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MINERAL RESOURCES TASMANIA

*“The Rehabilitation of Abandoned Tin
Mines in North Eastern Tasmania”*

**Determination of NAG Potential at
Endurance Mine**

September 1998



**SCIENTISTS
ENGINEERS
MANAGERS &
FACILITATORS**

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Mineral Resources Tasmania :
rehabilitation of abandoned tin mines in
north eastern Tasmania : determination of
NAG potential at Endurance Mine / SEMF

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1.0 INTRODUCTION

Following the establishment of the Rehabilitation of Mining Lands Trust Fund, Mineral Resources Tasmania (MRT) reviewed a number of Tasmania's abandoned mine sites and developed a priority list of sites requiring rehabilitation. The first of these sites to be addressed were the abandoned alluvial tin mines known as Monarch, Endurance and Star Hill mine, located in the north east of Tasmania.

In order to facilitate the fast, effective completion of rehabilitation activities, MRT engaged SEMF Holdings Pty Ltd (SEMF) to prepare a rehabilitation concept plan for the three mine sites. The concept plan identified and prioritised areas requiring stabilisation and rehabilitation.

Based on the findings of this report, SEMF were then commissioned to provide preliminary designs and costing for works, and undertake further investigations into areas of concern associated with the mines, such as the structural integrity of dams, water quality assessment and the net acid generation potential (NAG) of tailings.

As a component of the abandoned tin mines rehabilitation program the net acid generating (NAG) potential of waste water run-off was determined for tailings at the Endurance Mine. This report briefly describes the findings of NAG testing at the Endurance Mine site and the implications of these results in regard to the potential to cause environmental harm .

This report includes the collation, preparation and review of data for the Endurance mine site as detailed below:

1. The completion of a sampling program of the tailings site at the Endurance mine for heavy metals and sulphate and comparison of sampling results against the Department of Environment and Land Management (DELM) Environmental Investigation Guidelines
2. Determination of the NAG potential of samples collected from the tailings site.
3. Determination of the potential for generation of acid mine drainage (AMD).
4. Determination of the potential for environmental harm.



2.0 SAMPLING AND ANALYSIS PROGRAM

2.1 Sampling Methodology

The aim of the sampling and analysis program was to determine heavy metal and sulphate concentrations, and the NAG potential, in samples collected from the tailings site at Endurance mine. Tailings samples were extracted from the South Western Tailings fan at the Endurance mine on 26th June 1998. Sampling was conducted according to the SEMF ISO 9001 quality procedure "Soil Sampling for Chemical Analysis".

Samples were analysed for a range of analytes including heavy metals (cadmium, cobalt, chromium, copper, iron, manganese, nickel, lead and zinc) and sulphate. The NAG potential was determined in H⁺meq per 100g and then converted to kg H₂SO₄ per tonne for comparison with NAG tables.

2.2 Analytical Results

The results of the analyses are shown in the Tables below. The soil Environmental Investigation Limits, Fill Material Limits or Hazardous Waste Limits, are the guidelines identified by DELM (1996), ANZECC (1992) or Dutch (1994). All samples were analysed by a DELM recognised, NATA registered laboratory using NATA certified methodology. The laboratory analysis documentation is attached as Appendix A.

Table 1: Results of Heavy Metal and Sulphate Analyses

LIMITS (mg/kg)	Al	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Zn	SO ₄
Environmental Investigation Limit	NA	3	50	50	60	NA	500	60	300	200	2000
Fill Material Limit	NA	3	50	50	60	NA	NA	60	300	200	NA
Hazardous Waste Limit	NA	50	500	2500	1000	NA	NA	1000	3000	5000	NA
Samples (26/6/98)											
E1	870	<1	<1	1	<1	1440	7	1	3	2	3
E2	607	<1	<1	1	<1	2490	8	2	3	2	14
E3	931	<1	<1	1	<1	2650	4	1	5	1	6
E4	512	<1	<1	<1	<1	1360	3	<1	4	<1	5
E5	161	<1	<1	<1	<1	7820	1	<1	2	1	127
E6	504	<1	<1	1	<1	2090	10	<1	5	2	8
E7	1330	<1	<1	<1	<1	7370	4	<1	9	2	52
E8	153	<1	<1	1	<1	20600	5	<1	7	4	83
E9	726	<1	<1	2	<1	2070	6	<1	5	<1	4
E10	516	<1	<1	<1	<1	1350	5	<1	4	1	3
E11	1650	<1	<1	1	<1	1850	8	<1	51	2	18

NA - none available



The results of heavy metal analysis indicate that all samples collected from the tailings site are below the DELM or ANZECC Environmental Investigation Guidelines. Levels of cadmium, cobalt, chromium and copper were at or below laboratory detection limits. All samples were determined to be below the ANZECC Environmental Investigation Guideline for sulphate. No guidelines were available for comparison with aluminium and iron data.

2.3 NAG Sampling Results

Table 2 below shows the results of NAG testing on samples collected from the tailings site.

Table 2: Results and Determination of NAG Potential

Samples (26/6/98)	Net Acid Generating (NAG) Potential		
	H ⁺ meq/100g	kg H ₂ SO ₄ /t	Type
E1	2.8	1.4	2a
E2	3.5	1.7	2a
E3	4.2	2.1	2a
E4	1.9	0.9	2a
E5	2	1.0	2a
E6	3.5	1.7	2a
E7	8.3	4.1	2a
E8	1.7	0.8	2a
E9	3.8	1.9	2a
E10	3.1	1.5	2a
E11	1.4	0.7	2a

NAG results for all samples fall between the range of 0-5 kg H₂SO₄ per tonne. Comparison with NAG tables identify the samples as Type 2a, low acid producing potential. This observation is supported by the low sulphate and iron concentrations found in each sample.



3.0 CONCLUSIONS

Waste rock generated by former mining operations has been tested for its net acid generating potential. This measurement has been incorporated with heavy metal and sulphate analysis to determine the potential for generating acid mine drainage (AMD) and the likelihood of the AMD to contain significant levels of heavy metals.

AMD results from the oxidation of sulphide minerals which have been exposed to the atmosphere as surface disturbance, waste rock dumps, and within mine workings. The rate of sulphide oxidation determines the potential for the generation of acid drainage.

Secondary factors influencing acid generation are the presence of minerals, such as carbonates and silicates, that are in sufficient quantities to offset the acid producing potential of the material, effectively neutralising its acidity. The presence of sulphate and these minerals can act as indicators of impending acid drainage problems.

Oxidation products become entrained in run-off and groundwater resulting in acidification of water. The development of acid conditions increases the solubility and release of metals and increases salinity or solute loads (oxidation and neutralisation products). These metals tend to be transported into downstream catchments where they can impact on the rehabilitation of disturbed areas and reduce water quality thereby impacting on the receiving environment (specifically flora and fauna) and creating the potential for environmental harm.

NAG testing of samples extracted from Endurance mine tailings have been determined to have a low acid producing potential or consuming character. This is supported by low sulphate concentrations also determined in the samples. These results suggest that the potential to form AMD is minimal. However, the oxidation process of sulphide minerals can continue for extended periods of time (hundreds of years) and as such the ongoing risk of acid drainage is still possible. The potential to generate AMD is further increased by the sizeable extent of tailings in the South Western tailings fan.

Laboratory analysis has determined that concentrations of heavy metals in tailings samples are well below DELM Environmental Investigation Guidelines. Aluminium however, can at low levels of pH, leach into solution and become important in terms of its toxicity. Aluminium can also affect acidity by exchanging with hydrogen ions in clays to form a weak acid that then reacts with alkali.



This suggests that acid leaching by AMD of the tailings would not result in significant concentrations of heavy metals in the run-off or in groundwater. However, the extent of the tailings site, the potential length of time available and the presence of aluminium may result in the generation of AMD which may result in a build up of contaminated run-off or groundwater.

The results indicate that the South Western Tailings Fan has very low heavy metal contamination levels and a potential low acid producing or consuming character. In situ, the tailings do not present a contamination concern with regard to limited human contact. In contrast the subsurface water movement through these tailings (through factors of hydrochemical concentration) presents a realised contamination issue.



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MRT, 1998: *The rehabilitation of Abandoned Tin Mines in North Eastern Tasmania - Summary of Works Completed*, SEMF July 1998

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ANZECC, 1992: *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites*. Australian and New Zealand Environment and Conservation Council and National Health and Medical Research Council, January 1992.



LIMITATIONS STATEMENT

This Report has been prepared in accordance with the scope of services set out in the contract between SEMF Holdings Pty Ltd (SEMF) and Mineral Resources Tasmania ('the Client'). To the best of SEMF's knowledge, the proposal presented herein represents the Client's intentions at the time of printing of the Report. However, the passage of time, manifestation of latent conditions or impacts of future events may result in the actual project and its impact differing from that described in this Report. In preparing this Report, SEMF has relied upon data, surveys, analyses, designs, plans and other information provided by the Client and other individuals and organisations referenced herein. Except as otherwise stated in this Report, SEMF has not verified the accuracy or completeness of such data, surveys, analyses, designs, plans and other information.

Prepared by SEMF Holdings Pty Ltd
Published by SEMF Holdings Pty Ltd



APPENDIX A

Laboratory Results

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Laboratory Report

Project No: 9427 *Please quote this number when making enquiries about this project*
Submitted By: S. Talbot
Client: SEMF Holdings Pty Ltd
Site Description:
Received: 06-Jul-98
Report Date: 04-Aug-98
Report To: S. Talbot
Address: 45 Murray St, Hobart 7000

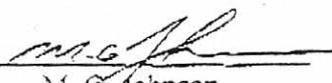
Test Method(s) :

Metals-Soil: DELM Metals in Soil by ICPAES *
ASLS10B3: Extractable Sulphur 1:5 Soil:0.01M Calcium Phosphate
NAG: Net Acid Producing Potential



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Samples analysed as received.

* Indicates test covered by and performed in accordance with terms of registration.


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Senior Chemist

0005/006
SEMIF HOLDINGS PTY LTD
LABORATORY



Tasmania

Department of Environment and Land Management
Division of Environment and Planning Laboratory
c/- Chemistry Department University of Tasmania
Sandy Bay Tasmania 7005



Project No: 9427

Report Date: 04-Aug-98

Lab.No.	Sample Id.	Date/Time Sampled	mg/100g
985508	E1	28/06/1998	2.8
985509	E2	26/06/1998	3.5
985510	E3	26/06/1998	4.2
985511	E4	28/08/1998	1.0
985512	E5	28/06/1998	2.0
985513	E6	26/08/1998	3.5
985514	E7	26/06/1998	8.3
985515	E8	26/06/1998	1.7
985518	E9	28/08/1998	3.8
985517	E10	28/06/1998	3.1
985518	E11	26/06/1998	1.4

Method: NAG

Analyte: N.A.G.



Tasmania

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 Division of Environment and Planning Laboratory
 c/- Chemistry Department University of Tasmania
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Project No: 9427

Report Date: 04-Aug-98

Method: ASLS10B3			
Lab.No.	Sample ID.	Analyte: Date/Time Sampled	Sulphate mg/kgDMB
985508	E1	26/06/1998	3
985509	E2	26/06/1998	14
985510	E3	26/06/1998	6
985511	E4	26/06/1998	5
985512	E5	26/06/1998	127
985513	E6	26/06/1998	8
985514	E7	26/06/1998	52
985515	E8	26/06/1998	83
985516	E9	26/06/1998	4
985517	E10	26/06/1998	3
985518	E11	26/06/1998	18



Tasmania

Department of Environment and Land Management
 Division of Environment and Planning Laboratory
 c/- Chemistry Department University of Tasmania
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Project No: 9427

Report Date: 04-Aug-98

Method: Metals-Soil

Lab.No.	Sample Id.	Analyte: Date/Time Sampled	Cd mg/kgDMB	Co mg/kgDMB	Cr mg/kgDMB	Cu mg/kgDMB	Fe mg/kgDMB	Mn mg/kgDMB	Ni mg/kgDMB	Pb mg/kgDMB	Zn mg/kgDMB
985508	E1	26/06/1998	<1	<1	1	<1	1440	7	1	3	2
985509	E2	26/06/1998	<1	<1	1	<1	2490	8	2	3	2
985510	E3	26/06/1998	<1	<1	1	<1	2650	4	1	5	1
985511	E4	26/06/1998	<1	<1	<1	<1	1360	3	<1	4	<1
985512	E5	26/06/1998	<1	<1	<1	<1	7820	1	<1	2	1
985513	E6	26/06/1998	<1	<1	1	<1	2090	10	<1	5	2
985514	E7	26/06/1998	<1	<1	<1	<1	7370	4	<1	9	2
985515	E8	26/06/1998	<1	<1	1	<1	20600	5	<1	7	4
985516	E9	26/06/1998	<1	<1	2	<1	2070	6	<1	5	<1
985517	E10	26/06/1998	<1	<1	<1	<1	1350	5	<1	4	1
985518	E11	26/06/1998	<1	<1	1	<1	1850	8	<1	51	2



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Laboratory Report

Project No: 9530 *Please quote this number when making enquiries about this project*

Submitted By: S. Talbot

Client: SEMF Holdings Pty Ltd

Site Description:

Received: 05-Aug-98

Report Date: 19-Aug-98

Report To: S. Talbot

Address: 45 Murray St, Hobart 7000

Test Method(s) :

Metals-Soil: Metals in Soil, Sediment & Dust by ICPAES *



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Samples analysed as received.

* Indicates test covered by and performed in accordance with terms of registration.


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Project No: 9530

Report Date: 19-Aug-98

Method: Metals-Soil

Analyte: Al

Lab.No.	Sample Id.	Date/Time Sampled	mg/kgDMB
986174	E1	26/06/1998	870
986175	E2	26/06/1998	607
986176	E3	26/06/1998	931
986177	E4	26/06/1998	512
986178	E5	26/06/1998	161
986179	E6	26/06/1998	504
986180	E7	26/06/1998	1330
986181	E8	26/06/1998	153
986182	E9	26/06/1998	726
986183	E10	26/06/1998	516
986184	E11	26/06/1998	1650