

SEDIMENT AND WATER QUALITY MONITORING

FINAL REPORT

Sediment and Water Quality Monitoring

Magnet Mine, Tasmania

prepared by

Millin EMS Pty Ltd

For Mineral Resources Tasmania

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1.0 Introduction

The historic Magnet Mine in North West Tasmania is being considered for certain rehabilitation and conservation works by Mineral Resources Tasmania. The site was mined from about late 1890s to the 1940s with silver and lead the predominant target minerals with zinc and ancillary gold as a by-product. In later years the tailings were mined for extraction of zinc (various records – refer “References”).

Mining was from several adits and a main shaft with a network of underground drives, and an onsite milling and concentrator plant located in the floor of the Magnet Creek valley adjacent to the main adits. A heritage assessment has been carried out by others, in which further details of the former mine, production plant, access railway and roads and hydro-power station are described (McConnell, 2013).

Millin EMS Pty Ltd was engaged by Mineral Resources Tasmania to conduct an assessment of water quality in the Magnet Creek and the nature of residual materials in the floor of the valley. These assessments were to provide background information to inform the nature of rehabilitation works in the mine environs and the downstream areas.

The current brief is for water and soil sampling to be conducted over two sampling episodes, with water sampling focussed on Magnet Creek itself and geochemical sampling of tailing and waste soil and rock heaps. This is aimed at characterisation of potential sources of contamination in the creek and providing data for later plant establishment as part of the rehabilitation programme planned for the area.

The results of the two stages of water monitoring conducted in May 2013 and November 2013 and the results of soil and sediment sampling in November 2013 are outlined in this report.

2.0 Location and Access

The historic Magnet Mine is located about 7 kilometres (line of sight) to the west of Waratah in North West Tasmania (Figure 1). The mine is situated in the valley of Magnet Creek, a headwater tributary to the Arthur River.

Access to the site is via the state highway B23 Waratah to Corinna and then (approximately 11.5 kilometres to the turn-off) a local track to the mine site. The existing track follows the course of the original horse-drawn tramway off Corinna Road and more recent access roads to the area.

3.0 Background and Understanding

The Magnet Mine is a lead-zinc-silver vein deposit emplaced during mid-Palaeozoic deformation that occurred from the Proterozoic to the early Carboniferous period. The deformation was associated with emplacement of granitoid rocks that gave rise to the concentration of minerals of various types, and in this case to a zoned mineral field around the Meredith Granite.

The centre of the mineral field is represented by tin-tungsten deposits (Mt Bischoff) with argentiferous (silver-rich) lead and zinc sulphide vein deposits in the outer halo of the mineral field (Zeehan, Magnet, Mt Farrell).

The predominant minerals are argentiferous galena (lead-silver sulphide) and sphalerite (zinc sulphide) and at Magnet, deposited along a fracture zone between early Cambrian mafic/ ultra-mafic rocks (Magnet "Dyke") and early Cambrian sedimentary rocks. The footwall contact is discordant, meaning that the mineral emplacement is both within the mafic rocks and in the Cambrian sedimentary rocks, which have limestone horizons.

The presence of carbonates (limestone horizons), as an integral component of the site mineralogy, provides some potential for buffering against metal-bearing acid drainage, both at the mine site and in creek bank deposits of eroded materials from the minesite.

Since disturbance of the areas around the mining activities, there has been significant erosion and redistribution of waste rock and tailings in the downstream environment. It is understood that this may have been exacerbated by surface redistribution of tailings and waste rock that was subsequently eroded and washed downstream during extreme flood events.

The deposits of eroded material appear to contain residues of possibly sulphidic gangue material (waste rock from mining) which, with time and exposure to rainfall and oxygen may be a continuing source of metal-bearing leachate to the creek environment. The generation of weak sulphuric acid would occur following rainfall and reaction of metal sulphides in mine waste residues within adits and stopes and from surfaces across the mine site as well as eroded tailings deposits downstream from the mine site.

The potential for neutralising any acid drainage from oxidation of sulphide minerals exists in the anticipated presence of carbonate minerals, both in the original ore formation and in the hanging wall limestone rocks.

4.0 Scope of Works

The objective of the requested works is as follows:

- identify and characterise potential sources of contamination associated with historic mining features to inform planning of on-ground rehabilitation works.

The scope of works as outlined in the brief is as follows:

4.1 Review of background information to be provided by MRT

- Review of historical mining reports, mine plans, aerial photographs and results of heritage surveys, as appropriate to addressing the water and soil sampling programme.

4.2 Water Quality Survey

- Two sampling events in each of autumn 2013 and spring 2013
- Eight samples were collected on 16 May 2013 during the autumn event as follows (Figure 2 and Table 1 below):
 - One sample upstream in the creek
 - Three samples in the creek downstream of tailings deposits on creek banks, where accessible from Magnet Road
 - Two samples were allowed for any mine drainage from adits or from drainage courses within the mine site (one drainage location was identified and sampled)
 - During the site visit, the tailings deposits were considered to represent a core source of metalliferous drainage to the creek environs and additional samples were collected in the creek adjacent to the larger bank deposits;
 - Further analyses of the samples were allowed after receiving authorisation from the Client.
- As well as the above samples, several additional water samples were collected on 27 November 2013 (spring event) as follows:
 - Two direct mine drainage samples from identified adits at South Adit and Adit #4;
 - One surface drainage from upstream of the main mine workings
 - Three samples from creek overbank tailings drainage waters.
- Field measurements at each site included pH/ oxidation-reduction potential, temperature, dissolved oxygen, electrical conductivity/ TDS;
- Samples were submitted to a NATA laboratory and analysed for a range of parameters as described in Section 5.4 of this report;
- A Draft interim Report (submitted in August 2013) with a Final Report (this report) to include:
 - Water quality trends within the creek from upstream to downstream locations

- Discussion on potential sources of acidity and metal contaminants including the mine site itself and other possible sources in riverbank deposits.
- Millin EMS QA/QC Documentation including field sheets, Chain of Custody documentation, laboratory QC and laboratory reports

4.3 Geochemical Survey

- One sampling event in Spring 2013, completed on 27 November 2013
- As well as the original six samples allowed, additional samples were collected as a preliminary assessment of creek overbank sediments to achieve an indication of variation within the mine waste materials downstream of the mine;
- Twelve samples were collected as shown in Figure 2 and Table 2. Descriptions of the samples are shown in Appendix 4.
- Samples were submitted to a NATA laboratory and analysed for pH, conductivity, calcium, sulphides, nitrate, phosphorus, major cations, major anions, total metals (As, Ag, Cd, Cu, Ni, Pb, Zn and Hg), as well as additional analytes to assess acid generation potential and acid neutralising capacity and organic carbon;
- Report to include:
 - Details of sampling, locations, mine site features;
 - Description of geological setting and ore formation with mineralogical descriptions;
 - Results of soil and rock geochemistry and physical description of soils in relation to native species revegetation;
 - Discussion on identified and potential sources of contamination
 - Discussion on contamination potential on nearby creek and implications of disturbing existing soil profiles.
 - Millin EMS QA/QC Documentation including field sheets, Chain of Custody documentation, laboratory QC and laboratory reports.

4.4 Deliverables

A “Draft Interim Report” was provided with results of the autumn 2013 water sampling and the preliminary site appraisal.

This is the Final Report and includes the two water sampling events and the soil sampling, with the latter completed on 27 November 2013.

5.0 Description of Works Carried Out

5.1 Description of Drainage and Sampling Locations

The main mine site is located on the west side of Magnet Creek (right hand bank). Several headwater tributaries enter the main creek channel upstream of the mine site contributing to the main flow in the creek channel (refer Figure 3).

The sampling locations are detailed in Table 1 and were selected on the basis of:

- An upstream reference point
- Identified mine drainage flows from adits in the main mine area
- Downstream from the mine site
- Adjacent to several bank deposits of tailings along the course of the creek.

Three tributary drainages run through the main mine site from the western flanks of the topography to the west of the mine. One of these is adjacent to the South Adit - MRT-09 was collected from drainage waters from the South Adit.

The “upstream sampling location”, MRT-08 was relocated about 50 metres upstream from the convergence of the South Adit drainage in the main creek channel during the second spring sampling event. The site was sampled during the autumn event close the confluence and was thought to have possibly been affected by South Adit drainage.

The main tributary drainage through the mine working is adjacent to the Adit No 4. In the second sampling event a water sample was collected from drainage from Adit #4 (MRT-14), which enters this tributary drainage. Flow from this drainage channel has been blocked by mine waste rock resulting in sub-surface flow through the rock pile, emerging on the creek flats below the main mine workings (Fig 3 - Site Drainage Plan). Sample MRT-06 was collected from the lower end of this emergent drainage. MRT-07 was collected from the main creek channel upstream from this lateral drainage.

The third of the three drainages flowing through the mine site was sampled at MRT-10, located above the main mine workings and below several surface excavations.

Downstream from the mine site, the floor of the steeply incised valley of Magnet Creek has been covered with flood debris and deposits of tailings from the mine workings. The tailings deposits are incised by several tributary drainages, of relatively short length from either side of the main creek. Along the course of Magnet Creek, flow from these tributaries is interrupted by deposited tailings and man-made works relating to the former tramway.

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The tributary drainages provide significant inflows of fresh water from the adjacent heavily-vegetated and wooded terrain. They also provide a conduit for free-flowing metalliferous leachates from the sediment deposits on the river banks to the main creek channel.

Where emerging onto the deposited tailings on the banks of Magnet Creek, “wetlands” have developed where high-organic outwash deposits have formed on the upper flats of the creek. Closer to the creek, a centrally eroded drainage channel exposes deposited tailings (refer Appendix 4 – Site Photographs) and provides a conduit for metalliferous leachates.

The “wetlands” appear to serve as depositional zones and could be modified to provide wetland treatment of leachates from the deposited tailings along the floor of the Magnet Creek valley (refer Recommendations later in this report).

Sample locations along the length of Magnet Creek were chosen in the vicinity of such bank deposits to determine any direct effect of the lateral drainages on the creek water and to determine any longitudinal trends along the course of the Magnet Creek. These included MRT-01 (Also MRT-S12 sediment sample), MRT-02 (Also MRT-S10 sediment sample), MRT-03, MRT-04, and MRT-05 (Also MRT-S4 sediment sample).

Where tributary drainages emerge from adjacent topography and enter the floodplain of Magnet Creek, and drainage channels have been impeded by deposited overbank sediments, wet seepage zones have formed in the sediments. Three samples were collected in these seepage areas or from channelized flow closer to the main creek channel.

MRT-11 was collected in the confluence area of one of the tributaries entering from the northern side of the creek. A soil/ sediment sample (MRT-S8 was also collected from this zone). Sample MRT-12 was collected from seepage waters in the confluence zone of a major tributary, locally known as School Creek. Sample MRT-13 was collected from a ponded seepage zone upstream (Also MRT-S7 sediment sample).

5.2 Water Monitoring Locations

Surface water sampling locations are shown in Appendix 1 – Figure 2 and summarised in Table 1 below.

Table 1: Surface Water Sampling Locations

Sampling Site	Location
No Sample	Arthur River (Site Measurements – Waypoint WP04)
MRT-01	Upstream confluence with Arthur River
MRT-02	Major Tailings Deposits
MRT-03	Major Tailings Deposits – near metalliferous flow
MRT-04	Major Tailings Deposits

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MRT-05	Downstream mine site and tailings
MRT-06	Lateral drainage from mine site (main adit flow)
MRT-07	Main creek channel, adjacent mill site
MRT-08	50 m upstream adit
MRT-09	Drainage from South Adit
MRT-10	Drainage above main mine workings
MRT-11	Seepage from creek overbank sediments (north side)
MRT-12	Seepage from creek overbank sediments (south side)
MRT-13	Seepage from creek overbank sediments (south side)
MRT-14	Drainage from Adit #4
Total 14 Samples	

5.3 Analytical Parameters - Water

The monitoring parameters, as amended by agreement with MRT, included the following suite for each of the 14 samples collected:

- Total Suspended Solids
- Redox (lab analyses to verify field measurements)
- Acidity
- Alkalinity
- Major Anions
- Major Cations
- Total and Dissolved metals - As, Cd, Cr, Cu, Ni, Pb, Ag, Zn and Hg as well as Al, Fe and Mn (additional metals considered relevant after review of literature and field observations);
- Silver was analysed for ultra-trace concentrations in the two mine drainage samples in the second sampling event in November.

The samples were analysed by NATA certified ALS Laboratory Group in Melbourne (refer Appendix 3 – Laboratory Reports QA/QC Documentation).

Measurements on site using a calibrated Horiba U-50 Series Multi-parameter water quality meter, included:

- pH
- Redox Potential (mV)
- Dissolved Oxygen (%saturation; mg/L)
- Temperature (degrees Celcius)
- Conductivity (microSiemens/cm)
- Salinity as TDS (mg/L)

5.4 Sediment Sampling Locations

Sediment sampling locations are shown in Appendix 1 – Figure 2 and summarised in Table 2 below.

Table 2: Sediment Sampling Locations

Sampling Site	Location
MRT-S1	Waste material adjacent mine site (near water MRT-07)
MRT-S2	Waste material adjacent access road/creek crossing
MRT-S3	Tailings deposits on creek banks near mine site
MRT-S4	Tailings deposits on downstream creek banks (near water MRT-05)
MRT-S5	Tailings deposits on creek banks downstream of water MRT-05
MRT-S6	Tailings deposits on creek banks between water MRT-04 and MRT-05
MRT-S7	Tailings deposits on creek banks in ponded seepage (near water MRT-04)
MRT-S8	Tailings deposits on creek banks (near water MRT-11)
MRT-S9	Tailings deposits on creek banks between water MRT-03 and MRT-02
MRT-S10	Tailings deposits on creek banks (near water MRT-02)
MRT-S11	Tailings deposits on creek banks downstream of water MRT-02
MRT-S12	Soil on creek banks (near MRT-01)
Total 12 Samples	

5.5 Analytical Parameters – Soils and Sediments

The monitoring parameters, as amended by agreement with MRT, included the following suite for each of the 12 samples collected:

- pH as CaCl₂
- NAPP (Net Acid Production Potential)
- Conductivity
- Net Acid Generation
- Acid Neutralising Capacity
- Moisture Content
- Sulphur as SO₄⁻², Sulphate-Calcium Phosphate Soluble (NEPM)
- Total Sulphur (LECO)
- Chloride
- Soluble Major Cations
- Total Metals (As, Cd, Cr, Cu, Pb, Ni, Ag, Zn, Hg)
- Nutrients (Nitrite, Nitrate, Total Phosphorus)
- Total Organic Carbon

The samples were analysed by NATA certified ALS Laboratory Group in Melbourne (refer Appendix 3 – Laboratory Reports, QA/QC Documentation).

6.0 Results of Monitoring - Water

6.1 Threshold Values

The results of the monitoring events are discussed with reference to limits indicated in the Guidelines for Fresh and Marine Water Quality (ANZECC, 2000), as follows:

- Default Trigger Values for Physical and Chemical Stressors (conductivity, pH, suspended solids);
- Trigger Values for Toxicants at Alternative Levels of Protection (Table 3.4.1 (metals)).

A table of results is presented in Appendix 2 and is shown in Figures 4, 5 and 6 below.

6.2 Conductivity

Conductivity is a measure of dissolved solids (salts) in the water. Typical values for upland rivers in south eastern Australia are between 55 and 90 $\mu\text{S}/\text{cm}$ with alpine rivers at around 30 $\mu\text{S}/\text{cm}$ (indicative value for upland rivers in Tasmania is 90 $\mu\text{S}/\text{cm}$) (ANZECC, 2000).

During the Autumn event, the upstream value at MRT-08 was lower at around 75 $\mu\text{S}/\text{cm}$, and there was a marked increase to 92 $\mu\text{S}/\text{cm}$ below the present mine site. The drainage from the mine site (possibly representing sub-surface water from Adit No 4 breaking out in the river flats) was at 219 $\mu\text{S}/\text{cm}$. These results were repeated in the Spring event.

The conductivity at all sampling locations within Magnet Creek below the mine site was between 85 and 95 $\mu\text{S}/\text{cm}$ during the Autumn event and a little higher during the Spring event at around 100 $\mu\text{S}/\text{cm}$. Values at the lower end of this range occurred in the downstream samples during the Autumn event (which appeared to be the result of dilution by strongly flowing tributary drainages entering Magnet Creek from either side below MRT-03 - note that a major tributary near MRT-03 and 04 was blocked and was being redirected along the former tramway route, entering Magnet Creek near MRT-02).

A notable difference was evident in the Spring event in mid-stream samples where conductivity values were higher in MRT-03, MRT-04 and MRT-05.

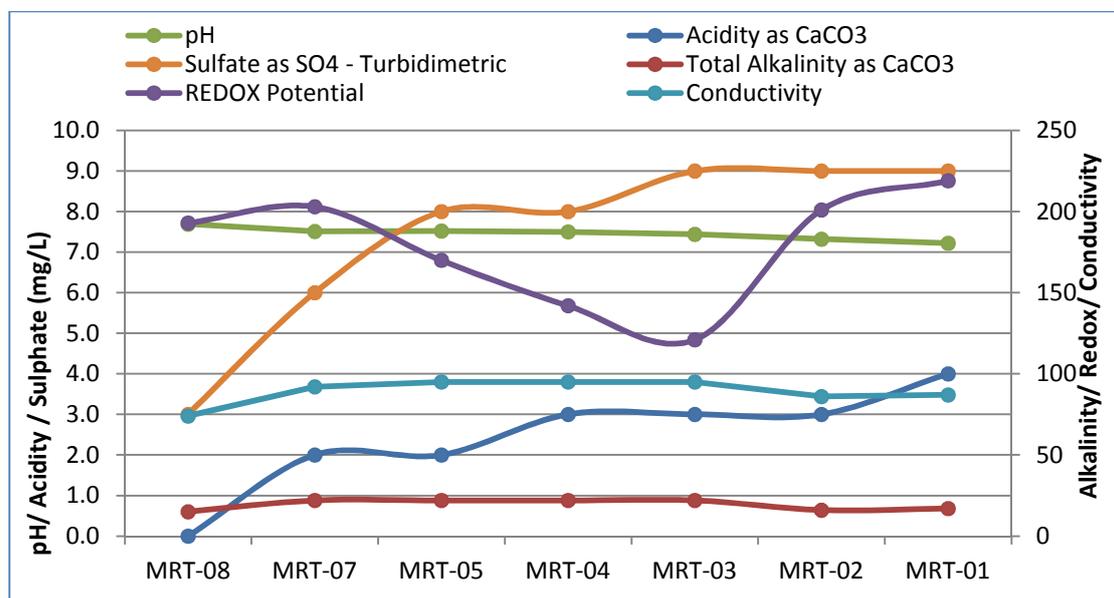
There appears to be a correlation between the above conductivity values in MR-03 and MRT-04 and lower field redox potential (40% lower in the Autumn event and only slightly lower in the Spring event), temperature (slightly higher in Autumn, but significantly higher in Spring) and dissolved metals (increasing significantly in MRT-03, MRT-04 and MRT-05).

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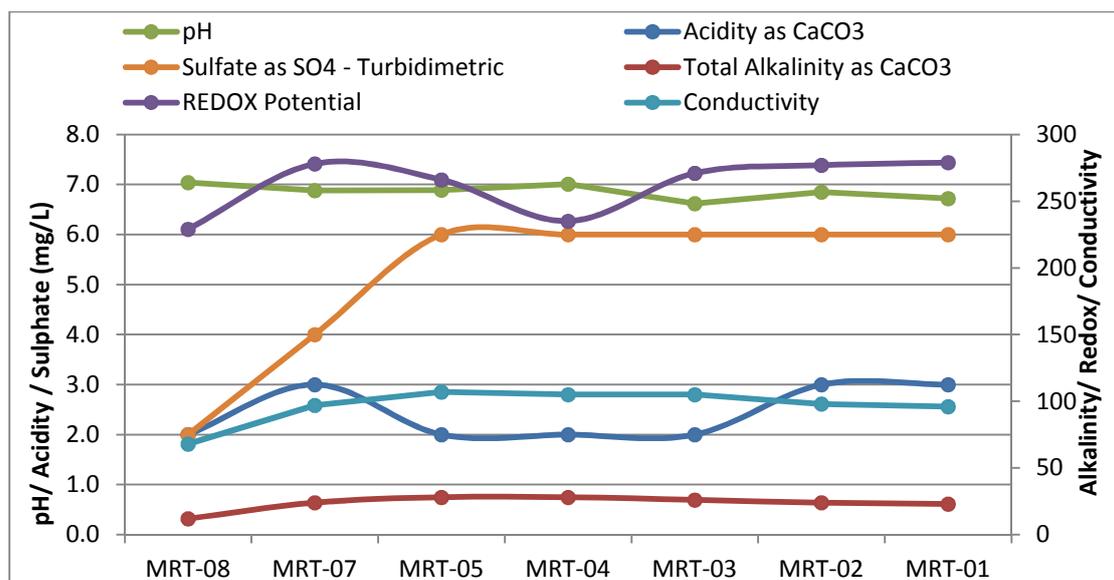
The significant difference in temperature in the mid-stream samples would appear to be related to flow through exposed overbank sediments, with temperature dropping in the lower reaches after dilution from adjacent tributary inflows.

Although minor trends are noticeable as outlined above, all conductivity values are within the expected range for upland Tasmanian rivers during the Autumn event and slightly higher in the Spring event. The above dilution trends on a downstream course are not apparent in dissolved and total metals described below, indicating a locally-derived source of the metals concentrations.

Figure 4 Autumn 2013 / Spring 2013 - General Parameters



Autumn 2013 Results



Spring 2013 Results

6.3 Dissolved Oxygen

Dissolved oxygen is relatively high in all samples at around 93% to 95%, typical of fast flowing upper catchment waters (Ecological stressors in Tasmanian upland rivers is indicated at 90% (ANZECC,2000)).

During the Spring event, dissolved oxygen was higher at over 100% saturation in the upper and lower parts of the main creek channel and over-saturated in the mid-section samples. This would appear to be related to the warmer waters and algal activity in warmer waters both in-stream and from lateral drainage channels through the creek overbank sediment deposits.

The sample collected from the mine drainage channel (MRT-06) was depleted in oxygen at 64% saturation in Autumn and 78% in Spring. This may be indicative of high oxygen demand in the “wetlands” immediately upstream of the sampling location, arising from both oxidising metalliferous streams and from decomposing organic matter.

Samples collected from direct mine drainage from the South Adit (MRT-09) and from Adit #4 (MRT-14) were severely depleted in oxygen at 58% and 18% respectively. Similarly samples collected from seeps in the creek overbank deposits were 56 and 77%. These results would be related to oxygen being used up in the oxidation of sulphide and other minerals, and in the case of seepage from creek overbank deposits, from both algal and bacterial processes in the oxidation of metalliferous flows.

6.4 Suspended Solids

Suspended solids are measured as a concentration of fine particulates in the water column and in upland rivers. Typical values are in the range 5 to 20 mg/L in south eastern Australia waterways (Tasmanian indicative value is 5 mg/L (ANZECC,2000)).

The clarity of waters in all samples is indicated by suspended solids below reportable limits, except in the two downstream samples at MRT-01 and MRT-02 at 10 mg/L and 14 mg/L in the Autumn event. The values are higher than trigger values for upland rivers in Tasmania, and appear to be related to the exposed river banks incised into the tailings deposits along the valley floor. Both samples were collected at the lower end of such bank deposits.

During the Spring event suspended solids were higher in all samples collected from mine drainage and seepages from creek overbank deposits. This may be related to iron oxide precipitates and/or disturbance of clays during sample collection. The values are not considered to be of adverse effect to the receiving creek environment.

6.5 Acidity, Alkalinity and pH

pH is a measure of the concentration of H⁺ ions in the water and is indicative of acid (low pH values) and alkaline conditions (high pH values). Trigger

values indicative of stressors to aquatic life in the water of upland rivers are between pH 6.5 to pH 7.5 (ANZECC, 2000).

During the Autumn event the pH of all sampling locations was above neutrality at between pH 7.2 to pH 7.5, and within the stressor values for upland rivers. There was an indicative slight decline in pH in downstream samples. Similarly, there is a slight decline in alkalinity downstream from 22 to 16 mg/L CaCO₃ and a suggestive marginal increase in acidity.

The sample (MRT-06) in mine drainage from Adit No 4 has substantially higher alkalinity than the creek samples and slightly higher acidity.

During the Spring event, pH values were all somewhat lower at slightly below or at neutrality. Exceptions were samples collected from seepages in the creek overbank deposits where pH values at around pH 6.2 were lower than the 6.5 to 7.5 stressor range. Total acidity in these samples was significantly elevated with respect to all other samples. Total alkalinity was also much lower than mine drainage waters which would render a higher net acidity in these drainage waters.

The higher net acidity, while low compared to typical acid mine drainage, appears to be related to elevated dissolved concentrations of arsenic, cadmium and zinc where all or most of these metals occurred in dissolved form (see metals results below). Aluminium and Lead was less soluble with about 50% occurring in dissolved form.

Notably, the pH of mine drainage from the South Adit was alkaline at pH 7.12, while that from Adit #4 was slightly under neutrality. Corresponding concentrations of acidity were significantly higher in mine drainage than creek waters, however, total alkalinity was also significantly higher. This would render a lower net acidity in mine drainage waters directly from the mine adits. Corresponding cadmium and zinc concentrations from the mine drainage was very low compared to values from leachate collected from the creek overbank deposits.

In summary, there is a low consequence of acidity and associated metals content from mine drainage waters entering the creek, but a significantly higher consequence of drainage waters from the creek over-bank deposits with elevated acidity a depleted alkalinity compared to mine drainage waters. Also, the concentrations of dissolved metals from the latter creek overbank deposits were extreme (see metals results below).

6.6 Cations and Anions

The major anions, sulphate and chloride, were at constant concentrations along the course of the creek. Similarly cations, calcium, magnesium and sodium were constant, while potassium was below reportable limits throughout.

Sulphate was elevated in the mine drainage samples MRT-06, MRT-09 and MRT-14, when compared with instream creek waters, and much higher in creek overbank leachate samples MRT-11, 12 and 13. This would indicate high rates of oxidation of metals in the release of sulphate to seepage waters from the overbank deposits.

Chloride was constant in all samples, as was sodium.

Calcium and magnesium were both elevated in mine drainage and in overbank leachate compared with creek samples, as would be expected from the presence of carbonate minerals in the mine source area and in the deposited materials downstream from the mine.

6.7 Metals

Metals are considered with respect to toxicity thresholds, applied as levels of survival of aquatic organisms in slightly to moderately disturbed ecosystems (ANZECC, 2000).

In the Autumn event, dissolved cadmium and zinc in all samples were well in excess of toxicity threshold values for survival of 80% of freshwater organisms and lead was in excess of toxicity threshold values for survival of 95% of freshwater organisms for most samples. In samples MRT-03 and 04 dissolved lead was at or above the toxicity threshold level for survival of 80% of species.

In essence, this means that at the concentrations of dissolved metals, cadmium and zinc, the survival and/or reproductive processes of 80% of typical aquatic organisms found in ecosystems that display slight to moderate levels of disturbance would be protected and at the lead concentrations, 95% of species would be protected (except in the vicinity of MRT-03 and MRT-04, where 80% of species would be protected).

The Spring results were similarly in excess of toxicity thresholds for aquatic organisms, but interestingly the concentrations of both cadmium and of zinc were much lower in the Spring event. Lead and iron was however at higher concentrations in the Spring event in the main creek channel.

Figure 5 Autumn 2013 Water Results – Dissolved and Total Metals

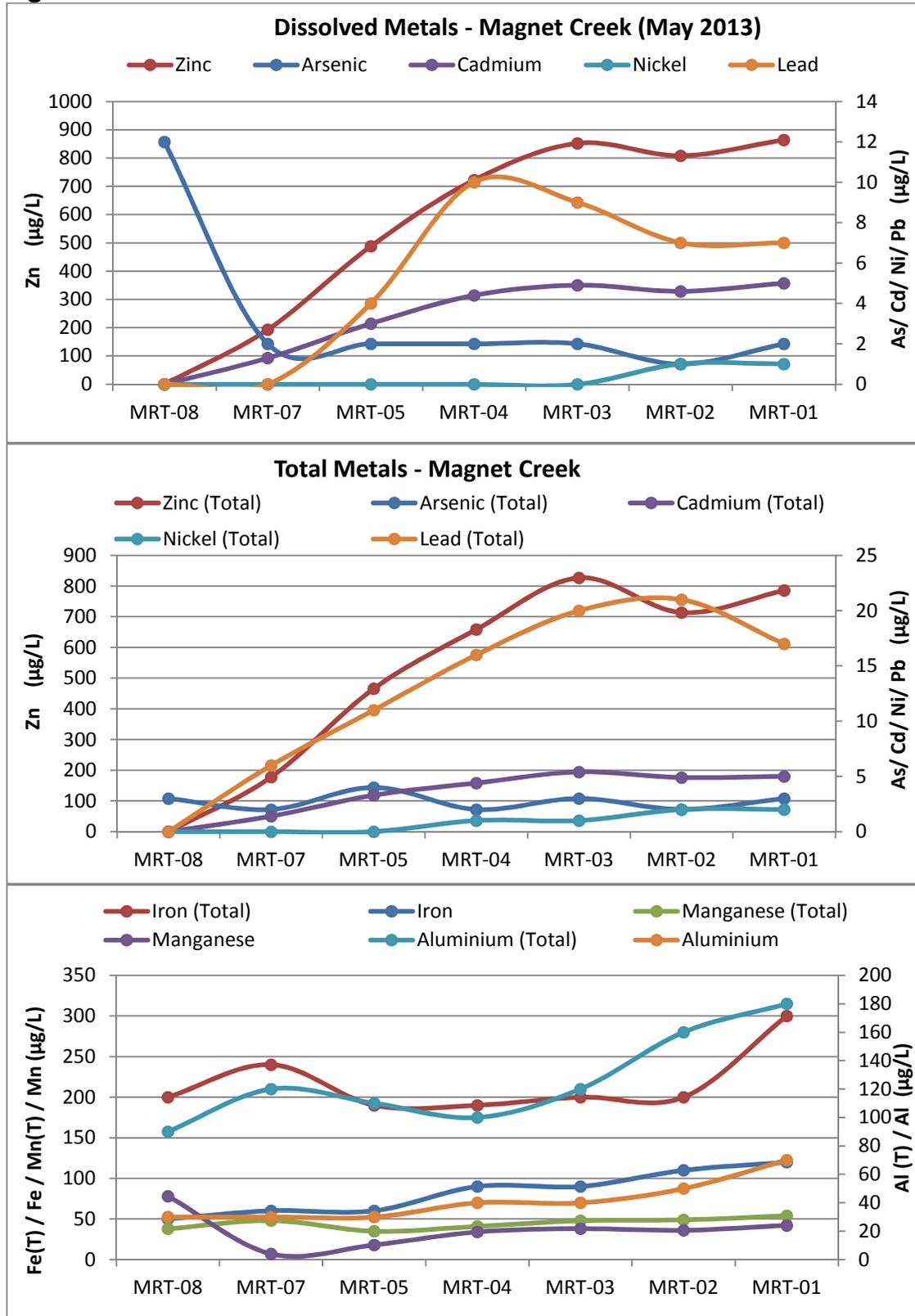
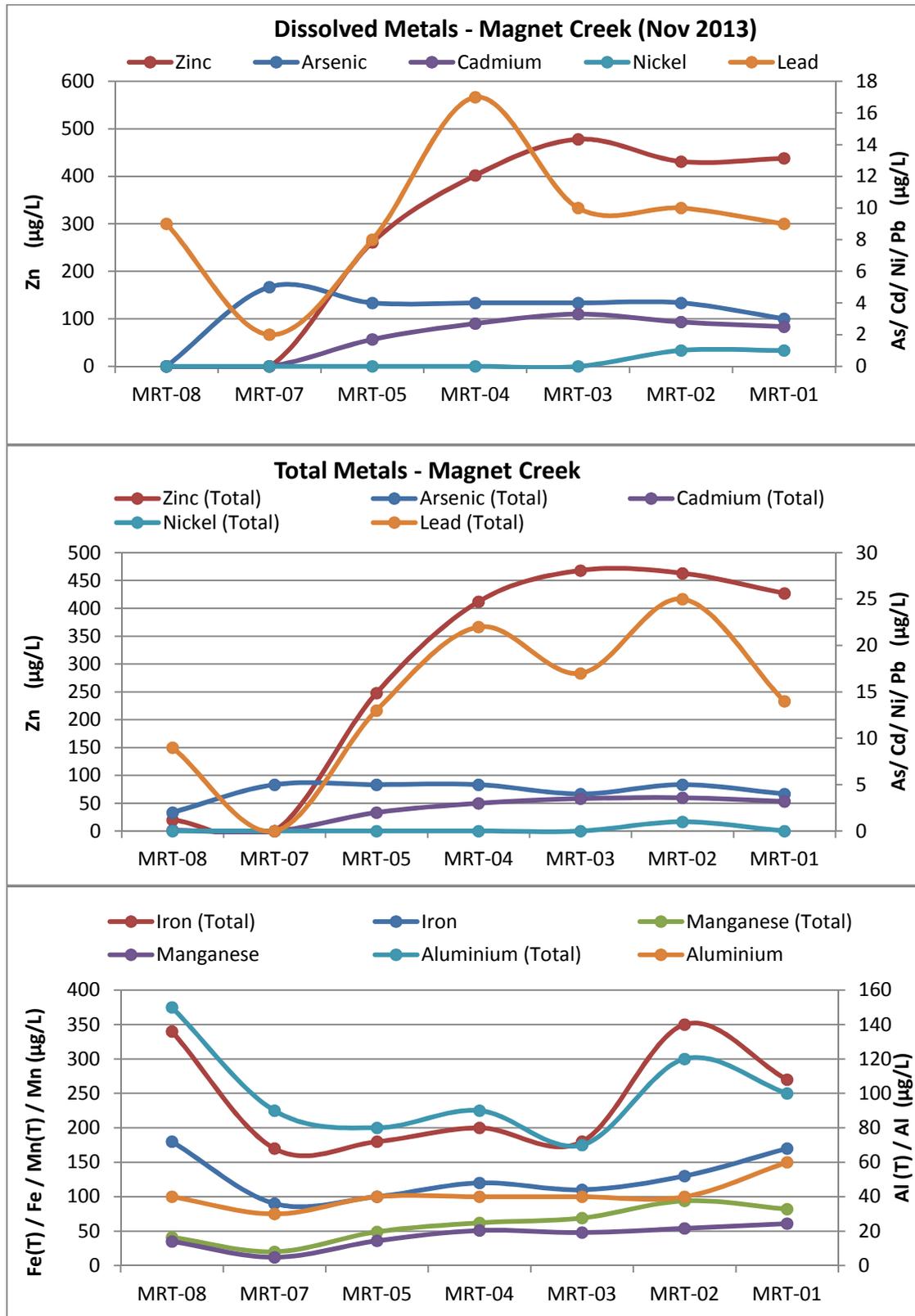


Figure 6 Spring 2013 Water Results – Dissolved and Total Metals



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The reportable limit for silver was higher than the specified toxicity threshold, and in order to assess the relevance of any dissolved silver a more sensitive analysis is required to a much lower reportable limit. The high analytical costs for ultra-trace silver analysis limited follow-up analyses to the actual mine drainage. Both samples were below reportable limits at the ultra-trace level.

Metals that were below or at reportable limits included chromium, copper, nickel and silver in both the Autumn and Spring events.

A gradual increase in the concentrations of metals downstream from the mine site, particularly aluminium, cadmium, zinc as well as in manganese and iron was evident in both the Autumn and Spring events. A marked decrease in concentrations of cadmium and zinc was notable when comparing the Autumn and Spring events, but an increase was evident in lead and iron.

The higher concentration of metals in total form provides an indication of potential toxicity in the event that solubilisation occurs in downstream areas of the river system.

The above distribution of metals in the Autumn sample suite indicated a contribution of metals occurring along the length of Magnet Creek from the mine site to the downstream location near the confluence with the Arthur River (and likely further downstream). This is despite dilution effects from tributary drainages, as possibly indicated by conductivity results, and it was considered likely that cadmium, lead and zinc were being leached from creek overbank deposits of tailings that occur along the length of the creek.

This is particularly evident for lead which is elevated in the mid-section of the creek in samples MRT-03 and 04.

When comparing total to dissolved metals:

- Aluminium – 25% to 40% is in dissolved form in all samples in the Autumn event, and much higher in the Spring event in MRT-01, 03 and 05.
- Arsenic – 50 to 70% is in dissolved form in the downstream samples (MRT-01, 02 and 03) and 100% in dissolved form closer to the mine site in the Autumn event, but much higher in the Spring event in all samples
- Cadmium and zinc is 80 to 100% in dissolved form in both events
- Lead – 30% to 40% is in dissolved form in the Autumn event but higher in dissolved form in the Spring event.

The above analysis is indicative of solubility of metals and proportion that is bound up by particulates or in insoluble form. The direct toxicity effects of metals is higher where occurring in bio-available form, i.e. dissolved component, whereas potential toxicity may be indicated by high total metals concentrations.

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The greatest direct ecological threat within the creek waters is from cadmium and zinc where elevated concentrations are in biologically available dissolved form, while lead has both direct effects in dissolved form and greater potential for high ecological effects downstream where total lead may enter soluble phases and become bio-available.

Follow-up sampling of seepage waters and sediment samples from the creek overbank deposits (see later) has confirmed the high metals concentrations in these deposits.

Seepage waters from the creek overbank deposits had significant concentrations of dissolved metals, as follows:

- cadmium at 56 to 357 µg/L, compared to a toxicity threshold of 0.8 µg/L for 80% of species;
- lead of 33 to 66 µg/L, compared to a toxicity threshold of 9.4 µg/L, and
- zinc at 10,500 to 97,400 µg/L, compared to a toxicity threshold of 31 µg/L.

It is notable that the samples were collected from highly concentrated seepages direct from the sediment deposits and significant dilution occurs when these concentrations reach the main creek. However the net result is still dissolved metals concentrations at significantly higher levels than toxicity thresholds for aquatic organisms.

Of particular note is the concentration of metals in mine seepage at MRT-06, where cadmium and zinc are most notable:

- dissolved cadmium at 8.8 µg/L Autumn and 6.6 µg/L Spring,
- dissolved lead at <0.1 µg/L Autumn and 5.0 µg/L Spring, and
- dissolved zinc is 1750 µg/L Autumn and 941 µg/L Spring.

The sample was collected from a stream after passing through a naturally developed “wetland” before being sampled and analysed. Lead was absent in both total and dissolved form in the Autumn event, but present in the Spring event at concentrations above toxicity threshold levels. Confirmation of such variation, as well as the variation noted in dissolved zinc, would require additional sampling over a longer timeframe to determine any effects of “wetland” treatment processes and seasonal effects on precipitation and solubility of metals in the mine drainage.

When compared with mine drainage from South Adit (MRT-09) and Adit #4 (MRT-14):

- dissolved cadmium is <0.1 and 0.4 µg/L,
- lead is 5 and 1 µg/L and
- zinc is 19 and 208 µg/L.

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These values are all significantly lower than dissolved metals values analysed in leachate waters from the creek overbank deposits. However, arsenic was much higher in direct mine drainage from the South Adit and Adit#4 compared with all other samples.

The significantly higher concentrations in dissolved metals indicated in seepage from the creek overbank deposits may be explained by the historic milling and processing operations at the mine, where dissolution of metals would more readily occur in tailings following crushing and milling in the metals extraction processes.

The flow of mine drainage from the adits is therefore considered to be of less relevance when compared with the concentrations in leachate from the creek overbank deposits. The former represents a higher flow rate, while the latter represents low seepage rates, but sourced from an extensive “exposure length” of exposed tailings deposited across the creek floodplain.

The flow would be relatively simple to stop and it appears that there is a relatively low rate of oxidation of the minerals and generation of acid mine drainage from the adits.

Conversely, the flow of metalliferous leachates from the mine wastes deposited in the downstream creek floodplain represents a persistent seepage of highly dissolved and highly concentrated metal content to the receiving waters of Magnet Creek and downstream Arthur River. The downstream effects need to be considered in conjunction with flows from the Mt Bischoff mining area to determine relative contributions of acidity and metals to the lower reaches of Arthur River.

Further analysis of flow rates from the mine drainage and modelled flow to the creek from the deposited tailings would be required to quantify the relative metals load to the creek system. However, the trends in dissolved metals analysed from samples along the length of the creek between the mine and Arthur River indicates increasing concentrations, ostensibly from the leachate seepage from the creek overbank deposits and would reinforce the assertion that these deposits represent the greater contribution of dissolved metals to the creek system than the mine drainage from the adits.

An analysis of results of soil and sediment samples in the next sections provide explanation for the source of these highly charged metalliferous drainage waters from the creek overbank deposits.

7.0 Results of Monitoring – Mine Tailings

7.1 Threshold Values

Twelve samples were collected from waste rock in the environs of the mine and in tailings deposited in downstream creek overbank deposits as shown in Figure 2.

The results are compared with both interim sediment quality guidelines (ANZECC, 2000) and recently released ecological investigation levels specified in the National Environment Protection Measure (NEPM, 1999) as amended in May 2013:

- Table 3.5.1 Recommended Sediment Quality Guidelines (Guidelines for Fresh and Marine Water Quality (ANZECC, 2000)) – values are shown for ;
- Table A1. Summary of the EILs for fresh and aged contamination in soil with various land uses.

The NEPM EILs for contaminated soil are intended to be applied to soil materials in which various land uses would occur, such as:

- “area of ecological significance” with associated 99% protection level for ecological values;
- “urban residential/public open space” with associated 80% protection level;
- “commercial and industrial” with associated 60% protection level.

The EILs require further analysis for each contaminating substance depending on soil physico-chemical characteristics such pH, CEC, %clay, organic carbon and inherent background levels.

The EILs are specifically not intended for application to sediments where direct effect relationships with affected aquatic organisms remain uncertain.

In this regard, the interim sediment quality guidelines (ISQG) published under ANZECC (2000) may be considered as a comparison threshold. However, these interim sediment quality guidelines are by inference intended to be applied to sub-aqueous sediments rather than the results of sediment over-wash from river channels, such as occur at Magnet Creek.

Of significance to the receiving aquatic environment at Magnet Creek is the concentration of metals in the host material, their solubility and the transport of dissolved metals in pore water from the host material to the receiving environment. Results of water sampling from accumulations of pore water in

the sediment deposits are outlined in the previous section, and indicate extremely high concentrations of cadmium, lead and zinc. As there is a direct relationship between discharges from the creek overbank deposits and the receiving waters of Magnet Creek, the ISQG values would represent an appropriate set of threshold values to apply against the results of sampling of the mine waste materials.

The ISQG values are shown as ISQG-Low (representing a “trigger value” requiring follow-up to determine possible sources of contaminants) and ISQG-High (representing an upper limit that would likely have adverse effects on associated aquatic organisms).

A table of results of all soil and sediment samples is presented in Appendix 2.

7.2 Acid Generating Potential and Neutralising Capacity

The following discussion is based on an outline provided in “Managing Acid and Metalliferous Drainage” published by the Australian Government Department of Industry Tourism and Resources (2007). The intention of the information provided is to develop an Acid Base Account (ABA) of acid-generating materials for classification of those materials for further analysis and/or treatment. The objective is to assess the “balance between acid generation (oxidation of sulphide minerals) and neutralising processes (dissolution of alkaline carbonates, displacement of exchangeable bases and weathering of silicates)”.

Analyses of all samples included a range of parameters to determine actual and potential acid generation which would have consequent effects on further accelerated acid generation and dissolution of metals from the mine materials upon exposure to free oxygen and water.

7.2.1 pH (CaCl₂)

The pH (CaCl₂) of all samples was in the range of 6.3 to 7.1, except in MRT-S12 at pH 4.8. At face value this suggested mine wastes generally at or slightly below neutrality, with the exception of the sample collected at the lower end of Magnet Creek, near its confluence with the Arthur River (MRT-S12).

The acidic nature of MRT-S12, with low sulphate and low total sulphur would suggest minimal influence of mine waste, as indicated in the field and appears to be outside the area of tailings deposition.

All other samples were above pH (CaCl₂) of 6.3, indicating the absence of acidity in the mine waste materials and normal for many soils in Tasmania.

The pH on its own provides little in the way of potential acidity that would follow from the oxidation of sulphide minerals, or whether there is any potential for acidity to develop at all (stabilised low pH), or the effect of neutralisation from buffering anions and carbonate minerals.

Of note is that the creek overbank deposits have been effectively oxidised as indicated by red-oxide sub-surface layers (refer photos) and also as indicated by the low total sulphur values and relatively high sulphate concentrations (a product of oxidation of sulphide minerals).

7.2.2 Net Acid Production Potential

Net Acid Production Potential (NAPP) is an estimation of the difference between the capacity to generate acidity and the capacity to neutralise acid (ANC).

The Net Acid Production Potential (NAPP) for all samples was highly negative at between -125 to -262 kgH₂SO₄/t., except for MRT-S01 and MRT-S12 at slightly positive and zero respectively. MRT-S05 was less negative at -47 kgH₂SO₄/t, explained by a much lower acid neutralising capacity in this sample.

This indicates the balance between maximum potential acidity (MPA) of the substrate and the acid neutralising capacity (ANC), where all results indicate inherent neutralising capacity greater than the maximum potential acidity of the substrate. There is therefore low potential for generation of acid drainage from the materials.

MPA may be derived from the NAPP value and the ANC value as follows:

$$\text{MPA} = \text{NAPP} + \text{ANC}$$

A margin of safety may be derived from the ratio between the MPA and ANC. All samples with the exception of MRT-S01 and MRT-S12 had a very high margin of safety of 20 to 30 compared with a ratio of 2 or more where the material will remain near-neutral and not generate acid drainage.

MRT-S01, taken from waste material closer to the mine site, indicated both a positive NAPP value of 15.4 kgH₂SO₄/t and ANC/MPA ratio of 0.3 indicating a low margin of safety for acid generation. The positive NAPP value and NAGpH of >4.5 would indicate “Potentially Acid Forming” (PAF) material but with a relatively low Total Sulphur content of <1.0%. It is notable that in this particular sample, the calcium and magnesium content was very low compared with all other samples.

The environment downstream of the sample site has a very high acid neutralising capacity, so the effects on the receiving environment of acidity developing from the area of MRT-S01 would be limited.

The above values, while providing an estimation of the potential for acid mine drainage, provide little guidance in the potential for metalliferous or saline drainage to develop.

In Summary, the low content of sulphidic minerals and low potential for development of acid drainage is indicated in the geochemical results obtained from soil and sediment samples, notably:

- Highly negative values for NAPP;
- Elevated NAGpH tests (pH after rapid oxidation in the lab);
- High neutralising capacity;
- Low Total Sulphur content (mostly between 0.5% and 1.0%), with relatively high sulphate (both in the soils and water analyses);
- Relatively high soluble calcium and magnesium in both the soil and water samples.

7.2.3 Non-Acid Metalliferous Drainage

Metalliferous drainage that is non-acid forming is uncommon as the solubility of most metals is pH dependent. Metals generally precipitate with an increase in pH brought about by dissolution of common carbonate minerals, particularly aluminium, copper and lead.

At near-neutral conditions, zinc, arsenic, nickel and cadmium may remain in solution. This may be associated with source sulphide minerals sphalerite and arsenopyrite together with a local source of carbonate minerals.

When originally assessing the site, a review of the mine history indicated mineral assemblages in the host geological formations that had potential to neutralise acid-forming oxidation processes. This was further supported by the sulphide mineral assemblages identified in the historic information in juxtaposition to carbonate footwall rocks.

The waste material from the mining and milling processes that was washed from the area of the Magnet Mine to be deposited in creek overbank deposits contains residues of these mineral assemblages. It is likely that much of the sulphides from the mining and milling operations have been oxidised with low residual sulphide minerals in the creek overbank deposits. Such oxidation over a prolonged period in highly porous sandy sediments would have converted most of the sulphides and mobilised metals into interstitial pore spaces (which in the case of water samples obtained from seepage from these deposits is highly charged with soluble metal solutions).

7.3 Metals Analyses

The analytical results from the mine waste material indicated very high residual metals in the creek overbank deposits, particularly with Zn, Pb and As values. The concentration in percentage terms could be considered economic for extraction and processing at existing facilities in the region.

With respect to ecological threshold values, the analysed values are orders of magnitude higher than both the ISQG-High and 60% protection levels specified in the ANZECC (2000) and NEPM (1999, as amended 2013).

Metals results indicated very high concentrations in the following ranges (with MRT-S06 being higher as shown below):

- Arsenic (As) at between 1900 and 3700 mg/kg, compared with ISQG-High of 70 mg/kg and upper values of 160 mg/kg for soil contamination;
- Cadmium (Cd) at between 90 and 370 mg/kg, compared with ISQG-High of 10 mg/kg
- Lead (Pb) at between 8000 to 18000 mg/kg, compared with ISQG-High of 220 mg/kg and upper values of 1800 mg/kg for soil contamination;
- Silver (Ag) at between 130 and 270 mg/kg, compared with ISQG-High of 3.7 mg/kg;
- Zinc at between 13000 and 62000 mg/kg, compared with ISQG-High of 410 mg/kg and upper values of 2000 mg/kg for soil contamination
- Mercury at between 2.0 and 2.8 mg/kg, compared with ISQG-High of 1.0 mg/kg.

The sample at MR-S06 was mostly higher than the above ranges with the following values:

- Arsenic at 4610 mg/kg
- Cadmium at 408 mg/kg
- Lead at 19000 mg/kg
- Silver at 200 mg/kg
- Zinc at 71400 mg/kg
- Mercury at 2.5 mg/kg

Other metals analysed within background ranges included Chromium (Cr), Copper (Cu) and Nickel (Ni).

It is notable that the concentrations of zinc, lead and silver in particular and arsenic and cadmium as ancillary products, occur in concentrations that may potentially be economically feasible for extraction. Consideration of any such extraction activity could provide the basis for large-scale creek floodplain rehabilitation for extended lengths of Magnet Creek and possibly upper parts of the Arthur River.

Further follow-up work to further evaluate potential for rehabilitation of the creek flats and likely source load to the creek system are outlined under “Recommendations” below.

7.4 Organic Carbon and Nutrients

The concentrations of nutrients in the soil and sediment samples were insufficient to sustain plant growth and organic carbon was extremely low in all samples.

Nitrogen in soluble form (nitrate+nitrite) was very low at 0.1 to 0.2 mg/kg in samples MRT-S02, 07, 08, 09, 11 and 12 and low in other samples except MRT-S01 at 2.4 mg/kg. A range of between 0.2 and 0.5 mg/kg is common in Tasmanian soils. Pasture requirements are in the order of around 10 mg/kg.

Phosphorus is between 100 and 200 in nitrogen high-deficient samples and between 300 to 400 mg/kg in other samples. The availability of phosphorus for plant uptake is highly variable and may be around 5 to 10% of the Total Phosphorus concentration. Phosphorus requirements for pastures are 15 to 20 mg/kg while for tree crops it is in the order of 30 to 50 mg/kg extractable phosphorus.

Potassium was deficient in all soils at less than 10 mg/kg.

Total organic carbon was analysed at between 0.1 and 0.5% in MRT-S02, 03, 06, 07, 08 and 09 with other samples between 1% and 5%. A desirable content for organic matters is around 2 to 6%.

Other significant factors for plant growth include the cation exchange capacity or the ability of soils to hold cations for plant availability with a desirable CEC of around 10 mequiv/100g. The estimated CEC in all samples was between 0.2 to 0.7 mequiv/100g.

In summary, substantial additives of nutrients and organic carbon would be required to enable the growth of plants on the creek overbank deposits, notwithstanding the ability to overcome metals and saline growth inhibitors in the interstitial pore spaces in the sediments.

8.0 Conclusions and Recommendations

8.1 Conclusions

The results of the first sampling event in May 2013 (autumn event) indicate a number of trends in water quality along the length of the Magnet Creek which were generally repeated, with some variations, in the second monitoring event in November 2013.

Results from monitoring locations along the length of Magnet Creek indicated a clear differentiation from MRT-08 (upstream location) to MRT-07 progressing downstream to MRT-05, 04, 03, 02 and 01 (MRT-06 was a lateral drainage of mine water, as described above).

One notable exception in the Autumn sampling was arsenic which was significantly higher upstream, compared to downstream location (unexplained at the time) and manganese. The upstream sampling location was relocated further upstream from the identified flow from the south adit, and arsenic was absent in the Spring sampling. Sampling of flow from the South Adit and from the Adit #4 in the Spring event indicated elevated dissolved arsenic at much higher concentrations than any of the other water samples analysed. The absence of arsenic in either dissolved or total form in downstream water samples would suggest a high degree of precipitation and retention in sediments downstream.

The downstream samples were elevated in all other metals with notably elevated concentrations of cadmium, lead and zinc. Silver was below laboratory reportable limits and required a more sensitive analysis to determine potential for toxicity effects on aquatic organisms. An ultra-trace analysis of mine discharge waters from South Adit and Adit #4 was carried out in the Spring event, with silver being less than reportable limits in both the two samples analysed.

The concentrations of dissolved cadmium and zinc were above toxicity threshold limits for the protection of 80% of aquatic species in slightly to moderately disturbed ecosystems and lead was above the threshold limit for protection of 95% of species, except in MRT-03 and MRT-04. The presence of lead at higher concentrations in total metal form is indicative of potential toxicity where dissolution may occur under a suitable chemical environment.

The notable presence of elevated dissolved lead in mid-sector samples (MRT-03 and MRT-04) and the increasing concentrations of most of the metals progressively downstream suggested a degree of leaching of metals from the tailings deposits on the banks of Magnet Creek. It is likely that this effect

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would continue downstream from similar deposits along the length of the downstream Arthur River.

The follow-up sampling in the Spring event confirmed similar trends of increasing metals concentrations downstream from the mine site. Further sampling and analysis of leachate water from the creek overbank deposits confirmed in all samples the presence of extremely high dissolved metals concentrations. Sampling and analysis of creek overbank deposits (mine waste materials) further confirmed the presence of extremely high concentrations of zinc, lead, arsenic in the sediments. These provide a ready source of dissolved metals in the leachates seeping from the overbank deposits.

In the Autumn sampling a more reactive mine drainage water at MRT-06 had slightly higher temperature, lower dissolved oxygen, slightly lower pH and much higher electrical conductivity. Dissolved metals were particularly elevated in cadmium and zinc at concentrations well in excess of toxicity threshold limits for protection of 80% of aquatic species. Other metals were absent, notably aluminium, chromium, copper, lead, nickel, silver, manganese and iron. The absence of most metals was associated with the “pre-treatment” of the mine drainage through a naturally-formed wetland between the point of emergence to the outflow to Magnet Creek (sampling location).

In the Spring sampling event, similar elevated cadmium and zinc concentrations were analysed in MRT-06, but direct drainage from the mine adits, while above toxicity threshold levels, were substantially lower in these metals. This would suggest that direct mine drainage is less of a concern in the immediate mine area, but where such drainage passes through mine waste rock, as in MRT-06, substantial uptake of dissolved metals occurs by percolating mine drainage waters.

The downstream leachate waters from creek overbank deposits were extremely high in dissolved metals, especially cadmium, lead and zinc, with other metals arsenic (in 1 sample), copper and nickel also exceeding toxicity threshold levels.

The high concentrations of dissolved metals in the leachates from the creek overbank deposits may be directly attributable to extremely high concentrations of metals in the sediments. Zinc and lead are in percentage concentrations (some orders of magnitude higher than sediment quality guidelines (ANZECC, 2000) and low protection levels for ecological values indicated under NEPM (1999).

The presence of deposits of tailings materials and waste materials from historic mining operations appears to represent a significant enduring effect on the ecological health of the downstream waterways. Given that the Magnet Mine is located near the headwaters of the Arthur River system, there is an opportunity to address the source of metalliferous drainage from the mine itself and from residual tailings deposits along the course of Magnet

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Creek. This would result in one headwater source of metalliferous drainage to the Arthur River System being reduced.

Quantification of such effects and the potential to achieve meaningful remediation requires further evaluation work, especially in relation to volume and content of the tailings deposits along a manageable section of the creek.

The source of leachates is expected to be both from the immediate river banks and from drainage channels across the tailings deposits, formed both locally within the deposits and where tributary drainages cross the deposits to reach the main river.

The potential for arresting the latter leachate streams is indicated in the natural development of “wetlands” in the upper flats of the creek overbank deposits, i.e. where tributary drainages emerge onto the creek flats, flow is impeded and organic-rich wetlands have formed across the surface of the tailings deposits. However closer to the creek, the flow has channelized into eroded channels, into which leachates seep from the metal-charged overbank deposits. The wetland formation could be assisted with relatively minor earthworks and surface modifications and possibly introduction of organic materials, lime and nutrients.

A number of options for further consideration include:

- Retardation of flows and control of erosion channels through the deposited tailings, with wetland “treatment” of leachates;
- In zones of low leachate/metals yield potential, surface treatment of tailings by addition of lime, organic material and nutrients.
- In zones of high potential yield of leachate and metals, removal of tailings deposits to retention dams located above flood elevations, with surface treatment and revegetation of exposed river banks;
- Construction of a series of weirs across the main channel of Magnet Creek and flooding of creek overbank deposits, to assist in the retention of metals in these deposits..

8.2 Recommendations

8.2.1 Recommendation 1 - Delineation of Creek Overbank Deposits

The extent of creek overbank deposits on the floor of the Magnet Creek floodplain requires further evaluation, with respect to lateral extent across the floodplain, the location of deposits with respect to creek morphology, the nature and depth of depositional phases and concentrations of metals.

Recommended works would include:

- Mapping of creek overbank deposits, initially by aerial photo mapping;
- Analysis of available topographic data to determine widths and levels of the creek floodplain and form of long sections (to determine possibilities of low level weir construction and flooding of the overbank deposits);
- Assessment of nature and area of the creek catchment, likely flooding levels and channel capacity in relation to larger scale storm events;
- Ground truthing of aerial photo mapping
- Hand auger drilling of cross sections across identified overbank deposits;
- Sampling and analysis of section intervals;
- Determination of likely volumes and concentrations (and thus evaluate the capacity of source materials and contained metals likely to leach to the creek system in the longer term).
- Determination of zones of direct exposure of metalliferous creek overbank deposits to the creek channelway (direct seepage to creek)
- Determination of flow pathways across the creek overbank deposits and existing “wetlands” treatment pathways (lateral seepage drainages).
- establish areas of higher concentrations of metals and thickness of mine waste overbank deposits and areas of less thickness and/or lower concentrations of metals

8.2.2 Recommendation 2 – Magnet Creek Management Plan

The works under Recommendation 1 would provide the basis for development of a Creek Management and Treatment Plan for longer term rehabilitation of Magnet Creek. This represents a discrete part of the upper Arthur River Catchment and would be of a manageable scale for complete rehabilitation of this portion of the Arthur River Catchment.

The works would also provide for further options for various site treatments to be developed, as outlined below.

8.2.3 Recommendation 3 - Treatment in Localised Drainage Pathways

Lateral tributary drainages and drainage courses across the existing tailings deposits, as delineated under Recommendation 1, be further investigated on site for suitability as trial remediation sites for localised treatment in artificially constructed wetlands.

Recommended works would include:

- Ground truthing of works carried out under Recommendation 1;
- Selection of a readily accessible location for trial remediation works;
- Remediation works would include such things as surface reshaping into open swales, flow retardation by rock/earthen berms, addition of lime and organic materials to encourage wetland plant establishment, direct seeding of organic sediment deposits as these develop with time.

8.2.4 Recommendation 4 - Treatment of Overbank Deposits

In areas of lower concentrations and/or shallower deposits, the following remediation options could be considered:

- Surface shaping, to create open swales to assist drainage;
- Deep ripping and incorporation of organic material, lime and nutrients (the possibility of incorporating limed sewage sludge would be investigated);
- Broad-acre spreading of grass cover crop, with or without an appropriate native seed mix.

In areas of higher concentration and thickness of deposits:

- Analysis of available topographic data to determine possibilities of low level weir construction and flooding of the overbank deposits;
- Estimation of likely contained volumes and concentrations of metals;
- Preliminary feasibility for extraction, transport and treatment of mine wastes for recovery of metals (lead, zinc, silver);
- Construction of a series of low level weirs and flooded cells across the creek flats.

A larger scale treatment option could include:

- Construction of a series of weirs across the main creek channel to flood adjacent creek flats bearing metalliferous sediments.
- This would assist in reducing availability of oxygen to the sediment and the enduring oxidation and leaching of dissolved metals to the creek environment.

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APPENDIX 1 - FIGURES

Figure 1 – Location Plan – Magnet Mine

Figure 2 – Sampling Location Plan – Water and Soil/Sediment

Figure 3 – Drainage Plan (Provisional)

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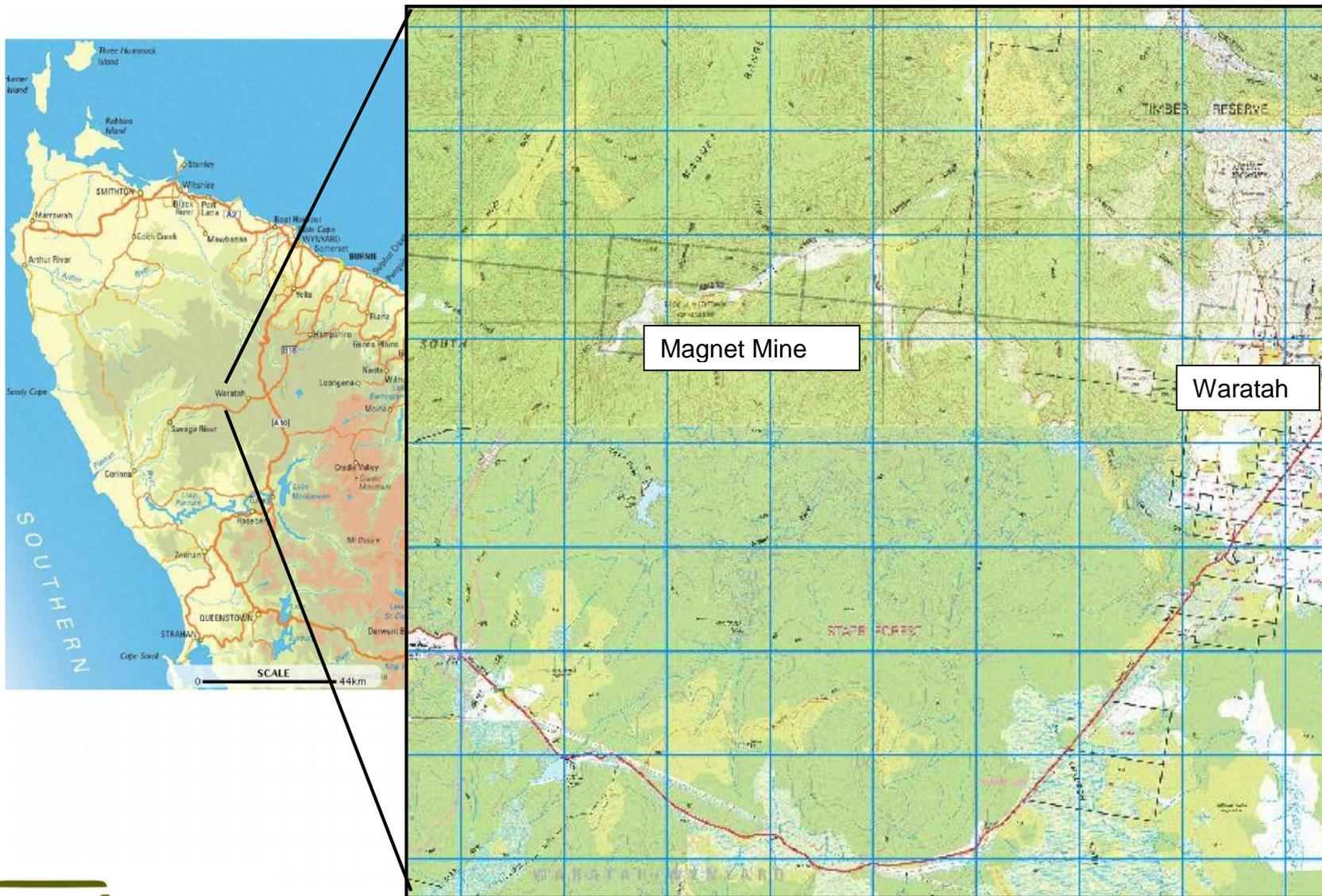


Figure 1 Location Plan – Magnet Mine





Figure 2. MRTMgnt - Sampling Locations
 Reference:

Image © 2014 DigitalGlobe
 © 2013 Google



2012

Imagery Date: 2/8/2012 55 G 371733.30 m E 5411258.43 m S elev 419 m eye alt 3.24 km

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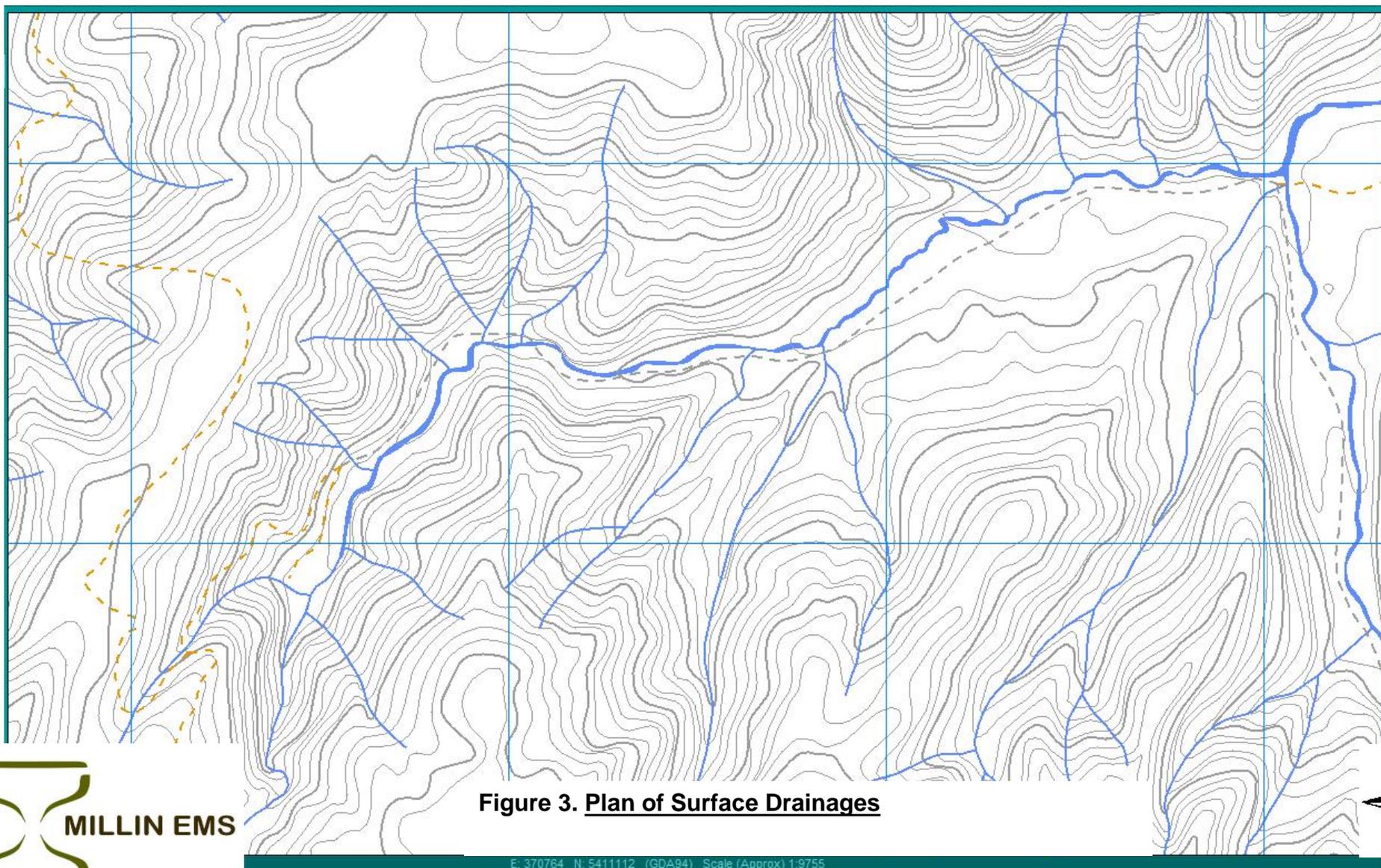
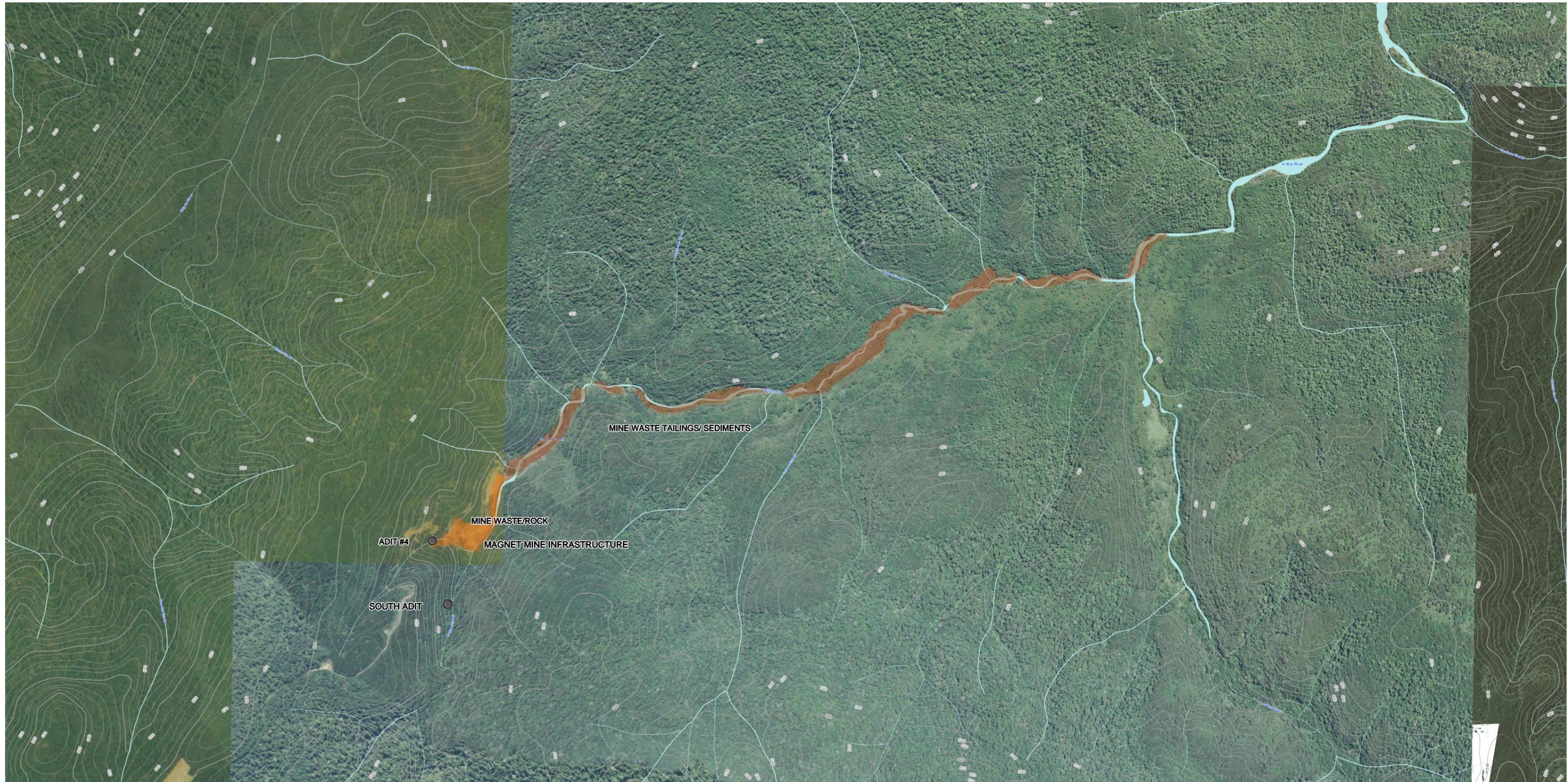


Figure 3. Plan of Surface Drainages





APPENDIX 2

Tabular Summary of Surface Water Results

Tabular Summary of Soil Results

SURFACE WATER MONITORING - MAGNET MINE

SURFACE WATER - MRTMgnt (16 May 2013)				WATER SAMPLES - MAGNET CREEK										MINE DRAINAGE	
ALS Sample number:				EM130517700:M130517700:M130517700:M130517700:M130517700:M130517700:M130517700:M130517700										EM1305177006	
Sample date:				16/05/2013 16/05/2013 16/05/2013 16/05/2013 16/05/2013 16/05/2013 16/05/2013 16/05/2013										16/05/2013	
Client sample ID (Primary):				95%	80%	MRT-08	MRT-07	MRT-05	MRT-04	MRT-03	MRT-02	MRT-01	Arthur River Site WP	MRT-06	
SITE MEASUREMENTS															
Temperature		oC		8.3	8.5	8.8	8.9	8.9	8.6	8.4	7.7	9.7			
Dissolved Oxygen		%		94.3	91.6	92.7	93.5	95.1	93.7	93.0	97.6	63.6			
Dissolved Oxygen		mg/L		10.8	10.4	10.5	10.5	10.7	11.0	10.6	11.3	7.0			
pH		units		7.69	7.51	7.52	7.50	7.44	7.32	7.22	7.37	7.32			
REDOX Potential		Eh mV		193	203	170	142	121	201	219	244	202			
Conductivity		µS/cm		74	92	95	95	95	86	87	42	219			
TDS		mg/L		47	60	62	62	62	56	56	27	142			
LAB ANALYSES															
Analyte grouping/Analyte	CAS Number	Units	LOR												
EA025: Suspended Solids		mg/L	5	<5	<5	<5	<5	<5	14	10	<5	<5			
EA075: Redox Potential		mV	0.1	263	265	264	264	264	262	268	270	270			
pH Redox		pH Unit	0.01	7.5	7.4	7.3	7.3	7.2	7.1	7	7.2	7.2			
ED037P: Alkalinity by PC Titrator		mg/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1			
Hydroxide Alkalinity as CaCO3	DMO-210-001	mg/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1			
Carbonate Alkalinity as CaCO3	3812-32-6	mg/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1			
Bicarbonate Alkalinity as CaCO3	71-52-3	mg/L	1	15	22	22	22	22	16	17	60	60			
Total Alkalinity as CaCO3		mg/L	1	15	22	22	22	22	16	17	60	60			
ED038A: Acidity		mg/L	1	<1	2	2	3	3	3	4	5	5			
Acidity as CaCO3		mg/L	1	<1	2	2	3	3	3	4	5	5			
Acidity as CaCO3 (pH 3.7)		mg/L	1	<1	2	2	3	3	3	4	5	5			
Acidity as CaCO3 (pH 8.3)		mg/L	1	<1	2	2	3	3	3	4	5	5			
Acidity as H2SO4		mg/L	1	<1	2	2	3	3	3	4	5	5			
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA		mg/L	1	3	6	8	8	9	9	9	31	31			
Sulfate as SO4 - Turbidimetric	14808-79-8	mg/L	1	3	6	8	8	9	9	9	31	31			
ED045G: Chloride Discrete analyser		mg/L	1	11	11	11	10	11	11	11	10	10			
Chloride	16887-00-6	mg/L	1	11	11	11	10	11	11	11	10	10			
ED093F: Dissolved Major Cations		mg/L	1	3	5	5	5	5	4	4	17	17			
Calcium	7440-70-2	mg/L	1	3	5	5	5	5	4	4	17	17			
Magnesium	7439-95-4	mg/L	1	3	4	4	4	4	3	3	12	12			
Sodium	7440-23-5	mg/L	1	8	9	8	9	8	8	8	7	7			
Potassium	7440-09-7	mg/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1			
EG020F: Dissolved Metals by ICP-MS		µg/L	10	Toxicity Threshold											
Aluminium	7429-90-5	µg/L	10	55	150	30	30	30	40	40	50	70	<10		
Arsenic	7440-38-2	µg/L	1	50	140	12	2	2	2	2	1	2	3		
Cadmium	7440-43-9	µg/L	0.1	0.2	0.8	<0.1	1.3	3	4.4	4.9	4.6	5	8.8		
Chromium	7440-47-3	µg/L	1	10	40	<1	1	<1	<1	<1	<1	<1	<1		
Copper	7440-50-8	µg/L	1	1.4	2.5	<1	<1	<1	<1	<1	<1	<1	<1		
Nickel	7440-02-0	µg/L	1	11	17	<1	<1	<1	<1	<1	1	1	2		
Lead	7439-92-1	µg/L	1	3.4	9.4	<1	<1	4	10	9	7	7	<1		
Zinc	7440-66-6	µg/L	5	8	31	<5	193	488	722	852	808	864	1750		
Manganese	7439-96-5	µg/L	1	1900	3600	78	7	18	34	38	36	42	2		
Silver	7440-22-4	µg/L	1	0.05	0.2	<1	<1	<1	<1	<1	<1	<1	<1		
Iron	7439-89-6	µg/L	50	50	60	60	60	90	90	110	120	<50			
EG020T: Total Metals by ICP-MS		µg/L	10	55	150	90	120	110	100	120	160	180	<10		
Aluminium (Total)	7429-90-5	µg/L	10	55	150	90	120	110	100	120	160	180	<10		
Arsenic (Total)	7440-38-2	µg/L	1	50	140	3	2	4	2	3	2	3	2		
Cadmium (Total)	7440-43-9	µg/L	0.1	0.2	0.8	<0.1	1.4	3.3	4.4	5.4	4.9	5	9.1		
Chromium (Total)	7440-47-3	µg/L	1	10	40	<1	<1	<1	<1	<1	<1	<1	<1		
Copper (Total)	7440-50-8	µg/L	1	1.4	2.5	2	<1	<1	<1	1	1	1	<1		
Nickel (Total)	7440-02-0	µg/L	1	11	17	<1	<1	<1	1	1	2	2	2		
Lead (Total)	7439-92-1	µg/L	1	3.4	9.4	<1	6	11	16	20	21	17	<1		
Zinc (Total)	7440-66-6	µg/L	5	8	31	<5	178	466	659	827	714	786	1540		
Manganese (Total)	7439-96-5	µg/L	1	1900	3600	38	48	35	41	48	49	54	4		
Silver (Total)	7440-22-4	µg/L	1	0.05	0.2	<1	<1	<1	<1	<1	<1	<1	<1		
Iron (Total)	7439-89-6	µg/L	50	200	240	190	190	190	200	200	300	<50			
EG035F: Dissolved Mercury by FIMS		µg/L	0.1	0.6	5.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		
Mercury	7439-97-6	µg/L	0.1	0.6	5.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		
EG035T: Total Recoverable Mercury by FIMS		µg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		
Mercury	7439-97-6	µg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		
EN055: Ionic Balance		meq/L	0.01	0.67	0.87	0.92	0.89	0.94	0.82	0.84	2.13	2.13			
Total Anions		meq/L	0.01	0.67	0.87	0.92	0.89	0.94	0.82	0.84	2.13	2.13			
Total Cations		meq/L	0.01	0.74	0.97	0.93	0.97	0.93	0.79	0.79	2.14	2.14			
Ionic Balance		%	0.01	5.08	5.16	0.55	4.4	0.58	1.43	2.64	0.33	0.33			

SURFACE WATER MONITORING - MAGNET MINE

SURFACE WATER - MRT Mgmt (27 November 2013)			WATER SAMPLES - MAGNET CREEK							MINE DRAINAGE				SEDIMENT LEACHATE SEEPAGE			
ALS Sample number:			EM13126610EM13126610EM13126610EM13126610EM13126610EM13126610EM1312661001							EM13126610EM13126610EM13126610EM13126610				EM13126610EM13126610EM13126610			
Sample date:			27/11/2013 27/11/2013 27/11/2013 27/11/2013 27/11/2013 27/11/2013 27/11/2013							27/11/2013 27/11/2013 27/11/2013 27/11/2013				27/11/2013 27/11/2013 27/11/2013			
Client sample ID (Primary):			MRT-08 MRT-07 MRT-05 MRT-04 MRT-03 MRT-02 MRT-01 Arthur River							MRT-06 MRT-09 MRT-14 MRT-10				MRT-11 MRT-12 MRT-13			
			Upstream Upstream Downstream Downstream Downstream Downstream Downstream Site WP							MineDrainage SouthAdit Adit #4 Tributary				Seep01 TribChannel Seep03			
ANZECC (2000)																	
Toxicity Threshold			95% 80%														
SITE MEASUREMENTS																	
Temperature	oC		10.06	10	14	15	11.27	12.45	11.71	9.42	16.23	10.28	10.55	12.5	18.9	20.65	20.35
Dissolved Oxygen	%		104.2	100.4	104.4	117.2	116.4	112	104.1		77.6	58	18.3	100	56	109.1	77.3
Dissolved Oxygen	mg/L		11.36	10.96	10.44	11.38	12.3	11.59	10.94		7.36	6.25	1.93	10.77	4.75	9.5	6.7
pH	units		7.04	6.88	6.89	7.01	6.62	6.85	6.72	6.95	6.78	7.12	6.83	7.42	6.22	6.4	6.23
REDOX Potential	Eh mV		229	278	266	235	271	277	279	272	271	208	237	251	245	261	273
Conductivity	µS/cm		68	97	107	105	105	98	96	48	206	386	396	234	249	268	595
TDS	mg/L		44.2	63.05	69.55	68.25	68.25	63.7	62.4	31.2	133.9	250.9	257.4	152.1	161.85	174.2	386.75
			by calculation														
LAB ANALYSES																	
Analyte grouping/Analyte	CAS Num	Units LOR															
EA025: Suspended Solids		mg/L 5	10	8	<5	<5	<5	<5	<5		10	8	9	9	16	11	12
Suspended Solids (SS)																	
EA075: Redox Potential		mV 0.1															
Redox Potential																	
pH Redox		pH Unit 0.01															
ED037P: Alkalinity by PC Titrator																	
Hydroxide Alkalinity as CaCO3	DMO-210-	mg/L 1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	mg/L 1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	mg/L 1	12	24	28	28	26	24	23		64	150	182	100	52	36	27
Total Alkalinity as CaCO3		mg/L 1	12	24	28	28	26	24	23		64	150	182	100	52	36	27
ED038A: Acidity																	
Acidity as CaCO3		mg/L 1	2	3	2	2	2	3	3		6	9	14	4	36	20	122
Acidity as CaCO3 (pH 3.7)		mg/L 1															
Acidity as CaCO3 (pH 8.3)		mg/L 1															
Acidity as H2SO4		mg/L 1															
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA																	
Sulfate as SO4 - Turbidimetric	14808-79-8	mg/L 1	2	4	6	6	6	6	6		17	27	10	6	44	66	265
ED045G: Chloride Discrete analyser																	
Chloride	16887-00-6	mg/L 1	13	13	12	13	13	13	14		12	12	12	12	14	12	9
ED093F: Dissolved Major Cations																	
Calcium	7440-70-2	mg/L 1	2	4	5	5	5	4	4		12	28	32	16	9	15	24
Magnesium	7439-95-4	mg/L 1	2	3	4	4	4	3	3		9	22	21	13	7	10	17
Sodium	7440-23-5	mg/L 1	6	7	7	6	6	6	6		7	5	5	5	5	7	4
Potassium	7709/7440	mg/L 1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
EG020F: Dissolved Metals by ICP-MS																	
Aluminium	7429-90-5	µg/L 10	55	150	40	30	40	40	40	60	<10	<10	<10	10	10	10	20
Arsenic	7440-38-2	µg/L 1	50	140	<1	5	4	4	4	3	4	74	51	<1	32	1	8
Cadmium	7440-43-9	µg/L 0.1	0.2	0.8	<0.1	<0.1	1.7	2.7	3.3	2.5	6.2	<0.1	0.3	0.2	84.3	55.7	357
Chromium	7440-47-3	µg/L 1	10	40	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Copper	7440-50-8	µg/L 1	1.4	2.5	<1	<1	1	2	1	1	<1	<1	<2	1	2	1	3
Nickel	7440-02-0	µg/L 1	11	17	<1	<1	<1	<1	1	1	2	7	12	<1	23	10	112
Lead	7439-92-1	µg/L 1	3.4	9.4	9	2	8	17	10	9	5	5	1	2	33	2	66
Zinc	7440-66-6	µg/L 5	8	31	<5	<5	261	402	478	438	941	19	208	28	21600	11400	93400
Manganese	7439-96-5	µg/L 1	1900	3600	35	12	36	51	48	61	21	200	862	4	1150	311	1220
Silver	7440-22-4	µg/L 1	0.05	0.2													
Iron	7439-89-6	µg/L 50	180	90	100	120	110	130	170		<50	50	<50	<50	260	<50	630
EG020T: Total Metals by ICP-MS																	
Aluminium (Total)	7429-90-5	µg/L 10	55	150	150	90	80	90	70	100	30	50	290	50	20	10	20
Arsenic (Total)	7440-38-2	µg/L 1	50	140	2	5	5	5	4	4	6	92	216	<1	61	<1	6
Cadmium (Total)	7440-43-9	µg/L 0.1	0.2	0.8	0.1	<0.1	2	3	3.5	3.2	11	0.3	0.4	0.2	102	61	407
Chromium (Total)	7440-47-3	µg/L 1	10	40	<1	<1	<1	<1	<1	<1	<1	<1	<1	3	<1	<1	<1
Copper (Total)	7440-50-8	µg/L 1	1.4	2.5	2	<1	<1	1	1	1	1	1	<1	1	8	1	3
Nickel (Total)	7440-02-0	µg/L 1	11	17	<1	<1	<1	<1	1	<1	2	7	12	<1	26	10	120
Lead (Total)	7439-92-1	µg/L 1	3.4	9.4	9	<1	13	22	17	14	16	10	5	13	348	<1	119
Zinc (Total)	7440-66-6	µg/L 5	8	31	20	<5	248	412	468	463	1070	73	259	27	22500	10500	97400
Manganese (Total)	7439-96-5	µg/L 1	1900	3600	41	20	49	62	69	82	93	226	892	24	2020	370	1160
Silver (Total)	7440-22-4	µg/L 1	0.05	0.2													
Iron (Total)	7439-89-6	µg/L 50	340	170	180	200	180	350	270		90	180	1260	70	1930	<50	310
EG035F: Dissolved Mercury by FIMS																	
Mercury	7439-97-6	µg/L 0.1	0.6	5.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
EG035T: Total Recoverable Mercury by FIMS																	
Mercury	7439-97-6	µg/L 0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS																	
Silver	7440-22-4	µg/L 0.1	0.05	0.2							<0.1	<0.1					
EN055: Ionic Balance																	
Total Anions	meq/L	0.01	0.65	0.93	1.02	1.05	1.01	0.97	0.98		1.97	3.9	4.18	2.46	2.35	2.43	6.31
Total Cations	meq/L	0.01	0.53	0.75	0.88	0.84	0.84	0.71	0.71		1.64	3.43	3.54	2.09	2.38	2.65	7.31
Ionic Balance	%	0.01													0.8	4.45	7.37

SOIL/ SEDIMENT SAMPLING RESULTS - MAGNET MINE

SOIL/ SEDIMENT - MRT Mgnt			ANZECC (2000)	EM1312660C												NEPM (Am 2013)				
ALS Sample number:			SEDIMENT QUALITY	27/11/2013 27/11/2013 27/11/2013 27/11/2013 27/11/2013 27/11/2013 27/11/2013 27/11/2013 27/11/2013 27/11/2013 27/11/2013 27/11/2013 27/11/2013												Ecological Investigation				
Sample date:				MRT-S-01 MRT-S-02 MRT-S-03 MRT-S-04 MRT-S-05 MRT-S-06 MRT-S-07 MRT-S-08 MRT-S-09 MRT-S-10 MRT-S-11 MRT-S-12												(EIL) for Soils, should not				
Client sample ID (Primary):																be applied to sediments				
Analyte grouping/Analyte			CAS Numb Units	LOR													exposed to Aquatic Env.			
EA001: pH in soil using 0.01M CaCl extract			pH Unit	0.1	6.5	6.6	7.1	6.3	6.6	6.7	6.6	6.8	6.9	7	6.4	4.8				
EA009: Nett Acid Production Potential			kg H2SO4/	0.5	15.4	-220	-262	-126	-46.7	-142	-155	-190	-224	-196	-154	-0.9				
EA010: Conductivity			µS/cm	1	25	86	109	37	48	64	98	99	107	103	85	9				
EA011: Net Acid Generation			pH Unit	0.1	6.6	8.4	8.6	8	7.8	7.6	6.8	7.3	8.2	8.2	7	6.6				
NAG (pH 4.5)			kg H2SO4/	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1				
NAG (pH 7.0)			kg H2SO4/	0.1	1	<0.1	<0.1	<0.1	<0.1	<0.1	0.4	<0.1	<0.1	<0.1	<0.1	<0.1				
EA013: Acid Neutralising Capacity			kg H2SO4	0.5	6.6	246	285	153	61.7	158	176	209	254	229	184	5.5				
ANC as CaCO3			% CaCO3	0.1	0.7	25.1	29	15.6	6.3	16.1	18	21.3	25.9	23.4	18.7	0.6				
Fizz Rating			Fizz Unit	0	0	3	3	3	2	3	3	3	3	3	3	0				
Maximum Potential Acidity (by Total S%)			kg H2SO4/t		22	26	23	27	15	16	21	19	30	32	30	5				
ANC/MPA Ratio					0.3	9.5	12.4	5.7	4.1	9.9	8.4	11.0	8.5	6.9	6.1	1.2				
EA055: Moisture Content			%	1	46.6	9.1	6.7	34.3	36.9	5.7	28.6	6.9	18.2	13.2	27.1	27.4				
ED040: Sulfur as SO4 2-			14808-79-ε mg/kg	100	1340	1430	2680	1320	3180	8160	1750	2000	1340	1950	1290	500				
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)			14808-79-ε mg/kg	50	0.134	0.143	0.268	0.132	0.318	0.816	0.175	0.2	0.134	0.195	0.129	0.05				
ED042T: Total Sulfur by LECO			%	0.01	0.72	0.86	0.75	0.87	0.49	0.52	0.69	0.63	0.98	1.06	0.98	0.15				
ED045G: Chloride Discrete analyser			16887-00-ε mg/kg	10	20	<10	<10	20	20	<10	<10	<10	<10	<10	<10	20				
ED093S: Soluble Major Cations					10	30	80	20	40	20	40	40	80	70	40	<10				
Calcium			7440-70-2 mg/kg	10	10	10	30	30	20	10	20	20	40	30	20	10				
Magnesium			7439-95-4 mg/kg	10	20	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	10				
Sodium			7440-23-5 mg/kg	10	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	10				
Potassium			7/09/7440 mg/kg	10	<10	<10	20	<10	<10	<10	<10	<10	<10	<10	<10	10				
Calcium					0.05	0.15	0.40	0.10	0.20	0.10	0.20	0.20	0.40	0.35	0.20					
Magnesium					0.08	0.08	0.25	0.25	0.17	0.08	0.17	0.17	0.33	0.25	0.17					
Sodium					0.09		0.04													
Potassium							0.05													
Estimated CEC			mequiv/100g		0.22	0.23	0.65	0.44	0.37	0.18	0.37	0.37	0.73	0.60	0.37					
EG005T: Total Metals by ICP-AES					ISQG-Trigger	ISQG-High													For General Reference:	
Arsenic			7440-38-2 mg/kg	5	20	70	111	2390	1940	1900	3660	4610	2500	2630	2340	2530	2300	131		
Cadmium			7440-43-9 mg/kg	1	1.5	10	11	322	189	90	155	408	335	280	204	370	268	16		
Chromium			7440-47-3 mg/kg	2	80	370	134	152	76	154	199	73	131	98	104	114	158	60		
Copper			7440-50-8 mg/kg	5	65	270	88	464	323	235	422	713	505	487	428	489	377	36		
Lead			7439-92-1 mg/kg	5	50	220	583	10500	15600	7930	19000	17700	16200	10400	9180	11200	15100	527		
Nickel			7440-02-0 mg/kg	2	21	52	101	86	38	61	98	55	78	49	48	66	71	14		
Silver			7440-22-4 mg/kg	2	1	3.7	24	165	229	130	230	199	210	157	224	270	224	7		
Zinc			7440-66-6 mg/kg	5	200	410	1150	48300	29600	12900	21600	71400	49100	44800	26400	61800	38400	1290		
EG035T: Total Recoverable Mercury by FIMS			7439-97-6 mg/kg	0.1	0.15	1	0.5	1.6	2.6	2.1	2	2.5	2.1	2.1	2.8	2.8	2	0.2		
EK057G: Nitrite as N by Discrete Analyser			mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1			
EK058G: Nitrate as N by Discrete Analyser			mg/kg	0.1	2.4	0.2	0.3	0.5	1.4	0.3	0.1	0.2	0.1	0.5	0.2	<0.1				
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser			mg/kg	0.1	2.4	0.2	0.3	0.5	1.4	0.3	0.1	0.2	0.1	0.5	0.2	<0.1				
EK067G: Total Phosphorus as P by Discrete Analyser			mg/kg	2	602	135	420	439	389	302	304	96	302	181	183	197				
EP003: Total Organic Carbon (TOC) in Soil			%	0.02	5.16	0.47	0.08	1.05	0.95	0.1	0.44	0.05	0.39	1.38	3.56	4.92				

APPENDIX 3

Laboratory Reports, QA/QC Documentation

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: EM1305177	Page	: 1 of 6
Amendment	: 1		
Client	: MILLIN EMS	Laboratory	: Environmental Division Melbourne
Contact	: MR PHILIP MILLIN	Contact	: Client Services
Address	: 1ST FLOOR 5 MORRISON ST HOBART TASMANIA, AUSTRALIA 7000	Address	: 4 Westall Rd Springvale VIC Australia 3171
E-mail	: philip.millin@millinems.com.au	E-mail	: Melbourne.Enviro.Services@alsglobal.com
Telephone	: +61 03 6231 9690	Telephone	: +61-3-8549 9600
Facsimile	: ----	Facsimile	: +61-3-8549 9601
Project	: MRTMgnt	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 17-MAY-2013
Sampler	: PM	Issue Date	: 27-MAY-2013
Site	: ----		
Quote number	: ME/300/10	No. of samples received	: 8
		No. of samples analysed	: 8

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results



NATA Accredited Laboratory 825

Accredited for compliance with
ISO/IEC 17025.

Signatories

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

<u>Signatories</u>	<u>Position</u>	<u>Accreditation Category</u>
Dilani Fernando	Senior Inorganic Chemist	Melbourne Inorganics
Dilani Fernando	Senior Inorganic Chemist	Melbourne Inorganics
Eric Chau	Metals Team Leader	Melbourne Inorganics
Varsha Ho Wing	Non-Metals Team Leader	Melbourne Inorganics
Varsha Ho Wing	Non-Metals Team Leader	Melbourne Inorganics



General Comments

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

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

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

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

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

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

LOR = Limit of reporting

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

- **EG020F & T: Filtered and Total Arsenic and Manganese has been confirmed by re-preparation and re-analysis.**
- **Ionic Balance out of acceptable limits for sample #7 and #8 due to analytes not quantified in this report.**
- **Ionic balances were calculated using: major anions - chloride, alkalinity and sulfate; and major cations - calcium, magnesium, potassium and sodium.**
- **It is recognised that total metals are less than dissolved metals for samples EM1305177. However, the difference is within experimental variation of the methods.**



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)

Client sample ID

Client sampling date / time

				MRT-01	MRT-02	MRT-03	MRT-04	MRT-05
				16-MAY-2013 11:10	16-MAY-2013 11:50	16-MAY-2013 13:15	16-MAY-2013 13:30	16-MAY-2013 14:00
Compound	CAS Number	LOR	Unit	EM1305177-001	EM1305177-002	EM1305177-003	EM1305177-004	EM1305177-005
EA025: Suspended Solids								
Suspended Solids (SS)	----	5	mg/L	10	14	<5	<5	<5
EA075: Redox Potential								
Redox Potential	----	0.1	mV	268	262	264	264	264
pH Redox	----	0.01	pH Unit	7.0	7.1	7.2	7.3	7.3
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	17	16	22	22	22
Total Alkalinity as CaCO3	----	1	mg/L	17	16	22	22	22
ED038A: Acidity								
Acidity as CaCO3	----	1	mg/L	4	3	3	3	2
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	9	9	9	8	8
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1	mg/L	11	11	11	10	11
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	4	4	5	5	5
Magnesium	7439-95-4	1	mg/L	3	3	4	4	4
Sodium	7440-23-5	1	mg/L	8	8	8	9	8
Potassium	7440-09-7	1	mg/L	<1	<1	<1	<1	<1
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.07	0.05	0.04	0.04	0.03
Arsenic	7440-38-2	0.001	mg/L	0.002	0.001	0.002	0.002	0.002
Cadmium	7440-43-9	0.0001	mg/L	0.0050	0.0046	0.0049	0.0044	0.0030
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	0.001	0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	0.007	0.007	0.009	0.010	0.004
Zinc	7440-66-6	0.005	mg/L	0.864	0.808	0.852	0.722	0.488
Manganese	7439-96-5	0.001	mg/L	0.042	0.036	0.038	0.034	0.018
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Iron	7439-89-6	0.05	mg/L	0.12	0.11	0.09	0.09	0.06
EG020T: Total Metals by ICP-MS								



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)

Client sample ID

Client sampling date / time

				MRT-01	MRT-02	MRT-03	MRT-04	MRT-05
				16-MAY-2013 11:10	16-MAY-2013 11:50	16-MAY-2013 13:15	16-MAY-2013 13:30	16-MAY-2013 14:00
Compound	CAS Number	LOR	Unit	EM1305177-001	EM1305177-002	EM1305177-003	EM1305177-004	EM1305177-005
EG020T: Total Metals by ICP-MS - Continued								
Aluminium	7429-90-5	0.01	mg/L	0.18	0.16	0.12	0.10	0.11
Arsenic	7440-38-2	0.001	mg/L	0.003	0.002	0.003	0.002	0.004
Cadmium	7440-43-9	0.0001	mg/L	0.0050	0.0049	0.0054	0.0044	0.0033
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	0.001	0.001	0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	0.002	0.002	0.001	0.001	<0.001
Lead	7439-92-1	0.001	mg/L	0.017	0.021	0.020	0.016	0.011
Zinc	7440-66-6	0.005	mg/L	0.786	0.714	0.827	0.659	0.466
Manganese	7439-96-5	0.001	mg/L	0.054	0.049	0.048	0.041	0.035
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Iron	7439-89-6	0.05	mg/L	0.30	0.20	0.20	0.19	0.19
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	0.84	0.82	0.94	0.89	0.92
Total Cations	----	0.01	meq/L	0.79	0.79	0.93	0.97	0.93
Ionic Balance	----	0.01	%	2.64	1.43	0.58	4.40	0.55



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)

Client sample ID

Client sampling date / time

				MRT-06	MRT-07	MRT-08	---	---
				16-MAY-2013 15:45	16-MAY-2013 15:30	16-MAY-2013 15:00	---	---
Compound	CAS Number	LOR	Unit	EM1305177-006	EM1305177-007	EM1305177-008	---	---
EA025: Suspended Solids								
Suspended Solids (SS)	---	5	mg/L	<5	<5	<5	---	---
EA075: Redox Potential								
Redox Potential	---	0.1	mV	270	265	263	---	---
pH Redox	---	0.01	pH Unit	7.2	7.4	7.5	---	---
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	---	---
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	---	---
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	60	22	15	---	---
Total Alkalinity as CaCO3	---	1	mg/L	60	22	15	---	---
ED038A: Acidity								
Acidity as CaCO3	---	1	mg/L	5	2	<1	---	---
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	31	6	3	---	---
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1	mg/L	10	11	11	---	---
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	17	5	3	---	---
Magnesium	7439-95-4	1	mg/L	12	4	3	---	---
Sodium	7440-23-5	1	mg/L	7	9	8	---	---
Potassium	7440-09-7	1	mg/L	<1	<1	<1	---	---
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	0.03	0.03	---	---
Arsenic	7440-38-2	0.001	mg/L	0.003	0.002	0.012	---	---
Cadmium	7440-43-9	0.0001	mg/L	0.0088	0.0013	<0.0001	---	---
Chromium	7440-47-3	0.001	mg/L	<0.001	0.001	<0.001	---	---
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	---	---
Nickel	7440-02-0	0.001	mg/L	0.002	<0.001	<0.001	---	---
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	---	---
Zinc	7440-66-6	0.005	mg/L	1.75	0.193	<0.005	---	---
Manganese	7439-96-5	0.001	mg/L	0.002	0.007	0.078	---	---
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	---	---
Iron	7439-89-6	0.05	mg/L	<0.05	0.06	0.05	---	---
EG020T: Total Metals by ICP-MS								



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)

Client sample ID

Client sampling date / time

				MRT-06	MRT-07	MRT-08	----	----
				16-MAY-2013 15:45	16-MAY-2013 15:30	16-MAY-2013 15:00	----	----
Compound	CAS Number	LOR	Unit	EM1305177-006	EM1305177-007	EM1305177-008	----	----
EG020T: Total Metals by ICP-MS - Continued								
Aluminium	7429-90-5	0.01	mg/L	<0.01	0.12	0.09	----	----
Arsenic	7440-38-2	0.001	mg/L	0.002	0.002	0.003	----	----
Cadmium	7440-43-9	0.0001	mg/L	0.0091	0.0014	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.002	----	----
Nickel	7440-02-0	0.001	mg/L	0.002	<0.001	<0.001	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	0.006	<0.001	----	----
Zinc	7440-66-6	0.005	mg/L	1.54	0.178	<0.005	----	----
Manganese	7439-96-5	0.001	mg/L	0.004	0.048	0.038	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	0.24	0.20	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	2.13	0.87	0.67	----	----
Total Cations	----	0.01	meq/L	2.14	0.97	0.74	----	----
Ionic Balance	----	0.01	%	0.33	5.16	5.08	----	----



CHAIN OF CUSTODY

ALS Laboratory: please tick →

Sydney 177 Woodpark Rd, Greenacre NSW 2155
 Ph: 02 8756 8500 E: enquiries@als.com.au
 Newcastle 5 Robinson Rd, Warabrah NSW 2274
 Ph: 02 4950 9400 E: enquiries@als.com.au

Brisbane 22 Strand St, Stalled QLD 4050
 Ph: 07 3247 7000 E: enquiries@als.com.au
 Townsville 14-16 Deane St, Borneo QLD 4810
 Ph: 07 4786 0800 E: enquiries@als.com.au

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 Ph: 03 8549 9000 E: enquiries@als.com.au
 Adelaide 11 Burns Rd, Prospect SA 5000
 Ph: 08 8350 0900 E: enquiries@als.com.au

Perth 10 Heathway, Mirrabooka WA 6049
 Ph: 08 9200 7800 E: enquiries@als.com.au
 Labradors 27 Whangara Cr, Labradors TAS 7250
 Ph: 03 6361 0100 E: enquiries@als.com.au

CLIENT: Millin EMS Pty Ltd		TURNAROUND REQUIREMENTS: <input checked="" type="checkbox"/> Standard TAT (List due date):				FOR LABORATORY USE ONLY (Circle)			
OFFICE: 1st Floor 5 Morrison Street HOBART 7000		(Standard TAT may be longer for some tests e.g. Ultra Trace Organics) <input type="checkbox"/> Non Standard or urgent TAT (List due date):				Custody Seal: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A			
PROJECT: MRTMgnt		ALS QUOTE NO.: MEBQ-148-13 / MillinEMS		COC SEQUENCE NUMBER (Circle)				Free ice (open ice bags present upon receipt): <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
ORDER NUMBER:				COC: 1 2 3 4 5 6 7				Random Sample Temperature on Receipt: <input type="checkbox"/> C <input type="checkbox"/> F	
PROJECT MANAGER: Philip Millin		CONTACT PH: Ph: 03 6231 9690		Fax: 03 62319695		Other comment: 8°C			
SAMPLER:	<i>PHILLIN</i>	SAMPLER MOBILE:		RELINQUISHED BY:	<i>PHILLIN</i>		RECEIVED BY:	<i>NAME</i>	
COC emailed to ALS? (YES	EDD FORMAT (or default):		DATE/TIME:	<i>16/5 17:45</i>		DATE/TIME:	<i>12/5 10:50</i>	
Email Reports to (will default to PM if no other addresses are listed):	<i>pm@millinems.com.au</i>			DATE/TIME:			DATE/TIME:		
Email Invoice to (will default to PM if no other addresses are listed):	<i>pm@millinems.com.au</i>			DATE/TIME:			DATE/TIME:		

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL: *SW yard*

LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	CONTAINER INFORMATION	ANALYSIS REQUIRED including SUITES VB. Suite Codes must be listed to attract suite price)														Additional Information		
						Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).																
						TOTAL BOTTLES	EA-025-H	TSS	EA-075	Redox	ED-038	Acidity	NT-02	Anions	NT-01	Cations	W-2	8 Me+3	W-2T	8 Me+3		
1	MRT-01	16/5 11:00	W	Lab Supplied		4	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	ADD Fe, Mn and Al - PLEASE FILTER AT LAB FOR DISSOLVED METALS
2	MRT-02	16/5 11:50	W	Lab Supplied		4	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	AS ABOVE
3	MRT-03	16/5 13:15	W	Lab Supplied		4	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	AS ABOVE
4	MRT-04	16/5 13:30	W	Lab Supplied		4	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	AS ABOVE
5	MRT-05	16/5 14:00	W	Lab Supplied		4	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	AS ABOVE
6	MRT-06	16/5 15:45	W	Lab Supplied		4	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	AS ABOVE
7	MRT-07	16/5 15:30	W	Lab Supplied		4	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	AS ABOVE
8	MRT-08	16/5 15:00	W	Lab Supplied		4	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	AS ABOVE

Environmental Division
 Melbourne
 Work Order
EM1305177



Telephone : +61-3-8549 9600

Please hold purple for ammonia - instruction to be confirmed - pls call Philip Millin 0419315791 to confirm

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

CERTIFICATE OF ANALYSIS

Work Order	: EM1312661	Page	: 1 of 8
Client	: MILLIN EMS	Laboratory	: Environmental Division Melbourne
Contact	: MR PHILIP MILLIN	Contact	: Shirley LeCornu
Address	: 1ST FLOOR 5 MORRISON ST HOBART TASMANIA, AUSTRALIA 7000	Address	: 4 Westall Rd Springvale VIC Australia 3171
E-mail	: philip.millin@millinems.com.au	E-mail	: shirley.lecornu@alsenviro.com
Telephone	: +61 03 6231 9690	Telephone	: +61-3-8549 9630
Facsimile	: ----	Facsimile	: +61-3-8549 9601
Project	: MRTMgnt	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 29-NOV-2013
C-O-C number	: ----	Issue Date	: 10-DEC-2013
Sampler	: HH	No. of samples received	: 14
Site	: ----	No. of samples analysed	: 14
Quote number	: ME/709/13		

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results



General Comments

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

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

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

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

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

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

LOR = Limit of reporting

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

- **EG020F&T: Filtered and total iron results for EM1312661-013 have been confirmed by re-preparation and re-analysis.**
- **EG020T: Results for EM1312661-014 have been confirmed by re-preparation and re-analysis.**
- **Ionic Balance out of acceptable limits for sample #13 due to analytes not quantified in this report.**
- **Ionic balances were calculated using: major anions - chloride, alkalinity and sulfate; and major cations - calcium, magnesium, potassium, sodium and Zinc for #11, #12 and #13.**
- **Ionic balances were calculated using: major anions - chloride, alkalinity and sulfate; and major cations - calcium, magnesium, potassium and sodium.**
- **It is recognised that total metals is less than dissolved metals for samples in work order EM1312661. However, the difference is within experimental variation of the methods.**
- **Ultra trace metals (EG093F) conducted by ALS Sydney, NATA accreditation no. 825, site no 10911.**



NATA Accredited Laboratory 825

Accredited for compliance with
ISO/IEC 17025.

Signatories

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

Signatories	Position	Accreditation Category
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Dilani Fernando	Senior Inorganic Chemist	Melbourne Inorganics
Eric Chau	Metals Team Leader	Melbourne Inorganics
Varsha Ho Wing	Non-Metals Team Leader	Melbourne Inorganics



Analytical Results

Sub-Matrix: SURFACE WATER (Matrix: WATER)

Client sample ID

Client sampling date / time

				MRT-01	MRT-02	MRT-03	MRT-04	MRT-05
				27-NOV-2013 15:00				
Compound	CAS Number	LOR	Unit	EM1312661-001	EM1312661-002	EM1312661-003	EM1312661-004	EM1312661-005
EA025: Suspended Solids								
Suspended Solids (SS)	----	5	mg/L	<5	<5	<5	<5	<5
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	23	24	26	28	28
Total Alkalinity as CaCO3	----	1	mg/L	23	24	26	28	28
ED038A: Acidity								
Acidity as CaCO3	----	1	mg/L	3	3	2	2	2
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	6	6	6	6	6
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1	mg/L	14	13	13	13	12
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	4	4	5	5	5
Magnesium	7439-95-4	1	mg/L	3	3	4	4	4
Sodium	7440-23-5	1	mg/L	6	6	6	6	7
Potassium	7440-09-7	1	mg/L	<1	<1	<1	<1	<1
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.06	0.04	0.04	0.04	0.04
Arsenic	7440-38-2	0.001	mg/L	0.003	0.004	0.004	0.004	0.004
Cadmium	7440-43-9	0.0001	mg/L	0.0025	0.0028	0.0033	0.0027	0.0017
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	0.001	0.001	0.001	0.002	0.001
Nickel	7440-02-0	0.001	mg/L	0.001	0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	0.009	0.010	0.010	0.017	0.008
Zinc	7440-66-6	0.005	mg/L	0.438	0.431	0.478	0.402	0.261
Manganese	7439-96-5	0.001	mg/L	0.061	0.054	0.048	0.051	0.036
Iron	7439-89-6	0.05	mg/L	0.17	0.13	0.11	0.12	0.10
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.10	0.12	0.07	0.09	0.08
Arsenic	7440-38-2	0.001	mg/L	0.004	0.005	0.004	0.005	0.005
Cadmium	7440-43-9	0.0001	mg/L	0.0032	0.0036	0.0035	0.0030	0.0020
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001



Analytical Results

Sub-Matrix: SURFACE WATER (Matrix: WATER)

Client sample ID

Client sampling date / time

				MRT-01	MRT-02	MRT-03	MRT-04	MRT-05
				27-NOV-2013 15:00				
Compound	CAS Number	LOR	Unit	EM1312661-001	EM1312661-002	EM1312661-003	EM1312661-004	EM1312661-005
EG020T: Total Metals by ICP-MS - Continued								
Copper	7440-50-8	0.001	mg/L	0.001	0.001	0.001	0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	0.014	0.025	0.017	0.022	0.013
Zinc	7440-66-6	0.005	mg/L	0.427	0.463	0.468	0.412	0.248
Manganese	7439-96-5	0.001	mg/L	0.082	0.094	0.069	0.062	0.049
Iron	7439-89-6	0.05	mg/L	0.27	0.35	0.18	0.20	0.18
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	0.98	0.97	1.01	1.05	1.02
Total Cations	----	0.01	meq/L	0.71	0.71	0.84	0.84	0.88



Analytical Results

Sub-Matrix: SURFACE WATER (Matrix: WATER)

Client sample ID

Client sampling date / time

				MRT-06	MRT-07	MRT-08	MRT-09	MRT-10
				27-NOV-2013 15:00				
Compound	CAS Number	LOR	Unit	EM1312661-006	EM1312661-007	EM1312661-008	EM1312661-009	EM1312661-010
EA025: Suspended Solids								
Suspended Solids (SS)	----	5	mg/L	10	8	10	8	9
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	64	24	12	150	100
Total Alkalinity as CaCO3	----	1	mg/L	64	24	12	150	100
ED038A: Acidity								
Acidity as CaCO3	----	1	mg/L	6	3	2	9	4
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	17	4	2	27	6
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1	mg/L	12	13	13	12	12
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	12	4	2	28	16
Magnesium	7439-95-4	1	mg/L	9	3	2	22	13
Sodium	7440-23-5	1	mg/L	7	7	6	5	5
Potassium	7440-09-7	1	mg/L	<1	<1	<1	<1	<1
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	0.03	0.04	<0.01	0.01
Arsenic	7440-38-2	0.001	mg/L	0.004	0.005	<0.001	0.074	<0.001
Cadmium	7440-43-9	0.0001	mg/L	0.0062	<0.0001	<0.0001	<0.0001	0.0002
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	0.002
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	0.001
Nickel	7440-02-0	0.001	mg/L	0.002	<0.001	<0.001	0.007	<0.001
Lead	7439-92-1	0.001	mg/L	0.005	0.002	0.009	0.005	0.002
Zinc	7440-66-6	0.005	mg/L	0.941	<0.005	<0.005	0.019	0.028
Manganese	7439-96-5	0.001	mg/L	0.021	0.012	0.035	0.200	0.004
Iron	7439-89-6	0.05	mg/L	<0.05	0.09	0.18	0.05	<0.05
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.03	0.09	0.15	0.05	0.05
Arsenic	7440-38-2	0.001	mg/L	0.006	0.005	0.002	0.092	<0.001
Cadmium	7440-43-9	0.0001	mg/L	0.0110	<0.0001	0.0001	0.0003	0.0002
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	0.003



Analytical Results

Sub-Matrix: SURFACE WATER (Matrix: WATER)

Client sample ID

Client sampling date / time

				MRT-06	MRT-07	MRT-08	MRT-09	MRT-10
				27-NOV-2013 15:00				
Compound	CAS Number	LOR	Unit	EM1312661-006	EM1312661-007	EM1312661-008	EM1312661-009	EM1312661-010
EG020T: Total Metals by ICP-MS - Continued								
Copper	7440-50-8	0.001	mg/L	0.001	<0.001	0.002	0.001	0.001
Nickel	7440-02-0	0.001	mg/L	0.002	<0.001	<0.001	0.007	<0.001
Lead	7439-92-1	0.001	mg/L	0.016	<0.001	0.009	0.010	0.013
Zinc	7440-66-6	0.005	mg/L	1.07	<0.005	0.020	0.073	0.027
Manganese	7439-96-5	0.001	mg/L	0.093	0.020	0.041	0.226	0.024
Iron	7439-89-6	0.05	mg/L	0.09	0.17	0.34	0.18	0.07
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS								
Silver	7440-22-4	0.1	µg/L	----	----	----	<0.1	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	1.97	0.93	0.65	3.90	2.46
Total Cations	----	0.01	meq/L	1.64	0.75	0.53	3.43	2.09



Analytical Results

Sub-Matrix: SURFACE WATER (Matrix: WATER)

Client sample ID

Client sampling date / time

				MRT-11	MRT-12	MRT-13	MRT-14	----
				27-NOV-2013 15:00	27-NOV-2013 15:00	27-NOV-2013 15:00	27-NOV-2013 15:00	----
Compound	CAS Number	LOR	Unit	EM1312661-011	EM1312661-012	EM1312661-013	EM1312661-014	----
EA025: Suspended Solids								
Suspended Solids (SS)	----	5	mg/L	16	11	12	9	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	52	36	27	182	----
Total Alkalinity as CaCO3	----	1	mg/L	52	36	27	182	----
ED038A: Acidity								
Acidity as CaCO3	----	1	mg/L	36	20	122	14	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	44	66	265	10	----
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1	mg/L	14	12	9	12	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	9	15	24	32	----
Magnesium	7439-95-4	1	mg/L	7	10	17	21	----
Sodium	7440-23-5	1	mg/L	5	7	4	5	----
Potassium	7440-09-7	1	mg/L	<1	<1	<1	<1	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.01	0.01	0.02	<0.01	----
Arsenic	7440-38-2	0.001	mg/L	0.032	0.001	0.008	0.051	----
Cadmium	7440-43-9	0.0001	mg/L	0.0843	0.0557	0.357	0.0003	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Copper	7440-50-8	0.001	mg/L	0.002	0.001	0.003	<0.001	----
Nickel	7440-02-0	0.001	mg/L	0.023	0.010	0.112	0.012	----
Lead	7439-92-1	0.001	mg/L	0.033	0.002	0.066	0.001	----
Zinc	7440-66-6	0.005	mg/L	21.6	11.4	93.4	0.208	----
Manganese	7439-96-5	0.001	mg/L	1.15	0.311	1.22	0.862	----
Iron	7439-89-6	0.05	mg/L	0.26	<0.05	0.63	<0.05	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.02	0.01	0.02	0.29	----
Arsenic	7440-38-2	0.001	mg/L	0.061	<0.001	0.006	0.216	----
Cadmium	7440-43-9	0.0001	mg/L	0.102	0.0610	0.407	0.0004	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----



Analytical Results

Sub-Matrix: SURFACE WATER (Matrix: WATER)

Client sample ID

Client sampling date / time

				MRT-11	MRT-12	MRT-13	MRT-14	----
				27-NOV-2013 15:00	27-NOV-2013 15:00	27-NOV-2013 15:00	27-NOV-2013 15:00	----
Compound	CAS Number	LOR	Unit	EM1312661-011	EM1312661-012	EM1312661-013	EM1312661-014	----
EG020T: Total Metals by ICP-MS - Continued								
Copper	7440-50-8	0.001	mg/L	0.008	0.001	0.003	<0.001	----
Nickel	7440-02-0	0.001	mg/L	0.026	0.010	0.120	0.012	----
Lead	7439-92-1	0.001	mg/L	0.348	<0.001	0.119	0.005	----
Zinc	7440-66-6	0.005	mg/L	22.5	10.5	97.4	0.259	----
Manganese	7439-96-5	0.001	mg/L	2.02	0.370	1.16	0.892	----
Iron	7439-89-6	0.05	mg/L	1.93	<0.05	0.31	1.26	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS								
Silver	7440-22-4	0.1	µg/L	----	----	----	<0.1	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	2.35	2.43	6.31	4.18	----
Total Cations	----	0.01	meq/L	----	----	----	3.54	----
Total Cations	----	0.01	meq/L	2.38	2.65	7.31	----	----
Ionic Balance	----	0.01	%	0.80	4.45	7.37	----	----

CERTIFICATE OF ANALYSIS

Work Order	: EM1312660	Page	: 1 of 8
Amendment	: 1		
Client	: MILLIN EMS	Laboratory	: Environmental Division Melbourne
Contact	: MR PHILIP MILLIN (PM)	Contact	: Shirley LeCornu
Address	: 1ST FLOOR 5 MORRISON ST HOBART TASMANIA, AUSTRALIA 7000	Address	: 4 Westall Rd Springvale VIC Australia 3171
E-mail	: pm@millinems.com.au	E-mail	: shirley.lecornu@alsenviro.com
Telephone	: +61 03 6231 9690	Telephone	: +61-3-8549 9630
Facsimile	: ----	Facsimile	: +61-3-8549 9601
Project	: MRTMgnt	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 29-NOV-2013
Sampler	: HH	Issue Date	: 17-JAN-2014
Site	: ----		
Quote number	: ME/709/13	No. of samples received	: 12
		No. of samples analysed	: 12

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results



General Comments

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

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

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

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

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

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

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

LOR = Limit of reporting

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

- (17/01/2014) This report has been amended and re-released to allow the reporting of additional analytical data.
- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.
- EG035T:EM1312660#4 duplicate failed for mercury due to sample heterogeneity. This has been confirmed by re-digestion and re-analysis.
- TOC (EP003), Total Sulphur (ED042T), ANC (EA009), NAP (EA013) and NAG (EA011) conducted by ALS Brisbane, NATA accreditation no. 825, site no. 818.



NATA Accredited Laboratory 825

Accredited for compliance with
ISO/IEC 17025.

Signatories

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

Signatories	Position	Accreditation Category
Eric Chau	Metals Team Leader	Melbourne Inorganics
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils
Nikki Stepniewski	Senior Inorganic Instrument Chemist	Melbourne Inorganics
SATISH.TRIVEDI	2 IC Acid Sulfate Soils Supervisor	Brisbane Acid Sulphate Soils



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

Client sampling date / time

				MRT-S-01	MRT-S-02	MRT-S-03	MRT-S-04	MRT-S-05
				27-NOV-2013 15:00				
Compound	CAS Number	LOR	Unit	EM1312660-001	EM1312660-002	EM1312660-003	EM1312660-004	EM1312660-005
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	6.5	6.6	7.1	6.3	6.6
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	15.4	-220	-262	-126	-46.7
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	25	86	109	37	48
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	6.6	8.4	8.6	8.0	7.8
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	1.0	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	6.6	246	285	153	61.7
ANC as CaCO3	----	0.1	% CaCO3	0.7	25.1	29.0	15.6	6.3
Fizz Rating	----	0	Fizz Unit	0	3	3	3	2
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	46.6	9.1	6.7	34.3	36.9
ED040: Sulfur as SO4 2-								
Sulfate as SO4 2-	14808-79-8	100	mg/kg	1340	1430	2680	1320	3180
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	350	50	90	<50
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.72	0.86	0.75	0.87	0.49
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	20	<10	<10	20	20
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	10	30	80	20	40
Magnesium	7439-95-4	10	mg/kg	10	10	30	30	20
Sodium	7440-23-5	10	mg/kg	20	<10	<10	10	<10
Potassium	7440-09-7	10	mg/kg	<10	<10	<10	20	<10
EG005T: Total Metals by ICP-AES								
Silver	7440-22-4	2	mg/kg	24	165	229	130	230
Arsenic	7440-38-2	5	mg/kg	111	2390	1940	1900	3660
Cadmium	7440-43-9	1	mg/kg	11	322	189	90	155



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

Client sampling date / time

				MRT-S-01	MRT-S-02	MRT-S-03	MRT-S-04	MRT-S-05
				27-NOV-2013 15:00				
Compound	CAS Number	LOR	Unit	EM1312660-001	EM1312660-002	EM1312660-003	EM1312660-004	EM1312660-005
EG005T: Total Metals by ICP-AES - Continued								
Chromium	7440-47-3	2	mg/kg	134	152	76	154	199
Copper	7440-50-8	5	mg/kg	88	464	323	235	422
Lead	7439-92-1	5	mg/kg	583	10500	15600	7930	19000
Nickel	7440-02-0	2	mg/kg	101	86	38	61	98
Zinc	7440-66-6	5	mg/kg	1150	48300	29600	12900	21600
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	0.5	1.6	2.6	2.1	2.0
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	----	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	----	0.1	mg/kg	2.4	0.2	0.3	0.5	1.4
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	2.4	0.2	0.3	0.5	1.4
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	602	135	420	439	389
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	5.16	0.47	0.08	1.05	0.95



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

Client sampling date / time

				MRT-S-06	MRT-S-07	MRT-S-08	MRT-S-09	MRT-S-10
				27-NOV-2013 15:00				
Compound	CAS Number	LOR	Unit	EM1312660-006	EM1312660-007	EM1312660-008	EM1312660-009	EM1312660-010
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	6.7	6.6	6.8	6.9	7.0
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-142	-155	-190	-224	-196
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	64	98	99	107	103
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	7.6	6.8	7.3	8.2	8.2
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	0.4	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	158	176	209	254	229
ANC as CaCO3	----	0.1	% CaCO3	16.1	18.0	21.3	25.9	23.4
Fizz Rating	----	0	Fizz Unit	3	3	3	3	3
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	5.7	28.6	6.9	18.2	13.2
ED040: Sulfur as SO4 2-								
Sulfate as SO4 2-	14808-79-8	100	mg/kg	8160	1750	2000	1340	1950
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	230	460	470	110	100
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.52	0.69	0.63	0.98	1.06
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	<10	<10	<10	<10	<10
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	20	40	40	80	70
Magnesium	7439-95-4	10	mg/kg	10	20	20	40	30
Sodium	7440-23-5	10	mg/kg	<10	<10	<10	<10	<10
Potassium	7440-09-7	10	mg/kg	<10	<10	<10	<10	<10
EG005T: Total Metals by ICP-AES								
Silver	7440-22-4	2	mg/kg	199	210	157	224	270
Arsenic	7440-38-2	5	mg/kg	4610	2500	2630	2340	2530
Cadmium	7440-43-9	1	mg/kg	408	335	280	204	370



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

Client sampling date / time

				MRT-S-06	MRT-S-07	MRT-S-08	MRT-S-09	MRT-S-10
				27-NOV-2013 15:00				
Compound	CAS Number	LOR	Unit	EM1312660-006	EM1312660-007	EM1312660-008	EM1312660-009	EM1312660-010
EG005T: Total Metals by ICP-AES - Continued								
Chromium	7440-47-3	2	mg/kg	73	131	98	104	114
Copper	7440-50-8	5	mg/kg	713	505	487	428	489
Lead	7439-92-1	5	mg/kg	17700	16200	10400	9180	11200
Nickel	7440-02-0	2	mg/kg	55	78	49	48	66
Zinc	7440-66-6	5	mg/kg	71400	49100	44800	26400	61800
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	2.5	2.1	2.1	2.8	2.8
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	----	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	----	0.1	mg/kg	0.3	0.1	0.2	0.1	0.5
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	0.3	0.1	0.2	0.1	0.5
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	302	304	96	302	181
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	0.10	0.44	0.05	0.39	1.38



Analytical Results

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

Client sample ID

Client sampling date / time

				MRT-S-11	MRT-S-12	---	---	---
				27-NOV-2013 15:00	27-NOV-2013 15:00	---	---	---
Compound	CAS Number	LOR	Unit	EM1312660-011	EM1312660-012	---	---	---
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	---	0.1	pH Unit	6.4	4.8	---	---	---
EA009: Nett Acid Production Potential								
Net Acid Production Potential	---	0.5	kg H2SO4/t	-154	-0.9	---	---	---
EA010: Conductivity								
Electrical Conductivity @ 25°C	---	1	µS/cm	85	9	---	---	---
EA011: Net Acid Generation								
pH (OX)	---	0.1	pH Unit	7.0	6.6	---	---	---
NAG (pH 4.5)	---	0.1	kg H2SO4/t	<0.1	<0.1	---	---	---
NAG (pH 7.0)	---	0.1	kg H2SO4/t	<0.1	<0.1	---	---	---
EA013: Acid Neutralising Capacity								
ANC as H2SO4	---	0.5	kg H2SO4 equiv./t	184	5.5	---	---	---
ANC as CaCO3	---	0.1	% CaCO3	18.7	0.6	---	---	---
Fizz Rating	---	0	Fizz Unit	3	0	---	---	---
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	---	1.0	%	27.1	27.4	---	---	---
ED040: Sulfur as SO4 2-								
Sulfate as SO4 2-	14808-79-8	100	mg/kg	1290	500	---	---	---
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	160	<50	---	---	---
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	---	0.01	%	0.98	0.15	---	---	---
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	<10	20	---	---	---
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	40	<10	---	---	---
Magnesium	7439-95-4	10	mg/kg	20	10	---	---	---
Sodium	7440-23-5	10	mg/kg	<10	<10	---	---	---
Potassium	7440-09-7	10	mg/kg	<10	10	---	---	---
EG005T: Total Metals by ICP-AES								
Silver	7440-22-4	2	mg/kg	224	7	---	---	---
Arsenic	7440-38-2	5	mg/kg	2300	131	---	---	---
Cadmium	7440-43-9	1	mg/kg	268	16	---	---	---



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID

				MRT-S-11	MRT-S-12	---	---	---
				27-NOV-2013 15:00	27-NOV-2013 15:00	---	---	---
				EM1312660-011	EM1312660-012	---	---	---
Compound	CAS Number	LOR	Unit					
EG005T: Total Metals by ICP-AES - Continued								
Chromium	7440-47-3	2	mg/kg	158	60	---	---	---
Copper	7440-50-8	5	mg/kg	377	36	---	---	---
Lead	7439-92-1	5	mg/kg	15100	527	---	---	---
Nickel	7440-02-0	2	mg/kg	71	14	---	---	---
Zinc	7440-66-6	5	mg/kg	38400	1290	---	---	---
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	2.0	0.2	---	---	---
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	----	0.1	mg/kg	<0.1	<0.1	---	---	---
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	----	0.1	mg/kg	0.2	<0.1	---	---	---
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	0.2	<0.1	---	---	---
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	183	197	---	---	---
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	3.56	4.92	---	---	---

APPENDIX 4

Description of Soil Samples

SOIL PROFILES: MAGNET MINE

MRT – S 01

- 0-3cm: Fine tailings. Damp.
- 3-15cm: Fine tailings with more silt and organics. Wet.
- 15-30cm: Silty clay, chocolate brown in colour. Very wet.



MRT – S 02

- 0-1cm: Deep ripped waste rock.
- 1-6cm: Grey clay. Some orange streaks.
- 6-30cm: Orange gravel. Large (7-10cm) rocks.



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Summary Report – Sediment and Water Quality Monitoring, Magnet Mine

MRT – S 03

- 0-10cm: Interbedded small pebbles of waste rock and weathered pebbles from creek. (See first image) Held in matrix of fine tailings.
- 10-30cm: Light yellow – orange gravelly sand.



MRT – S 04

- 0-5cm: Weathered dark fine tailings. Silty, with some organics.
- 5-20cm: Orange gravel.
- 20-30cm: Light grey silty clay, some remanent rotting vegetation present, thus indicating rapid coverage or persistent veg.



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MRT – S 05

- 0-25cm: Dark brown sandy/gravel.
- 25-30cm: Orange gravel.



MRT – S 06

- 0-10cm: Sand, but dark due to tailings mixing. High amounts of waste rock chips.
- 10-30cm: Orange sandy gravel. More dark blue (oxidised waste rock) pebbles in gravel than red/orange.



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MRT – S 07

- 0-10cm: Dark sandy/gravel (from mixing with tailings fines), lots of small weathered waste rock chips.
- 10-30cm: Orange sandy gravel.
- See photo for MRT – S – 08.

MRT – S 08

- 0-10cm: Dark sandy/gravel (from mixing with tailings fines), lots of small weathered waste rock chips.
- 10-30cm: Orange sandy gravel (same as previous), but with richer orange, indicating more iron staining.



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MRT – S 09

- 0-1cm: Dark, silt, almost clay, with a bit of iron tinge.
- 1-5cm: Fine sand, orange.
- 5-15cm: Coarse sandy gravel, light orange, some organics.
- 15-30cm: Grey clay with red blobs from completely oxidised iron.
- See photo of MRT – S 11.

MRT – S 10

- 0-10cm: Dark sandy/gravel (from mixing with tailings fines), lots of small weathered waste rock chips.
- 10-30cm: Orange sandy gravel, same as MRT – S – 08, but with some organics.
- See MRT – S 08 photo.

MRT – S 11

- 0-1cm: Moss.
- 1-3cm: Silt (fine), chocolate brown.
- 3-30cm: Silty light grey clay with remnant organics and oxidised iron blobs. Random areas of coarse orange sand/gravel. Very wet at base.



MRT – S 12

- 0-5cm: Silt, dark brown, some organics.
- 5-30cm: Silty clay, dark brown. Seems to be out of the limit of influence of tailings and waste rock.

APPENDIX 5

5A. Water Sampling Locations/ Photographs

5B. General Site Photographs

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Water Sampling Locations: Magnet Mine

Site	Location	Comment	
MRT - AR	NA	Arthur River prior to convergence. No lab analysis.	
MRT - 01	145.47955 / -41.43377		Upstream of convergence with Arthur River.
MRT - 02	145.47423 / -41.43375		
MRT - 03	145.46893 / -41.43548		
MRT - 04	145.4677 / -41.43641		
MRT - 05	145.45605 / -41.43933		
MRT - 06	145.45068 / -41.4413		Wetland drainage along main waste rock area.
MRT - 07	145.44826 / -41.44487		Magnet Creek near MRT-06 (Autumn 2013) Sample at bridge upstream of main infrastructure (Spring 2013)
MRT - 08	No GPS due to tree cover		Background, upstream of South Adit convergence.

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MRT - 09	No GPS due to tree cover		South Adit
MRT - 10	No GPS due to tree cover		Small drainage line above graben
MRT - 11	145.46832 / -41.43626		Seep 1, North Side Deposit
MRT - 12	145.46651 / -41.43789		Seep 2, South Side Deposit (near MRT-04 in creek channel)
MRT - 13	145.46596 / -41.43809		Seep 3, South Side Deposit
MRT - 14	No GPS due to tree cover		West Adit #4

SAMPLING LOCATIONS – MINE DRAINAGE



MRT-09 (South Adit)



MRT-14 (West Adit/ Adit#4)

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MRT-10

Drainage from behind Main Mine Waste Rock Dump



MRT-06

Lateral Drainage from Mine Site

SAMPLING LOCATIONS ALONG MAGNET CREEK



MRT-08

Magnet Creek – upstream from South Adit



MR-07

Magnet Creek near Mine Site



MRT-05

Magnet Creek - Downstream

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MRT-04

Magnet Creek - Downstream



MRT-01

**Magnet Creek – Downstream
near confluence with Arthur
River**

DRAINAGE SEEPAGES WITHIN MINE WASTE DEPOSITS



MRT-11

**Seepage channel in Mine Waste Deposits –
North Side Deposits**



MRT-12

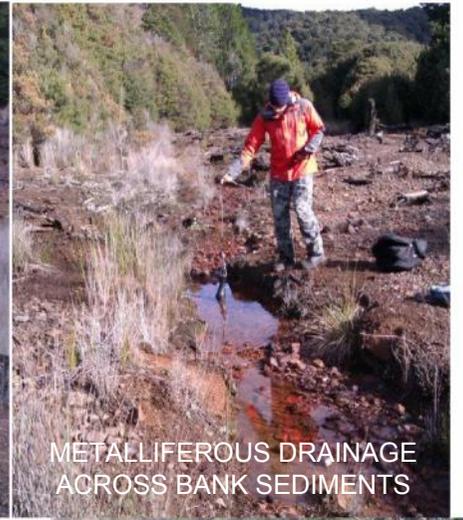
**Seepage channel in Mine Waste Deposits –
South Side Deposits**



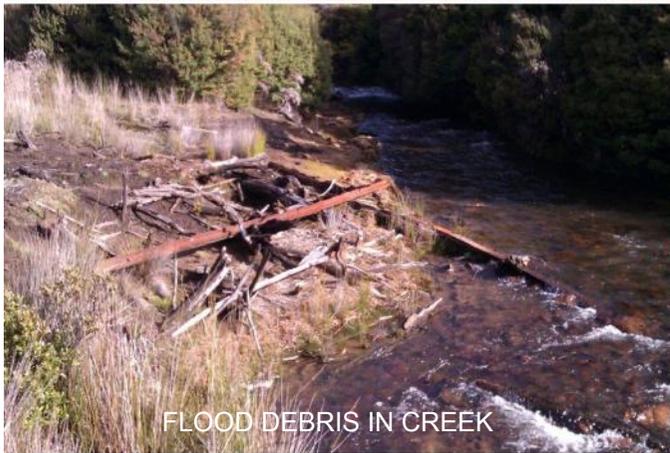
DRAINAGE FROM MINE ADIT #4



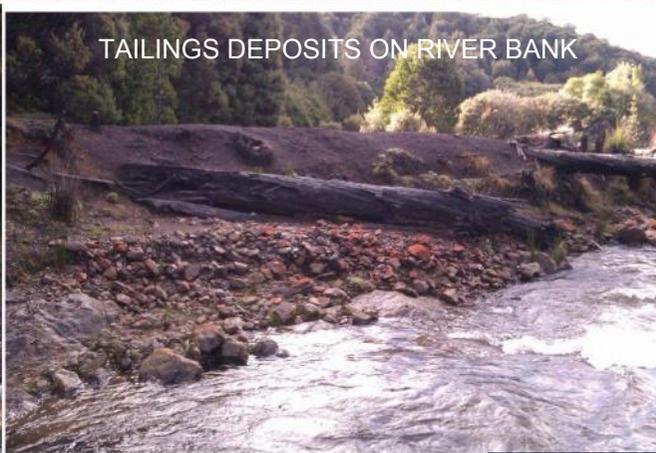
NATURALLY DEVELOPED 'WETLANDS'



METALLIFEROUS DRAINAGE
ACROSS BANK SEDIMENTS



FLOOD DEBRIS IN CREEK



TAILINGS DEPOSITS ON RIVER BANK



CURRENT MAGNET CREEK CHANNEL

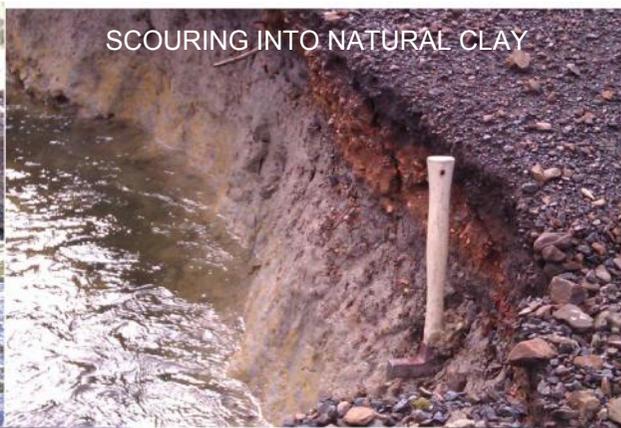


TAILINGS 'WASTELANDS' DOWNSTREAM FROM MAGNET MINE





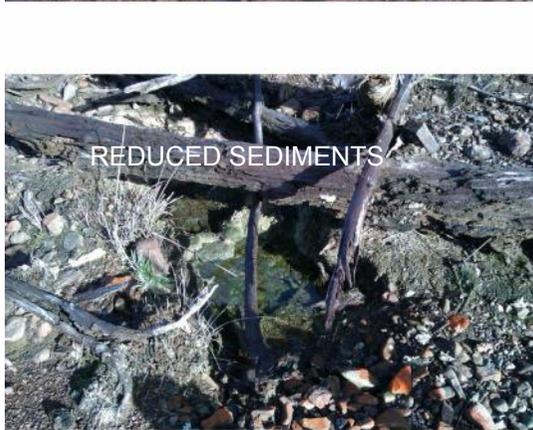
NATURAL SOIL PROFILE IN BANK



SCOURING INTO NATURAL CLAY



OXIDISED PROFILE - TAILINGS DEPOSITS



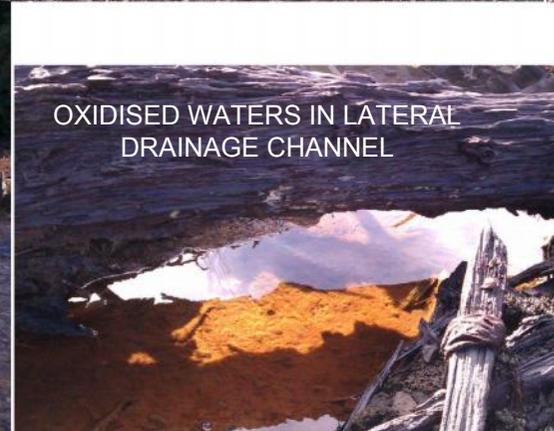
REDUCED SEDIMENTS



OXIDISED SEDIMENTS/TAILINGS



LATERAL DRAINAGE ACROSS TAILINGS



OXIDISED WATERS IN LATERAL DRAINAGE CHANNEL



FORMER SITE REHABILITATION WORKS?



NATURALLY FORMED 'WETLAND' IN TAILINGS