Zinc	mg/kg	1																																				
1M HCl Extractable Metals by ICPMS	Selenium	mg/kg	0.5																																				
Leachable Mercury by FIMS (leached)	Mercury (Filtered)	mg/l	0.001																																				
Leachable Metals by ICPAES (leached)	Aluminium (Filtered)	mg/l	0.1																																				
	Antimony (Filtered)	mg/l	0.1																																				
	Arsenic (Filtered)	mg/l	0.1																																				
	Cadmium (Filtered)	mg/l	0.05																																				
	Chromium (III+VI) (Filtered)	mg/l	0.1																																				
	Copper (Filtered)	mg/l	0.1																																				
	Lead (Filtered)	mg/l	0.1																																				
	Nickel (Filtered)	mg/l	0.1																																				
	Zinc (Filtered)	mg/l	0.1																																				
Moisture Content	Moisture	%	1 (Primary): 0.5 (Interlab)											39.4	40.0	2	9.2	9.7	5	24.2	24.0	1	14.5	12.0	19														
pH (1:5)	pH (Lab)	pH_Units	0.1																							4.3													
TCLP for Non & Semivolatile Analytes (leached)	pH (after HCL)	pH_Units	0.1																																				
	pH (Final)	pH_Unit	0.1																																				
	pH (Initial)	pH_Units	0.1																																				
	TCLP Fluid	-	1																																				
Total Cyanide by Segmented Flow Analyser	Cyanide Total	mg/kg	1																								<1.0												
Total Mercury by FIMS	Mercury	mg/kg	0.1 (Primary): 0.05 (Interlab)											0.2	0.18	11	61.2	42.0	37	58.3	15.0	118	1.9	0.85	76														
Total Metals by ICP-AES	Aluminium	mg/kg	50 (Primary): 1 (Interlab)			3450.0	3120.0	10	13100.0	13400.0	2															990.0	840.0	16											
	Antimony	mg/kg	5 (Primary): 3 (Interlab)			6070.0	6070.0	0	<5.0	9.0	57		36.0	55.0	42	4700.0	7800.0	50	9670.0	7100.0	31	626.0	270.0	79															
	Arsenic	mg/kg	5 (Primary): 3 (Interlab)			3620.0	4000.0	10	16.0	12.0	29	129.0	51.0	87	1950.0	2200.0	12	5280.0	4700.0	12	1370.0	450.0	101																
	Cadmium	mg/kg	1 (Primary): 0.3 (Interlab)			<1.0	<1.0	0	<1.0	<1.0	0	3.0	0.5	143	<1.0	0.4	0	<1.0	<0.3	0	<1.0	<0.3	0																
	Chromium (III+VI)	mg/kg	2 (Primary): 0.3 (Interlab)			34.0	44.0	26	15.0	15.0	0	10.0	10.0	0	18.0	27.0	40	9.0	9.8	9	4.0	1.4	96																
	Copper	mg/kg	5 (Primary): 0.5 (Interlab)			231.0	111.0	70	12.0	13.0	8	30.0	52.0	54	136.0	250.0	59	21.0	18.0	15	47.0	22.0	72																
	Iron	mg/kg	2 (Primary): 0.3 (Interlab)			17600.0	21200.0	19	25400.0	29400.0	15																												
	Lead	mg/kg	5 (Primary): 1 (Interlab)			996.0	1450.0	37	12.0	12.0	0	17.0	17.0	0	150.0	73.0	69	133.0	180.0	30	69.0	39.0	56																
	Nickel	mg/kg	2 (Primary): 0.5 (Interlab)			<2.0	<2.0	0	5.0	5.0	0	3.0	2.3	26	<2.0	1.6	0	9.0	12.0	29	<2.0	<0.5	0																
	Zinc	mg/kg	5 (Primary): 0.5 (Interlab)			39.0	42.0	7	8.0	9.0	12	76.0	22.0	110	47.0	70.0	39	24.0	25.0	4	20.0	18.0	11																

*RPDs have only been considered where a concentration is greater than 1 times the EQL.
**High RPDs are in bold (Acceptable RPDs for each EQL multiplier range are: 50 (1-10 x EQL); 50 (10-30 x EQL); 50 (> 30 x EQL).
***Interlab Duplicates are matched on a per compound basis as methods vary between laboratories. Any methods in the row that are not matched are shown in grey.

Trip Blanks

			Antimony
EQL			5
ANZECC (2000) Interim Sediment Quality Guidelines - High			25
NEPM 1999 HIL E			
USEPA RES			310

Field ID	Sampled Date-Time	Matrix	Description
TB01	6/08/2012	soil	<5
TB02	6/08/2012	soil	<5

WATER QA/QC Duplicate Data

SDG	ES1220550	ES1220550		ES1220550	Interlab_D	
Field_ID	SW003	SWDUP01	RPD	GW006	GWLABDUP01	RPD
Sampled Date-Time	22/08/2012	22/08/2012		22/08/2012	22/08/2012	

Method Type	ChemName	Units	EQL						
Alkalinity by PC Titrator	Alkalinity (total) as CaCO3	mg/l	1 (Primary): 50 (Interlab)	4.0	4.0	0	285.0	300.0	5
	Alkalinity (Bicarbonate as CaCO3)	mg/l	1	4.0	4.0	0			
	Alkalinity (Carbonate as CaCO3)	mg/l	1	<1.0	<1.0	0			
	Alkalinity (Hydroxide) as CaCO3	mg/l	1	<1.0	<1.0	0			
Chloride by Discrete Analyser	Chloride	mg/l	1 (Primary): 0.05 (Interlab)	33.0	33.0	0	184.0	170.0	8
Dissolved Mercury by FIMS	Mercury (Filtered)	mg/l	0.0001	<0.0001	<0.0001	0			
Dissolved Metals by ICP-MS - Suite A	Aluminium (Filtered)	mg/l	0.01 (Primary): 0.001 (Interlab)	0.19	0.21	10	2.19	2.0	9
	Antimony (Filtered)	mg/l	0.001	0.12	0.112	7	1.39	5.1	114
	Arsenic (Filtered)	mg/l	0.001	0.118	0.116	2	72.6	20.0	114
	Cadmium (Filtered)	mg/l	0.0001	<0.0001	<0.0001	0	<0.0001	<0.0001	0
	Chromium (III+VI) (Filtered)	mg/l	0.001	<0.001	<0.001	0	0.014	0.013	7
	Copper (Filtered)	mg/l	0.001	0.012	0.011	9	0.011	0.01	10
	Iron (Filtered)	mg/l	0.05 (Primary): 0.005 (Interlab)	1.21	1.23	2	37.4	6.1	144
	Lead (Filtered)	mg/l	0.001	0.003	0.003	0	0.125	0.16	25
	Nickel (Filtered)	mg/l	0.001	<0.001	<0.001	0	0.013	0.01	26
	Zinc (Filtered)	mg/l	0.005 (Primary): 0.001 (Interlab)	0.032	0.031	3	0.063	0.036	55
Ionic Balance by PCT DA and Turbi SO4 DA	Anions Total	meq/L	0.01	1.05	1.05	0			
	Cations Total	meq/L	0.01	1.07	1.07	0			
Major Cations - Dissolved	Calcium (Filtered)	mg/l	1 (Primary): 0.1 (Interlab)	2.0	2.0	0	12.0	13.0	8
	Magnesium (Filtered)	mg/l	1 (Primary): 0.1 (Interlab)	2.0	2.0	0	20.0	21.0	5
	Potassium (Filtered)	mg/l	1 (Primary): 0.2 (Interlab)	1.0	1.0	0	8.0	8.5	6
	Sodium (Filtered)	mg/l	1 (Primary): 0.1 (Interlab)	18.0	18.0	0	194.0	190.0	2
Sulfate (Turbidimetric) as SO4 2- by Discrete Anal	Sulphate	mg/l	1 (Primary): 0.1 (Interlab)	2.0	2.0	0	<10.0	29.0	97
Suspended Solids (High Level)	Total Suspended Solids	mg/l	5	9.0	9.0	0	1190.0	15000.0	171
Total Cyanide By Discrete Analyser	Cyanide Total	mg/l	0.004 (Primary): 0.005 (Interlab)	<0.004	<0.004	0	0.597	1.3	74
Total Dissolved Solids (High Level)	Total Dissolved Solids	mg/l	10	107.0	106.0	1	970.0	960.0	1
Total Metals by ICP-MS - Suite A	Aluminium	mg/l	0.01	0.25	0.25	0			
	Antimony	mg/l	0.001	0.139	0.154	10			
	Arsenic	mg/l	0.001	0.171	0.171	0			
	Cadmium	mg/l	0.0001	<0.0001	<0.0001	0			
	Chromium (III+VI)	mg/l	0.001	<0.001	<0.001	0			
	Copper	mg/l	0.001	0.017	0.014	19			
	Iron	mg/l	0.05	1.72	1.71	1			
	Lead	mg/l	0.001	0.005	0.006	18			
	Nickel	mg/l	0.001	<0.001	<0.001	0			
	Zinc	mg/l	0.005	0.026	0.03	14			

*RPDs have only been considered where a concentration is greater than 1 times the EQL.

**High RPDs are in bold (Acceptable RPDs for each EQL multiplier range are: 50 (1-10 x EQL); 50 (10-30 x EQL); 50 (> 30 x EQL))

***Interlab Duplicates are matched on a per compound basis as methods vary between laboratories. Any methods in the row header relate to those used in the primary laboratory

Supplementary Soil and Stockpile Chemistry

				Inorganics	Metals										
				Moisture	Aluminium	Antimony	Arsenic	Cadmium	Chromium (III+VI)	Copper	Iron	Lead	Mercury	Nickel	Zinc
				%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL				1	50	5	5	1	2	5	50	5	0.1	2	5
NEPM 1999 EIL							20	3	1	100		600	1	60	200
NEPM 1999 HIL E							200	40	200	2000		600	30	600	14000
USEPA RES						310									
10 times HIL E/USEPA RES						3100	2000	400	2000	20,000		6000	300	6000	140,000
30 times HIL E/USEPA RES						9300	6000	1200	6000	60,000	0	18,000	900	18,000	420,000

Field_ID	LocCode	Sample Depth	Sampled Date												
BH007 0.0-0.1	BH007	0-0.1	11/12/2012	4.9	-	3140	1370	-	-	-	-	-	-	-	-
BH007 0.3-0.5	BH007	0.3-0.5	11/12/2012	8.6	-	37	21	-	-	-	-	-	-	-	-
BH085 0.0-0.1	BH085	0-0.1	10/12/2012	2.8	-	506	184	-	-	-	-	-	-	-	-
BH086 0.0 0.1	BH086	0.1	10/12/2012	3.3	-	767	171	-	-	-	-	-	-	-	-
BH087 0.0-0.1	BH087	0-0.1	10/12/2012	2.8	-	156	44	-	-	-	-	-	-	-	-
BH087 0.3-0.4	BH087	0.3-0.4	10/12/2012	3.4	-	75	20	-	-	-	-	-	-	-	-
BH102 0.0-0.1	BH102	0-0.1	11/12/2012	74.8	-	1830	30	-	-	-	-	-	-	-	-
BH102 0.3-0.5	BH102	0.3-0.5	11/12/2012	57.4	-	632	88	-	-	-	-	-	-	-	-
BH103 0.0-0.1	BH103	0-0.1	11/12/2012	59.4	3550	4120	343	<1	34	272	4440	40	4.2	<2	26
BH103 0.3-0.5	BH103	0.3-0.5	11/12/2012	24.6	6760	17	442	<1	38	161	131,000	31	8.4	<2	30
BH104 0.0-0.1	BH104	0-0.1	11/12/2012	14.6	-	169	24	-	-	-	-	-	-	-	-
BH104 0.3-0.5	BH104	0.3-0.5	11/12/2012	12.3	-	65	15	-	-	-	-	-	-	-	-
BH105 0.0-0.1	BH105	0-0.1	11/12/2012	40.7	8270	1190	279	<1	78	380	12,700	40	98.4	<2	27
BH105 0.3-0.5	BH105	0.3-0.5	11/12/2012	15.2	5970	134	18	<1	8	20	6430	11	22.2	3	32
BH106 0.0-0.1	BH106	0-0.1	11/12/2012	10.6	-	82	14	-	-	-	-	-	-	-	-
BH107 0.0-0.1	BH107	0-0.1	11/12/2012	13.2	-	60	23	-	-	-	-	-	-	-	-
BH107 0.2-0.3	BH107	0.2-0.3	11/12/2012	10.2	-	22	16	-	-	-	-	-	-	-	-
MP001A	Mercury Plug 1		11/12/2012	16.7	<50	39,100	956	<1	<2	8	970	<5	3800	<2	47
MP001B	Mercury Plug 1		11/12/2012	17.6	<50	41,900	521	<1	<2	<5	650	<5	5840	<2	32
MP002A	Mercury Plug 2		11/12/2012	10.4 - 11.2	<50	36,900	554	<1	<2	<5	590	<5	2440	<2	26
MP002B	Mercury Plug 2		11/12/2012	10.4 - 11.2	<50	41,000	1660	<1	<2	61	24,100	<5	4680	<2	99
SP004 0.0-0.1	Stockpile 4	0-0.1	10/12/2012	11.4	5350	565	241	<1	16	66	33,300	139	4.6	3	120
SP004 0.1-0.2	Stockpile 4	0.1-0.2	10/12/2012	7.2	5170	409	452	<1	11	77	19,200	50	4.1	4	143

Supplementary Sediment Chemistry

	Inorganics	Metals	
	Moisture	1M HCl Extractable Antimony	1M HCl Extractable Arsenic
	%	mg/kg	mg/kg
EQL	1	1	1
ANZECC (2000) Interim Sediment Quality Guidelines - High		25	70
ANZECC (2000) Interim Sediment Quality Guidelines - Low		2	20
10 times ANZECC (2000) Interim Sediment Quality Guidelines - High		250	700
30 times ANZECC (2000) Interim Sediment Quality Guidelines - High		750	2100

Field_ID	LocCode	Sample Depth	Sampled Date			
SE015_0.0-0.1	SE015	0-0.1	10/12/2012	76.8	211	20
SE023_0.0-0.1	SE023	0-0.1	10/12/2012	79.7	1590	96
SE023_0.1-0.25	SE023	0.1-0.25	10/12/2012	74.2	45.6	37.5
SE024_0.0-0.1	SE024	0-0.1	10/12/2012	76.7	95.2	29.1
SE034_0.0-0.15	SE034	0-0.15	10/12/2012	76.3	616	62.6
SE035_0.0-0.1	SE035	0-0.1	10/12/2012	79	1580	55.1
SE036_0.0-0.2	SE036	0-0.2	10/12/2012	85.8	413	23
SE044_0.0-0.05	SE044	0-0.05	10/12/2012	63.5	198	56.2
SE045_0.0-0.2	SE045	0-0.2	10/12/2012	75.7	240	17.8
SE069_0.0-0.15	SE069	0-0.15	10/12/2012	84.9	439	348
SE070_0.0-0.3	SE070	0-0.3	10/12/2012	74.4	394	27.9
SE071_0.0-0.15	SE071	0-0.15	10/12/2012	51.6	57.8	36.8
SE072_0.0-0.3	SE072	0-0.3	10/12/2012	85	682	25.8
SE103_0.05-0.1	SE103	0.05-0.1	10/12/2012	75.9	467	32.5
SE103_0.1-0.3	SE103	0.1-0.3	10/12/2012	43.1	87.6	3.5
SE104_0.0-0.1	SE104	0-0.1	10/12/2012	73.1	14.2	6.5

Supplementary QA/QC Results

SDG	ES1229225	ES1229225		ES1229225	ES1229225		ES1229225	ES1229225	
Field_ID	BH007_0.0-0.1	BHDUP 20	RPD	SE103_0.05-0.1	SEDUP 21	RPD	SE104_0.0-0.1	SEDUP 20	RPD
Sampled_Date-Time	11/12/2012	11/12/2012		10/12/2012	10/12/2012		10/12/2012	10/12/2012	

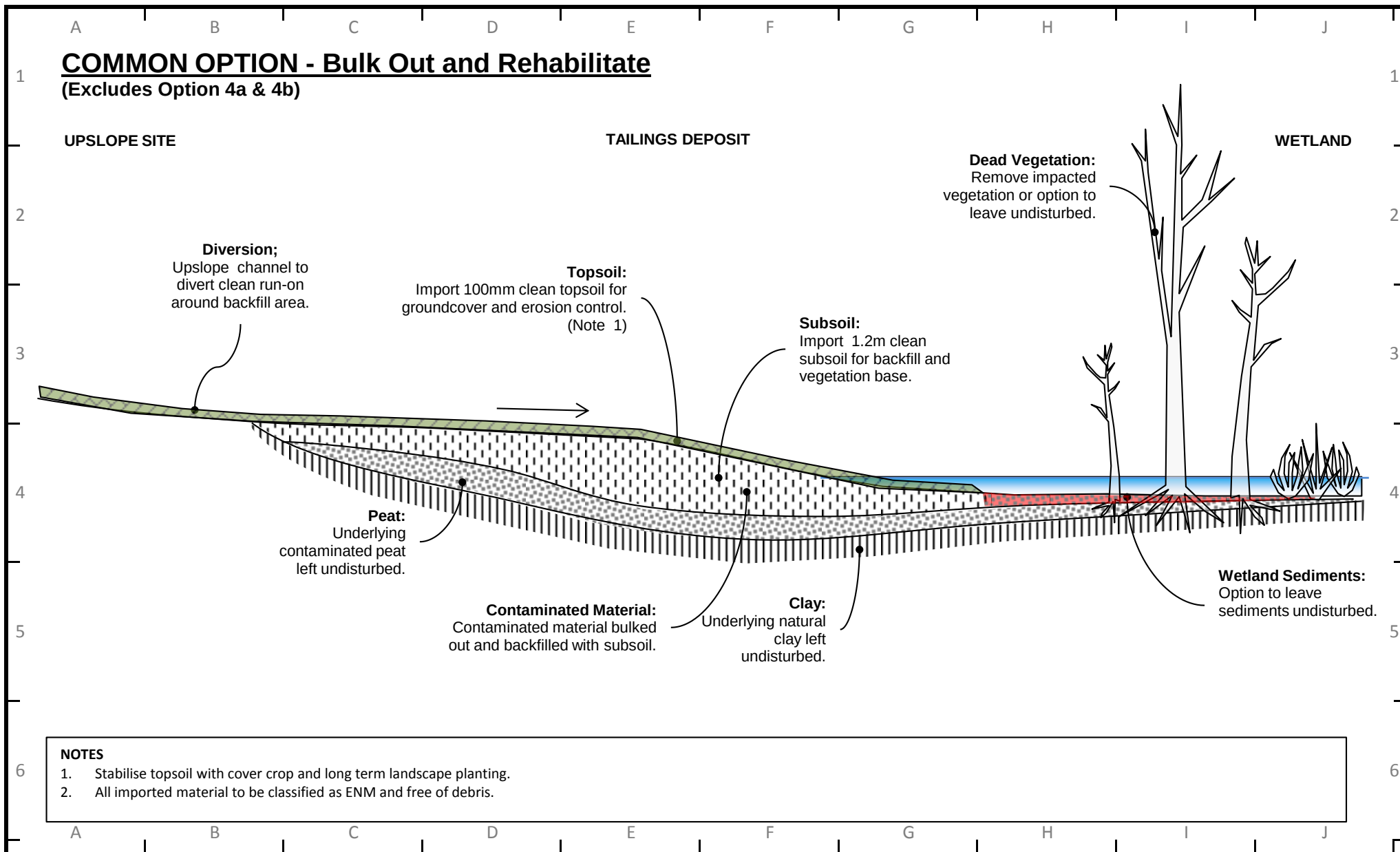
Chem_Group	ChemName	Units	EQL									
Inorganics	Moisture	%	1	4.9	6.2	23	75.9	80.0	5	73.1	70.6	3
Metals	Antimony	mg/kg	5	3140.0	3190.0	2						
	Antimony	mg/kg	1				467.0	1030.0	75	14.2	10.2	33
	Arsenic	mg/kg	5	1370.0	1420.0	4						
	Arsenic	mg/kg	1				32.5	40.6	22	6.5	2.0	106

*RPDs have only been considered where a concentration is greater than 1 times the EQL.

**High RPDs are in bold (Acceptable RPDs for each EQL multiplier range are: 50 (1-10 x EQL); 50 (10-30 x EQL); 50 (> 30 x EQL))

***Interlab Duplicates are matched on a per compound basis as methods vary between laboratories. Any methods in the row header relate to those used in the primary laboratory

Appendix B Remediation Concepts



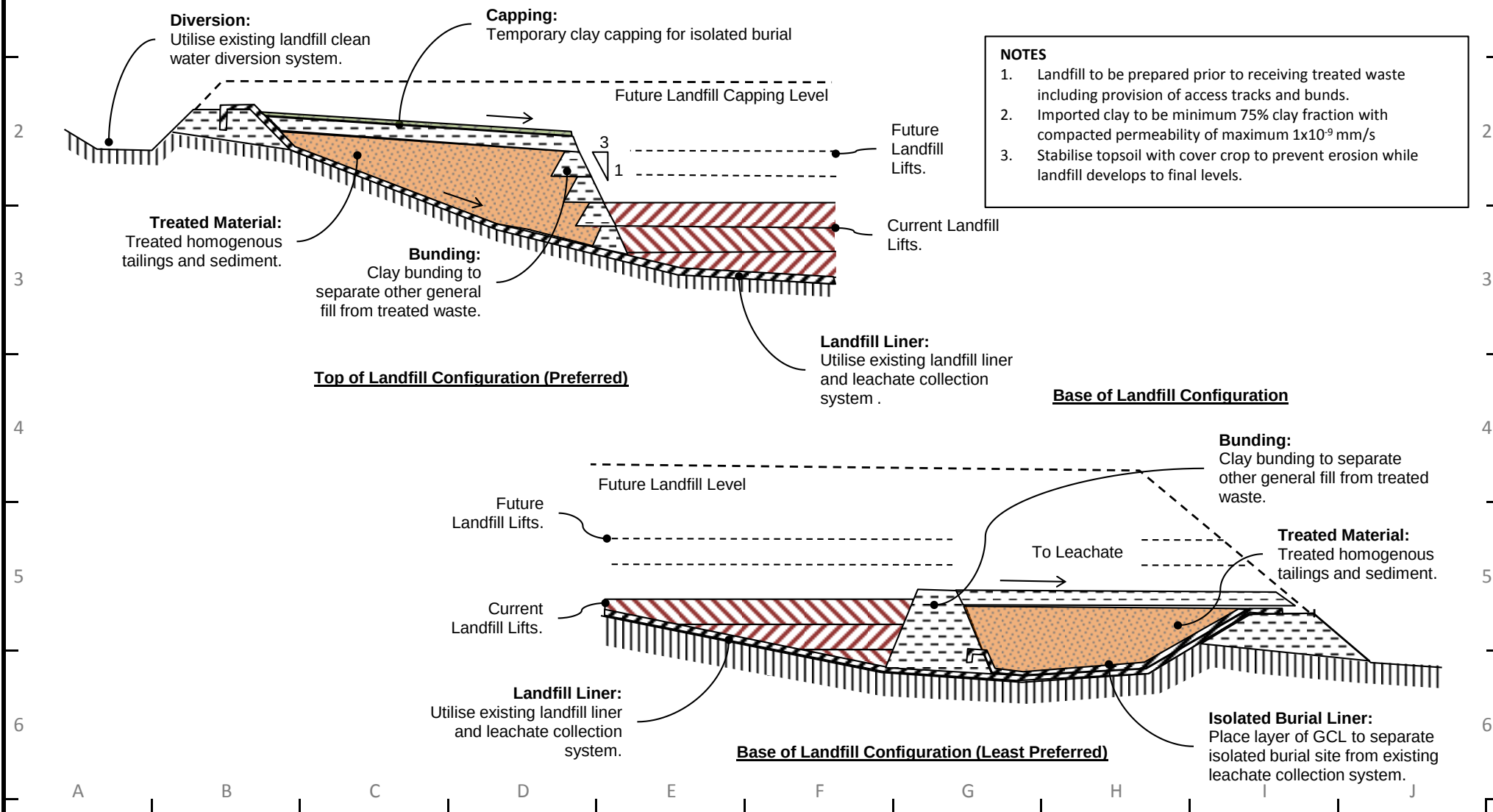
Project	Urunga Antimony Contaminated Site
Client	Crown Lands

Title	Option 1 Bulk Out and Rehabilitate
Drawing	Conceptual Cross-section

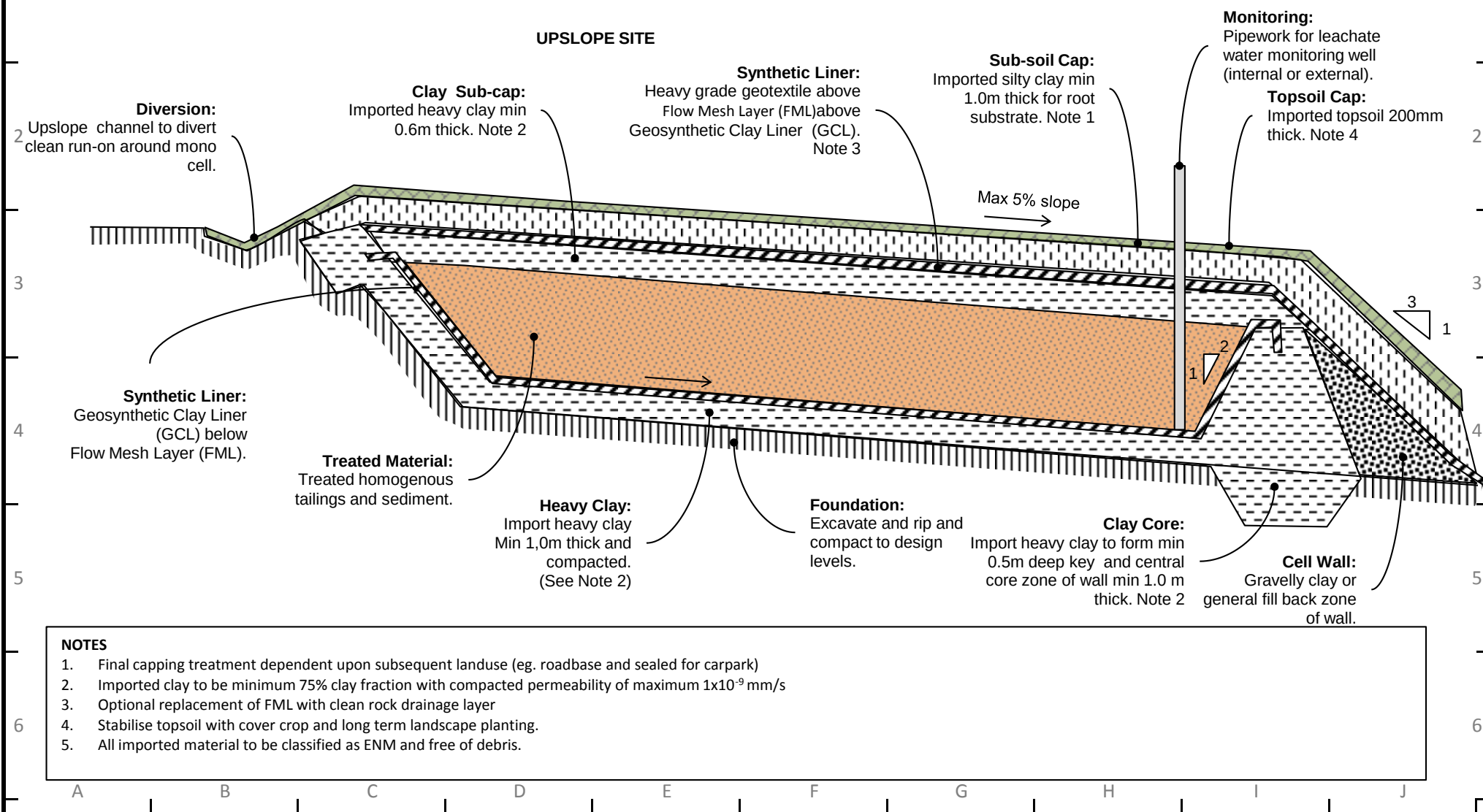
Rev.	Date

Proj. No:	5008143
Scale:	N.T.S.
Date:	27/11/2013
Dwg No:	4b
Rev	0

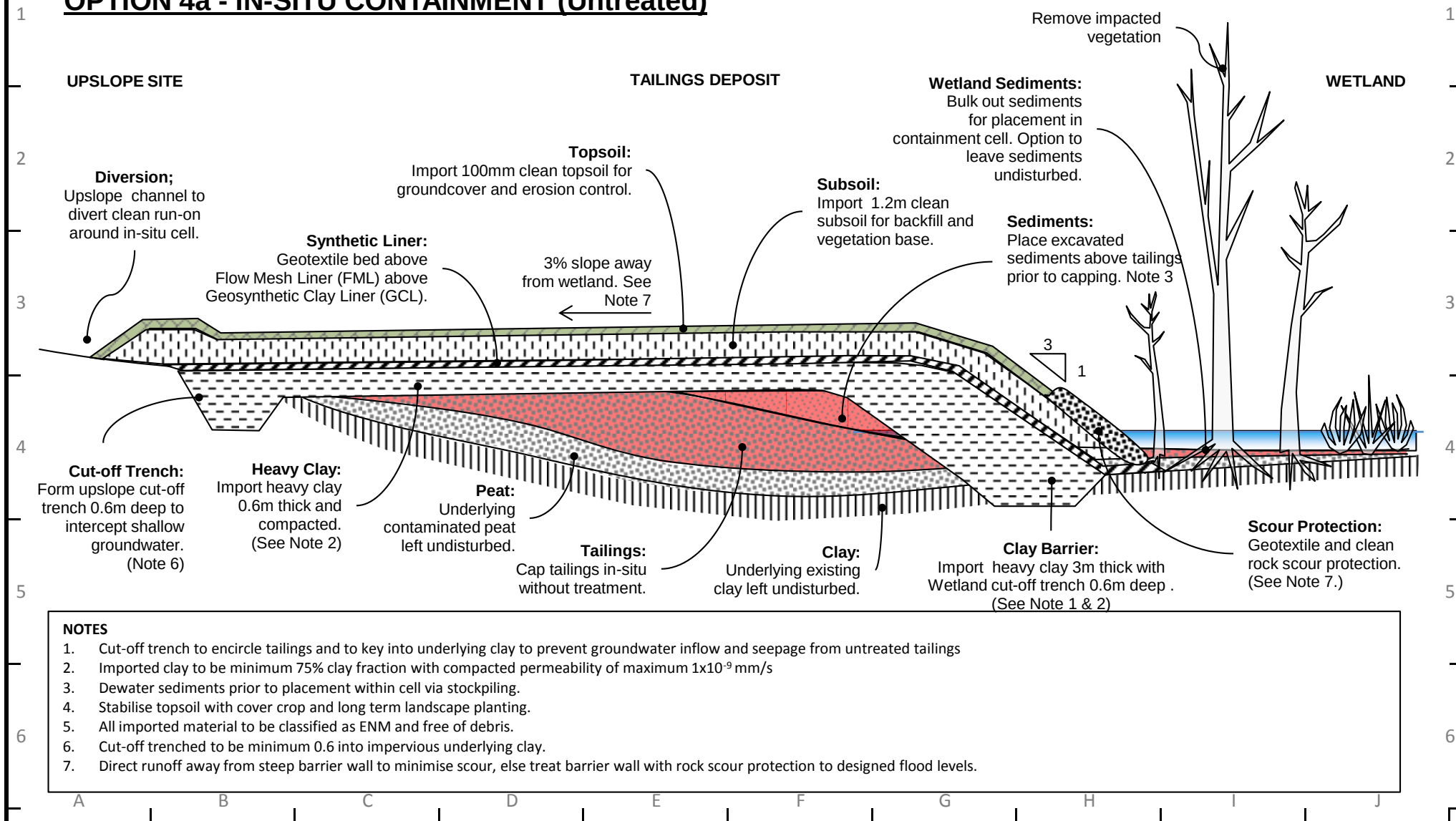
OPTION 2 - LANDFILL ISOLATED BURIAL (Treated)

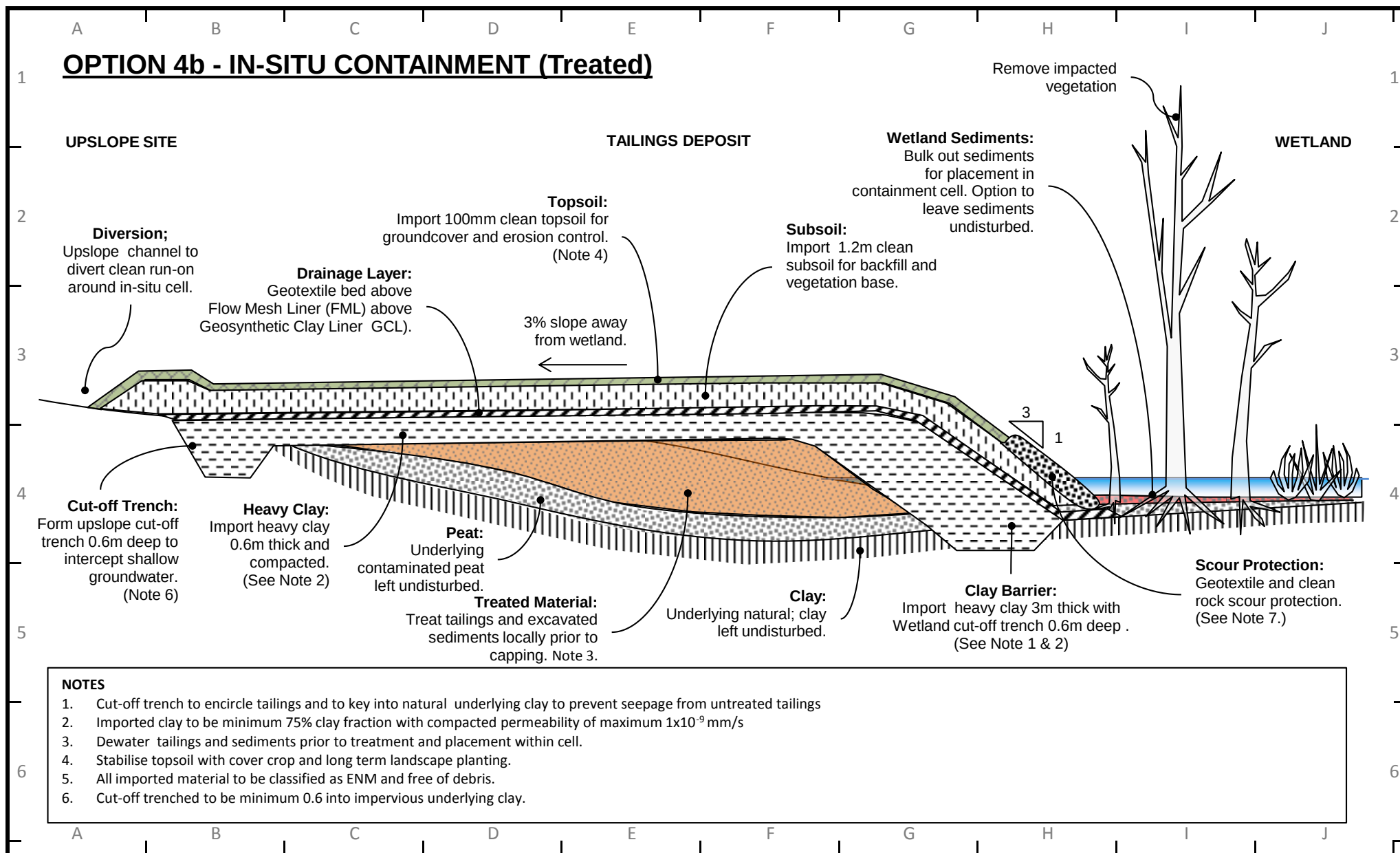


OPTION 3a or 3b - ONSITE CONTAINMENT CELL



OPTION 4a - IN-SITU CONTAINMENT (Untreated)





Appendix C Risk Assessment

Approach to Assessment of Risks

Background

The likelihood and consequence descriptors and risk matrix have been adopted taking into account the risk tolerance of the site owner, the regulator and other stakeholders. This calibration is recommended in AS/NZS ISO 31000:2009 – *Risk Management: Principles and Guidelines*. Indicative probabilities are included in **Table C-1**; these are intended to assist in understanding the descriptor and are not intended to be quantitative measures.

Adopted Likelihood Descriptors

Table C-1 lists the adopted likelihood categories for assessing risks to health and the environment for the site.

The likelihood rankings are limited to “highly unlikely”; where it is considered implausible that an adverse effect would occur, the situation is not considered further.

Table C-1 **Likelihood Categories**

Rating	Descriptor	Description
A	Certain	The event is occurring or will occur (e.g. probability > 90%), or is expected to occur almost all of the time.
B	Likely	It is likely but not certain that the event will occur (e.g. probability 60 – 90%), or it is expected to occur most of the time.
C	Possible	It is possible that the event may occur, although it is also possible that it will not occur (e.g. probability 40 – 60%).
D	Unlikely	It is unlikely that the event will occur, although it is possible it may occur (e.g. probability 10 – 40%). (It might occur but is not expected to).
E	Highly Unlikely	It is highly unlikely that the event will occur; it would only occur in exceptional or unforeseen circumstances (e.g. probability < 10%).

Adopted Consequence Descriptors

For the purposes of assessing risk for the remediation options, descriptors have been adopted to consider a range of impacts that might occur, with reference to the various receptors and pathways for impact, and various regulatory requirements, policies and guidance documents. The latter include:

- AS/NZS ISO 31000:2009 – *Risk Management: Principles and Guidelines*;
- Vic EPA Publication 1321.2: *Licence Assessment Guidelines*;
- National Environment Protection (Assessment of Site Contamination) Measure (NEPM), 1999;
- Vic EPA Publication 788.1: *Best Practice Environmental Management Siting, Design, Operation and Rehabilitation of Landfills*, 2010.

The adopted descriptors are listed in Table C-2.

Table C-2 Consequence Categories

1	Severe	▶ Death of person(s) either on site or off site. ▶ Substantial long term impacts to an extensive area of the environment off site, offsite clean-up required, breach of environmental legislation, regulatory action. ▶ Severe on-site impacts requiring immediate major rectification works to restore site function. ▶ Broader community outrage or action / adverse media coverage to national level. ▶ Examples: – Off-site: severe extensive impact (e.g. fish kills or surface water contamination impacting on existing recreational users) with the need to undertake immediate large rectification works with major cost (>\$1 million) – Off-site and on-site: death or serious long-term health effects to persons arising from – Severe impact with regulatory action likely to result in prosecution.
2	Significant	▶ On-site: hospitalisation of workers. ▶ Offsite: minor immediately observable effects to health of persons; likely longer term significant health effects. ▶ Offsite impacts to a segment of the environment, medium-term environmental damage, offsite clean-up required, breach of environmental legislation. ▶ Significant on-site impacts requiring substantial works to maintain function of site. ▶ Local community outrage / adverse media coverage to state level. ▶ Examples: – Offsite impact (e.g. surface water contamination) resulting in requirement for substantial rectification works (eg \$0.5 – 1 million). – EPA enforcement action; issue of order requiring major works – Off-site extensive long term impacts on relevant use of groundwater, surface water or soil (eg extensive area of vegetation affected or where HILs are exceeded by order of magnitude) – On-site impact on beneficial uses of site.
3	Moderate	• On-site: medical attention but no hospitalisation or long term effects • Off-site: no immediately observable effect on human health, but possible longer term health effects • Off-site: temporary or short-term environmental impacts • Moderate long-term on-site impacts requiring ongoing maintenance. • Local community concern and media coverage. • Examples: – Off-site impact requiring moderate rectification costs (\$50 000 - \$500 000) – EPA enforcement action resulting in fine or moderate rectification costs – Off-site: short-term visually observable impacts on fauna, groundwater,

		surface water or vegetation – Unacceptable aesthetic impacts leading to persistent complaints from neighbours.
4	Minor	▶ On-site: first aid required but no formal medical attention ▶ On-site: On-site: extensive areas of vegetation impact ▶ Off-site: some localised areas where impact is minor but discernible (eg to vegetation, surface water, soil) ▶ Minor on-site impacts immediately contained, or minor maintenance required. ▶ No external complaints received. ▶ Examples: – Off-site impact involving minor rectification costs (<\$50,000) – EPA enforcement action unlikely – Off site: contaminant concentrations are measured to exceed beneficial use criteria in localised areas but existing use is not affected (eg use of groundwater, surface water or land) – Off-site: localised area of vegetation effect – Off-site: aesthetic impacts detected beyond the boundary, but few complaints received
5	Negligible	▶ Off-site: long term health impacts unlikely. ▶ Off-site: possible minor (but no clearly discernible) adverse effects on the relevant beneficial uses of groundwater, surface water or land ▶ On-site: some discernible localised areas of vegetation impact but not impeding function of site or requiring maintenance. ▶ Examples: – Off-site: Groundwater, surface water and soil monitoring results in the order of guidelines values with some minor localised exceedence in the immediate vicinity of the site but no existing sensitive use affected – Off-site: no complaints

Adopted Risk Matrix and Risk Ratings

Table D-3 presents the adopted risk matrix and risk rankings that reflect the level of risk expected to result from the various combinations of likelihood and consequence relevant to the remediation options.

In deriving the risk matrix, the following considerations applied:

- Where the likelihood of an event (consequence) occurring is considered to not be plausible, this will not be considered;
- Where consequences are considered to be “negligible”, whatever the likelihood the risk is ranked as “low”; and
- Where consequences are considered to be “catastrophic”, the risk is ranked as “very high” if this is judged to be “possible” (or more likely); “high” if this is judged to be “unlikely” (but possible), and “medium” if it is judged to be “highly unlikely” (but plausible).

Table D-3 Adopted Risk Matrix

Consequence		Likelihood				
		A	B	C	D	E
		Certain	Likely	Possible	Unlikely	Highly Unlikely
1	Severe	V	V	V	H	M
2	Significant	V	H	H	M	M
3	Moderate	H	H	M	M	L
4	Minor	M	M	M	L	L
5	Negligible	L	L	L	L	L

The following definitions of risk ratings are applied:

- V – Very high risk, immediate action required involving emergency response.
- H – High risk, immediate action required by site management.
- M – Medium risk, management action required. Check frequently (eg. monthly).
- L – Low risk, manage with standard operating procedure. Check periodically (eg. annually).

GHD

230 Harbour Drive

Coffs Harbour NSW 2450

T: (02) 6650 5600 F: (02) 6650 5601 E: cfsmail@ghd.com

© GHD 2014

This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

G:\22\16251\WP\15401.docx

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	B. Luffman	I. Gregson		I. Gregson		7/4/2014
1	B. Luffman	I. Gregson		I. Gregson		5/9/2014

www.ghd.com





Appendix F Containment Cell Design



LEGEND:

- | | |
|---|----------------------------------|
|  | MAJOR DESIGN CONTOUR |
|  | MINOR DESIGN CONTOUR |
|  | TOP OF DESIGN BATTER |
|  | TOE OF DESIGN BATTER/GRADE BREAK |
|  | CLEAN WATER DIVERSION DRAINS |
|  | SITE BOUNDARY |
|  | PROBABLE MAXIMUM FLOOD (PMF) |
|  | EXISTING SEWER |
|  | TRIAL PIT LOCATION |
|  | BOREHOLE LOCATION |
|  | EXISTING VEGETATION |
|  | EXISTING ELECTRICAL SERVICE |



CONCEPT

B	CLIENT ISSUE	DB*	26.06.14
A	INITIAL ISSUE	DB*	29.05.14
rev	description	app'd	date

NSW CATCHMENT & LANDS - CROWN LANDS
FORMER ANTIMONY PROCESSING PLANT - URUNGA
CONTAINMENT CELL
TOP OF WASTE LAYOUT PLAN

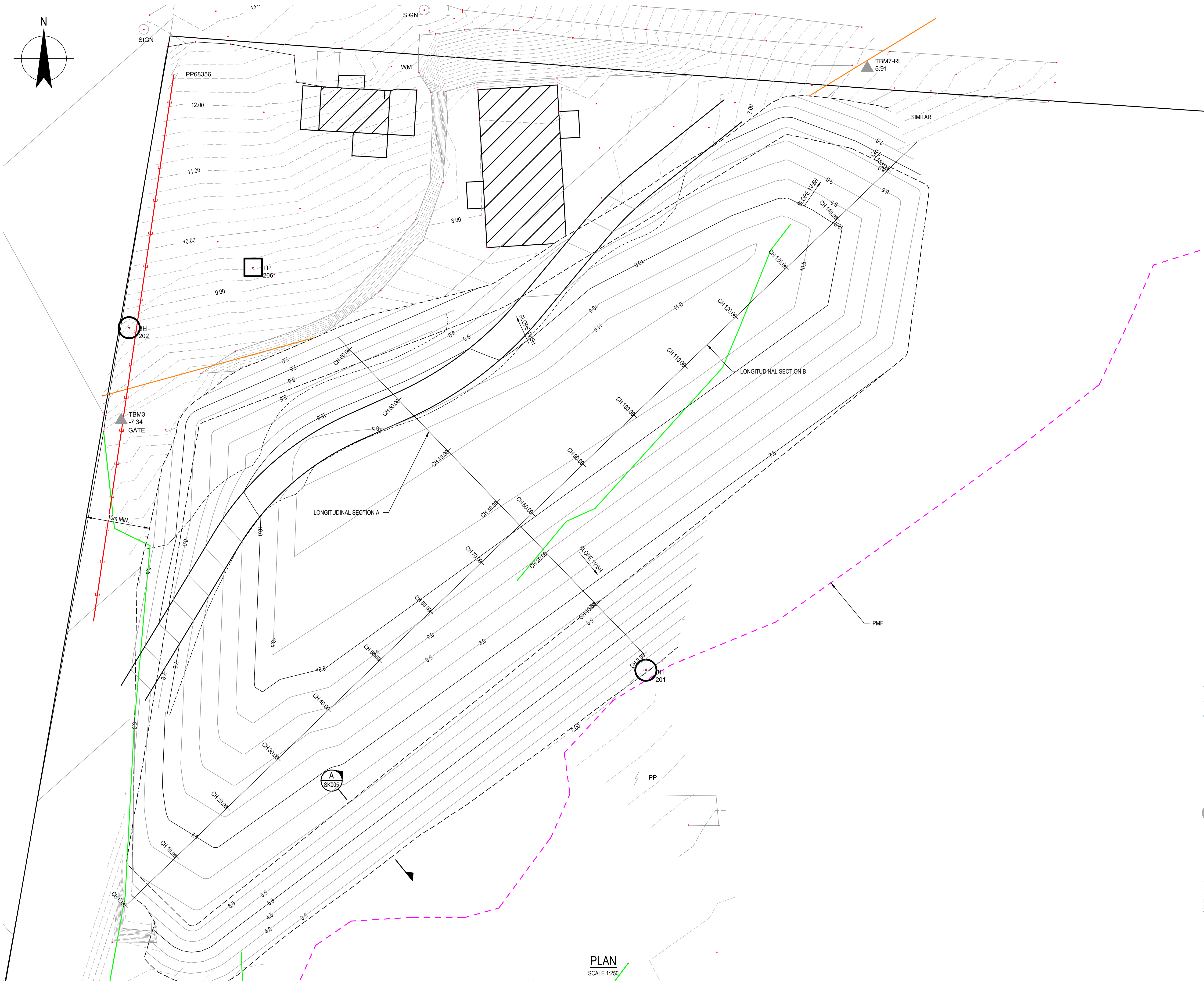


Suite 10, 6 Reliance Drive Tuggerah Business Park
PO Box 3220 Tuggerah NSW 2259
T 61 2 4350 4100 F 61 2 4350 4101
E centralcoastmail@ghd.com W www.ghd.com

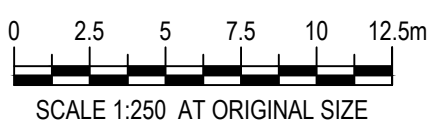
Conditions of Use: This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

scale	1:250	for A1	job no.	22-16251
date	JUNE 2014		rev no.	B

approved (PD) SK002



- LEGEND:**
- 2.5 MAJOR DESIGN CONTOUR
 - MINOR DESIGN CONTOUR
 - TOP OF DESIGN BATTER
 - TOE OF DESIGN BATTER/GRADE BREAK
 - CLEAN WATER DIVERSION DRAINS
 - SITE BOUNDARY
 - PROBABLE MAXIMUM FLOOD (PMF)
 - EXISTING SEWER
 - TRIAL PIT LOCATION
 - BOREHOLE LOCATION
 - EXISTING VEGETATION
 - EXISTING ELECTRICAL SERVICE



CONCEPT

B	CLIENT ISSUE	DB*	26.06.14
A	INITIAL ISSUE	DB*	29.05.14
rev	description	app'd	date

NSW CATCHMENT & LANDS - CROWN LANDS
FORMER ANTIMONY PROCESSING PLANT - URUNGA
CONTAINMENT CELL
FINAL LANDFORM LAYOUT PLAN



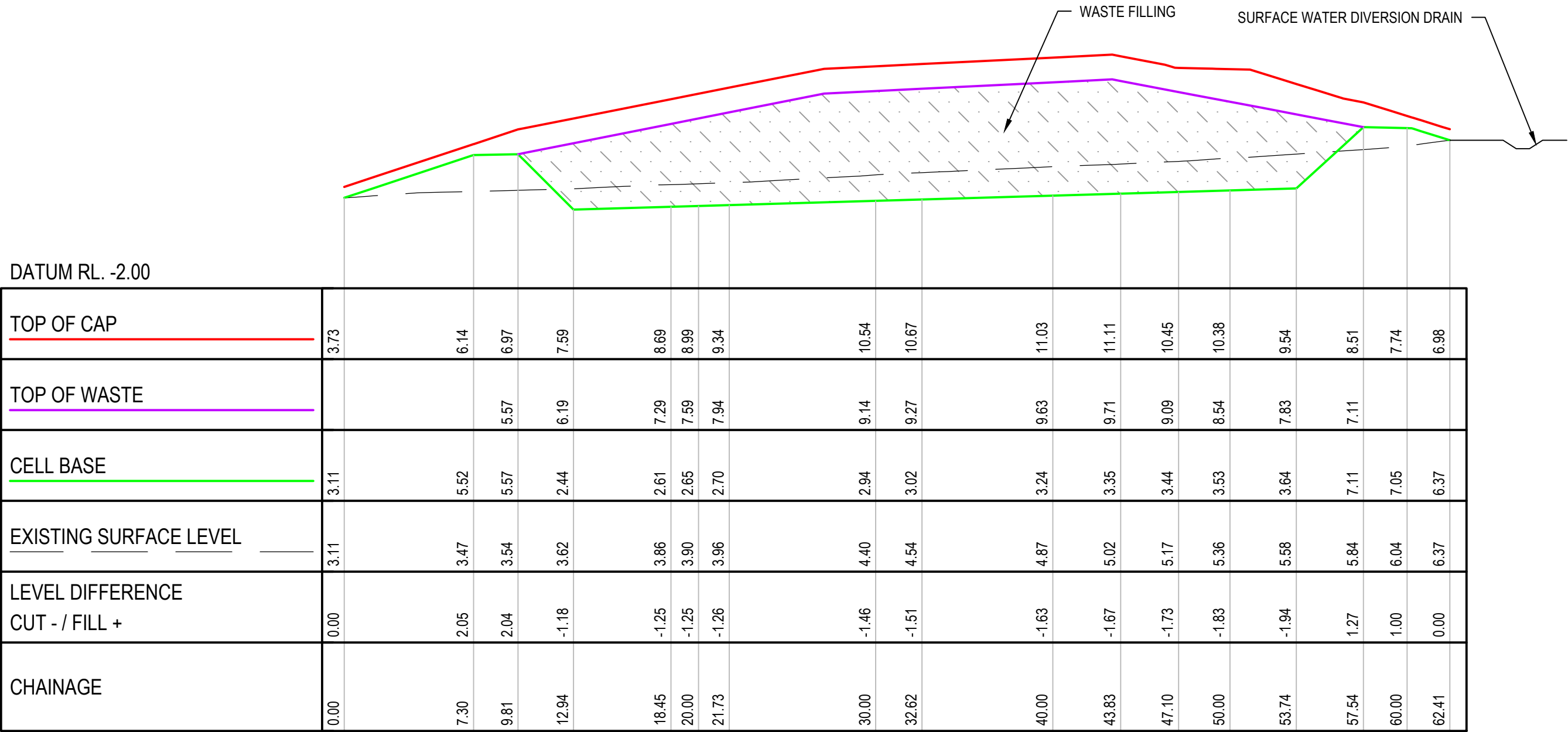
Suite 10, 6 Reliance Drive Tuggerah Business Park
PO Box 3220 Tuggerah NSW 2259
T 61 2 4350 4100 F 61 2 4350 4101
E centralcoastmail@ghd.com W www.ghd.com

Conditions of Use: This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

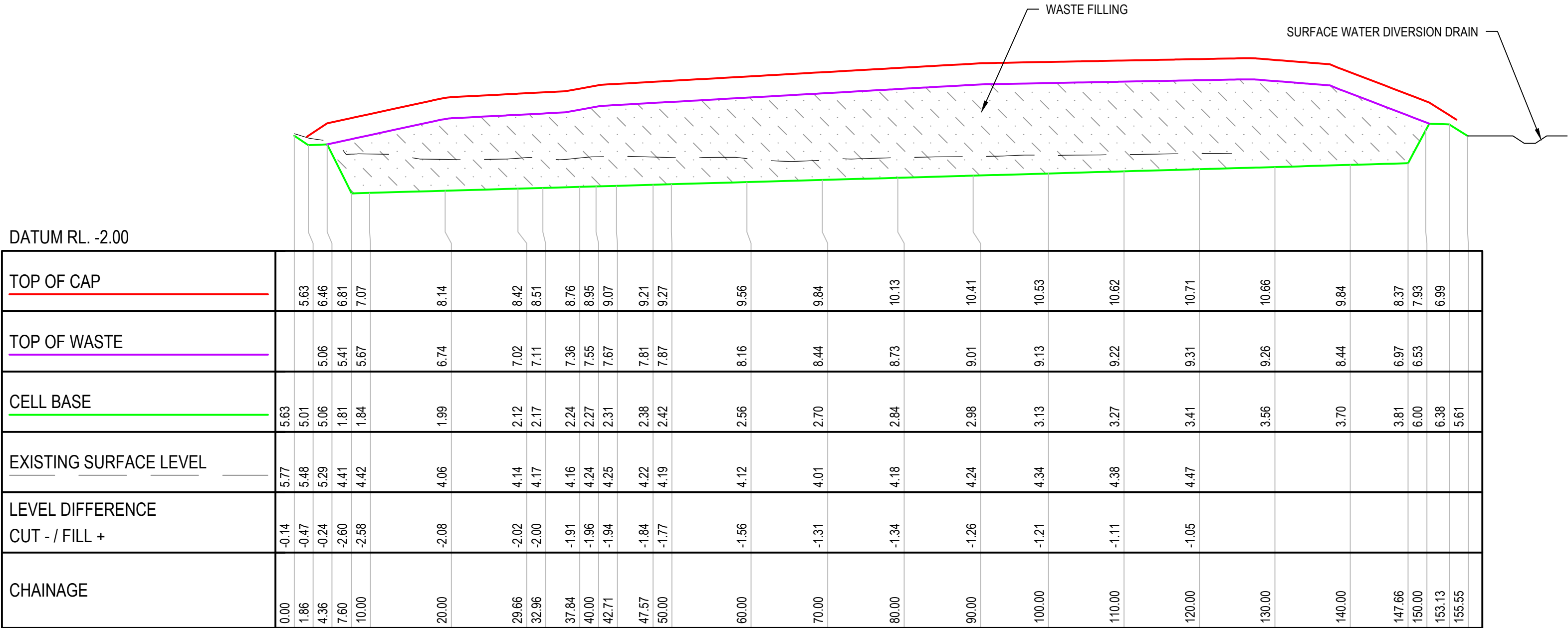
scale 1:250 for A1 job no. 22-16251
date JUNE 2014 rev no. B

approved (PD) SK003

PLAN
SCALE 1:250



LONGITUDINAL SECTION A
SCALE 250H : 250V



LONGITUDINAL SECTION B
SCALE 500H : 250V

CONCEPT

B	CLIENT ISSUE	DB*	26.06.14
A	INITIAL ISSUE	DB*	29.05.14
rev	description	app'd	date

NSW CATCHMENT & LANDS - CROWN LANDS
FORMER ANTIMONY PROCESSING PLANT - URUNGA
CONTAINMENT CELL
LONGITUDINAL SECTIONS



Suite 10, 6 Reliance Drive Tuggerah Business Park
PO Box 3220 Tuggerah NSW 2259
T 61 2 4350 4100 F 61 2 4350 4101
E centralcoastmail@ghd.com W www.ghd.com

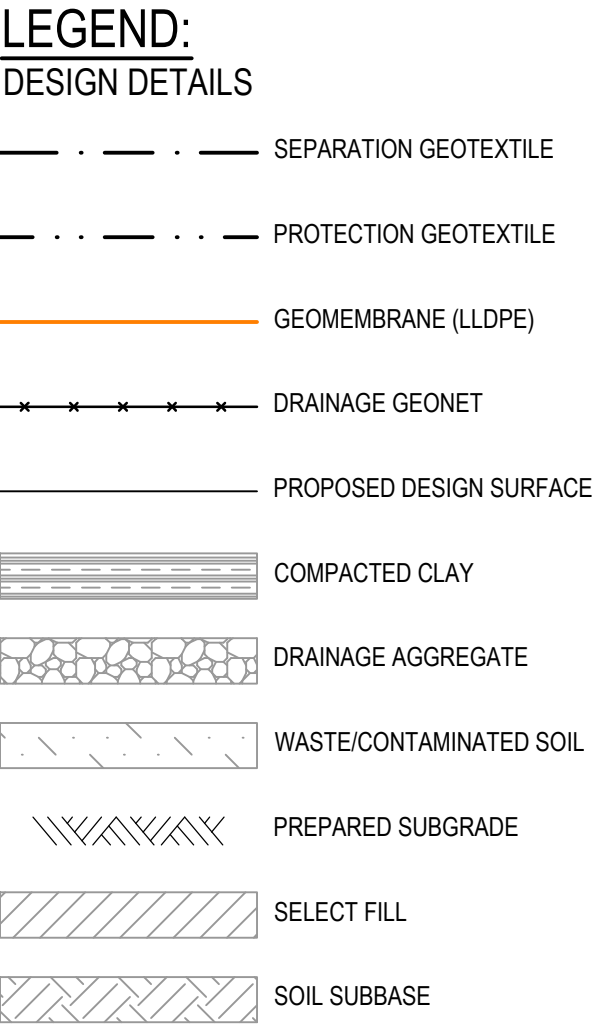
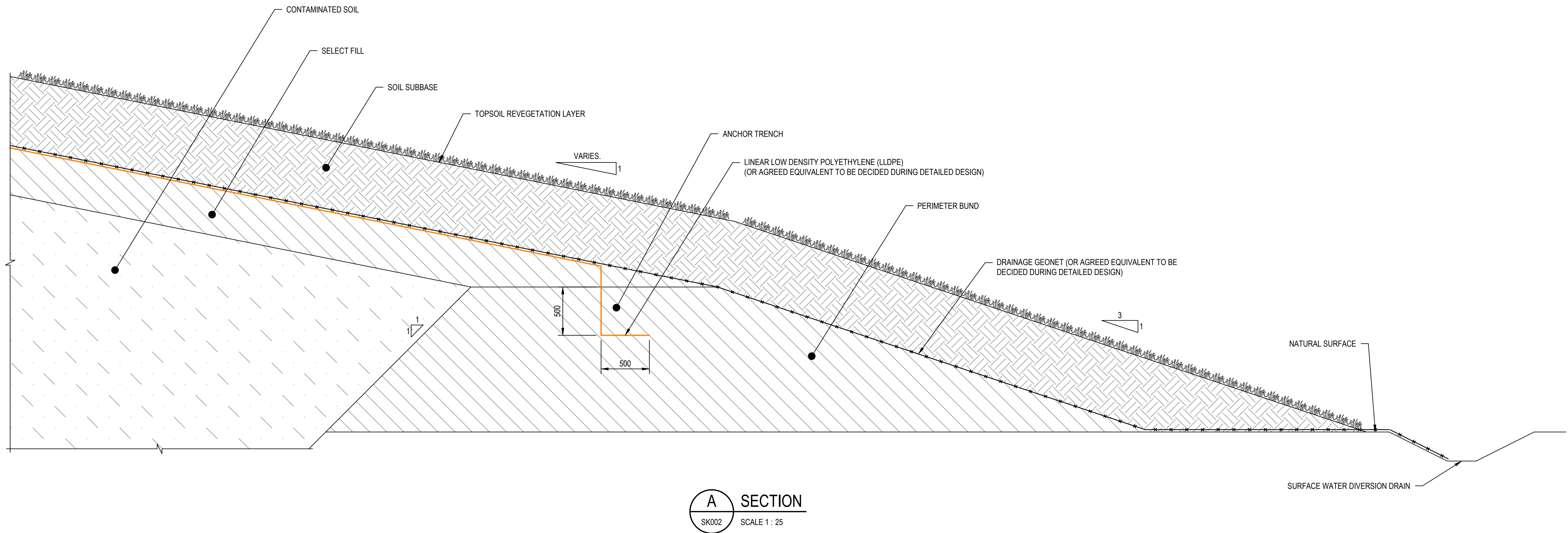
Conditions of Use: This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

scale SHOWN for A1 job no. 22-16251
date JUNE 2014 rev no. B

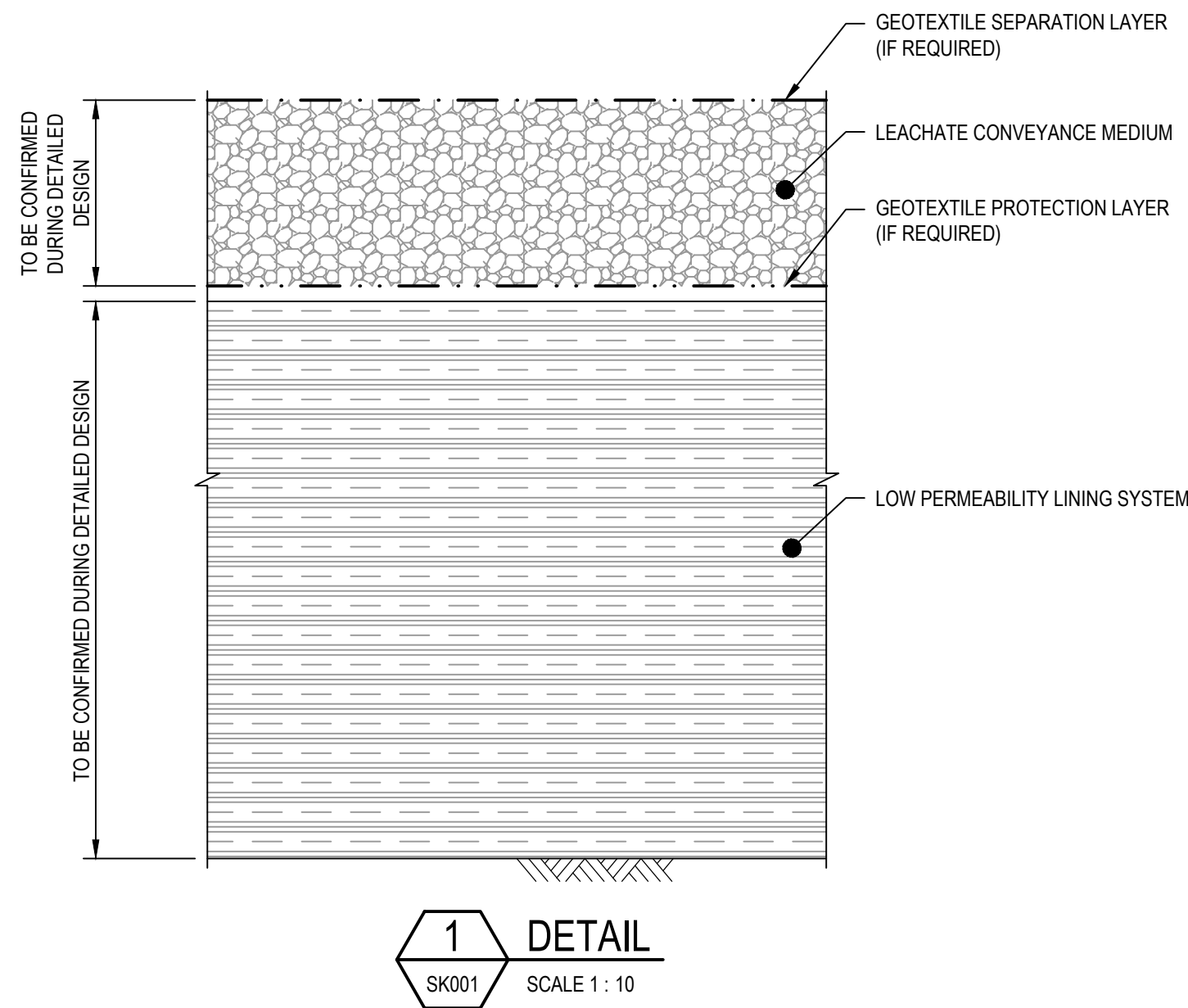
approved (PD) SK004

VERTICAL 1:250
AT ORIGINAL SIZE
HORIZONTAL 1:250
AT ORIGINAL SIZE

VERTICAL 1:250
AT ORIGINAL SIZE
HORIZONTAL 1:500
AT ORIGINAL SIZE



TYPICAL CAP PROFILE AND PERIMETER TIE-INTO NATURAL SURFACE



TYPICAL CELL BASE LINER SYSTEM
(DIMENSIONS AND PROFILE TO BE
CALCULATED DURING DETAILED DESIGN)

CONCEPT

A	CLIENT ISSUE	DB*	26.06.14
rev	description	app'd	date

NSW CATCHMENT & LANDS - CROWN LANDS
FORMER ANTIMONY PROCESSING PLANT - URUNGA
CONTAINMENT CELL
TYPICAL CAP & CELL BASE - SECTIONS & DETAILS

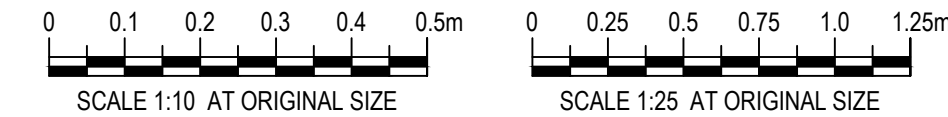


Suite 10, 6 Reliance Drive Tuggerah Business Park
PO Box 3220 Tuggerah NSW 2259
T 61 2 4350 4100 F 61 2 4350 4101
E centralcoastmail@ghd.com W www.ghd.com

Conditions of Use: This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

scale	SHOWN for A1	job no.	22-16251
date	JUNE 2014	rev no.	A

approved (PD) SK005



Appendix G Clause 228 of EP&A Regulations and EPBC Act Considerations

Clause 228(2) Checklist

The following factors, listed in Clause 228(2) of the EP&A Regulation, are required to be considered to assess the likely impacts of the Proposal on the natural and built environment.

Factor	Impact
<i>a. Any environmental impact on a community?</i> As a remediation project, the Proposal would generally have a beneficial impact as it would reduce the potential impacts on soil and water quality, increase visual amenity values, restore ecological values and recreational values and promote socio-economic opportunities in the area. The Proposal would still have potential to result in some short term negative impacts on soil and water quality, traffic, air quality, noise and biodiversity. Mitigation measures as detailed in this EIS would ameliorate or minimise these potential impacts.	Short term minor negative Long term positive
<i>b. Any transformation of a locality?</i> The locality would be transformed through removal of contamination resulting in restored vegetation and modified topography (via construction of the containment cell).	Short term minor negative Long term positive
<i>c. Any environmental impact on the ecosystems of the locality?</i> As a remediation project, the Proposal will mainly impact the ecosystems of the locality in a positive way, through removal of contaminants and restoration of habitat. Some short term, negative impacts may result to the ecosystem through direct injury and mortality of fauna during civil works and disturbance of fauna from noise and vibration during the works. Overall impacts to flora and fauna during the Proposal are considered minimal with the implementation of mitigation measures (see Section 7.10). Mitigation measures outlined in this EIS and proposed for inclusion in the CEMP would reduce the likelihood of any impacts produced during the construction phase of the Proposal. Minimal native vegetation clearing is required.	Short term minor negative Long term positive
<i>d. Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality?</i> As a remediation project, the Proposal will improve the aesthetic, recreational, scientific and other environmental qualities of the locality.	Short and long term positive
<i>e. Any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations?</i> No impacts on known Aboriginal, non-Aboriginal heritage items or localities with architectural, cultural, historical, scientific or social significance are anticipated. Aesthetic values will be increased	Short and long term positive

Factor	Impact
through the remediation of the impacted site, including a SEPP 14 wetland.	
<i>f. Any impact on the habitat of protected fauna (within the meaning of the National Parks and Wildlife Act 1974)?</i> A positive impact on the habitat of protected fauna would be gained through the remediation of the site including a SEPP 14 wetland.	Short and long term positive
<i>g. Any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air?</i> The Proposal is considered unlikely to endanger any species of flora or fauna due to the minimal amount of vegetation to be removed, historical levels of disturbance and the presence of large areas of other potential habitat in the locality and immediately adjacent to the study area. Safeguards are outlined in Section 7.10. Conversely, the Proposal will have a potential long term positive impact on flora and fauna through the creation of habitat.	Long term positive
<i>h. Any long-term effects on the environment?</i> The Proposal would generally result in the positive long-term effects on the environment through increased soil and water quality, increased visual amenity values, restored ecological values and recreational values and promote socio-economic opportunities in the area	Short and long term positive
<i>i. Any degradation of the quality of the environment?</i> Any degradation of the quality of the environment would be short-term and localised (e.g. increased traffic, sedimentation, dust and noise). Mitigation measures as outlined in Section 6 would ameliorate these potential impacts.	Minor short term negative Long term positive
<i>j. Any risk to the safety of the environment?</i> There would be some minor short term risks to the safety of the environment during the Proposal. These risks would be managed via the identified mitigation measures and CEMP. In the long term, the risk to the safety of the environment will be improved through removal of contamination.	Minor short term negative Long term positive
<i>k. Any reduction in the range of beneficial uses of the environment?</i> There would be no reduction of the beneficial uses of the environment. Beneficial uses of the environment would be increased through the remediation of the site, increasing recreational and ecological amenity.	Short and long term positive
<i>l. Any pollution of the environment?</i> The Proposal could potentially result in minor short-term water pollution from sediment, contaminants and spilt fuels and chemicals. Management of water quality impacts would be undertaken in	Short term minor negative

Factor	Impact
accordance with the mitigation measures outlined in Section 7.2. The Proposal would also result in minor short-term air pollution from plant and machinery and the generation of dust. Management of air quality impacts would be undertaken in accordance with the mitigation measures outlined in Section 7.3. □ The mitigation measures outlined in this EIS and the CEMP would limit the potential for generation and impact of any pollution.	
<i>m. Any environmental problems associated with the disposal of waste?</i> The basis of the Proposal relates to the disposal of contaminated waste generated from former antimony processing at the Site. Potential environmental problems associated with the Proposal are assessed in Section 7 of this EIS. Other waste streams generated during construction are common and would pose no difficulty in their disposal. Waste would be recycled wherever possible. The mitigation measures outlined in this REF and the CEMP would manage waste generation and disposal in such a way to reduce any environmental degradation.	Minor short term negative Long term positive
<i>n. Any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply?</i> All resources required for the Proposal are readily available and are not in short supply. Refer to Section 7.16.	Nil
<i>o. Any cumulative environmental effect with other existing or likely future activities?</i> The Proposal would not significantly contribute to cumulative environmental impacts of existing or likely future activities in the vicinity of the Site, as discussed in Section 7.18.	Nil
<i>p. Any impact on coastal processes and coastal hazards, including those under projected climate change conditions?</i> The Proposal is located approximately 2 km from the coast. The wetland drains into Station Creek and Urunga Lagoon which forms part of the Bellinger-Kalang estuarine system. Hazards to this coastal environment will be reduced by the Proposal through reducing the potential for surface water contamination. Potential impacts on climate change of the Proposal are deemed insignificant.	Long term positive

Matters of National Environmental Significance

Under the environmental assessment provisions of the *Environment Protection and Biodiversity Conservation Act 1999*, the following matters of national environmental significance (MNES) and impacts on Commonwealth land are required to be considered to assist in determining whether the Proposal should be referred to the Australian Government Department of Sustainability, Environment, Water, Population and Communities.

Factor	Impact
<i>a. Any impact on a World Heritage property?</i> The Proposal would not have any impact on a World Heritage property. There are no World Heritage properties within 10 kilometres of the Proposal.	Nil
<i>b. Any impact on a National Heritage place?</i> The Proposal would not have any impact on a National Heritage place. There are no National Heritage places located within 10 kilometres of the Proposal.	Nil
<i>c. Any impact on a wetland of international importance?</i> The Proposal would not have any impact on a wetland of international importance. There are no wetlands of international importance within 10 kilometres of the Proposal site.	Nil
<i>d. Any impact on a listed threatened species or communities?</i> Threatened species have been recorded in the area. However, it is not considered likely that a significant long term impact would result on a listed threatened species or ecological community. A positive impact on threatened species will be achieved through the remediation of potential habitat.	Positive
<i>e. Any impacts on listed migratory species?</i> The Proposal would not impact on any Commonwealth listed migratory species. Refer Section 7.10.	Nil
<i>f. Any impact on a Commonwealth marine area?</i> The Proposal is located approximately 2 km from the ocean. A Commonwealth Marine Area 'EEZ and Territorial Sea' is located from three to two hundred nautical miles from the coast. The Proposal will not have any impact on this marine area.	Nil
<i>g. Does the Proposal involve a nuclear action (including uranium mining)?</i> The Proposal does not involve a nuclear action.	Nil
<i>h. Additionally, any impact (direct or indirect) on Commonwealth land?</i> No Commonwealth land would be impacted by the Proposal.	Nil



Appendix H Ecological Assessment



NSW Catchment and Lands- Crown Lands

Proposed Remediation of the Former Antimony Processing Plant - Urunga

Ecology Assessment

June 2014

Table of contents

1.	Introduction	1
1.1	The proposal	1
1.2	Scope and purpose of this report	1
1.3	Limitations	1
2.	Methods	3
2.1	Desktop review	3
2.2	Site survey	4
3.	Results	5
3.1	Desktop review	5
3.2	Likelihood of occurrence	6
3.3	SEPP 14 Wetland	6
3.4	Aerial photographs	7
3.5	Observations from site	7
4.	Potential impacts	13
4.1	Summary	13
4.2	Clearing of terrestrial vegetation - impact on total native vegetation and habitat in the area	13
4.3	Clearing of aquatic vegetation – impact on adjacent wetland	14
4.4	Removal of soils – impact on local geomorphology, drainage and soil ecology	14
4.5	Disturbance of site - potential for runoff, sedimentation and water quality into adjacent wetland	14
4.6	Impacts from machinery and equipment on local fauna – collision, noise, air, vibration	15
4.7	Spread of weeds	15
4.8	Increased edge effects on remnant adjacent vegetation	15
4.9	Importation of soil from off-site	15
5.	Mitigation measures	16
5.1	Clearing of terrestrial vegetation - impact on total native vegetation and habitat in the area	16
5.2	Clearing of aquatic vegetation – impact on adjacent wetland	16
5.3	Removal of soils - impact on local geomorphology	16
5.4	Disturbance of site - potential for runoff, sedimentation and water quality into adjacent wetland	16
5.5	Impacts from machinery and equipment on local fauna – collision, noise, air, vibration	17
5.6	Spread of weeds	17
5.7	Increased edge effects on remnant adjacent vegetation	17
6.	Assessment of significance of the potential impacts	18
6.1	Endangered ecological communities and plant species	18
6.2	Endangered and Vulnerable fauna	20

6.3 Vulnerable Mammals.....	22
7. Conclusion	24
References	25

Table index

Table 1 Key to Likelihood of Occurrence for Threatened Species	3
Table 2 Observed native flora species.....	7
Table 3 Weed species observed within the study area.....	11
Table 4 Habitat types observed on site.....	12

Figure index

Figure 1 View across the Urunga site towards the south east	4
Figure 2 Vegetation communities on site and extent of proposed clearing.....	10
Figure 3 A boundary zone of the Urunga site.....	14
Figure 4 The wetland within the impact zone of the Urunga site.....	14
Figure 5 Weeds established at the Urunga site entrance	15

Appendices

- Appendix A – BioNet Atlas Search Results
- Appendix B – Likelihood of Occurrence Tables
- Appendix C – Protected Matters Search Tool results
- Appendix D – Aerial Photography Comparison

1. Introduction

GHD has been engaged by NSW Catchments and Lands – Crown Lands, to undertake an ecological assessment as part of the Environmental Impact Statement (EIS) assessment for the remediation of the former antimony processing plant at part of Lot 1 and Lot 2 DP 874875 and Lot 253 DP 46013 on Hillside Drive, Urunga, New South Wales ('the site').

1.1 The proposal

The site was previously used for mineral stockpiling and processing. The remediation works will involve clearing of vegetation and removal of soil and surface materials to a depth of up to approximately three metres (refer to Figure 2 in Section 3.5 below).

At the completion of the remediation, it is proposed to revegetate the site with similar species to those in the adjacent vegetated areas.

1.2 Scope and purpose of this report

The purpose of this report is to provide a snapshot of the ecological condition, functions and processes that are associated with the study area in relation to its proposed remediation.

The key tasks in the assessment included:

- A desktop review of available reports, data and maps. Database searches for threatened biota, including *Threatened Species Conservation Act 1995* (TSC Act) and *Fisheries Management Act 1991* (FM Act) species and matters of national environmental significance (MNES) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) were completed. An overview of the threatened biota likely to be affected by the proposal has been completed.
- Site inspection to ground-truth the flora and fauna of the site and note the general nature and condition of the habitats present and their relevance to potential threatened biota, including assessment of habitats for threatened species, populations and ecological communities as listed under the TSC Act, and the wetland adjoining a State Environmental Planning Policy 14 (SEPP 14) listed wetland.
- Preparation of a preliminary vegetation map of the site, using available data (e.g. aerial imagery, vegetation data and contours).
- An overview assessment of the significance of potential impacts on threatened biota (as listed under the TSC Act and FM Act), according to the 7-part test under Section 5A of the EP&A Act. We have assumed that individual 7-part tests or detailed assessments for individual threatened biota are not required.
- Identification of suitable measures to mitigate and/or offset potential impacts.

1.3 Limitations

This report: has been prepared by GHD for NSW Catchment and Lands- Crown Lands and may only be used and relied on by NSW Catchment and Lands- Crown Lands for the purpose agreed between GHD and the NSW Catchment and Lands- Crown Lands as set out in this report.

GHD otherwise disclaims responsibility to any person other than NSW Catchment and Lands- Crown Lands arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

2. Methods

2.1 Desktop review

2.1.1 Literature and database searches

A desktop review was undertaken which included review of the following:

- A site ecological survey - Redpath, P. and Body, M., 2003. *Flora and Fauna Evaluation for the Urunga Antimony Contaminated Site: An inventory assessment for an EIS*. Although that this work was undertaken 11 years ago, it provides information on the previous condition of the site, and information on species that it may support.
- Atlas of NSW Wildlife (BioNet) database search for a 10 km radius from the centre of the site. An assessment of the likelihood of occurrence of the species identified in this search has been conducted with reference to the broad habitats contained within the study area. This was further refined following field surveys. The likelihood of threatened and migratory biota occurring in the study area was assessed based on presence of records from the locality, species distribution and habitat preferences, and quality of potential habitat present in the study area.
- NSW Department of Primary Industries (Fisheries and Aquaculture), Threatened & protected species – records viewer.
- Protected Matters Search Tool (PMST) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) for a one kilometre buffer from the site boundary. This database provides records of EPBC listed threatened species and species that are predicted to occur (based upon modelling), listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as well as species and communities listed as part of International treaties and agreements including the Bonn Convention on Migratory Species, the Japan-Australia Migratory Bird Agreement (JAMBA), the China-Australia Migratory Bird Agreement (CAMBA) and the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).
- A comparison was made of aerial photography (Google Earth 2010) from 2004, 2010 and 2013.

2.1.2 Likelihood of occurrence

An assessment of the likelihood of occurrence of threatened species returned from database searches was undertaken, based upon the results of the desktop assessment (including database searches and previous surveys) as well as the site survey. The results of this are tabulated in Appendix C.

Table 1 provides a key to the likelihood of occurrence in the study area of threatened biota known or likely to occur in the locality.

Table 1 Key to Likelihood of Occurrence for Threatened Species

Likelihood	Definition
Likely	Species previously recorded within a 10 kilometre radius of the study area and suitable habitat occurs within the study area.
Possible	Species previously recorded within a 10 kilometre radius of the study area but only marginal suitable habitat recorded, OR

Likelihood	Definition
	Species not previously recorded within a 10 kilometre radius of the study area, but the study area is within the species known distribution and suitable habitat occurs within the study area.
Unlikely	Species previously recorded within a 10 kilometre radius of the study area but no suitable habitat recorded.
Nil	Species not previously recorded within a 10 kilometre radius of the study area, suitable habitat not recorded within subject, and/or study area outside species known distribution.

2.2 Site survey

The site was attended on 14 May 2013 by a Senior Ecologist. A random meander across the site was completed, with observations recorded of flora, fauna, habitat and general conditions associated with the vegetation and wetland present (see Figure 1 for a general impression of the site).



Figure 1 View across the Urunga site towards the south east

3. Results

3.1 Desktop review

The results obtained from the desktop review are provided below.

3.1.1 Previous site ecological survey

The *Flora and Fauna Evaluation for the Urunga Antimony Contaminated Site: An inventory assessment for an EIS* (Redpath and Body 2003), involved flora plots and transects, fauna trapping, scat analysis, diurnal bird census, call playback for nocturnal birds and nocturnal searches for herpetofauna in late 2001. The following results were obtained:

- 21 vulnerable fauna species, three endangered fauna species, one threatened species, and four vegetation communities with no threatened flora species, were identified from records and database searches.
- 73 fauna species were recorded on site, including one endangered species and six vulnerable species
 - o Black-necked Stork (*Ephippiorhynchus asiaticus*) – endangered
 - o Australasian Bittern (*Botaurus poiciloptilus*) - vulnerable
 - o Glossy-black Cockatoo (*Calyptorhynchus lathami*) - vulnerable
 - o Grey Crowned Babbler (*Pomatostomus temporalis*) - vulnerable
 - o Mangrove Honeyeater (*Lichenosstomus fasciocularis*) - vulnerable
 - o Northern Long-eared Bat (*Nyctophilus bifax*) - vulnerable
 - o Little Bent-wing Bat (*Miniopterus australis*) - vulnerable
- Four vegetation communities were identified:
 - o Swamp sclerophyll forest
 - o Wet sclerophyll forest
 - o Dry sclerophyll forest
 - o Weed dominated vegetation

3.1.2 BioNet Wildlife Atlas search

The full results of the BioNet Search are included in Appendix A. The search returned a total of 6,282 records of 802 species. An extract from this list including the results relating to the study area for threatened species, populations and ecological communities under the TSC Act that are likely to occur within the study area or that may occur because there is habitat present within the study area, is provided in tabular format in Appendix C.

3.1.3 Fisheries records viewer

A search of the DPI (Fishing and Aquaculture) Threatened and protected species – records viewer (DPI 2013) returned no species for the Bellingen Local Government Area within which Urunga is located.

3.1.4 Protected Matters Report

The Protected Matters Search Tool (PMST) returned the following matters listed under the EPBC Act:

Matters of National Environmental Significance	
World Heritage Properties	None
National Heritage Properties	None
Wetlands of International Importance	None
Great Barrier Reef Marine Park	None
Commonwealth Marine Areas	1
Listed Threatened Ecological Communities	3
Listed Threatened Species	61
Listed Migratory Species	49

3.2 Likelihood of occurrence

The assessment of likelihood of occurrence (refer Appendix C) indicates that, under both State and Commonwealth legislation, a number of species are considered likely or have the possibility of occurrence.

Under the NSW TSC Act the following species are listed and have been assessed as 'likely' to occur or 'may occur' given the available and suitable habitat within the site:

- three endangered ecological communities
- two vulnerable and one endangered plant species
- one vulnerable frog species
- 10 vulnerable and one endangered bird species
- 8 vulnerable mammal species
- six migratory marine species

An assessment of the likelihood of occurrence within the proposed footprint was completed and those species and communities with an assessment of likely or possible under the EPBC Act include:

- 1 endangered and 2 vulnerable plant species
- 6 migratory marine species
- 2 migratory wetland species

The full results of the PMST Report are provided in Appendix B.

3.3 SEPP 14 Wetland

The State Environmental Planning Policy 14 (SEPP 14) aims to protect coastal wetlands in the environmental and economic interests of the State. SEPP 14 imposes restrictions on development within wetlands mapped and listed under this instrument. Section 7A pertains to restrictions on carrying out of restoration works and outlines the consent requirements.

The wetland along the eastern boundary of the study area flows eventually into Urunga Lagoon (approx. 800 m to the east) and then the Bellinger River before exiting to the sea. This wetland

is a coastal wetland and is mapped under SEPP 14. The proposed remediation may extend into the SEPP14 wetland.

3.4 Aerial photographs

Aerial photography from 2004 and 2010 was compared to the most recent images through Google Earth (2013). There is some indication that between 2004 and 2010 a patch of the paperbark forest to the south east of the bare ground area has died, as shown by the white lines in 2010 that have replaced the green points in 2004 (refer Appendix D), as well as another patch approximately 100 m to the east. In the most recent aerial photographs, it appears that there has been some recovery of these previously impacted areas. It is worth noting that aerial photography represents a snapshot in time and the appearance may be affected by other factors such as seasonal differences, water levels and other disturbances.

3.5 Observations from site

The site was not in use at the time of the survey. The site has historically been substantially cleared and contained disused rusting equipment and infrastructure

The site could broadly be divided into terrestrial and wetland areas. The terrestrial area was comprised of cleared areas and those areas that retain vegetation, while the wetland contained vegetated areas, and areas where vegetation had died but remained standing.

A dilapidated artificial drainage system located within the cleared section still served to direct stormwater across the site and into the adjacent wetland. In some parts the drain was concrete lined or followed an excavated channel. There was some evidence of erosion in association with this drainage system and there were parts of the system where an accumulation of green algae was evident which may indicate some subterranean or up-slope nutrient source.

The wetland was located in the south east of the site, and its extent and depth is likely to vary according to seasonal conditions and rainfall.

3.5.1 Flora and vegetation

A list of species observed during the site visit is provided in Table 2. This is not a comprehensive list but an indication of the dominant species and communities observed within the study area.

Table 2 Observed native flora species

Botanical name	Common name
<i>Acrostichum speciosum</i>	Mangrove Fern
<i>Casuarina glauca</i>	Swamp Oak
<i>Cyperus sp.</i>	Sedge
<i>Eucalyptus robusta</i>	Swamp Mahogany
<i>Gahnia aspera</i>	Rough Saw-sedge
<i>Gleichenia sp.</i>	Coral Fern
<i>Imperata cylindrica</i>	Blady Grass
<i>Juncus usitatus</i>	Common Rush

Botanical name	Common name
<i>Lomandra longifolia</i>	Matt-rush
<i>Melaleuca decora</i>	White Feather Honey Myrtle
<i>Melaleuca quinquenervia</i>	Prickly Paperbark
<i>Parsonsia straminea</i>	Monkey Rope
<i>Phragmites australis</i>	Common Reed
<i>Pteridium esculentum</i>	Soft Bracken
<i>Triglochin striatum</i>	Streaked Arrow-grass
<i>Typha orientalis</i>	Cumbungi

Vegetation communities

Native vegetation has been removed from much of the site as a result of historical clearing followed by excavation of the surface soils and materials to a bedrock base in some parts. Bare soil devoid of vegetation was present in other parts of the site. There is some indication that regeneration of native vegetation has occurred in some parts of the site.

The Redpath and Body (2003) report identified four vegetation communities present on site. The site survey confirmed these findings however two of the communities previously identified now fall within the same vegetation community, resulting in three communities as follows:

- Swamp sclerophyll forest is known as *Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions* – endangered ecological community, which now includes the previously identified 'wet sclerophyll forest'.
- Dry sclerophyll forest is known as *Dry Grassy Blackbutt-Tallowwood Open Forest of the central parts of the North Coast of NSW*
- Sedgeland/Rushland is known as *Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions* – endangered ecological community

Using the NSW TSC Act identification criteria, the swamp sclerophyll forest is an identified endangered ecological community referred to as *Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions* (SSF). This community forms the vegetation within and immediately adjacent to the wetland to the west and east.

The *Dry Grassy Blackbutt-Tallowwood Open Forest of the central parts of the North Coast of NSW* (GBT) comprises the remainder of the site that is not in the low lying areas. It is dominated by *Eucalyptus pilularis* (Blackbutt) or *E. microcorys* (Tallowwood) depending on the local soil and other conditions such as past fires.

The sedgeland/rushland identified by Redpath and Body (2003) conforms to the identification criteria for *Freshwater Wetlands on the Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions* (FW). This community forms the vegetation community dominated by sedges approximately one metre tall such as *Baumea articulata*, *Eleocharis equisetina* and *Lepironia articulata* as well as floating species in more open water spaces such as *Ludwigia peploides* subsp *montevicensis*. The vegetation community is located in the

transitional zone between the SSF and the GBT as well as dominating the wetland to the east of the site (refer Figure 2).

Further to these communities, there are areas of previously cleared land which support exotic vegetation and a component of the site is comprised of previously cleared land with regenerating natural vegetation and exotic species combined (refer Figure 2).