MT PORTER WASTE CHARACTERISATION AND ARD MANAGEMENT

NOVEMBER 2006

PREPARED FOR

ARAFURA RESOURCES NL

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1. EXECUTIVE SUMMARY

Open pit mineable gold ore occurs on the south-eastern slopes of Mt Porter, north-west of Pine Creek, Northern Territory, Australia. The host rocks are sulphidic carbonaceous silty shale, chloritic cherty banded iron formation with minor felsic and mafic intrusives.

Within the oxide zone 35 diamond drill core samples from the oxide zone were analysed to determine geochemical properties. Results indicate that sulphides in the waste material between ore lenses are largely oxidised to sulphates, have an acidic pH reaction and a low acid producing potential, the median (measured) value being 1.2 kilogram H_2SO_4 per tonne. Five samples collected from transitional material between the oxide zone and fresh rock were found to have high acid producing potential (between 64 and 273 kilograms H_2SO_4 per tonne). No fresh rock waste samples were tested, as almost all fresh rock to be mined from the pit will be ore.

Small amounts (estimated about 3%) of fresh sulphidic waste rock will be generated and will have acid producing potential ranging up to >300 kilograms H_2SO_4 per tonne. This material, plus any transitional oxide zone to fresh rock waste will need to be encapsulated within oxide material in the waste landform to prevent acid production.

A number of surface water samples were collected from the project site. Soil samples were collected near each of the three water sample sites and from a fourth location downstream from the proposed waste landform, at the site of a proposed sediment basin (TS4 Swampy meadow).

The Pit Gully and TS5 Rainforest samples were used as groundwater and surface water comparative standards for the soil leachates. Pit Gully spring water and Pandana waterhole (both draining mineralised ground) exceed ecological trigger values for all analytes except for molybdenum and selenium. Water from un-mineralised areas was also found to exceed trigger values for aluminium, arsenic, cobalt, thallium and zinc.

Soil leachates apart from arsenic (higher) and lead (lower) were generally similar to the groundwater, but all at least twice the fresh water comparative standard.

Five samples of oxidised waste and five samples of transitional oxide to fresh rock wastes were water leached then subsequently leached with hot pH = 1.5 acid, to simulate the "worst case scenario" likely to occur in the waste landform. Samples were chosen to cover all waste rock types and total sulphur content levels. Of the oxide samples four were from greater than 15 metres and one from 20 to 21 metres depth. The transitional zone samples were from greater than 20 metres depth, the one high in fresh sulphides from 30 to 31 metres.

Analytical data indicates leachate from oxide waste should not significantly increase dissolved metal and selenium content in ground or surface water, nor cause acidification. The fresh waste rock is capable of producing significant additional metals and acid. It will be essential that all fresh sulphidic wastes are encapsulated within oxide material.

Initially, Arafura proposed construction of an artificial wetland to minimise chemical effects from heavy metal leachate or acidic drainage. Based on the analytical results for surface

waters, groundwater and waste sample leachates, there appears to be no ecological advantage in undertaking such construction. In addition, all three locations are liable to dry out in the dry season, dramatically reducing effectiveness of a wetland filter. Shallow detention basins will be at least as, or more effective, than a constructed wetland in retaining sediment on site.

The final pit void lake will partially fill with water. As the pit will be small, shallow and outcropping rock high in free carbon, acidification will be slow. High pit walls on the north and west will minimise thermal transfer to the water, convective overturn and evaporation. Thus reducing conditions should be maintained and significant acidification should be very slow. Relatively high base metal levels may eventuate over a long time frame.

2. INTRODUCTION

The Mt Porter gold orebody is hosted in carbonaceous sulphidic siltstone, shale and sulphidic laminated chloritic/carbonaceous shale with chert layers and boudins. Additional rock types are dolerite sills and minor felsic porphyry.

Arafura propose to mine from the surface to just below the base of the oxidised zone. A minor amount of fresh rock material may be mined, but this will all be ore, with no fresh rock expected to report to the waste landform.

Initial drilling and resource calculations were undertaken by Pine Creek Goldfields Limited [PCG] a subsidiary of Renison Goldfields Consolidated between 1988 and 1994. Deep drilling by Homestake Gold proved unsuccessful. In 2003 Arafura took over the project and drilled a further seven diamond core holes to establish grade continuity, convert the resource to a mineable reserve and provide fresh material for wastes characterisation.

Inspection of diamond drill logs and assay results shows a general relationship between visually recorded sulphide mineral content and gold values. Of the higher recorded sulphide content intervals, most also record greater than 0.7 grams per tonne gold. This indicates that where sulphides can be recognised (fresh rock), ore grade intervals have higher sulphide content than waste intervals. It is probable that a similar situation applies in the oxide ore and waste situation.

Ore is planned to be processed off site at the Union Reef processing plant. Tailings from the ore will be deposited in the Tailings Storage Facility at the Union Reef plant and as such, their geochemical properties were not considered as part of this assessment.

Since the ore will be processed off site and no fresh rock is characterised as waste, the quantity of high sulphur materials that will report to the Mt Porter wastes landform will be low.

3. REVIEW OF PREVIOUS MT PORTER GEOCHEMICAL INVESTIGATIONS

In 1998, 17 samples were lodged with Environmental Geochemistry International [EGI] for Acid Rock Drainage [ARD] determination. The samples were composite drill hole samples and included material now considered to be "ore". At least ten samples included fresh sulphidic material from beneath the oxide zone. Details of the samples and the data obtained as reported by EGI are shown in Table 1.

Since more than 50% of these samples are non-representative of the wastes to be mined by Arafura, MBS Environmental were commissioned to undertake additional waste characterisation studies. Results of this are discussed in Section 4 onwards.

The EGI interpretation of ARD is based on the assumption that 100% of the sulphur forms included in the Leco Total Sulphur determination will produce sulphuric acid within a similar time frame. This assumption is not valid. Three separate sulphide types, pyrite, pyrrhotite and arsenopyrite are present which all oxidise in different manners. In addition, many samples from within the oxide zone at Mt Porter have a significant content of sulphur now present as sulphates.

EGI also examined the "total strong acid soluble" content of 32 elements in a selection of the samples and classified those elements using the Geochemical Abundance Index [GAI] published by Förstner *et al*. (1993). The analytical methodology is not specified and laboratory reports were not available. Based on analytical results for certain elements, the analysis method is believed to have been a "Total" analysis using hydrofluoric, hydrochloric, nitric and perchloric acids. EGI then compared each elemental result with the "average crustal abundance" as published by Bowen, H.J.M. (1979) to determine whether those elements were potential contaminants.

Use of a "Total" analysis is unrealistic as this is undertaken at very high acidity with very strong oxidants present and assumes total solution of the silicate, sulphide and oxide minerals in the waste within a geologically very short time frame. Due to the high to very high carbon content in these rocks, a reducing, not an oxidising environment will be present.

The waste landform will be subject to natural rainfall at circum-neutral pH, with a high proportion of natural rainfall never penetrating the landform. A better appreciation of the effects of weathering will be obtained from simple water leaches at pH = 7.0±0.5 and leaches at appropriate pH values of *ca.* 5.0 and/or *ca.* 1.5.

The GAI is a useful concept, however the "background" values against which data should be compared is critical. To be valid, the "background" comparison must be made against the natural background (inclusive of minor mineralisation) for the area under examination.

Since almost all (over 90%) of waste rock at Mt Porter mine-site is carbonaceous shale, carbonaceous shaley siltstone and finely laminated chloritic/carbonaceous cherty rocks, a more relevant methodology is to compare directly with average crustal abundance in shale. MBS Environmental used this methodology.

There are very substantial differences between the Net Acid Generation and Net Acid Producing Potential values in Table 1. These values should be identical if all sulphur converts to sulphuric acid and all Acid Neutralising Capacity is derived from carbonate minerals.

The worst cases are Sample 13 from close to the surface, fully oxidised with only 17% of the total sulphur being acid forming and Sample 6 with only 28% of the total sulphur as acid forming. The closest is Sample 10, which is largely from beneath the water table, probably largely fresh rock, with 77% of the sulphur as acid forming.

Therefore, at Mt Porter it is clear that a large proportion of the sulphur is non-acid producing and some ANC may not be derived from carbonate.

In summary:

- The EGI classifications are valid but all the higher values are from samples that may include or be totally classifiable as ore.
- A substantial proportion of the total sulphur is unlikely to be acid producing.

Table 1: Pine Creek Goldfields Limited Acid Rock Drainage Results

	Site Sample	Sample Type	Hole No.	Northing	Easting	From	To	Core Interval	Geology	Sulphides	pH (1:2)	EC (1:2)	Total S	ANC	NAPP	NAG	NAG pH	Classification
	No.					(m)	(m)	(m)				µS/cm	(%S)	kg H2SO4/tonne				
1	34524	chips	MPDH178	10464.91	10152.64	0.00	25.00	25.00	Gr. Muds	oxide	2.5	2950	3.00	0	90			*acid forming*
2	34495	core	MPDH179	10464.91	10152.64	25.00	40.00	15.00	Gr. Shale	2.5 py; 2.5 po	5.2	2340	13.00	1	397	196	2.2	*potentially acid forming*
3	34496	core	MPDH179	10464.91	10152.64	40.00	60.00	20.00	Int	2 py; 5 po; tr asp	5.7	1100	10.70	5	322	144	2.3	*potentially acid forming*
4	34525	chips	MPDH180	10420.24	10156.44	0.00	20.00	20.00	Gr. Muds	oxide	2.8	3550	3.20	0	97			*acid forming*
5	34526	chips	MPDH180	10420.24	10156.44	20.00	35.00	15.00	Gr. Muds	0-30% py	4.5	3840	16.00	0	490	137	2.2	*potentially acid forming*
6	34494	core	MPDH180	10420.24	10156.44	36.00	52.00	11.00*	Shale	2 po; tr asp	6.0	885	10.90	7	327	133	2.3	*potentially acid forming*
7	34520	chips	MPRC187	10439.92	10204.75	0.00	14.00	14.00	Muds	oxide	5.0	316	0.06	4	-2	0	6.4	*non acid forming*
8	34517	chips	MPRC190	10398.06	10112.57	7.00	24.00	17.00	Dolerite	tr py	4.0	3980	0.52	0	16	6	3.9	*acid forming (low risk)*
9	34522	chips	MPRC190	10398.06	10112.57	24.00	40.00	16.00	Gr. Muds	tr py	2.3	8470	6.20	0	190			*acid forming*
10	34518	chips	MPRC190	10398.06	10112.57	40.00	49.00	9.00	Cl. Shale	1 py	4.8	1300	1.10	8	26	20	2.7	*potentially acid forming*
11	34523	chips	MPRC191	10400.51	10155.71	0.00	13.00	13.00	Gr. Muds	oxide	4.8	762	0.08	18	-16	0	6.1	*non-acid forming*
12	34521	chips	MPRC191	10400.51	10155.71	13.00	32.00	19.00	Cl. Shale	tr py	3.6	3030	1.90	3	55	32	2.5	*acid forming*
13	34492	core	MPDH192	10399.95	10174.76	0.03	14.84	14.81	Gr. Muds	oxide	4.1	265	0.20	0	6	1	4.8	*PAF (low risk)*
14	34493	core	MPDH192	10399.95	10174.76	14.84	24.75	9.91	Gr. Muds	sulphates	1.5	23000	9.80	0	300			*acid forming*
15	34519	chips	MPDH194	10375.06	10180.58	3.00	18.00	15.00	Gr. Muds	oxide	2.5	3940	2.80	0	86			*acid forming*
16	34515	chips	MPDH194	10375.06	10180.58	18.00	32.00	14.00	Gr. Muds	tr py	2.4	13530	15.30	0	468			*acid forming*
17	34516	chips	MPRC195	10375.10	10204.63	24.00	60.00	36.00	Int	2.5 py	5.1	1270	2.00	11	51	34	2.5	*potentially acid forming*

Notes:

1*	Core interval – sample 34494 excludes 39 – 44m
2	Geology and Sulphide – Information provided by Pine Creek from drill core logs (Gr = graphite; py = pyrite; po = pyrrhotite; asp = arsenopyrite)
3	pH = acidity of sample as measured on 1:2 ratio sample : water extract
4	EC = electrical conductivity of 1:2 ratio sample : water extract (indicates salinity of material)

5	ANC = Acid Neutralising Capacity														
6	NAPP = Net Acid Producing Potential														
7	NAG = Net Acid Generation (calculated)														
8	NAG pH = Final pH of NAG solution after oxidation of any sulphides														

Additional Note: Depth of total oxidation is variable with material deeper than 17m vertically beneath the surface containing fresh sulphides.

4. ARAFURA WASTE ROCK CHARACTERISATION

Arafura intend to mine the Mt Porter orebody using a low gold cut-off value. As a result, a lot of material from between the two separate orebodies, previously designated as waste by PCG, is now re-classified as ore. This reclassification includes several of the potentially acid forming (PAF) samples previously lodged by PCG and shown in Table 1.

4.1 METHODOLOGY

Arafura lodged 35 waste rock samples for ARD determination, 34 of them of one metre and one of 0.8 metre. All samples were from freshly drilled core. Colour photographs and full geological logs of the diamond drill core were supplied to MBS Environmental.

The samples were analysed prior to MBS being commissioned to undertake geochemical characterisation. Inspection of the results and queries to the laboratory indicated the Net Acid Generation methodology was not ideal though adequate. Non-barite (barium sulphate), sulphate-Sulphur was not determined. Of the 35 samples, five covering a wide range of sulphur values were re-submitted for non-barite sulphate-Sulphur determination.

All samples were analysed for ANC, NAPP, NAG and $HCl/HNO_3/HCLO_4$ soluble Sulphur. The sulphur method is excellent, as, unlike the LECO Sulphur method, it does not include barium sulphate (barite) complexed sulphur. Barite is an expected mineral in this geological environment.

4.2 NON BARIUM SULPHATE, SULPHATE-SULPHUR DETERMINATION

Barium sulphate (barite) is an expected mineral in this geological environment. Barite is extremely insoluble, so any sulphur contained in barite is extremely unlikely to contribute to acid mine drainage.

Results indicated that Sulphur not associated with sulphides or barium sulphate ranged from 8 to 40% of the Total Sulphur recorded, a highly significant percentage. This sulphur is probably present as soluble sulphates and elemental sulphur. The information assisted in re-classification of the ARD status of low sulphur samples.

Even with this methodology, NAPP may be over-estimated in the acid-sulphate soils as jarosite-alunite-alum sulphate minerals are likely to be present and are dissolved by the strong mixed acid attack used for the sulphur determination.

4.3 RESULTS

In summary the results showed that:

- Twenty-one samples could be classified as non acid forming (NAF).
- Nine samples could be classified as potentially acid forming – low capacity (PAF-LC) (i.e. less than five kilograms H_2SO_4 per tonne).
- Two samples could be classified as PAF (with 35 and 88 kilograms H_2SO_4 per tonne respectively).
- Three samples could be classified as potentially acid forming - high capacity (PAF-HC), all with greater than150 kilograms H_2SO_4 per tonne.
- The median value for the 35 samples is only 1.2 kilograms H2SO4 per tonne, which is normally classifiable as NAF.

The 35 samples comprised four separate rock type groupings:

- **Dolerite sills**. Two samples, both low in sulphide content with traces of carbonate material. Both were found to be non acid forming (NAF).
- **Carbonaceous siltstone-banded iron formation**. Twenty-four samples. Generally dark-grey, black to dark-brown, massive, with rare thin well bedded intervals, sometimes with thin chloritic beds. Very rare millimetre thick layers of oxidised sulphides at less than 19 metre down-hole depth with traces of fresh bedded sulphide through to 26 metres. Occasional fine wispy quartz veins mostly less than one centimetre thick.

  The twelve samples from the surface to about 19 metre were all NAF. The remaining samples between 19 and 26 metres (deepest sample supplied) were PAF including the three of PAF-HC ranking.
- **Felsic dyke samples**. Three samples, two PAF-LC, one NAF. The NAF sample has relatively high sulphate-Sulphur and high ANC. The two PAF-LC samples were not analysed for sulphate-Sulphur, are very marginal (3.0 and 3.2 kilograms H_2SO_4 per tonne), both have ANC/MPA ratios of less than 2.0 and will automatically classify as NAF if they have similar sulphate-Sulphur to the third sample.
- **Chloritic-cherty banded iron formation**. Six samples, all very low in sulphide content and all NAF.

The percentage content of significantly PAF material appears small and all contain carbonaceous siltstone-BIF with visible sulphides. Due to its black coloration PAF material should be relatively easily recognisable. Because of the high free carbon content, the Eh value of this material should be extremely low and non-oxidising, thus minimising sulphide oxidation and the potential for acid generation.

Table 2: Arafura Acid Rock Drainage Analysis Results

IDENTIFICATION	DESCRIPTION	ANC	MPA	ANC/MPA	NAPP	NAPP	NAG_pH	NAG	S	SO4-S	Classification
		(measured)	(calc)		(measured)	(calc)	(measured)	(measured)	ICP-OES	Na_2CO_3	
UNITS		kg/t H_2SO_4	kg/t H_2SO_4		kg/t H_2SO_4			kg/t H_2SO_4	%	%	
SCHEME		ANC			ANC		NAG	NAG	G320I		
DDH241 01.0-02.0m	Weathered dolerite: Dark orange clay, completely oxidised	6.8	0.6	11.7	<0.01	-6.2	7.3	<0.01	0.02	-	Non Acid Forming
DDH241 09.0-10.0m No lab number	Weathered dolerite: Yellow, orange-green fractured, oxidised. Fe oxide coatings on fractures.	17.4	0.2	113.7	<0.01	-17.2	7.5	<0.01	<0.01		Non Acid Forming
DDH242 02.0-03.0m No lab number	Carbonaceous Siltstone: Black to dark-brown, massive with thin chloritic beds. Completely oxidised. Thin <1cm wispy qtz veins. No evidence of former sulphides.	0.0	4.1	0.0	<0.01	4.1	5.8	1.6	0.14		Non Acid Forming
DDH245 02.0-03.0m No lab number	Carbonaceous siltstone: Black, weathered, massive with fractures coated with Fe oxides.	0.0	3.5	0.0	<0.01	3.5	6.1	0.5	0.11		Non Acid Forming
DDH243 03.0-04.0m No lab number	Carbonaceous Siltstone: Grey-black with fractures coated with Fe oxides. Very rare bedding traces.	3.3	1.3	2.6	<0.01	-2.1	6.3	1.6	0.04		Non Acid Forming
DDH244 03.0-04.0m No lab number	Carbonaceous Siltstone. Black, massive with fractures coated with Fe oxides or white to pink clays.	0.0	17.3	0.0	6.27	17.3	5.1	1.1	0.57		Potentially Acid Forming Low Capacity
DDH246 03.0-04.0m No lab number	Carbonaceous Siltstone: Black, weathered, massive with narrow well bedded intervals.	0.0	2.6	0.0	<0.01	2.6	5.1	3.4	0.09		Non Acid Forming

IDENTIFICATION	DESCRIPTION	ANC	MPA	ANC/MPA	NAPP	NAPP	NAG_pH	NAG	S	SO4-S	Classification
		(measured)	(calc)		(measured)	(calc)	(measured)	(measured)	ICP-OES	Na_2CO_3	
UNITS		kg/t H_2SO_4	kg/t H_2SO_4		kg/t H_2SO_4			kg/t H_2SO_4	%	%	
SCHEME		ANC			ANC		NAG	NAG	G320I		
DDH247 03.0-04.0m No lab number	Carbonaceous Siltstone: Grey to black, soft, oxidised. Zone of red-black clay. Poorly bedded. <1mm wide white-clay veinlets.	0.0	3.9	0.0	<0.01	3.9	5.4	1.8	0.13		Non Acid Forming
DDH242 07.0-08.0m No lab number	Carbonaceous Siltstone: Black to dark-brown, massive with thin chloritic beds. Completely oxidised. Thin <1cm wispy qtz veins. No evidence of former sulphides.	0.0	15.5	0.0	2.67	15.5	4.4	3.4	0.51		Potentially Acid Forming Low Capacity
DDH245 07.0-08.0m No lab number	Carbonaceous siltstone: Black, weathered, massive with fractures coated with Fe oxides.	1.5	4.7	0.3	<0.01	3.1	7.1	<0.01	0.15		Non Acid Forming
DDH246 07.0-08.0m No lab number	Carbonaceous Siltstone: Black, weathered, massive with narrow well bedded intervals.	0.0	4.4	0.0	<0.01	4.4	7.2	<0.01	0.15		Non Acid Forming
DDH247 08.0-09.0m No lab number	Carbonaceous Siltstone: Grey to black, soft, oxidised. Poorly bedded. <1mm wide white-clay veinlets. 5cm wide pale grey bed at 8.5m.. <1mm wide white clay/qtz veinlets.	0.0	23.4	0.0	10.6	23.4	4.9	1.1	0.76		Potentially Acid Forming Low Capacity
DDH245 13.0-14.0m No lab number	Carbonaceous siltstone: Black, weathered, massive with fractures coated with Fe oxides.	0.0	5.1	0.0	<0.01	5.1	5.4	1.2	0.17		Non Acid Forming

IDENTIFICATION	DESCRIPTION	ANC	MPA	ANC/MPA	NAPP	NAPP	NAG_pH	NAG	S	SO4-S	Classification
		(measured)	(calc)		(measured)	(calc)	(measured)	(measured)	ICP-OES	Na_2CO_3	
UNITS		kg/t H_2SO_4	kg/t H_2SO_4		kg/t H_2SO_4			kg/t H_2SO_4	%	%	
SCHEME		ANC			ANC		NAG	NAG	G320I		
DDH242 14.0-15.0m No lab number	Carbonaceous Siltstone: Black to dark-brown, massive with thin chloritic beds. Completely oxidised. Thin <1cm wispy qtz veins. No evidence of former sulphides.	0.0	4.7	0.0	<0.01	4.7	6.6	0.9	0.16		Non Acid Forming
DDH246 14.0-15.0m No lab number	Carbonaceous Siltstone: Black, weathered, massive with narrow well bedded intervals.	0.0	7.2	0.0	<0.01	7.2	6.1	0.9	0.24		Non Acid Forming
DDH247 14.0-15.0m No lab number	Carbonaceous Siltstone: Grey to black, soft, oxidised. Zone of red-black clay. Poorly bedded. <1mm wide white-clay veinlets.	0.0	0.0	0.0	5.3	0.0	5.7	1.4	0.42	0.51	Potentially Acid Forming Low Capacity
DDH241 15.0-16.0m No Lab number	Carbonaceous Siltstone: Dark grey-black partially oxidised. White, clayey <1cm breccia pattern qtz veinlets. Fracture surfaces Fe-ox coated, little visible bedding.	1.5	4.1	0.4	<0.01	2.6	7.2	<0.01	0.14		Non Acid Forming
DDH242 18.0-19.0m No lab number	Carbonaceous Siltstone: Black to dark-brown, massive with thin chloritic beds. Completely oxidised. Thin <1cm wispy qtz veins. No evidence of former sulphides.	0.0	21.8	0.0	10.8	21.8	7.6	<0.01	0.71		Potentially Acid Forming Low Capacity

IDENTIFICATION	DESCRIPTION	ANC	MPA	ANC/MPA	NAPP	NAPP	NAG_pH	NAG	S	SO4-S	Classification
		(measured)	(calc)		(measured)	(calc)	(measured)	(measured)	ICP-OES	Na_2CO_3	
UNITS		kg/t H_2SO_4	kg/t H_2SO_4		kg/t H_2SO_4			kg/t H_2SO_4	%	%	
SCHEME		ANC			ANC		NAG	NAG	G320I		
DDH245 19.0-20.0m No lab number	Carbonaceous siltstone: Black, weathered, massive with fractures coated with Fe oxides.	2.4	3.2	0.8	<0.01	0.7	6.8	0.7	0.10		Non Acid Forming
DDH247 19.0-20.0m No lab number	Carbonaceous Siltstone: Partially oxidised with white clay-quartz coatings on fractures. Pyrite common as veins and patches near fractures from 19.8-20m.	0.0	261.0	0.0	273	261.0	2.2	178.0	8.54		Potentially Acid Forming – High Capacity
DDH241 20.0-21.0m No lab number	Carbonaceous Siltstone: Black partially oxidised with Fe oxide coatings	1.5	9.0	0.2	<0.01	7.5	7.5	<0.01	0.30		Potentially Acid Forming Low Capacity
DDH242 20.0-21.0m Lab No. 139538	Carbonaceous Siltstone: Black to dark-brown, massive with thin chloritic beds. Completely oxidised. Thin <1cm wispy qtz veins. No evidence of former sulphides.	0.0	13.3	0.0	0.53	13.3	8.6	<0.01	0.44		Potentially Acid Forming Low Capacity
DDH244 22.0-23.0m Lab No. 139639	Carbonaceous Siltstone: Black, weathered, soft and clay-rich. Irregular rough grey-white coated fractures. Minor sulphides, no chert. Pyrite patches associated with grey qtz vein in fractured zone.	0.0	74.6	0.0	63.6	74.6	2.7	34.9	2.44		Potentially Acid Forming

IDENTIFICATION	DESCRIPTION	ANC	MPA	ANC/MPA	NAPP	NAPP	NAG_pH	NAG	S	SO4-S	Classification
		(measured)	(calc)		(measured)	(calc)	(measured)	(measured)	ICP-OES	Na_2CO_3	
UNITS		kg/t H_2SO_4	kg/t H_2SO_4		kg/t H_2SO_4			kg/t H_2SO_4	%	%	
SCHEME		ANC			ANC		NAG	NAG	G320I		
DDH245 27.0-28.0m No lab number	Carbonaceous Siltstone: Black, weathered, massive with fractures coated with Fe oxide. Very thin and spotty parallel to bedding pyrite veining.	0.0	168.0	0.0	180	168.0	2.3	87.9	5.50		Potentially Acid Forming
DDH241 30.0-31.0m No lab number	Carbonaceous Siltstone: Black, massive with rare chloritic bedded layers. Rare <2mm pyrite bedding parallel veins	0.0	157.0	0.0	245	157.0	2.2	162.0	7.92	2.78	Potentially Acid Forming – High Capacity
DDH243 23.6-25.6m Lab No. 139584	Felsic dyke. Completely oxidised, pink, margins not chilled, not parallel. Clay coated fractures, no visible sulphides.	41.0	28.4	1.4	<0.01	-12.6	4.4	3.0	0.93		Potentially Acid Forming Low Capacity
DDH241 26.0-27.0m No lab number	Felsic dyke or tuff: Pale grey, oxidised with fine disseminated and vein form pyrite. Clasts siltstone present.	0.0	17.8	0.0	6.82	17.8	4.7	3.2	0.58		Potentially Acid Forming Low Capacity
DDH245 30.0-32.0m No lab number	Felsic dyke: Oxidised white to fresh grey, feldspathic. Occasional <5mm siliceous veins.	50.0	13.5	3.7	<0.01	-36.5	5.7	1.4	0.57	0.13	Non Acid Forming
DDH247 26.0-27.0m No lab number	Carbonaceous Siltstone: Immediately below felsic sill. Black, well bedded with white clay coated fractures. Pyrite as bedding replacements and right angle patches.	0.0	241.0	0.0	241	241.0	2.2	158.0	7.88		Potentially Acid Forming – High Capacity

IDENTIFICATION	DESCRIPTION	ANC	MPA	ANC/MPA	NAPP	NAPP	NAG_pH	NAG	S	SO4-S	Classification
		(measured)	(calc)		(measured)	(calc)	(measured)	(measured)	ICP-OES	Na_2CO_3	
UNITS		kg/t H_2SO_4	kg/t H_2SO_4		kg/t H_2SO_4			kg/t H_2SO_4	%	%	
SCHEME		ANC			ANC		NAG	NAG	G320I		
DDH244 09.2-10.0m Lab No. 139626	Chlorite-Chert BIF: Crushed clay zones with minor <10cm carbonaceous zones. Abundant chert nodules with red-brown patches suggesting oxidised sulphides. Bedding preserved but badly fractured.	0.0	0.0	0.0	<0.01	0.0	5.4	1.2	0.28	0.54	Non Acid Forming
DDH244 15.0-16.0m Lab No. 139632	Chlorite-Chert BIF: Crushed clay zones with minor <10cm carbonaceous zones. Abundant chert nodules with red-brown patches suggesting oxidised sulphides. Bedding preserved but badly fractured.	0.0	0.6	0.0	<0.01	0.6	9.5	<0.01	0.02		Non Acid Forming
DDH243 14.0-15.0m Lab No. 139574	Chloritic Cherty BIF: Oxidised orange and grey-green. Fractured with wavey bedding, abundant chert nodules with red-brown patches of pre-existent sulphide, mosaic breccia texture.	3.3	1.7	2.0	<0.01	-1.6	7.3	<0.01	0.06		Non Acid Forming
DDH243 20.0-21.0m Lab No. 139580	Chloritic Cherty BIF: Oxidised orange and grey-green. Fractured with wavey bedding, abundant chert nodules with red-brown patches of pre-existent sulphide, mosaic breccia texture.	3.3	3.2	1.0	<0.01	-0.1	6.1	0.9	0.11		Non Acid Forming

IDENTIFICATION	DESCRIPTION	ANC	MPA	ANC/MPA	NAPP	NAPP	NAG_pH	NAG	S	SO4-S	Classification
		(measured)	(calc)		(measured)	(calc)	(measured)	(measured)	ICP-OES	Na_2CO_3	
UNITS		kg/t H_2SO_4	kg/t H_2SO_4		kg/t H_2SO_4			kg/t H_2SO_4	%	%	
SCHEME		ANC			ANC		NAG	NAG	G320I		
DDH246 22.0-23.0m Lab No. 139705	Chloritic-Cherty BIF: Orange white weathered. Highly fractured, chert mainly nodules, also as bands to 10cm. Biotite-sericite present. No sulphides where sample taken.	5.1	1.7	3.1	<0.01	-3.4	7.3	<0.01	0.05		Non Acid Forming
DDH242 24.0-25.0m. Lab No. 139542	Chlorite-Cherty BIF. Completely oxidised orange and white. Orange colours from oxidation of chlorite & diss py, po. Fractured friable core, best described as crackle breccia.	1.5	10.7	0.1	0.57	9.2	6.2	1.8	0.49	0.14	Non Acid Forming

5. POTENTIAL FOR LEACHATE CONTAMINATION OF SURFACE AND GROUND WATER

The proposed location for the waste landform covers two narrow deeply incised streams, the more westerly known as Pit Gully draining directly from the open pit region. This gully includes a permanent spring sourced from the mineralised area. The second creek with substantially lower gradient is further to the north-east and is locally described as East Gully. This flattens south-easterly into a "riparian swampy meadow", a portion of which will be covered by waste rock. Any waste dump leachate will flow directly down the extensions of these existing drainages and eventually into Nellie Creek further to the south.

A third creek further north-east in an area described as "Riparian Rainforest", drains to the north-east of the infrastructure area.

On the western side of the proposed open pit, a fourth creek also partially (nominally 50%) sourced from mineralised ground has a permanent water hole known as Pandana Waterhole.

A single sample of flowing stream water from Pit Gully was collected in May 2004 and analysed. No groundwater samples were available apart from water from Pit Gully Spring. Arafura data in prior reporting indicates that:

".....SWL in a water bore 300 m south of the initial pit is at 190-195 m AHD (490-495 m RL). This is 30-35 m above the anticipated lowest level of the main 10400 Zone pit (460 RL). Consequently, a permanent artificial lake will form in this pit after mining is completed and groundwater equilibrates to regional levels.

Because primary sulphide mineralisation will remain under water in the walls of this pit after mining is completed, relatively low pH and high base metal levels may eventuate for the water in the pit. This is unlikely to detrimentally affect the quality of groundwater in the surrounding area as previous analysis of the bore water has established that it is unfit for human consumption due to natural elevated levels of arsenic and other base metals. ....."

No bore water analysis was available for this study, the results of which are based entirely on data gathered and interpreted in this report. The stated location of the sample is close to Pandana Waterhole.

5.1 METHODOLOGY

Analysis of one sample of flowing water collected after rainfall was available from Pit Gully. Results from analysis of one groundwater sample was also available from the Pit Gully spring. A partial evaporatively concentrated water sample from Pandana Waterhole plus samples from the stream within the Riparian rainforest were also analysed. None of these samples were filtered prior to analysis and samples for metals were collected in pre-acidified bottles.

Additional partial evaporatively concentrated water samples were collected in June 2006 from the spring in Pit Creek, the creek line in the riparian rainforest and a waterhole in Pandana

Creek. These samples were all filtered prior to analysis and samples for metals were acidified after filtration. Results differ substantially from previously analysed samples.

All results are presented in Table 3.

Soil samples were collected adjacent to the Pit Gully Spring, Pandana Waterhole and Riparian Rainforest. Samples were collected near to where the water samples were taken at these same locations. A soil sample was also collected from the Riparian Swampy Meadow area. All were analysed using a 1:5 soil to water ratio 15-16 hour oxygenated bottle roll procedure which simulates the amount of leaching likely over an extended period of years. Results for all samples were compared with the Pit Creek spring water and TS5 Rainforest stream surface water samples as is shown in Table 4. This direct comparison is valid as the original samples were not filtered prior to acidification.

Table 3: Mt Porter Area Water Samples

IDENTIFICATION	Job number	Geological Information	Water Samples As Delivered	EC	pH	TDS	Cl	F	NH3_N	NO3_N	SO4_F	Al_T	As_T	B_T	Ba_T
UNITS				**µS/cm**	None	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	**µg/L**	**µg/L**	mg/L	mg/L
SCHEME				**ALK1**	**ALK1**	**TDS1**	**FIA_3**	**FISE1**	**FIA**	**FIA_3**	**W100I**		**W200M**	**W200I**	**W200I**
"Reliability" (L, M, H) Ecological Trigger Value							None	None	2.18 (H) pH=7.0	0.70 (M)	None	55 (M)	24 (H)	0.37 (H)	None
PANDANA WATERHOLE (unfiltered)	EL04563	Part shale, part granitoid	Partially evaporated water	387	7.3	280	4.8	0.6	0.865	<0.005	14.8	21000	152	0.04	0.1
PIT GULLY SPRING (unfiltered)	EL04563	Mineralised Shale Site	Mineralised groundwater	330	7.6	240	2.2	0.3	<0.005	0.285	7	20800	88.5	0.03	0.075
PIT CREEK FLOW WATER (unfiltered)	EL03509		Flowing Surface water	248	7.1	nd	nd	nd	nd	nd	nd	25	3.35	0.014	0.054
TS4 SWAMPY MEADOW	EL04752	Granitoid Site 3	No water sample	---	---	---	---	---	---	---	---	---	---	---	---
TS5 RAINFOREST STREAM (unfiltered)	EL04563	Un-mineralised Shale Site 4	Partially evaporated water	262	6.6	190	4.7	0.5	0.085	0.06	66.5	160	98.5	<0.01	0.08
UNITS				**µS/cm**	None	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	**µg/L**	**µg/L**		
SCHEME				**ALK1**	**ALK1**	**TDS1**	**FIA_3**	**FISE1**	**FIA**	**FIA_3**	**W108I**	**W100M**	**W100M**	**W100M**	**W100M**
PIT GULLY SPRING (filtered)	EL06064	Mineralised Shale Site	Mineralised groundwater	220	7.2	180	1.3	0.3	0.005	0.010	18.3	14.9	5.4	0.011	42.2
RAINFOREST STREAM (filtered	EL06064	Un-mineralised Shale Site 4	Partially evaporated water	242	6.7	190	2.3	0.2	<0.005	0.015	12.6	2.0	1.65	0.012	57.2
Exceeds 2X Trigger			Not necessarily anomalous, highlighted for reporting purposes												

IDENTIFICATION	Job number	Geological Information	Water Samples As Delivered	Be_T	Bi_T	Ca_T	Cd_T	Co_T	Cr_T	Cu_T	Fe_T	K_T	Li_T	Mg_T	Mn_T
UNITS				**µg/L**	**µg/L**	mg/L	**µg/L**	mg/L	mg/L	mg/L	mg/L	mg/L	**µg/L**	mg/L	mg/L
SCHEME				**W200M**	**W200M**	**W200I**	**W200M**	**W200I**	**W200I**	**W200I**	**W200I**	**W200I**	**W200M**	**W200I**	**W200I**
"Reliability" (L, M, H) Ecological Trigger Value				0.13 (ECL)	0.7 (ECL)	None	0.20 (H)	0.0014 (L)	0.0033 (L)	0.0014 (H)	0.3 (Can)	None	None	None	1.7 (M)
PANDANA WATERHOLE	EL04563	Part shale, part granitoid	Partially evaporated water	2.4	1.7	41.9	1.54	0.025	0.04	0.05	56.5	5.7	41	29.4	3.44
PIT GULLY SPRING	EL04563	Mineralised Shale Site	Mineralised groundwater	1.25	0.5	30.3	1.10	0.025	0.06	0.09	51.5	2.4	30.5	28.5	<0.002
PIT CREEK FLOW WATER	EL03409		Flowing Surface water	<0.05	<0.05	18.6	0.02	0.0001 7	0.0006	0.006	0.06	nd	1.3	16.4	0.003
TS4 SWAMPY MEADOW	EL04752	Granitoid Site 3	No water sample	---	---	---	---	---	---	---	---	---	---	---	---
TS5 RAINFOREST STREAM	EL04563	Un-mineralised Shale Site 4	Partially evaporated water	0.15	<0.05	11.3	0.12	0.01	<0.02	<0.005	21.5	3.1	7.1	18	<0.002

UNITS				µg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	mg/L	µg/L
SCHEME				W100M	W100M	W100I	W100M	W100M	W100M	W100M	W100M	W100I	W100M	W100I	W100M
PIT GULLY SPRING (filtered)	EL06064	Mineralised Shale Site	Mineralised groundwater	<0.05	<0.05	14.7	0.42	0.02	<0.1	0.82	20	1.2	2.1	13.8	59.0
RAINFOREST STREAM (filtered	EL06064	Un-mineralised Shale Site 4	Partially evaporated water	<0.05	<0.05	16.3	0.38	0.10	<0.1	0.55	40	2.2	4.7	17.5	51.2
Exceeds 2X Trigger			Not necessarily anomalous, highlighted for reporting purposes												

IDENTIFICATION	Job number	Geological Information	Water Samples As Delivered	Mo_T	Ni_T	P_T	Pb_T	S_T	Se_T	Si_T	Sr_T	Tl_T	U_T	V_T	Zn_T
UNITS				µg/L	mg/L	mg/L	µg/L	mg/L	µg/L	mg/L	mg/L	µg/L	µg/L	mg/L	mg/L
SCHEME				W200M	W200I	W200I	W200M	W200I	W200M	W200I	W200I	W200M	W200M	W200I	W200I
"Reliability" (L, M, H) Ecological Trigger Value				34 (L)	0.011 (H)	None	3.4 (H)	None	11 (H)	None	None	0.03 (L)	0.5 (L)	0.006 (L)	0.008 (H)
PANDANA WATERHOLE	EL04563	Part shale, part granitoid, Site 1	Partially evaporated water	0.5	0.04	0.4	133	5.86	1.0	57.7	0.085	0.7	4.05	0.06	0.555
PIT GULLY SPRING	EL04563	Mineralised Shale Site 2	Mineralised groundwater	0.45	0.05	0.3	375	2.42	1.2	46.1	0.135	0.67	2.81	0.18	0.58
PIT CREEK FLOW WATER	EL03409	Stream Water	Flowing Surface water	0.45	0.001	nd	0.3	nd	0.2	nd	0.078	0.05	0.002	0.001	0.009
TS4 SWAMPY MEADOW	EL04752	Granitoid Site 3	No water sample	---	---	---	---	---	---	---	---	---	---	---	---
TS5 RAINFOREST STREAM	EL04563	Un-mineralised Shale Site 4	Partially evaporated water	0.5	<0.01	0.1	4.33	22	0.4	12.8	0.045	0.06	0.142	<0.01	0.105
Exceed 2X Trigger			Not necessarily anomalous, highlighted for reporting purposes												
UNITS				µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L
SCHEME				W100M	W100M	W100M	W100M	W108I	W100M	W108I	W100M	W100M	W100M	W100M	W100M
PIT GULLY SPRING (filtered)	EL06064	Mineralised Shale Site	Mineralised groundwater	0.4	1.35	0.020	0.05	6.1	0.4	20	57.2	0.05	0.357	1.3	3.2
RAINFOREST STREAM (filtered	EL06064	Un-mineralised Shale Site 4	Partially evaporated water	0.25	1.76	0.015	0.67	4.2	0.2	21	49.8	0.02	0.222	0.6	20.6
Exceeds 2X Trigger			Not necessarily anomalous, highlighted for reporting purposes												

5.2 INTERPRETATION OF WATER SAMPLE DATA

- **Natural Rainfall**. No natural rainfall samples were available against which to compare water sample data. Nominally half of the Pit Creek flow water sample will have fallen on and flowed over the weathered mineralised subcrops and outcrops prior to entering the stream. No evaporation concentration will have occurred.

  The flow water sample is relatively high in aluminium, arsenic, beryllium, cadmium, copper, lead, lithium and thallium when compared with expected values for rainwater and these will have been sourced from flowing over mineralised bedrock. Values for these elements whilst greater than for rainfall are not ecologically significant.

- **Surface Water Samples – Mineralised Bedrock**. The sample taken at Pandana Waterhole gives a nominal mid "dry season" water concentration. This waterhole will be largely sourced from alluvial base flow and should be similar to natural mineralised area groundwater. The waterhole is about 350 metres downstream from the mineralised area. The Pit Gully Spring sample is considered representative of natural (mineralised) groundwater at the proposed waste landform site.

  These two samples are very similar and both exceed ecological "fresh water" trigger values for aluminium, arsenic, beryllium, chromium, copper, iron, lead, thallium, uranium, vanadium and zinc. The Pandana waterhole sample also exceeds "fresh water" trigger values for bismuth and manganese. Significantly anomalous values are those for aluminium, arsenic, lead and iron, the last of these possibly due to the reducing effect of the high carbon shale bedrock and it is probable high bismuth and manganese at Pandana waterhole are also the result of low Eh water conditions.

  Both of these samples were collected very close to where they emerge from the natural water table. They were not filtered prior to acidification and could have included colloidal suspensions of iron, aluminium and arsenic sesquioxides plus ultrafine carbon, other hydroxides, silicates and alumino-silicates. A subsequent sample taken at the Pit Gully site was filtered prior to acidification and has orders of magnitude lower values of iron, arsenic and aluminium, plus significantly lower silicon.

  The data clearly indicates the water contains suspended material that leach significant quantities of metals under acidic conditions.

- **Surface Water Samples – Un-mineralised Bedrock**. The sample taken from the TS5 Rainforest location will be slightly concentrated due to evaporation, but the watershed is largely un-mineralised carbonaceous shale bedrock. The sample has similar arsenic and thallium values plus elevated but lower aluminium, cobalt, iron, silicon and zinc compared to the mineralised bedrock areas plus traces of lead. Trace metal levels appear to be about double those of the surface flow water indicative of a realistic 100% concentration by evaporation. This sample is considered representative of naturally occurring dry season surface water overlying un-mineralised bedrock.

  The TS5 sample represents the un-mineralised background condition for the area and has been used, along with the Pit Gully spring (natural mineralised groundwater) sample as comparative samples for ecological purposes. The trace metal values would appear to be moderately representative of those expected from groundwater occurring naturally in shale bedrock of this area.

The repeat sample taken in 2006 at the rainforest location has similar chemistry to the original sample excluding aluminium, arsenic, iron and silicon. All these elements apart from silicon are sesquioxides liable to form colloidal suspensions particularly if Eh (oxygen content in the water) is low and the pH between 5.1 and 7.8, which is the case with all waters at Mt Porter. The simple act of filtering will remove these sesquioxides plus colloidal carbon.

The filtered sample has orders of magnitude lower values for iron, arsenic and aluminium plus significantly lower silicon.

Ground and surface water in the Mt Porter area is utilised by local indigenous and introduced bird, insect and animal populations. The samples collected, preserved and analysed are representative of available water in the district in the form available to flora and fauna and potential waste landform leachates should be compared with these samples, not with ecological trigger values which bear no relationship to waters from the district or even to pre-filtered samples which also bear no relationship to waters from the district. Local fauna and flora will be adapted to water which has relatively high values of soluble aluminium, arsenic, bismuth, beryllium, chromium, copper, iron, lead, thallium, uranium, vanadium and zinc.

Table 4: 1:5 Soil / Oxygenated Water Leachates and Comparison with Surface Water Samples

IDENTIFICATION	Job number	Sample Information		Moisture	paste EC	paste pH		Cl	paste F	paste NH3_N	NO3_N	SO4 =	Al	As	B	Ba
UNITS			Soil Samples @ 1:5w/w Soil/Water	%	µS/cm	None		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/kg	mg/kg	mg/kg
SCHEME				MOIST 1	EA	EA		FIA_4	FISE_P	FIA	FIA_4	C104I	G905I	G905M	G905I	G905I
"Reliability" (L, M, H) Ecological Trigger Value						6.5-8.5		None	None	None	None	None	0.055 [M]	24 [H]	0.37 [H]	None
PANDANA WATERHOLE	EL04563	Mixed Site 1	Soil Water Leach	47.7	359	7		5	3	4.1	3.3	600	12.3	135	0.2	0.02
PIT GULLY SPRING	EL04563	Shale Site 2	Soil Water Leach	43.2	200	5.9		3	2	4.4	0.86	300	80.3	355	0.3	0.2
TS4 SWAMPY MEADOW	EL04752	Granitoid Site 3	Soil Water Leach	8.4	194	6.3		6.5	4.3	0.04	<0.02	300	5.6	20	0.05	<0.02
TS5 RAINFOREST	EL04563	Shale Site 4	Soil Water Leach	43.8	264	5.0		17.5	0.5	21.4	0.26	9400	27.4	155	0.3	0.54
TS5 RAINFOREST WATER	EL04563		Reference Surface Water		262	6.6		4.7	0.5	0.085	0.06	66.5	0.16	98.5	<0.01	0.08
PIT GULLY SPRING WATER	EL04563		Reference Groundwater		330	7.6		2.2	0.3	<0.005	0.29	7.2	20.8	88.5	0.03	0.075

IDENTIFICATION	Job number	Sample Information		Moisture	Be	Bi	Ca	Cd	Co	Cr	Cu	Fe	K	Li	Mg	Mn
UNITS			Soil Samples @ 1:5w/w Soil/Water	%	µg/kg	µg/kg	mg/kg	µg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/kg	mg/kg	mg/kg
SCHEME				MOIST 1	G905M	G905M	G905I	G905M	G905I	G905I	G905I	G905I	G905I	G905M	G905I	G905I
"Reliability" (L, M, H) Ecological Trigger Value					0.13 [ECL]	0.7 [ECL]	None	0.20 [H]	0.0014 [H]	0.0033 [L]	0.0014 [H]	0.3 [Can]	None	None	None	1.7 [M]
PANDANA WATERHOLE	EL04563	Mixed Site 1	Soil Water Leach	47.7	<5	1	144	<5	0.02	<0.05	0.22	11	36.5	110	64	0.64
PIT GULLY SPRING	EL04563	Shale Site 2	Soil Water Leach	43.2	<5	1	44.5	<5	0.04	0.1	0.42	72.6	28	90	37	1.62
TS4 SWAMPY MEADOW	EL04752	Granitoid Site 3	Soil Water Leach	8.4	<5	<1	51	<5	0.02	<0.05	0.04	4	7.5	175	39.5	0.66
TS5 RAINFOREST	EL04563	Shale Site 4	Soil Water Leach	43.8	<5	<1	59.5	<5	0.44	<0.05	0.14	33.4	30.5	125	76.5	9.44

TS5 RAINFOREST WATER	EL04563		Reference Surface Water		0.15	<0.05	11.3	0.12	0.01	<0.02	<0.005	21.5	3.1	7.1	18	<0.002
PIT GULLY SPRING WATER	EL04563		Reference Groundwater		1.25	0.5	30.3	1.10	0.025	0.06	0.09	51.5	2.4	30.5	28.5	<0.002
IDENTIFICATION	**Job number**	**Sample Information**		**Moisture**	**Mo**	**Ni**	**P**	**Pb**	**S**	**Se**	**Si**	**Sr**	**Tl**	**U**	**V**	**Zn**
UNITS			**Soil Samples @ 1:5w/w Soil/Water**	**%**	**µg/kg**	**mg/kg**	**mg/kg**	**µg/kg**	**mg/kg**	**µg/kg**	**mg/kg**	**mg/kg**	**µg/kg**	**µg/kg**	**mg/kg**	**mg/kg**
SCHEME				**MOIST 1**	**G905M**	**G905I**	**G905I**	**G905M**	**G905I**	**G905M**	**G905I**	**G905I**	**G905M**	**G905M**	**G905I**	**G905I**
"Reliability" (L, M, H) Ecological Trigger Value					**34 [L]**	**0.011 [H]**	**None**	**3.40 [H]**	**None**	**11 [H]**	**None**	**None**	**0.03 [L]**	**0.5 [L]**	**0.006 [L]**	**0.008 [H]**
PANDANA WATERHOLE	EL04563	Mixed Site 1	Soil Water Leach	47.7	30	<0.05	1	47	137	<20	76	0.16	<0.5	1	<0.05	0.22
PIT GULLY SPRING	EL04563	Shale Site 2	Soil Water Leach	43.2	14	0.15	0.5	252	55.5	<20	164	0.22	2	8	0.2	0.48
TS4 SWAMPY MEADOW	EL04752	Granitoid Site 3	Soil Water Leach	8.4	17	<0.05	<0.5	5	59.4	20	76.5	0.16	<0.5	4	<0.05	0.02
TS5 RAINFOREST	EL04563	Shale Site 4	Soil Water Leach	43.8	<5	0.4	0.5	188	108	<20	78	0.2	3.5	10	<0.05	2.48
TS5 RAINFOREST WATER	EL04563	Low Level Background	Reference Surface Water		0.5	<0.01	0.1	4.33	22	0.4	12.8	0.045	0.06	0.142	<0.01	0.105
PIT GULLY SPRING WATER	EL04563	Wastes Area Background	Reference Groundwater		0.45	0.05	0.3	375	2.4	1.2	46.1	0.135	0.67	2.81	0.18	0.58
Enhanced Values			Not necessarily anomalous. Abundance value of > 2.0 times the Ecological Trigger Value determined on moist sample and corrected for contained moisture													

5.2.1 Time Equivalence and Composition of Soil Leachates

The soil water leach was undertaken in a nominal 15 – 16 hour 1:5 Sample / Water bottle roll with head air space ≡ >10 times naturally dissolved oxygen. This provides maximum oxygen accessibility to mineral fragments in an abrasive environment that eliminates surface "armouring". The water to sample ratio exceeds 20 times the average soil saturation capacity.

Soil sample material has greater than 80% with average grainsize less than 0.005 centimetres (50 microns) compared with waste landform material with a high percentage of fragments exceeding 1.0 to 10 centimetres and average size 1.0 centimetres. The relative surface area exposed to leaching of soil particles in the leach procedure compared to the equivalent situation in a waste dump exceeds 2,500 times, more likely 10,000 to 20,000 times. Based on 50 rainfall saturations each of nominally 20-25 millilitres of a waste landform per year, with 100% saturation (~30% porosity) averaging 16 to 18 hours per saturation, one soil leach procedure is theoretically equivalent to 50 to 200 years of waste landform weathering. These figures assume 1,000 to 1,250 millimetres per year rainfall, equivalent to the historical rainfall records for Pine Creek.

Excluding very easily dissolved substances such as chlorides, nitrates and sulphates, the water leach thus estimates the maximum metals contaminants likely to leach from wastes over a minimum time frame of nominally 50 to 200 years (say conservatively 20 to 25 years) at saturation capacity with high Eh rainwater. Since proper waste management procedures should minimise ingress of rainwater to less than 15% of total precipitation, the water leach values are estimated to indicate six to 600 times the worst-case short term scenario values for waste landform leachates.

From experience, a flush of from 40% to 90% (dependent on substance) of the very easily dissolved substances is likely to occur on the first saturation occasion due to the presence of highly oxidised material and initial high positive oxygen fugacity (Eh saturation). After the first flush, further dissolved substance release will be dependent on positive oxygen fugacity (if any) within the waste landform. The high to very high iron values in surface water (Table 3), surface soil leaches (Table 4) and waste sample leachates (Table 5) are indicative of extremely low Eh within all of these three groups of samples, which will minimise sulphide oxidation. The Pit Gully Spring water sample represents the background value for leachates from oxidised materials in the proposed waste dumps, as it is about 50% sourced directly from mineralisation.

5.2.2 Review of Analyses compared with Ecological Fresh Water Trigger Values

There are no human habitations close to the proposed mining operations. All water usage will be by indigenous and introduced fauna and flora species. Analysis data is therefore compared to Ecological Fresh Water Trigger Values, not to groundwater guidelines.

- Pit Gully Flow Water: The unfiltered sample has slightly enhanced nitrates and sulphate compared with rainwater, but trace quantities of metals and selenium not normally found in rainwater. These values do not exceed Ecological Fresh Water Trigger Values and are shown in Table 3. The trace metals, selenium and radicals represent surface run-off

solution of soluble materials in this mineralised area. The metals contents are very significantly reduced if samples are filtered prior to preservation. In these cases, the metals are generally very close to or below ecological trigger values.

- TS5 Rainforest Creek standing water (Un-mineralised Background): The unfiltered sample shows metal values that exceed Ecological Fresh Water Trigger Values of three times for aluminium, four times for arsenic, seven times for cobalt, 1.3 times for lead, twice for thallium and 13 times for zinc. This sample is interpreted as reflecting a combination of soluble materials from run-off and creek base flow in this area. Despite the high ratios of measured values relative to "trigger values", only Arsenic is considered to be anomalous but is well within Stock Water Guidelines.

  The filtered sample collected in June 2006 does not show metal values exceeding Ecological Fresh Water Trigger Values. Thus, by following the Australasian Institute of Mining and Metallurgy recommendations for sampling procedures, namely that samples for metals determination must be filtered prior to preservation, it is evident that this water meets Ecological guidelines.

- Pit Gully Spring water (Mineralised Background Groundwater): The unfiltered sample shows metal values that exceed Ecological Fresh Water Trigger Values by 40 times for aluminium, four times for arsenic, 10 times for beryllium, five times for cadmium, 20 times for cobalt, 10 times for chromium, 40 times for copper, five times for nickel, 120 times for lead, 20 times for thallium, five times for uranium, 30 times for vanadium and 70 times for zinc. This sample is interpreted as reflecting natural groundwater base flow in this area. The ratios of measured values relative to "Ecological Fresh Water Trigger Values" for aluminium, arsenic, cadmium, copper, thallium, vanadium and zinc are all considered anomalous but within Stock Water Guidelines.

  The filtered sample collected in June 2006 does not show metal values exceeding Ecological Fresh Water Trigger Values. Thus, by following the Australasian Institute of Mining and Metallurgy recommendations for sampling procedures, namely that samples for metals determination must be filtered prior to preservation, it is evident that this water meets Ecological guidelines.

- Leachates from adjacent to Pit Gully Spring, Pandana Waterhole and TS5 Rainforest are soils developed on shale with various degrees of mineralisation. Due to higher total dissolved solids the detection limits for all leachates are nominally 100 times higher than for the waters.

  The Pit Gully Spring and TS5 Rainforest leachates are weakly acidic. Both have similar metal values to those of the background unfiltered waters, except for beryllium, bismuth, cadmium, chromium, thallium and vanadium, which are low. Thallium is enhanced at Pit Gully Spring. The ratios of measured values relative to "Ecological Fresh Water Trigger Values" for aluminium, arsenic, copper and zinc are considered to be anomalous but within Stock Water Guidelines.

  Soil collected from the Swampy Meadow site is believed to be largely developed on granite with only alluvial contribution from the mineralised shale areas. It is very weakly acidic and only slight traces of aluminium, cobalt, chromium, copper, lead and selenium are detected. None of the ratios of measured values relative to "Ecological Fresh Water Trigger Values" are considered anomalous.

In summary overall, data from the natural unfiltered waters and soil leachates indicate that prior to any mining taking place, the 'background' water available to flora and fauna populations is:

- Weakly acidic, mainly in the pH range from pH = 4.0 to pH = 6.3, averaging pH = 5.7.
- Very low in dissolved oxygen as dissolved iron values commonly exceed 50 milligrams per litre, suggestive of dissolved oxygen contents lower than 1% of maximum.
- High to very high in arsenic but also containing elevated contents of soluble aluminium, copper, lead, thallium, vanadium and zinc plus significant traces of other metals, sulphate and selenium. Most of these metals are likely to be held adsorbed onto colloidal sesquioxide (aluminium + iron +arsenic) suspension in the waters.

There are diverse flora and fauna populations in the area and it is considered that these populations must be well adapted to the high background trace metal geochemistry of local water to survive. There is no reason to believe that leachates from the waste landform will increase background water chemistry levels.

5.3 STRONG ACID LEACHATES FROM SURFACE SOILS

The soil samples collected adjacent to the Pit Gully, Pandana Waterhole and Riparian Rainforest water samples plus a soil sample from the Riparian Swampy Meadow area were analysed using a nitric – perchloric – hydrochloric acid leach which extracts all sulphur excluding that complexed as barium sulphate. The sample analyses are listed in Table 5.

Results indicate that acid leachate values are generally more than 200 times the water soluble leachates and that, compared with world-wide "average" shale, these soils contain significantly enhanced values for arsenic, bismuth, cadmium, lead, selenium, thallium and zinc. There is very slight enhancement for copper, but copper cannot be considered anomalous.

Arsenic is the exception. The water soluble and acid soluble arsenic content for Pit Gully are virtually identical. For the other three samples, the ratio is less than 1:4 compared with the nominal 1:200 value for other elements. Thus, most arsenic in this area is very readily soluble suggesting it is present as As^{5+}, not the more poisonous As^{3+}. As^{5+} reacts similarly to phosphate.

None of these elements are significantly anomalous considering the mineralisation present in the area. Since arsenic is already present in a water available form (soluble or in colloidal suspension), mining will not increase arsenic contents in soils and waters as most arsenic mined will be present in the low solubility arsenopyrite, which will remain stable at the surface over long periods of time.

Table 5: Strong Acid Leachates from Surface Soils

IDENTIFICATION	Job			As	Ba	Bi	Cd	Co	Cr	Cu	Fe	Mn	Mo
UNITS	Number	Soil Samples		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
SCHEME		HCl_HNO3_HClO4		G310M	G310I	G310 M	G310M	G310I	G310I	G310I	G310I	G310I	G310 M
Average Crustal Abundance for Shale				15	700	0.18	0.2	20	100	50		850	3
PANDANA WATERHOLE	EL04563	Mixed Site 1	Acid Leach	33.5	44	3.22	1.15	14	50	62	52000	480	0.25
PIT GULLY SPRING	EL04563	Shale Site 2	Acid Leach	328	114	1.5	0.75	22	95	165	10400	872	2.4
TS4 SWAMPY MEADOW	EL04563	Granitoid S. 3	Acid Leach	43	284	0.62	0.4	32	60	64	66200	2890	1.85
TS5 RAINFOREST	EL04563	Shale Site 4	Acid Leach	123	136	0.78	1.25	30	40	56	77300	488	4.4
IDENTIFICATION	Job			Ni	P	Pb	S	Se	Sr	Tl	U	V	Zn
UNITS	Number	Soil Samples		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
SCHEME		HCl_HNO3_HClO4		G310I	G310I	G310 M	G310I	G310 M	G310I	G310 M	G310 M	G310I	G310I
Average Crustal Abundance for Shale				70		20		0.6	300	0.3	4	130	160
PANDANA WATERHOLE	EL04563	Mixed Site 1	Acid Leach	34	130	89.8	1240	2	14	0.56	1.6	28	644
PIT GULLY SPRING	EL04563	Shale Site 2	Acid Leach	68	250	418	400	4	28	0.87	7.25	152	460
TS4 SWAMPY MEADOW	EL04563	Granitoid S. 3	Acid Leach	36	50	102	140	<2	16	0.67	9.43	82	234
TS5 RAINFOREST	EL04563	Shale Site 4	Acid Leach	40	330	403	3000	4	18	0.74	4.85	76	512
Average Crustal Abundance for Shale:			From Levinson, A A. (1974) Introduction to Exploration Geochemistry. Re-produced in AusIMM Monograph 9.										
GAI anomaly			Geochemical Abundance Index value of 5 times or more the average crustal abundance for shale. This approximates Mean + 2 Standard Deviations. The GAI was developed by Förstner et al (1993) and is defined as: GAI=Log2 [Cn/(1.5 X Bn)] where: Cn = measured content of nth element in the sample; Bn = "background" content of the nth element in the sample. For this report, "background" is the Average Crustal Abundance for Shale										
G310 HCl_HNO3_HClO4 Leach Procedure	M		Analytical method G310. Analysis by ICP-MS										
G310 HCl_HNO3_HClO4 Leach Procedure	I		Analytical method G310. Analysis by ICP-OES										

5.4 POTENTIAL LEACHATES FROM THE WASTE LANDFORM

Ten samples were selected from those submitted for Acid Rock Drainage determination for leachate testing. These included:

- All rock types from within the proposed open pit.
- Samples of the lowest, average and highest ARD potential.
- The "least oxidised" sample which also has the highest ARD potential.
- Specific samples to establish the content of non-barium sulphate related sulphate-sulphur present. This form of sulphur is either already present as sulphuric acid or is not acid generating.

The samples were analysed for:

- Water soluble compounds via analysis by instrumental and chemical methods for EC, pH, HCO_3, chloride and fluoride, plus a 1:5 sample to water leach followed by micropore filtration using ICP-OES and ICP-MS analysis, for aluminium, arsenic, boron, barium, bismuth, calcium, cadmium, copper, iron, potassium, magnesium, manganese, molybdenum, sodium, lead, sulphur, selenium, silicon, thallium and zinc.
- A subsequent analysis of the water leached sample for weak acid soluble compounds via a 25:1 excess of simmering dilute HCl leach adjusted to pH = 1.5 for three hours, followed by micropore filtration and analysis using ICP-OES and ICP-MS for arsenic, boron, barium, calcium, cadmium, cobalt, copper, iron, magnesium, manganese, molybdenum, sodium, lead and zinc.
- Non-barium sulphate, sulphate-sulphur.

The logistical reasons for the water-soluble analysis are detailed in Section 5.2.1.

The weak acid digest methodology should dissolve most of the sulphide, plus sulphate minerals of the alum group, calcium and magnesium sulphates, but little or no barite. In the presence of the relatively high elemental carbon in these rocks, elemental sulphur formed during dissolution of pyrrhotite and arsenopyrite will not convert to sulphuric acid and can be filtered off. The barium contents obtained by this analysis are low and indicate there has been insufficient solution of any barium sulphate (barite) present to affect the ARD determinations. Sulphur values obtained are minimum figures as some sulphur will be lost as H_2S during dissolution and these values not used for purposes of interpretation.

This pH 1.5 leach estimates the maximum contaminants likely to leach from wastes over a time frame measurable in a small number of centuries, if waste landform construction and rehabilitation is inadequate and the unlikely situation of free oxygen access to the waste occurs. It is a more realistic measure than the Geochemical Abundance Index methodology.

Non-barium sulphate, sulphate – Sulphur has been determined by the South African Institute of Mining & Metallurgy methodology. This is the preferred method for sulphate – Sulphur, but will tend to give slightly low values in acid sulphate soils and weathered rocks due to insolubility of Jarosite group iron- and aluminium-sulphates.

5.4.1 Water Soluble Components

Since run-off and base flow from beneath the waste landform will report to existing ephemeral watercourses, the soluble chemical data is compared with Ecological Trigger Values. The electrical conductivity, pH, HCO_3, chloride and fluoride were measured separately. All other values were obtained after completion of the 16 hour digest.

The four rock types present are dolerite, felsic dyke, chloritic cherty banded iron formation and carbonaceous siltstone. Of the ten samples, nine are partially to strongly oxidised with one carbonaceous siltstone sample (DDH241 / 30.0 - 31.0 metres) being virtually fresh rock with a small content of fresh sulphides. This is the only sample that contains anomalous contaminants. A careful study of the diamond drill logs and the drill log pictures strongly suggest that less than 3% of the proposed waste material will be represented by that sample.

All rock types have some soluble aluminium and all EC values apart from DDH241 / 30.0 – 31.0 metres are very low. The dolerite has neutral pH, very low sulphate, no carbonate and a minor trace of soluble copper. The felsic dyke has weakly acidic pH, moderate sulphur and some carbonate plus trace amounts of soluble copper, iron, manganese and zinc. The chloritic-cherty BIF's have moderately acidic pH, low sulphate, no carbonates and minor bismuth, copper, manganese and zinc. No metals are anomalous in any sample, considering the natural surface water and groundwater values.

The carbonaceous siltstones have, with one exception, moderately acidic pH, no carbonate and bismuth, low sulphur and low copper, iron, manganese and zinc, which exceed ecological trigger values and the values in the TS5 Rainforest surface water and Pit gully spring groundwater. With these siltstones, there is a pattern where the lower the pH, the higher the EC value and contents of soluble iron, manganese, copper, sulphate, selenium and zinc. Clearly this unit is the major source of the contaminant metals seen in the soils and waters and these appear to be sulphide sourced.

The final sample is carbonaceous siltstone DDH241 / 30.0 - 31.0 metres. This sample has a strongly acidic pH, very high EC, contains thin 'bedded' layers of fresh sulphides, very high sulphate and relatively high content of arsenic, as well as anomalous values of fluoride, selenium and all other metals analysed in the other carbonaceous siltstone samples.

Comparing the sulphur, pH and drill log feature values for sample DDH241 / 30.0 – 31.0 metres, with the previous ARD data, it appears that all samples with bedding parallel sulphides have similar pH, similar high sulphur content and colour with all coming from the deepest portion of the proposed pit.

In relation to the two background water samples, the waste leachates are higher in copper, iron, manganese and zinc, all elements known to dissolve freely in low to very low Eh environments. Due to poor detection limits, the situation with ecologically difficult elements arsenic and lead is indeterminable. As iron content increases, so do the other metals. With dilution, aeration and ferrous iron oxidation to ferric, all of these metals, particularly arsenic, should precipitate with residual values diluting to figures similar to the existing background samples.

Table 6: 1:5, 16 Hour Waste Sample / Water – Oxygenated Leachates

IDENTIFICATION	PRÉCIS OF DRILL LOG GEOLOGICAL DETAILS	paste EC	paste pH	HCO_3	Cl	F	Al	As	B	Ba
UNITS		**µS/cm**	**None**	**mg/L**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
DIGEST	**1:5w/w sample to water, where applicable**	**1:5w/w**	**1:5w/w**				**1:5w/w**	**1:5w/w**	**1:5w/w**	**1:5w/w**
SCHEME		**EA**	**EA**	**EA**	**pCL4**	**FISE_P**	**G905I**	**G905I**	**G905I**	**G905I**
"Reliability" (L, M, H) Ecological Trigger Value			**[6.5-8.5]**		**None**	**None**	**0.055 [M]**	**0.024 [H]**	**0.37 [H]**	**None**
DDH241 / 9.0 - 10.0m	Weathered dolerite: Yellow, orange-green fractured, oxidised. Iron oxide coatings on fractures.	54	7.2	0	N.A.	N.A.	1.3	<0.2	<0.05	<0.02
DDH243 / 03.0 - 04.0m	Carbonaceous Siltstone: Grey-black with fractures coated with iron oxides. Very rare bedding traces.	61	4.3	0	N.A.	N.A.	0.3	<0.2	<0.05	5.4
DDH242 / 07.0 - 08.0m	Carbonaceous Siltstone: Black to dark-brown, massive with thin chloritic beds. Completely oxidised. Thin <1cm wispy quartz veins. No evidence of former sulphides.	345	3.6	0	N.A.	N.A.	20.8	<0.2	0.05	0.18
DDH247 / 14.0 - 15.0m	Carbonaceous Siltstone: Grey to black, soft, oxidised. Zone of red-black clay. Poorly bedded. <1mm wide white-clay veinlets.	183	3.6	0	23.5	6	13.4	<0.2	<0.05	0.38
DDH241 / 20.0 - 21.0m	Carbonaceous Siltstone: Black partially oxidised with iron oxide coatings.	93	5.3	0	N.A.	N.A.	18.1	<0.2	<0.05	0.22
DDH241 / 30.0 - 31.0m	Carbonaceous Siltstone: Black, massive with rare chloritic bedded layers. Rare <2mm pyrite bedding parallel veins.	8960	2.4	0	4.5	48.5	4130	9	1.95	<0.02
DDH245 / 30.0 - 32.0m	Felsic dyke: Oxidised white to fresh grey, feldspathic. Occasional <5mm siliceous veins.	703	5.5	90	15	1.5	1.4	<0.2	0.15	0.16
DDH244 / 09.2 - 10.0m	Chlorite-Chert BIF: Crushed clay zones with minor <10cm carbonaceous zones. Abundant chert nodules with red-brown patches suggesting oxidised sulphides. Bedding preserved but badly fractured.	120	4.6	0	9	<0.5	0.7	<0.2	<0.05	0.1
DDH243 / 20.0 - 21.0m	Chloritic Cherty BIF: Oxidised orange and grey-green. Fractured with wavey bedding, abundant chert nodules with red-brown patches after pre-existent sulphide, mosaic breccia texture.	58	4.3	0	N.A.	N.A.	0.2	<0.2	<0.05	0.04
DDH242 / 24.0 - 25.0m	Chlorite-Cherty BIF. Completely oxidised orange and white. Orange colours from oxidation of chlorite & disseminated pyrite, pyrrhotite. Fractured friable core, best described as crackle breccia.	79	4.4	0	16.5	0.5	0.7	<0.2	<0.05	<0.02

TS5 RAINFOREST	Surface Water: Standing water in partially dry creek during the middle of the dry season, 2005	262	6.6		4.7	0.5	0.16	0.0985	<0.01	0.08
PIT GULLY SPRING	Groundwater: Derived from the vicinity of the open pit plus the area beneath the proposed Waste Dumps.	330	7.6		2.2	0.3	20.8	0.0885	0.03	0.075
IDENTIFICATION	**Details**	**Bi**	**Ca**	**Cd**	**Cu**	**Fe**	**K**	**Mg**	**Mn**	**Mo**
UNITS		**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
DIGEST	**1:5w/w sample to water, where applicable**	**1:5w/w**	**1:5w/w**	**1:5w/w**	**1:5w/w**	**1:5w/w**	**1:5w/w**	**1:5w/w**	**1:5w/w**	**1:5w/w**
SCHEME		**G905I**	**G905I**	**G905I**	**G905I**	**G905I**	**G905I**	**G905I**	**G905I**	**G905I**
"Reliability" (L, M, H) Ecological Trigger Value		**0.0007 [ECL]**	**None**	**0.0002 [H]**	**0.0014 [H]**	**0.3 [Can]**	**None**	**None**	**1.7 [M]**	**0.034 [L]**
DDH241 / 9.0 - 10.0m	Weathered dolerite: Yellow, orange-green fractured, oxidised. Iron oxide coatings on fractures.	<0.1	7	<0.02	0.06	2.2	3.5	5.5	<0.02	0.04
DDH243 / 03.0 - 04.0m	Carbonaceous Siltstone: Grey-black with fractures coated with iron oxides. Very rare bedding traces.	0.1	2.5	<0.02	<0.02	<0.2	30.5	2	0.08	0.04
DDH242 / 07.0 - 08.0m	Carbonaceous Siltstone: Black to dark-brown, massive with thin chloritic beds. Completely oxidised. Thin <1cm wispy quartz veins. No evidence of former sulphides.	0.1	12	<0.02	1.84	190	31	38	9.06	0.02
DDH247 / 14.0 - 15.0m	Carbonaceous Siltstone: Grey to black, soft, oxidised. Zone of red-black clay. Poorly bedded. <1mm wide white-clay veinlets.	0.2	8	<0.02	1.98	19	49.5	13.5	2.72	0.04
DDH241 / 20.0 - 21.0m	Carbonaceous Siltstone: Black partially oxidised with iron oxide coatings.	0.2	12	<0.02	0.1	9.2	45.5	14.5	0.32	<0.02
DDH241 / 30.0 - 31.0m	Carbonaceous Siltstone: Black, massive with rare chloritic bedded layers. Rare <2mm pyrite bedding parallel veins.	1.5	186	1.3	217	13900	<0.5	691	37	<0.02
DDH245 / 30.0 - 32.0m	Felsic dyke: Oxidised white to fresh grey, feldspathic. Occasional <5mm siliceous veins.	<0.1	95.5	<0.02	0.1	54.6	226	269	12.2	<0.02
DDH244 / 09.2 - 10.0m	Chlorite-Chert BIF: Crushed clay zones with minor <10cm carbonaceous zones. Abundant chert nodules with red-brown patches suggesting oxidised sulphides. Bedding preserved but badly fractured.	0.1	3.5	<0.02	0.04	1	89.5	7	5.58	<0.02

DDH243 / 20.0 - 21.0m	Chloritic Cherty BIF: Oxidised orange and grey-green. Fractured with wavey bedding, abundant chert nodules with red-brown patches after pre-existent sulphide, mosaic breccia texture.	<0.1	4	<0.02	0.08	<0.2	17	7	0.2	<0.02
DDH242 / 24.0 - 25.0m	Chlorite-Cherty BIF. Completely oxidised orange and white. Orange colours from oxidation of chlorite & disseminated pyrite, pyrrhotite. Fractured friable core, best described as crackle breccia.	0.2	7.5	<0.02	<0.02	11.6	25	10.5	2.18	<0.02
TS5 RAINFOREST	Surface Water: Standing water in partially dry creek during the middle of the dry season, 2005	<0.05	11.3	0.0001	<0.001	21.5	3.1	18	<0.002	<0.001
PIT GULLY SPRING	Groundwater: Derived from the vicinity of the open pit plus the area beneath the proposed Waste Dumps.	0.0005	30.3	0.0011	<0.001	51.5	2.4	28.5	<0.002	0.0005
IDENTIFICATION	**Details**	**Na**	**Pb**	**S**	**SO4**	**Se**	**Si**	**Tl**	**Zn**	
UNITS		**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	
DIGEST	**1:5w/w sample to water, where applicable**	**1:5w/w**	**1:5w/w**	**1:5w/w**		**1:5w/w**	**1:5w/w**	**1:5w/w**	**1:5w/w**	
SCHEME		**G905I**	**G905I**	**G905I**	**CALC**	**G905I**	**G905I**	**G905I**	**G905I**	
"Reliability" (L, M, H) Ecological Trigger Value		**None**	**0.0034 [H]**	**None**	**None**	**0.011 [H]**	**None**	**0.00003 [L]**	**0.008 [H]**	
DDH241 / 09.0 - 10.0m	Weathered dolerite: Yellow, orange-green fractured, oxidised. Iron oxide coatings on fractures.	35	<0.2	7	21	<0.1	50.5	0.1	0.02	
DDH243 / 03.0 - 04.0m	Carbonaceous Siltstone: Grey-black with fractures coated with iron oxides. Very rare bedding traces.	15	<0.2	0.7	2	0.1	39	<0.1	0.08	
DDH242 / 07.0 - 08.0m	Carbonaceous Siltstone: Black to dark-brown, massive with thin chloritic beds. Completely oxidised. Thin <1cm wispy quartz veins. No evidence of former sulphides.	16.5	<0.2	246	740	0.1	56	<0.1	11.6	
DDH247 / 14.0 - 15.0m	Carbonaceous Siltstone: Grey to black, soft, oxidised. Zone of red-black clay. Poorly bedded. <1mm wide white-clay veinlets.	9.5	<0.2	90	270	0.1	42.5	<0.1	23.4	
DDH241 / 20.0 - 21.0m	Carbonaceous Siltstone: Black partially oxidised with iron oxide coatings.	18	<0.2	48.9	147	<0.1	62	<0.1	0.06	
DDH241 / 30.0 - 31.0m	Carbonaceous Siltstone: Black, massive with rare chloritic bedded layers. Rare <2mm pyrite bedding parallel veins.	<0.5	1.4	17700	53000	0.8	24.5	0.4	148	
DDH245 / 30.0 - 32.0m	Felsic dyke: Oxidised white to fresh grey, feldspathic. Occasional <5mm siliceous veins.	20.5	<0.2	573	1720	<0.1	28	<0.1	0.14	

DDH244 / 09.2 - 10.0m	Chlorite-Chert BIF: Crushed clay zones with minor <10cm carbonaceous zones. Abundant chert nodules with red-brown patches suggesting oxidised sulphides. Bedding preserved but badly fractured.	11.5	<0.2	57.3	175	<0.1	39.5	<0.1	0.08	
DDH243 / 20.0 - 21.0m	Chloritic Cherty BIF: Oxidised orange and grey-green. Fractured with wavey bedding, abundant chert nodules with red-brown patches after pre-existent sulphide, mosaic breccia texture.	8.5	<0.2	4.9	15	<0.1	91	<0.1	0.1	
DDH242 / 24.0 - 25.0m	Chlorite-Cherty BIF. Completely oxidised orange and white. Orange colours from oxidation of chlorite & disseminated pyrite, pyrrhotite. Fractured friable core, best described as crackle breccia.	11.5	<0.2	33.8	100	<0.1	50.5	<0.1	0.06	
TS5 RAINFOREST	Surface Water: Standing water in partially dry creek during the middle of the dry season, 2005		0.0004	22	67	0.0004	0.0013	<0.0001	0.105	
PIT GULLY SPRING	Groundwater: Derived from the vicinity of the open pit plus the area beneath the proposed Waste Dumps.		0.375	2.42	7.2	0.0012	0.046	<0.0001	0.48	

5.4.2 Weak Acid Leach at Nominal pH of 1.5

The same ten samples used for the water leaches were re-submitted for a nominal pH = 1.5 acid leach. The process is similar to that used for ANC measurement but with sufficient acid to ensure the pH remained in the range 1.0 to 1.9. The leachate values obtained are presented in Table 7.

The modified ANC leach ensures that the sample material is subjected to attack at a pH similar to or below the ferrihydrite – copiapite / jarosite – alunite – alum buffer interface. This pH is effectively the lowest pH attainable in a graphite controlled environment with minimal oxygen availability in the fluid system. This will define the maximum metals solubility conceivable even though extremely unlikely in both the Mt Porter proposed waste landform and the final pit void lake.

Solubility of sulphides in this digest is proportional to the ferric ion content of the solution. For all samples except the dolerite and felsic dyke, this should be close to zero because of the reducing effect of the graphitic carbon in these rocks.

The final column in Table 7 shows the sodium carbonate soluble sulphate value. That digest does not dissolve barium sulphate or minerals of the jarosite – alunite – alum group. Thus the difference between the sulphate – Sulphur and HCl soluble sulphur values in Table 7 is a measure of the jarosite formed in the sample by sulphide oxidation prior to this digest.

The extremely low values for arsenic indicate the presence of insoluble arsenopyrite, and the relatively low lead, copper and soluble sulphur may indicate that these elements are locked in jarosite whilst the correlation between zinc and manganese indicates that zinc may have been adsorbed onto manganese or ferric oxides, both of which are totally soluble in this digest.

The analysis values for Sample DDH 241 / 30 – 31 metres represent a realistic approximation to the maximum final metals concentration likely to occur in the final pit void. The values for the other samples represent the total content of soluble metals likely to leach from that material whilst free carbon remains within the waste landform.

Table 7: Acid Leach at Nominal pH of 1.5

IDENTIFICATION	SAMPLE DETAILS	As	B	Ba	Ca	Co	Cu	Fe
UNITS		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
DIGEST		ANC / HCL	ANC / HCL	ANC / HCL	ANC / HCL	ANC / HCL	ANC / HCL	ANC / HCL
SCHEME		G910I	G910I	G910I	G910I	G910I	G910I	G910I
LLD		0.5	0.1	0.05	1	0.05	2	
DDH241 / 09.0 - 10.0m	Weathered dolerite: Yellow, orange-green fractured, oxidised. Iron oxide coatings on fractures.	<0.5	0.2	46	3820	14.5	7.05	616
DDH243 / 03.0 - 04.0m	Carbonaceous Siltstone: Grey-black with fractures coated with iron oxides. Very rare bedding traces.	<0.5	0.2	77	59	0.05	3.75	247
DDH242 / 07.0 - 08.0m	Carbonaceous Siltstone: Black to dark-brown, massive with thin chloritic beds. Completely oxidised. Thin <1cm wispy quartz veins. No evidence of former sulphides.	<0.5	0.5	7.65	45	0.75	29	2110
DDH247 / 14.0 - 15.0m	Carbonaceous Siltstone: Grey to black, soft, oxidised. Zone of red-black clay. Poorly bedded. <1mm wide white-clay veinlets.	<0.5	0.2	16.5	40	0.75	22	931
DDH241 / 20.0 - 21.0m	Carbonaceous Siltstone: Black partially oxidised with iron oxide coatings.	3	0.6	37	837	8.75	23.5	1090
DDH241 / 30.0 - 31.0m	Carbonaceous Siltstone: Black, massive with rare chloritic bedded layers. Rare <2mm pyrite bedding parallel veins.	21.5	2.6	<0.05	483	14	255	18700
DDH245 / 30.0 - 32.0m	Felsic dyke: Oxidised white to fresh grey, feldspathic. Occasional <5mm siliceous veins.	1	3.1	17	1540	1.65	2.3	9320
DDH244 / 09.2 - 10.0m	Chlorite-Chert BIF: Crushed clay zones with minor <10cm carbonaceous zones. Abundant chert nodules with red-brown patches suggesting oxidised sulphides. Bedding preserved but badly fractured.	<0.5	0.8	3.6	24	0.4	7.05	2940
DDH243 / 20.0 - 21.0m	Chloritic Cherty BIF: Oxidised orange and grey-green. Fractured with wavey bedding, abundant chert nodules with red-brown patches after pre-existent sulphide, mosaic breccia texture.	<0.5	0.2	12	874	0.45	8.9	1140
DDH242 / 24.0 - 25.0m	Chlorite-Cherty BIF. Completely oxidised orange and white. Orange colours from oxidation of chlorite & disseminated pyrite, pyrrhotite. Fractured friable core, best described as crackle breccia.	14	0.3	4.1	150	0.9	7.3	2990
	NB: sulphate – Sulphur (last column) is a different digest. Analyses G910l are a pH=1.5 HCL leach. N.A. = Not Analysed							

IDENTIFICATION	SAMPLE DETAILS	Mg	Mn	Mo	Pb	S	Zn	SO4-S as S
UNITS		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
DIGEST		ANC / HCL	ANC / HCL	ANC / HCL	ANC / HCL	ANC / HCL	ANC / HCL	Na2CO3
SCHEME		G910I	G910I	G910I	G910I	G910I	G910I	C104I
LLD		1	1	0.05	0.5	2	1	
DDH241 / 09.0 - 10.0m	Weathered dolerite: Yellow, orange-green fractured, oxidised. Iron oxide coatings on fractures.	1710	190	0.1	1.5	5.4	47.5	N.A.
DDH243 / 03.0 - 04.0m	Carbonaceous Siltstone: Grey-black with fractures coated with iron oxides. Very rare bedding traces.	19	2.05	<0.05	10	14.4	4.45	N.A.
DDH242 / 07.0 - 08.0m	Carbonaceous Siltstone: Black to dark-brown, massive with thin chloritic beds. Completely oxidised. Thin <1cm wispy quartz veins. No evidence of former sulphides.	69	16.5	0.1	1.5	246	28	N.A.
DDH247 / 14.0 - 15.0m	Carbonaceous Siltstone: Grey to black, soft, oxidised. Zone of red-black clay. Poorly bedded. <1mm wide white-clay veinlets.	32	9.3	0.1	2	90.4	55.5	5100
DDH241 / 20.0 - 21.0m	Carbonaceous Siltstone: Black partially oxidised with iron oxide coatings.	346	29	0.1	1.5	44	17.5	N.A.
DDH241 / 30.0 - 31.0m	Carbonaceous Siltstone: Black, massive with rare chloritic bedded layers. Rare <2mm pyrite bedding parallel veins.	850	42.5	0.1	2.5	21400	174	27800
DDH245 / 30.0 - 32.0m	Felsic dyke: Oxidised white to fresh grey, feldspathic. Occasional <5mm siliceous veins.	1520	120	0.05	1	681	65	1300
DDH244 / 09.2 - 10.0m	Chlorite-Chert BIF: Crushed clay zones with minor <10cm carbonaceous zones. Abundant chert nodules with red-brown patches suggesting oxidised sulphides. Bedding preserved but badly fractured.	44	48.5	<0.05	0.5	84	2.5	5400
DDH243 / 20.0 - 21.0m	Chloritic Cherty BIF: Oxidised orange and grey-green. Fractured with wavey bedding, abundant chert nodules with red-brown patches after pre-existent sulphide, mosaic breccia texture.	1170	35.5	<0.05	<0.5	32.6	20.5	N.A.
DDH242 / 24.0 - 25.0m	Chlorite-Cherty BIF. Completely oxidised orange and white. Orange colours from oxidation of chlorite & disseminated pyrite, pyrrhotite. Fractured friable core, best described as crackle breccia.	152	61	<0.05	0.5	33.6	1.45	1300
	NB: sulphate – Sulphur (last column) is a different digest. Analyses G910l are a pH=1.5 HCL leach. N.A. = Not Analysed							

6. WASTE LANDFORM

The waste landform will cover Pit and East gullies plus the intervening high ground. A high proportion of all wastes from the surface to about 195m AHD should be NAF and it is recommended some of this be stockpiled for encapsulating carbonaceous siltstone waste from deeper in the pit and as a final cover material over the dump.

Encapsulation of sulphidic waste is to be positioned high in the profile of the waste landform, not over the original valley areas. This will minimise any possibility of acidic drainage or heavy metal contamination of surface and groundwater.

The digital photographs of Mt Porter drill core indicate that hard blocky rock suitable for use in rip-rap under waste landform drains is absent. Even the dolerite appears fragmented and unsuitable. Other rock types form laminar, schistose and angular fragments. No coarse fragmental material was observed suitable for sub-dump drainage. On this basis, it is recommended that any coarser rocky material from above 195m AHD be positioned in the centres of the original drainages to act as rip-rap and minimise contaminant flow to ephemeral streams.

Whilst drainage down pre-existing water courses beneath the waste landform will occur, the top surface of the waste landform is to be designed to shed water. Surface flow will be directed to open drainage lines at the outer edge of the waste landform, then down rock lined spillways, to rejoin the natural creekline below the waste landform. Since soils are already acidic, this is unlikely to create ecological problems, particularly if near surface material is used as a final cover.

7. PROPOSED WETLAND FILTER

The 2004 NOI included the following statement.

"..... East Gully and Pit Gully join a short distance below the mine site but within the tenement boundaries. It is intended to construct a wetland filter immediately downstream of the confluence of the two gullies to remediate any acid water emanating from the site. The filter will be designed according to accepted engineering standards to maximise residence time within the structure. Depending on the depth of the naturally occurring soils it may be necessary to import some clay soil into which suitable species (Scleria, Typha and Eleocharis spp.) may be established. ....."

Of the recommended plant genera only one species of *Scleria* was identified in the area. The anticipated soil at the site selected approximately corresponds to the soil at the TS4 'Swampy Meadow' soil sample site (Tables 3 and 4). The dampest point within this site was dry with soil holding less than 10% residual moisture (Table 4) when sampled in mid April 2005, very shortly after the completion of the wet season. This suggests that the soil in this area is unsuitable and strongly mitigates against use of the site as a wetland filter.

A wetland filter can only be successful if kept permanently fed with water and capable of supporting appropriate vegetation. To do this will require a no contaminant loss drainage to the site, appropriate vegetation capable of removal of the contaminants and ex-site drainage where de-contaminated water can be discharged or evaporated without increase of soil contaminants.

The preferred alternative to the use of wetland filters is the use of shallow sedimentation basins placed near the base of the waste landform in both drainage lines or at the confluence of the creeks at the ROM area. These will provide the most effective water management systems for the site. The waste landform will be designed to shed water, so most rainwater will follow surface drainage features. Sediment will be the dominant contaminant from drainage off the waste landform.

The quantity of seepage water from the underdrain systems is expected to be minor relative to the surface flows. The seepage water will also report to the sedimentation basins. Quantities will be at maximum during the wet season, when dilution with surface flows is also at maximum. The creeks are ephemeral, so no seepage during the dry season is expected.

8. FINAL PIT VOID

Limited information is available to permit a good evaluation of final void geochemistry. The North – South elongated pit will have high walls on the north and west sides, relatively shallow on the east and south. The north wall will be largely PAF carbonaceous siltstone whilst the south wall, also carbonaceous siltstone may have much lower acid forming capacity as most of that wall will be oxidised. Dominantly NAF chloritic cherty BIF should comprise most of the west and east walls. The base of the pit will be mostly fresh sulphidic carbonaceous siltstone but this will be dominantly below the water table following mining.

Since all of the PAF material in the completed open pit other than a small portion of the North wall, will be below the projected water level, strong acidification is possible, but unlikely. The high carbon content of the wall rocks will reduce oxygen availability to sulphides and simultaneously minimise oxidation of ferrous ions to ferric. The high pit walls on the north and west will also minimise thermal transfer to the water, in turn minimising convective overturn, mixing and evaporation. Thus significant acidification should be slow, but relatively high base metal levels comparable to sample DDH 241 / 30 – 31 metres may eventuate as metals will be released in oxidising sulphides above water table levels on the north wall, and be washed into the pit water during rain periods.

Due to minimal convective overturn, the pit water is likely to stratify with fresher water near the surface and progressively more contaminated at depth. This is unlikely to detrimentally affect the quality of groundwater in the surrounding area as both porosity and permeability of the wall rocks will be extremely low. Existing groundwater data plus the diamond drill hole logs and photographs all suggest that the only significant aquifers are within the oxide zone.

9. GLOSSARY OF GEOLOGICAL AND TECHNICAL TERMS

ANC	Acid Neutralising Capacity A process where a sample is reacted with excess dilute HCl at a pH of about 1.5, for 2-3 hours at 80-90°C followed by back-titration to pH=7 with sodium hydroxide. This determines the acid consumed by soluble materials in the sample.
adsorption	The process of metals attaching themselves to mineral particles, normally clays.
anticline	A fold in rock strata that is convex upward with a core of older rocks.
antiformal	A complex structure which is generally anticlinal.
assay	The value of gold or other elements as measured by laboratory techniques.
azimuth	The horizontal direction of a drill hole or rock stratum.
banded iron formation	A banded rock composed of layers of an iron-rich mineral such as magnetite, pyrite, pyrrhotite or iron carbonate, and silica such as quartz or chert.
basalt	Dark coloured fine grained volcanic rock composed mainly of feldspar and pyroxene.
basement	Term used to describe the geological rock unit underlying all other units in the described area.
chlorite	A hydrated magnesium alumino-silicate mineral formed by low grade metamorphism.
chloritic banded iron formation	A banded rock composed of layers of chlorite mineral in banded iron formation
colluvial, colluvium	Weathered material transported by gravity slip on gently sloping surfaces.
desorption	Process whereby metals detach themselves from clays and go into solution.
dextral (fault)	A right lateral strike-slip fault. Viewed from one side, the block on the other side appears to have moved to the right.
diamond drilling	Method used to obtain a core of rock using a diamond impregnated bit.
dip	The angle at which a stratum is inclined from the horizontal.
fault	A fracture in the rock along which there has been an observable amount of displacement.
feldspar	A group of abundant rock forming minerals.
felsic	A generalised term to describe igneous and metamorphic rocks composed dominantly of quartz and alkali feldspar.

foliated	Parallel orientation of platy minerals or mineral banding in rocks.
granite	A coarse-grained igneous rock consisting essentially of quartz (20-40%), alkali feldspar and very commonly a biotite and/or muscovite and sometimes hornblende.
gossan	A surface capping of hydrated oxides of iron formed by weathering of metallic sulphides.
horizon	A time-plane recognisable in rocks by some characteristic feature such as flora, fauna or lithology.
intrusion	A body of igneous rock which invades older rocks.
laterite	A strongly leached iron and aluminium-rich rock formed close to the surface by weathering in tropical conditions.
mafic	Descriptive of rocks composed dominantly of magnesium and iron forming silicates.
magnetite	An important iron ore mineral, Fe_3O_4.
metallurgical	Referring to treatment of ores to extract concentrates or the metals within them.
mineralisation	The concentration of metals and their chemical compounds within a body of rock.
MPA	Maximum Potential Acidity A calculation where the total sulphur in the sample is assumed to all be present as pyrite. This value is multiplied by 30.6 to produce a value known as the Maximum Potential Acidity. Correctly, the MPA should multiply only the non-sulphate sulphur by 30.6 but sulphate-sulphur is often not determined.
NAG	Net Acid Generation A process where a sample is reacted with 15% hydrogen peroxide solution at pH=4.5 to oxidise all sulphides and then time allowed for the solution to react with acid soluble materials. This is a direct measure of the acid generating capacity of the sample but can be affected by the presence of organic materials.
NAPP	Net Acid Producing Potential (MPA-ANC) A calculation where the total sulphur minus the sulphur present as sulphate is assumed to all be present as pyrite. The non-sulphate sulphur value is multiplied by 30.6 to produce a value. The ANC value is now deducted from this to produce the NAPP. NAPP is a very conservative (excessive acid content) figure as sulphides which do not contain iron are assumed to produce acid which is incorrect.
ore	Mineral bearing rock which can be mined and treated at a profit.
overburden	Any loose unconsolidated material which rests upon solid rock; useless material which overlies a bed of useful material.

oxidation	Near surface decomposition by exposure to the atmosphere and ground water.
oxide zone	The weathered portion of the regolith.
plunge	Inclination of a fold axis or other structure.
quartz	A mineral composed of silicon dioxide (silica).
Quaternary	Recent geological period less than 1.8 million years old.
RAB drilling	Rotary airblast drilling. A shallow drilling method where rock chips are recovered at the surface by air pressure.
reverse circulation drilling	A percussion drilling technique in which the cuttings are recovered through the drill rods thus minimising losses.
regolith	The portion of the earth's crust which has been affected by mechanical and chemical weathering of unaltered bedrock.
resource	In the context of this report, mineralisation to which conceptual tonnage and grade figures are assigned, but for which exploration data are inadequate to calculate geological reserves.
schist	A metamorphic rock with a platy or foliated texture.
sediment	Rocks formed by the deposition of solids from water.
sesquioxide	a precipitate formed in water within a nominal pH of 5.1 to 7.8. This will be largely aluminium tri-hydrate plus iron tri-hydrate but will include arsenic penta-hydrate, arsenic tri-hydrate, titanium hydroxides, manganese^{III} hydroxides plus other adsorbed metas.
sinistral (fault)	A left lateral strike-slip fault. Viewed from one side, the block on the other side appears to have moved to the left.
strike	The course or bearing of a bed, a vein or a layer of rock.
stringers	Very thin commonly irregular veins, usually of quartz, cutting through other rock types.
strip-ratio	The amount of overburden that has to be removed to produce a tonne of ore.
sub-crop	Rubble or poor outcrops which barely protrude through surface soil.
supergene	Processes involving water, with or without dissolved material, percolating down from the surface.
syncline	A fold in rock strata that is convex downward with a core of younger rocks.
transitional zone	The section of the regolith normally where water table fluctuation occurs and where there has been incomplete oxidation. Fresh, partially altered and totally altered sulphide and silicate minerals co-exist. Supergene precipitation of heavy metals and precious metals often occurs in this zone.

ultramafic	Descriptive of igneous rock containing virtually no quartz or feldspar and composed essentially of ferromagnesian silicates, mainly olivine, pyroxene and derived minerals.
vein	A thin sheet-like intrusion into a fissure or crack, commonly bearing quartz.
volcanic	Descriptive of rocks originating from volcanic activity.

10. REFERENCES

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