OCEANIA TASMANIA Pty Ltd

Acid Mine Drainage Status of the Comstock Waste Rocks & Swansea Tramway Waste Rock Dump

1 December 2003

Qualifications and Disclaimers

Paul Heath has prepared this final report. Paul is currently employed as a geologist at the Comstock Mine for Oceania Tasmania Pty. Ltd, and has a BSc (Hons) in geology that was completed at the end of 1999 from the University of Tasmania. His undergraduate BSc Degree was completed at La Trobe University during 1997. Other qualifications include The Advanced Certificate of Horticulture at Burnley, Victoria (1993). All Allison pit waste rock samples were collected by the author and analysed at Analabs Pty Ltd, Burnie. Thin sections were produced at the University of Tasmania, Geology Department Lapidary.

Paul accepts no liability to any person for errors or omissions, for losses or damages claimed as a result, directly or indirectly, of opinions or data produced in this report.

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Introduction

'Acid rock drainage (ARD) is produced by the exposure of sulphide minerals such as pyrite to atmospheric oxygen and water. The ability to identify in advance any mine materials that could potentially produce ARD is essential for timely implementation of mine waste management strategies for ARD control.' - (AMIRA, 2002, p. A1)

This report focuses on samples obtained between July 1, 2002 to 30 September 2003, from the Comstock Mining Leases held by Oceania Tasmania Pty Ltd, and forms part of a biannual report, in accordance with Permit Conditions (06-07-01) as outlined in the Development Proposal and Environmental Plan (DPEMP – 2001). The parameters listed as required in the Monitoring Schedule include: NAG, NAG pH, and AMD status.

The aim of this report is to summarise the ARD status of the Swansea Tramway Waste Rock Dump (STWRD) and investigate the ARD potential of waste rocks that may be used on the dump in the future.

Metals Produced

Silver, lead and zinc as sulphide concentrates.

Methods

A systematic program to determine ARD of waste rocks was analysed at Analabs Pty Ltd., Burnie, Tasmania. Analyses included: net acid producing potential (NAPP), net acid generation (NAG), net acid generation pH (NAG pH), acid neutralising capacity (ANC % $CaCO_3$), Electrical Conductivity (EC) and Total % Sulphur. Additionally, several thin-sections were cut at the University of Tasmania, Geology Department Lapidary to determine minerals. Results are shown in Table 2.

Three classification systems from Miller (1998), AMIRA (2002) and Environment Australia (1997) have been used as a guide to try and determine the acid generation of samples.

Miller (1998) has proposed a scheme for assessing a rock's propensity to generate ARD. A classification table that uses NAG pH, static NAG values and NAPP categorises individual samples as potentially acid forming, potentially acid forming–low capacity, non-acid forming, acid consuming or uncertain (Table 1).

Table 1. Classification scheme of the potential for acid production (Miller, 1998).

Primary Geochemical Waste Type	Final NAG pH	Static NAG Value (kg H_2SO_4/t)	NAPP (kg H_2SO_4/t)
Potentially Acid Forming	<4.5	>5	Positive
Potentially Acid Forming - Low Capacity	<4.5	≤5	Positive
Non Acid Forming	≥4.5	0	Negative
Acid Consuming	≥4.5	0	Less than −100
Uncertain	≥4.5	0	Positive
	>4.5	>0	Negative

Additionally, AMIRA (2002) have developed a number of procedures to determine acid forming characteristics of mine waste materials. AMIRA (2002) propose the most widely used assessment methods for ARD characterisation are the Acid-Base Account (ABA) and the Net Acid Generation (NAG) test. These methods are referred to as static tests procedures because each involves a single measurement in time. Figures 1 to 3 show ABA and Geochemical classification plots with Comstock samples.

A silver-lead-zinc mine (Cannington) operated by BHP Minerals in Environment Australia (1997) have identified a characterisation process for mine waste materials and has been referred to in Table 2, for a technique used in the determination of the ARD status of waste materials at the Comstock Mine, Zeehan.

Swansea Tramway Waste Rock Dump

During September 2003, mine geologist Paul Heath collected two composite samples from the STWRD for determination of the ARD status (Table 2).

Main Lode - carbonates

During September 2003, mine geologist Paul Heath collected two samples; a talc-silica rock and carbonate rock. The samples were collected to determine acid buffering potential. These rocks are represented as R1 and R2 in Table 2.

Allison's Pit Waste Rock Study

During August 2002, carbonate petrologist Dr Mohammad Adabi and mine geologist Paul Heath collected 12 waste rock samples from Allison's pit that have been planned as overburden to the STWRD.

Additionally, five representative down-hole samples were collected from drillholes SY021 and SY022 (Table 2) as a first pass to characterise the acid forming potential or acid neutralising potential of waste rock from Allison's decline that is proposed to be used during stages 2 to 6 of the Preliminary Waste Management Plan (Appendix 4 of: Comstock Revised Management Plan & Mine Plan, 2002).

Table 2: Acid forming/buffering values of mine waste materials, Comstock Mine. Updated : November 18, 2003 by & P. Heath

Sample	Northing	Easting	Type	From (m)	To (m)	Thin sections	NAPP	NAG Kg H_2SO_4/tonne	NAG pH	ANC % $CaCO_3$	ANC Kg H_2SO_4/tonne	Total %S	EC US/cm	EC dS/cm	MPA Kg H_2SO_4/tonne 30.6	Environement Australia, 1997	Miller, 1998	Amira, 2002	Rock Name
Swansea Dump (30-9-03)																			
STWRD01	357327	5359994	Grab	N/A	N/A	No	4.1	33.31	2.1	0.1	0.98	2.98	N/A	N/A	91.19	PAF	PAF	PAF	composite*
STWRD02	357329	5359931	Grab	N/A	N/A	No	1.6	31.29	2.3	0.1	0.98	1.11	N/A	N/A	33.97	PAF	PAF	PAF	composite*
Main Lode (30-9-03)																			
R1	357364	5360582	Grab	N/A	N/A	No	3.3	2.52	6.7	0.4	3.92	0.02	N/A	N/A	0.61	NAF	UC (NAF)	Barren	Silica-micrite-talc
R2	357368	5360595	Grab	N/A	N/A	No	-213.3	<0.5	9.8	42.9	420	0.08	N/A	N/A	2.45	NAF	ACM	NAF	carbonate
Allison's open pit (30-8-02)																			
WR1	5360522	357585	Grab	N/A	N/A	No	-1.78	1.96	6.1	0.4	3.92	0.1	220	0.22	3.06	NAF	NAF	NAF	Silica-micrite-talc
WR2	5360524	357586	Grab	N/A	N/A	No	-0.97	2.69	3.3	0.3	2.94	0.29	196	0.20	8.87	PAF-LC	UC (NAF)	UC (NAF)	Silica-micrite-talc
WR3	5360529	357587	Grab	N/A	N/A	No	-1.08	1.47	6.3	0.4	3.92	0.09	287	0.29	2.75	NAF	NAF	NAF	Silica-micrite-talc
WR4	5360536	357585	Grab	N/A	N/A	Yes	-0.20	1.23	4.9	0.3	2.94	0.15	377	0.38	4.59	NAF	NAF	NAF	Silica-micrite-talc
WR5	5360557	357579	Grab	N/A	N/A	No	-6.03	5.64	3.7	0.1	0.98	0.13	471	0.47	3.98	PAF-LC	UC (NAF)	Barren	Silica-micrite-talc
WR6	5360578	357579	Grab	N/A	N/A	Yes	0.50	2.2	6.2	0.2	1.96	0.03	96	0.10	0.92	NAF	UC (NAF)	Barren	Silica-micrite-talc
WR7	5360595	357572	Grab	N/A	N/A	Yes	-0.37	0.74	6.6	0.2	1.96	0.03	91	0.09	0.92	NAF	NAF	NAF	Silica-micrite-talc
WR8	5360603	357575	Grab	N/A	N/A	No	-0.37	0.74	6.7	0.1	0.98	0.03	89	0.09	0.92	NAF	NAF	NAF	Silica-micrite-talc
WR9	5360612	357597	Grab	N/A	N/A	No	-4.98	3.18	3.8	0.1	0.98	0.08	140	0.14	2.45	NAF	UC (NAF)	Barren	Silica-micrite-talc
WR10	5360613	357605	Grab	N/A	N/A	Yes	-2.15	1.96	5.5	0.1	0.98	0.03	84	0.08	0.92	NAF	NAF	NAF	Silica-micrite-talc
WR11	5360613	357617	Grab	N/A	N/A	Yes	-0.78	3.43	5.8	0.1	0.98	0.05	97	0.10	1.53	NAF	NAF	NAF	Silica-micrite-talc
WR12	5360525	357597	Grab	N/A	N/A	No	4.61	102.9	2.4	0.1	0.98	4.35	663	0.66	133.11	PAF	PAF	PAF	shale
Drill Holes (30-8-02)																			
SY021			Drill Core	2	3	Yes	-88.52	<0.5	8.2	11.6	114	1.44	832	0.83	44.06	NAF	NAF	NAF	carbonate
SY021			Drill Core	8	11	No	10.48	88.2	2.4	0.4	3.92	4.28	830	0.83	130.97	PAF	PAF	PAF	shale
SY022			Drill Core	1.3	6.2	Yes	-2.27	1.47	4.1	0.2	1.96	0.12	91	0.09	3.67	NAF	UC (NAF)	Barren	Silica-micrite-talc
SY022			Drill Core	6.2	10.2	Yes	-4.87	<0.5	9.3	1.3	12.74	0.03	116	0.12	0.92	NAF	NAF	NAF	carbonate
SY022			Drill Core	13	14	No	13.18	98.98	2.3	0.3	2.94	4.04	678	0.68	123.62	PAF	PAF	PAF	shale

MPA	Maximum Potential Acidity (Kg H_2SO_4/tonne)=(Total%S)* 30.6
ANC	Acid Neutralising Capacity
ACM	Acid Consuming Capacity
NAPP	Net Acid Producing Potential
NAG	Net Acid Generation
NAG-pH	Final pH of solution following NAG test
UC (NAF)	Uncertain
Barren	No acid generating capacity and no buffering capacity
PAF-LC	Potentially Acid Forming - Low Capacity
***Composite sample**	Mixture of talc, quartz, shale
NAF	Not Acid Forming
PAF	Potentially Acid Forming

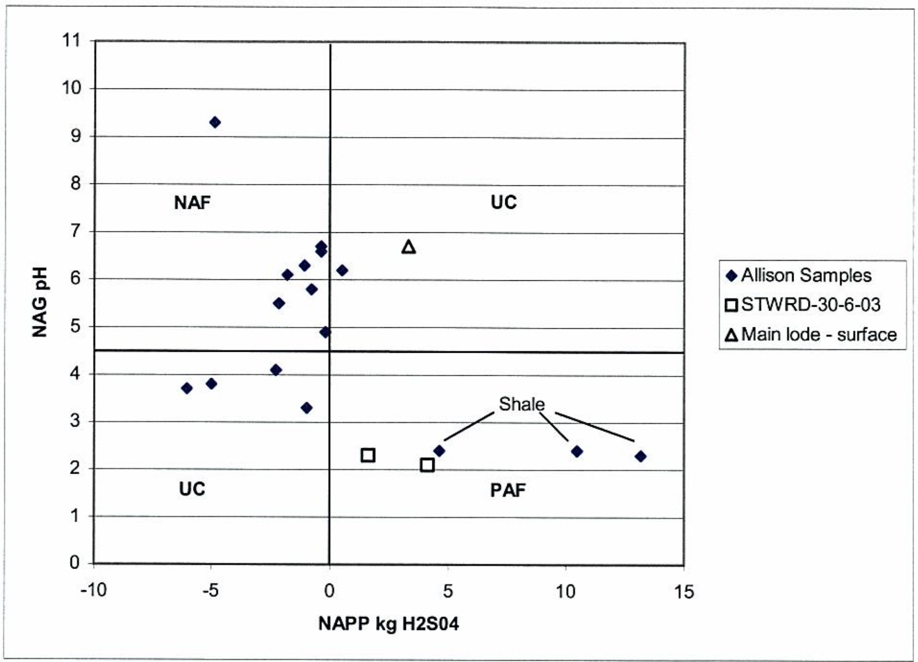

Figure 1. Geochemical classification plot taken from AMIRA (2002) showing fields as non acid forming (NAF), potentially acid forming (PAF) and uncertain (UC). Samples with a NAPP <-10 NAPP kg H_2SO_4 are not shown.

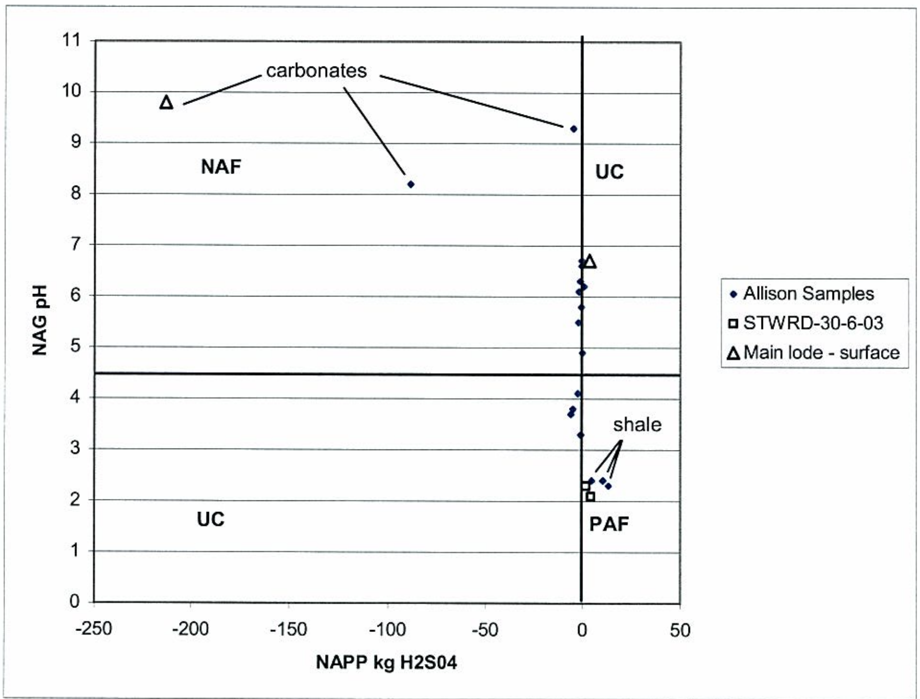

Figure 2. Geochemical classification plot taken from AMIRA (2002) showing fields as non acid forming (NAF), potentially acid forming (PAF) and uncertain (UC). All samples are shown that are represented in Table 2.

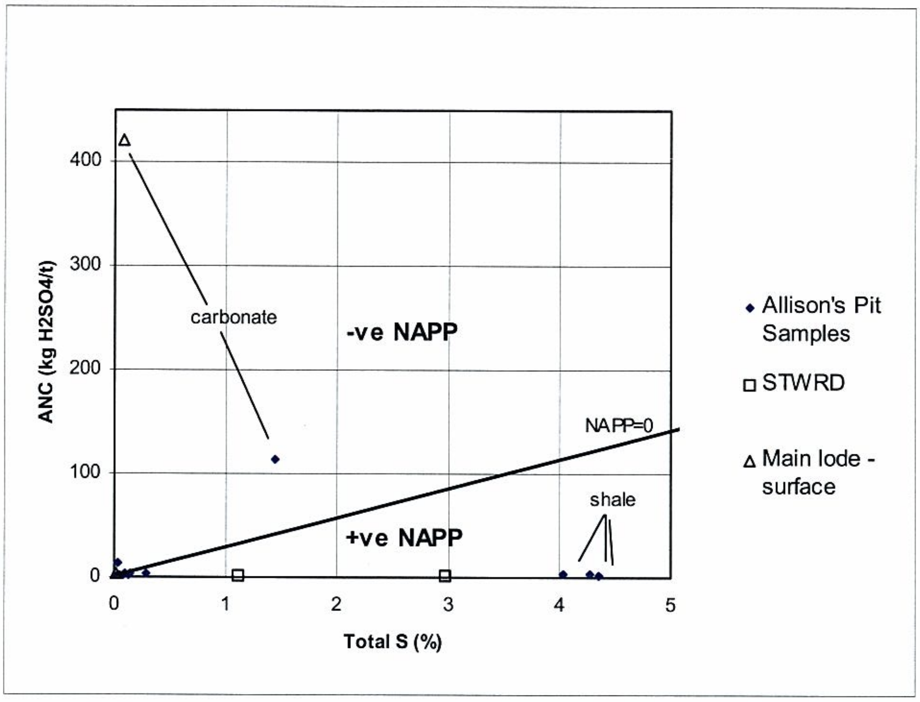

Figure 3. Acid-base account (ABA) plot adapted from AMIRA (2002). The shale and STWRD samples have a positive NAPP and Total S (%) >1 % and therefore have been classified as PAF. Additionally, the carbonates can be classified as non acid forming and may be acid buffering. Note, the remainder of the samples, accept for sample SY021 (2-3m), have a low Total sulphur content of <0.35%.

The techniques used in Miller, (1998), AMIRA, (2002), Environment Australia, (1997) have been used as a guide for the characterisation of the ARD status at the Comstock Mine. The three techniques described in the methods are comparable with the samples in Table 2 classified overall as either PAF or NAF.

Five samples (2 x STWRD & 3 x shale) in Table 2 have been classified as PAF. The remaining 16 samples (3 x carbonate, 13 x talc-silica-micrite) have been classified as NAF.

Samples R1, WR2, WR5, WR6, WR9 and SY021 (1.3m) have been classified as UC in some of the classification schemes. An UC classification is used when there is apparent conflict between the NAPP and NAG results. However, by using both NAPP and NAG tests, the risk of misclassification is significantly reduced and samples with UC classification are highlighted and may reflect organic acidity, rather than sulphide derived acidity (AMIRA, 2002). Additionally, some sulphur may occur as other metal sulphides (e.g. sphalerite, galena), that yield less acidity than pyrite when oxidised, or in some cases, may be non-acid generating or acid consuming. Total sulphur (%) suggests that these can be classified as NAF due to the small amount of Total sulphur (<0.35%). Samples classified as PAF always has significant sulphur contents (AMIRA, 2002), such as samples STWRD01. STWRD02, WR12, SY021 (8-11m) and SY022 (13-14m), that ranges from 1.11% to 4.35% Total sulphur.

Samples R2 and SY021 (2-3m), are shown to be carbonates, and have an acid buffering-consuming capacity indicated by low NAPP (-88 and –213 respectively) and Total sulphur values (0.08% and 0.03%) respectively.

Discussion on STWRD

During June 2000 to September 2003 the STWRD has been the site for overburden from the Allison's decline. The majority of rock moved from Allison's pit has been talc-silica-micrite (overburden outside of ore zone; Table 2, WR1 to WR11), talc-silica-micrite-disseminated pyrite (within Allison's ore zone – see Koehnken, 2001), shale (Table 2 and Koehnken, 2001) carbonate (Table 2) and minor massive pyrite, galena, sphalerite (Koehnken, 2001).

The shale, talc-silica-micrite-pyrite and massive pyrite, show to be PAF (Table 2, Koehnken, 2001) and are probably the cause of ARD shown in samples STWRD01 and STWRD02 (Table 2).

Originally, the removal of talc containing disseminated pyrite within the ore zone was deposited within the centre of the STWRD, with low NAG material partially encapsulating it. However, recent site excavations have mixed these zones to achieve maximum compaction, contouring and access to the base.

Summary of the STWRD

NAG and NAG pH: The majority of the material believed to be present in the dump has a final NAG value of > 5kg H_2SO_4/t and a NAG pH of <4.5 (STWRD01 & STWRD02), resulting the material being classified as "Potentially Acid Forming' based on the classification of Miller (1998), AMIRA (2002) and Environment Australia (1997).

AMD status: The status of the dump is considered to be actively oxidising with minor amounts of buffering capacity available to neutralise the generated sulphuric acid at this stage. Disseminated pyrite within the shale shows to be the main contributor of ARD to the STWRD.

Reference

AMIRA., 2002. *Project P387A - Prediction & Kinetic Control of Acid Mine Drainage*, AMIRA International.

Environment Australia., 1997. *Managing Sulphidic Mine Wastes and Acid Drainage*. Commonwealth of Australia.

Koehnken, L., 2001. *AMD Status of Central Mine Waste Rock Dump at Oceania Comstock Mine*. Unpublished Report.

Miller, S., 1998. *Assessment of Acid Forming Characteristics*. Environmental Geochemistry International Pty Ltd, p.5 Appendix 10.

Miller, S., 1998. *Predicting Acid Drainage*, Groundwork, Australian Minerals and Energy Environment Foundation, v2, no.1, p 8-9.

Appendix A – Analytical Data

For action:

For information:

File:

Analabs Pty Ltd
ACN 004 591 664

RECEIVED
30 AUG 2002

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ANALYSIS REPORT SHEET

To
Paul Heath
Oceania Tasmania
PO Box 1603
HOBART TAS 7000

Order No.: 436 Our Reference BU019093

SAMPLE	NAPP	NAG	NAG pH	ANC	%S	
		Kg H_2SO_4/tonne		% $CaCO_3$		
WR01-02	-1.78	1.96	6.1	0.4	0.10	✓
WR02-02	-0.97	2.69	3.3	0.3	0.29	
WR03-02	-1.08	1.47	6.3	0.4	0.09	✓
WR04-02	-0.20	1.23	4.9	0.3	0.15	✓
WR05-02	-6.03	5.64	3.7	0.1	0.13	✓
WR06-02	0.50	2.2	6.2	0.2	0.03	✓
WR07-02	-0.37	0.74	6.6	0.2	0.03	✓
WR08-02	-0.37	0.74	6.7	0.1	0.03	
WR09-02	-4.98	3.18	3.8	0.1	0.08	
WR10-02	-2.15	1.96	5.5	0.1	0.03	
WR11-02	-0.78	3.43	5.8	0.1	0.05	
WR12-02	4.61	102.9	2.4	0.1	4.35	Shale
SY021 (2-3M)	-88.52	<0.5	8.2	11.6	1.44	
SY021 (8-11M)	10.48	88.2	2.4	0.4	4.28	Shale
SY022 (1.3-6.2M)	-2.27	1.47	4.1	0.2	0.12	✓
SY022 (6.2-10.8M)	-4.87	<0.5	9.3	1.3	0.03	✓
SY022 (13-14M)	13.18	98.98	2.3	0.3	4.04	Shale

M. A. Good

Mark Good
Laboratory Supervisor

A N A L A B S

Our reference	:	BU19093A
Your reference	:	**436**
Project code	:	Submission 158109
Report date	:	02/10/02
Report status	:	Final
Page	:	1 of 1

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ANALYTICAL DATA

Sample	Conduc					
WR01-02	220					
WR02-02	196					
WR03-02	287					
WR04-02	377					
WR05-02	471					
WR06-02	96					
WR07-02	91					
WR08-02	89					
WR09-02	140					
WR10-02	84					
WR11-02	97					
WR12-02	663					
SY021 (2-3M)	832					
SY021 (8-11M)	830					
SY022 (1.3-6.2M)	91					
SY022 (6.2-10.8M)	116					
SY022 (13-14M)	678					
Method	E1006					
Units	uS/cm					
Detection Limit	1					

Notes: N.A. = not analysed, -- = element not determined, I.S. = insufficient sample, L.N.R. = listed not received

ANALYSIS REPORT SHEET

To: Oceania Tasmania Pty Ltd
PO Box 1603
HOBART TAS 7001

Attention: Paul Heath

Purchase Order No: 522

Our reference: BU019574 Date: 30 September 2003

SAMPLE	NAPP	NAG	NAG pH	ANC	%S
		Kg H_2SO_4/tonne		% $CaCO_3$	
STWRD01	4.1	33.31	2.1	0.1	2.98
STWRD02	1.6	31.29	2.3	0.1	1.11
R1	3.3	2.52	6.7	0.4	0.02
R2	-213.3	<0.5	9.8	42.9	0.08

Authorised by ....M.a Good.........
On behalf of:

Ricky Gelston
Manager - Tasmania

The results in this analytical report pertain to the samples provided to this laboratory for analysis as requested by the client.