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Mt Bischoff
Webster Creek Diversion Drain
Inspection August 2005

Prepared for

Mineral Resources Tasmania

August 2005

Prepared by: Jim Lockley

Pitt & Sherry Ref: H05257H001.Bischoff.Report/JVL/Rev 00

Table of Contents

	Name	Signature	Date
Authorised by:	**Jim** Lockley		**September 2005**

1. Introduction

Pitt & Sherry was commissioned by Mineral Resources Tasmania in August 2005 to undertake an inspection and report on the Mt Bischoff, Webster Creek diversion drain.

The aim of the inspection and report was to supply an update on the status and performance of the drain.

2. Background

Mineral Resources Tasmania undertook acid mine drainage remediation works at the historic Mt Bischoff in 2003/2004. A key component of the remediation works was the installation of a diversion drain, directing the acid drainage in the upper catchment of Webster Creek to a wetlands area approximately 2.5 km downstream and adjacent to the Waratah River.

The diversion drain was constructed utilising the remnant formation of the historic North Valley track. Where possible clean surface water runoff from the up gradient catchment of the new diversion drain was separated from the acid mine drainage diversion drain using culvert drains.

The historic track was upgraded to accommodate the new drain and for routine access for maintenance and recharging of the limestone in the drain. The diversion drain was approximately 2.0 m wide and approximately 0.5 m deep depending on the natural ground and available area. The tracks upgrade included vegetation clearing, track reshaping, and track reconstruction as well as traversing old mine workings in some areas.

Due to the permeable nature of the drain and old track, the 1.9 kilometres length of the diversion drain was lined with a 0.7 mm polypropylene geomembrane liner. The drain was also lined with approximately 800 tonnes of limestone of nominal 150 - 250 mm diameter sizing. Approximately half of the limestone in the upper reaches of the drain was sourced from Mole Creek with the lower half sourced from Queenstown.

The limestone lining was installed as a sacrificial sulphuric acid neutralisation material. The neutralisation of the sulphuric acid raises the pH and alkalinity of the acid mine drainage and precipitates metal hydroxides that absorb other metals to mitigate the toxic nature of the drainage to the downstream wetlands, Waratah River and Arthur River.

Where the diversion drain crosses the Gun Club Road, a 900 mm concrete culvert was installed, capable of taking over 2 cumecs diversion flow under the road to Cliffs Creek and on to the wetlands area.

The prime aim of the works was to improve the water quality and the biodiversity of the Waratah River from its confluence with Webster Creek to its confluence with the Arthur River. The location of the diversion drain, Webster Creek, the wetlands, Waratah River and Arthur River are shown in Figure 1 below.

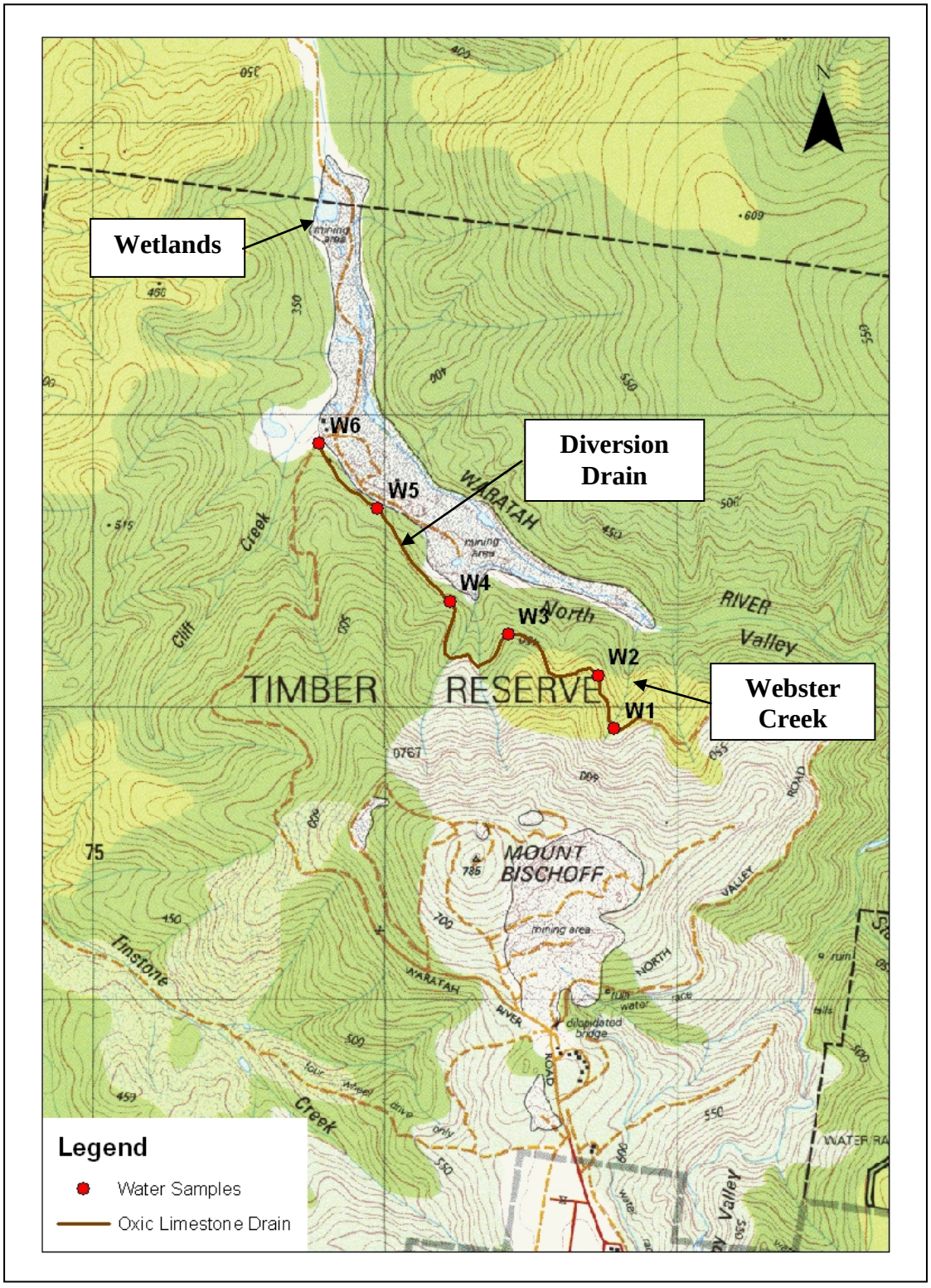

Figure 1. Local setting. **Source: Tasmap 1:25000 Topographic Map Series: Waratah 3641.**

The works commenced in summer 2003, but due to delays and the early onset of winter weather, the works were not completed until Christmas 2004.

On the 29 April 2004, Pitt & Sherry undertook an informal investigation of the completed works and the results of that investigation are contained in Appendix A and discussed in Section 4 below.

2.1 Investigation 29 April 2004

A site investigation was undertaken 29 April 2004 and demonstrated that the open limestone diversion drain was operating satisfactorily under very low flow conditions (0.1 L/s).

In drain measurements were taken using a 'Hydrolab'. Water samples were collected for analysis by Analytical Services Tasmania.

The pH of the diverted acid mine drainage was raised significantly within 200 m of the upper commencement of the drain and iron and aluminium precipitation was evident.

No permanent armouring of the limestone was evident at that time of investigation with the metal hydroxide and gypsum flocs easily removed from the limestone to expose new limestone surface.

Generally:

- The pH was increased.
- The acidity decreased.
- The alkalinity increased.
- Heavy metal concentrations decreased.
- Sulphate levels decreased.
- Electrical conductivity decreased.
- Calcium concentrations increased.

Information, photographs and analyses for the 2004 investigation are contained in Appendix A.

3. Main Observations August 2005

1. Approximately 20 to 30 small trees have fallen across the track. The trees have all fallen from the uphill side of the track where reinstating the track has undermined the trees or disturbed the roots. The tree can be easily walked around or over but need to be pushed over the downhill bank for safer access along the entire track.

2. A major amount of the limestone has been consumed or washed downstream. It is estimated that two thirds of the limestone (approximately 500 tonne) has been used. Refer to photographs in Appendix B compared to original photographs in Appendix A.

3. Track is fundamentally sound and the integrity of the diversion drain appears intact. Refer to photographs in Appendix B.

4. Short-circuiting of acid mine drainage is occurring at the top of the diversion drain where it is designed to pick up all the Webster Creek drainage. The original dam works consisted of mainly limestone and this has now been consumed by the acid mine drainage and the dam breached. Refer to photographs in Appendix B.

5. A partial blockage of one drain culvert at the old workings with twigs and leaves was evident. Refer to photograph Appendix B.

4. Investigation Findings 25 August 2005

The location of photographs, water samples for analysis and field water quality measurements are shown in Figure 1 in Section 2.

4.1 Flow

Flow measurements of the pipe discharge from Webster Creek to the diversion drain were taken using a 9 L bucket and a watch.

Flows from the drainage pipe averaged 9 L per 1.7 seconds. This equates to approximately 5.3 L/s.

Approximately 30 % of the pipe flow was short-circuiting past the collection pipe over the bank to the diversion drain. The total flow from Webster Creek was therefore 7.6 L/s (5.3 L/s plus 2.3 L/s).

Approximately 60 % or 4.6 L/s of the total Webster Creek flow to the diversion drain collection area is being lost directly to the Waratah River.

The flow down the diversion drain was approximately 40 % or **3 L/s**.

This flow increases to varying degrees down the diversion drain due to the collection of up gradient clean storm water run off. This flow has not been measured.

The minimum retention time for acceptable neutralisation is approximately 3 hours. (Reference PIRAMID Consortium - Engineering Guidelines for the Passive Remediation of Acidic and /or Metalliferous Mine Drainage and Similar Wastewaters).

As the diversion drain was limestone lined for the entire 2 km length, the maximum flow velocity is therefore 2 km in 3 hours.

This equates to 2km/3h = 0.67 km/h.

This equates to 0.67 km/h x 1000 m/km divided by 3600 s/h or 0.2 m/s.

Visual observations indicate that for assumed average flows of 3 L/s, the velocity of the drain water is less than 0.2 m/s. For lower diversion flow velocity the retention time will be higher and therefore neutralisation efficiency should be better than PIRAMID design criteria.

For higher winter flow velocities the retention time is likely to be insufficient for optimum neutralisation efficiency.

4.2 Locations

The locations of the field measurements, photographs and water sample sites were measured using a Garmin GPS 12.

Measurements were taken using WGS 84 map datum and UTM/UPS position format.

The use of the WGS 84 datum allowed the coordinates to be directly imposed onto the Arc View 8 GIS.

The ’eastings’ and ‘northings’ readings are contained in the field results contained in Table 1 below.

4.3 Field Water Quality Readings

The ‘in drain’ water quality measurements were taken using a TPS 90 – FC Field Lab Analyser multi meter.

Water samples were collected for analysis by Analytical Services Tasmania.

Field measured water quality data are contained in Table 1 below.

Date	Time	Site#	Oxygen	Cond.	pH	Temp
25/08/2005	12:46:13	W1	8.5%	2730.µS	2.55	13.4°C
25/08/2005	13:06:36	W2	2.0%	1539.µS	2.86	10.7°C
25/08/2005	13:30:08	W3	10.3%	1669.µS	2.94	11.7°C
25/08/2005	13:51:04	W4	10.7%	1555.µS	3.01	8.8°C
25/08/2005	14:06:17	W5	12.3%	1276.µS	3.11	8.2°C
25/08/2005	14:26:15	W6	16.2%	1048.µS	3.20	8.5°C

	Easting	Northing	Altitude	Photos
Site W1	0376896	5413108	500 m	1 to 4
Site W2	0376840	5413289	476 m	5 to 7
Site W3	0376532	5413430	452 m	8 to 14
Site W4	0376334	5413543	435 m	None
Site W5	0376086	5413859	380 m	15 to 17

The results indicate that should Mineral Resources Tasmania wish to improve the performance of the water treatment in the Webster Creek diversion drain, the reinstatement of Webster Creek drainage collection pond and reinstatement of the limestone or magnesite load in the drain is required.

A significant portion of the original 800 tonnes of limestone load in the diversion drain appears to have been consumed and the remainder appears to have lost its original effectiveness and requires refreshing with new limestone or magnesite.

This is subject to potential future mining activity at the Mt Bischoff mine. Future mining activities may completely alter pollutant fluxes and their nature.

4.4 Analytical Results

Based on the field results only two water samples were taken for analysis. The results are contained in Appendix C.

The results indicate that the remaining limestone has lost its original reactivity or effectiveness or that the nominal approximately 3 hours retention time required is not being achieved in the drain.

The pH of the diverted acid mine drainage was not raised significantly within the 2000 m length of the diversion drain. (2.55 to 3.2)

Permanent armouring of the limestone was evident at the time of the investigation with the metal hydroxide and gypsum flocs difficult to removed from the limestone to expose new limestone surface. Refer to photograph in Appendix B.

The results were not as dramatic as the original findings and can be generally summarised as follows:

- The pH increased only slightly.
- Heavy metal total concentrations were reduced by the existing treatment but the majority of the remaining metal concentrations were in the dissolved form as filtered to 0.45 µm. Toxicity attenuation was therefore unlikely as the analytical results indicate an actual increase in the soluble form of most metals.
- The reason for this increase in dissolved metals from top to bottom of the drain is unknown but may be due to:
  - Inadequate pH increase
  - Sample at the top was not representative of the actual drain input (E.g. bypassing at the top)
  - Dissolution or equilibrium shift of previously settle metal flocs in the drain
  - Particulate material less than 0.45 µm sizing and reporting as dissolved.
- Sulphate levels were reduced.
- Electrical conductivity decreased.
- Calcium concentrations increased.

Photographs and field data for the 2005 investigation are contained in Appendix B and water sample analytical results are contained in Appendix C.

4.5 Limestone Usage

It appears that approximately 500 tonnes of limestone has been consumed over the last 1.67 years. (Beginning of 2003 to August 2005)

The diversion flow from Webster Creek can vary significantly from zero to unknown flows due to incident storm events on the open mine workings at Mt Bischoff.

Webster flows appear to correlate directly with rainfall intensity and the retention time of waters in the mine workings appears to be low, less than 24 hours, based on previous observations.

Using an annual average diversion drain flow of 3 L/s @ approximately 2000 mg/L assumed annual average acidity (expressed as calcium carbonate), the average limestone usage is approximately 6000 mg/s

This equates to 6g/s x 3600 s/h = 21600 g/h.

This equates to 21600 g/h x 24 h/d = 518400 g/d.

This equates to518400 g/d x 365 d/y = 189216 kg/y = 190 t/y

This equates to approximately 190 t/y x 1.67 years = 320 tonnes of limestone usage since the commencement of the project.

The availability of limestone for neutralisation is never 100% due to varying reactivity and purity of the limestone. A realistic availability factor would be approximately 75%.

The requirement to neutralise the assumed acidity flux for 1.67 years is therefore approximately 430 tonnes.

This is a similar order of magnitude to the observed 500 tonnes of limestone that appears to have been consumed over the last 1.67 years.

For budgetary purposes, if MRT wishes to maintain the acid neutralisation performance of the Webster Creek diversion drain, approximately 250 tonnes per year of 150 – 250 mm diameter limestone will be required.

5. Recommendations

Should Mineral Resources Tasmania wish to continue to maintain access to the Webster Creek diversion drain and continue to treat the Webster Creek acid mine drainage diversion water with limestone, the following actions are required:

- Fallen trees need removing.
- Regular limestone reinstatement is required in the drain to maintain water treatment effectiveness.
- It is estimated that approximately 250 tonnes of limestone is required annually.
- Repairs are required to prevent the acid mine drainage bypassing the Webster Creek diversion drain collection system.
- Before implementing the above recommendations, the likely impact of future mining activity at Mt Bischoff on the Webster Creek diversion and acid neutralisation drain should be taken into consideration.
- All culverts need to be checked regularly.

Appendix A

INVESTIGATION 29 APRIL 2004

Bischoff Oxic Limestone Drain

The following measurements were taken on 29 April 2004.
Water samples were also taken at four of the five sites.
Photos were also taken.

No water sample taken for analysis at Web 3. Difficulty getting sample from drain. Drain level low due to shape of drain.

GPS readings in AGD 66 (Australian Geodetic Datum 1966)

Site	**Co-ordinates AMG66-Zone 55 (accurate to 1m)**	**PH**	**Temp °C**	**Conductivity**
Webster (flow 0.3 L/ 3s = 0.1 L/s out pipe)	376773 Easting 5412904 Northing	2.3	11.8	3.8 mS/cm
Web 1	376772 5412935	3.54	10.5	1319 µS/cm
Web 2	376395 5413237	5.7	10.5	1143 µS/cm
Web 3	376395 5413268	7.0	9.4	1088 µS/cm
Web 4	375733 5413935	6.9	10.0	1060 µS/cm

ANALYTICAL SERVICES TASMANIA

Sandy Bay Laboratory
c/- Chemistry Department University of Tasmania
Sandy Bay Tasmania 7005
NATA Accreditation
Number: 5589

Report No: 22258 **Report Date:** 14-May-2004 16:05

		Lab.No.:	57981	57982	57983	57984
		Sample Id.:	Webster	Web 1	Web 2	Web 4
1101-Water	Alkalinity Total	mg CaCO3/L	<1	<1	3	76
1102-Water	Acidity	mg CaCO3/L	2360	228	37	8
1103-Water	Sulphate	mg/L	2700	890	700	560
1301-Water	Al Dissolved	µg/L	57500	26400	3780	<20
	Al Total	µg/L	58600	26900	3960	661
	As Dissolved	µg/L	8570	<5	<5	<5
	As Total	µg/L	8740	17	<5	<5
	Cd Dissolved	µg/L	147	55	30	<1
	Cd Total	µg/L	151	57	30	<1
	Co Dissolved	µg/L	356	157	106	<1
	Co Total	µg/L	365	159	106	2
	Cr Dissolved	µg/L	58	5	<1	<1
	Cr Total	µg/L	59	8	<1	7
	Cu Dissolved	µg/L	9260	3290	342	<1
	Cu Total	µg/L	9460	3310	350	6
	Fe Dissolved	µg/L	611000	731	<20	<20
	Fe Total	µg/L	622000	6630	41	1220
	Mn Dissolved	µg/L	742	1910	2000	79
	Mn Total	µg/L	755	1940	2000	147
	Ni Dissolved	µg/L	264	135	86	2
	Ni Total	µg/L	271	136	86	7
	Pb Dissolved	µg/L	87	252	<5	<5
	Pb Total	µg/L	89	263	<5	15
	Zn Dissolved	µg/L	17600	8750	5050	17
	Zn Total	µg/L	17900	8890	5070	61
1302-Water	Ca Total	mg/L	7.10	187	195	236
	K Total	mg/L	1.14	3.00	2.88	3.37
	Mg Total	mg/L	48.6	26.5	22.9	19.1
	Na Total	mg/L	4.56	5.86	5.51	6.08

Appendix B

INVESTIGATION 25 AUGUST 2005

Date	Time	Log#	Oxy	Cond	pH	Temp
25/08/2005	12:46:13	W1	8.5%	2730.uS	2.55pH	13.4oC
25/08/2005	13:06:36	W2	2.0%	1539.uS	2.86pH	10.7oC
25/08/2005	13:30:08	W3	10.3%	1669.uS	2.94pH	11.7oC
25/08/2005	13:51:04	W4	10.7%	1555.uS	3.01pH	8.8oC
25/08/2005	14:06:17	W5	12.3%	1276.uS	3.11pH	8.2oC
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	Easting	Northing	Altitude	Photos
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Site W3	0376532	5413430	452 m	8 to 14
Site W4	0376334	5413543	435 m	None
Site W5	0376086	5413859	380 m	15
Site W6	0375886	5414082	355 m	16 & 17

Photo 2. Webster Creek collection pond - bypassing due to limestone dissolution in containment wall.

Photo 3. Webster Creek bypassing over track to Waratah River (top left).

Photo 4. Webster Creek flow and sampling point at collection pond.

Photo 6. Loss of limestone from drain and coating of remainder evident.

Photo 7. Coating not easily removed to expose fresh limestone (Centre rock shows scratching of the coating).

Photo 9. Upstream end of two culvert pipes at bridge over all mine workings. Left one partially blocked.

Photo 10. Bridge over old mine workings appeared in good order.

Photo 12. Northern side of bridge over old workings. Left culvert submerged on the downstream end.

Photo 13. Gun Club Creek culverts OK.

Photo 14. Gun Club Creek culverts OK.

Photo 16. Gun Club Road culvert. Note loss of limestone compared to similar photo 29/04/04 in Appendix A.

Photo 17. Gun Club Road. Again note lack of limestone and the un-neutralised nature of the water in the drain.

Appendix C

AUGUST 2005 ANALYTICAL RESULTS

ANALYTICAL SERVICES TASMANIA

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Sandy Bay Laboratory

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The invoice for this report will follow.

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Laboratory Report

Report No: 26096 **Issue No:** 1 **Report Date** 05-Sep-2005 16:34

Status: Full Report

Site Description: Bischoff

Received: 26-Aug-05

Submitted to: Sandy Bay Laboratory

Submitted By: J. Lockley (Pitt & Sherry)

Client Order No:

Report To: J. Lockley

Client: Pitt & Sherry

Address: PO Box 94 Hobart TAS 7001

ANALYTICAL SERVICES TASMANIA

Report No: 26096 **Issue No:** 1 **Report Date:** 05-Sep-2005 16:34

		Lab.No.:	78879	78880
		Sample Id.:	W1	W6
Method	**Analyte**	**Units / Sampled On :**	25/08/05 12:30	25/08/05 14:30
1102-Water	Acidity	mg CaCO3/L	2050	
1103-Water	Sulphate	mg/L	3000	1000
1301-Water	Al Dissolved	µg/L	<20	7620
	Al Total	µg/L	24800	7660
	As Dissolved	µg/L	<5	<5
	As Total	µg/L	3060	180
	Cd Dissolved	µg/L	<1	21
	Cd Total	µg/L	76	23
	Co Dissolved	µg/L	<1	64
	Co Total	µg/L	321	65
	Cr Dissolved	µg/L	<1	6
	Cr Total	µg/L	31	6
	Cu Dissolved	µg/L	125	2800
	Cu Total	µg/L	17000	2820
	Fe Dissolved	µg/L	40	47300
	Fe Total	µg/L	611000	78800
	Mn Dissolved	µg/L	17	444
	Mn Total	µg/L	759	447
	Ni Dissolved	µg/L	2	36
	Ni Total	µg/L	136	37
	Pb Dissolved	µg/L	<5	106
	Pb Total	µg/L	458	111
	Zn Dissolved	µg/L	232	1900
	Zn Total	µg/L	5150	1910
1302-Water	Ca Total	mg/L	8.63	42.6
	K Total	mg/L	4.57	1.43
	Mg Total	mg/L	64.2	13.3
	Na Total	mg/L	4.66	6.34

ANALYTICAL SERVICES TASMANIA

Report No: 26096 **Issue No:** 1 **Report Date:** 05-Sep-2005 16:34

Test Method(s) :

		Test Date
Inorganic Testing		
1102-Water:	Acidity by APHA Method 2310	02-Sep-2005
1103-Water:	Anions by Ion Chromatography APHA Method 4110B	29-Aug-2005
1301-Water:	Metals in Water by APHA Method 3030/3120	30-Aug-2005
1302-Water:	Major Cations in Water by APHA Method 3030/3120	30-Aug-2005

Authorised By: