

Final Cover Design Old Tailings Storage Facility and Heap Leach Pad Number 2

Mt Gordon Mine

Prepared for Birla Mt Gordon Pty Ltd | 28 August 2015



Final cover design

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Final cover design

Draft Report

Report B15035RP1 | Prepared for Birla Mt Gordon Pty Ltd | 28 August 2015

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Date 28 August 2015

Date 28 August 2015

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Document Control

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Executive Summary

ES1 Introduction

The Mt Gordon Mine (the mine) has a long history of environmental non compliance and has reported breaches of the Environmental Authority (EA) to the Department of Environment and Heritage Protection (EHP) on a number of occasions during the time that the mine has been owned, operated and managed by Aditya Birla Minerals Limited (Aditya Birla).

As a result of previous environmental non compliance a Transitional Environmental Program (TEP) was issued in 2014, which outlined a series of actions for completion within a five year period, up to 2019. In the TEP the outcome is stated as follows:

...the actions proposed in the draft TEP shall result in substantial improvements to the Old TSF area and Heap Leach Pad #2 landforms and reduce their impact on the receiving environment, including avoidance of any unauthorised discharge (EA condition C2-1). The remaining aspects of the action program aims to reduce the contaminated load entering the groundwater and receiving environment.

ES2 Scope

Aditya Birla, the owner of the mine, have engaged the services of EMGA Mitchell McLennan (EMM) to addresses immediate actions (Table 1.1) that must be completed and sufficient evidence (performance indicator and reporting requirements) provided to EHP by 21 August 2015. Namely, this is the development and reporting of a final cover design for the Mammoth tailings storage facility (TSF) (the Old TSF) and heap leach pad number 2 (HLEP#2).

ES3 Review and investigation

A review and investigation of the opportunities and constraints found that the Old TSF cover and tailings would be suitable for reuse in the construction of a new cover subject to verification. This is advantageous because at least some of the borrow material for the new cover can be won directly from the Old TSF reducing the overall cost of construction. Alternatively, assuming the tailings and cover are suitable for use in constructing a new cover, the entire facility could be used to build a cover on one of the existing waste rock dumps, the Old TSF would therefore be rehabilitated by removal. This alternative is beyond the scope of this report and is not discussed further.

The review and investigation of HLEP#2 found that rehabilitation of HLEP#2 is constrained by the fact that the domain geometry is predominately batter slope. The flat top areas make up less than half of the total area. Building a cover on the batter slopes is considered very difficult using conventional construction methods. Therefore, Aditya Birla are committed to excavating HLEP#2 and removing the PAF waste rock and ore to the underground mine, or another location where the excavated waste rock and ore can be selectively handled to create a final landform that is safe, stable, sustainable and non polluting. The excavation and removal of HLEP#2 is beyond the scope of this report and will not be discussed further.

For the purpose of this report it is assumed that the cover design would cater to both the Old TSF and HLEP#2 even though this is not the preferred rehabilitation strategy for HLEP#2.

It was identified that a new cover would require a bridging layer/capillary break to reduce the potential for capillary rise of constituents in the new cover.

ES4 Cover options, modelling and recommendation

There are two recommended cover options.

ES4.1 Option 2b: 200 cm plant growth medium with a 50 cm reduced permeability layer and 60 cm bridging layer/capillary break

The field investigation and review identified the need for a bridging layer/capillary break at the base of the cover to provide a stable platform for machine traffic and to prevent the capillary rise of constituents back into the cover. Option 2b is considered to be the base case, and the most desirable, because most soil and rock (plant growth medium), clay (reduced permeability layer - RPL) and rock (bridging layer/capillary break) can be harvested directly from the Old TSF for the covers. The model showed that the bridging layer/capillary break (260 cm bgl) generally remains unsaturated for most of the 100 year period and generally remained below a degree of saturation (S) of approximately 0.8 (volumetric water content of approximately 0.3), the threshold value at which percolation would be expected from the layer. The model shows that the effectiveness of the cover option will be determined by how well the RPL is built to, and meets, the design standard. Provided the RPL is built to the design standard then the capillary break will never become saturated and will effectively close down percolation to the underlying tailings because it will create a permanent air entry value break between the overlying RPL and underlying tailings. Provided there is an air entry value break percolation is expected to be limited to 0.025% and is not expected to exceed 2% if there is poor establishment of vegetation.

Figure E.1 presents a summary of the proposed design standard for Option 2b.

Profile	Dimensions	Material description	Material source	Placement and compaction	Construction tolerance
Soil mulch	200 cm	Rudosols using the Australian Soil Classification	North Rock Quarry	Placed by end dumping	-
RPL	50 cm	Silty clay loam	Old TSF	Refer to compaction requirement below	+5 cm -0 cm
Bridging layer/ capillary break	60 cm	Gravel and boulders	Crushed and screened gravel and boulders from North Rock Quarry	Place by end dumping and spread with bulldozer. Compact with four passes using a 10 tonne with a smooth drum roller	+5 cm -0 cm

Compaction requirement: RPL to be moisture condition so that it is $\pm 3\%$ of optimum moisture condition;
RPL to be placed and spread in uniform thicknesses;
RPL to be compacted in 15 cm thicknesses;
RPL to be compacted to at least 95% of maximum dry density;
RPL to be water so that it maintains its moisture content until covered; and
RPL to be covered within five days of placement.

Figure E.1 Option 2b: 200 cm plant growth medium with a 50 cm reduced permeability layer and 60 cm bridging layer/capillary break summary of design standard

ES4.2 Option 3: 200 cm plant growth medium 50 cm 1:5 trafficked plant growth medium and tailings reduced permeability layer and 60 cm bridging layer/capillary break

The option evaluated using the Old TSF as a quarry to provide suitable cover. Using tailings as part of the cover addresses the additional volume requirement described in section 3.2.1. The model shows that the potential seepage becomes near constant at a maximum steady state percolation rate of 0.1% of cumulative rainfall assuming that the RPL has not been built to, and met the design standard. Assuming that the RPL has met the design standard then the maximum infiltration can be expected to be two orders of magnitude lower at 0.003%. The effect of removing vegetation from the model would likely increase the potential seepage rate by one of order of magnitude, putting it in the range of 0.03-1% depending on the permeability of the RPL. The seepage potential from the cover is better than Option 2b.

Figure E.2 presents a summary of the proposed design standard for Option 3.

Profile	Dimensions	Material description	Material source	Placement and compaction	Construction tolerance
Soil mulch	200 cm	Rudosols using the Australian Soil Classification	North Rock Quarry	Placed by end dumping	-
RPL	50 cm	1:5 trafficked plant growth medium layer: Tailings Ratio measured by volume Maximum particle size 20 cm	Old TSF	Refer to compaction requirement below	+5 cm -0 cm
Bridging layer/ capillary break	60 cm	Gravel and boulders	Crushed and screened gravel and boulders from North Rock Quarry	Place by end dumping and spread with bulldozer. Compact with four passes using a 10 tonne with a smooth drum roller	+5 cm -0 cm

Compaction requirement: RPL to be moisture condition so that it is $\pm 3\%$ of optimum moisture condition;
RPL to be placed and spread in uniform thicknesses;
RPL to be compacted in 15 cm thicknesses;
RPL to be compacted to at least 95% of maximum dry density;
RPL to be water so that it maintains its moisture content until covered; and
RPL to be covered within five days of placement.

Figure E.2 **Option 3: 200 cm plant growth medium 50 cm 1:5 trafficked plant growth medium and tailings reduced permeability layer and 60 cm bridging layer/capillary break summary of design standard**

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1 Introduction

1.1 Location

The Mt Gordon Mine (the mine) is a historic copper operation located approximately 120 kilometres (km) north of Mount Isa. The mine is currently in care and maintenance (Figure 1.1). Previous operations have occurred over a 30 year period under six different mine owners. There are various environmental non compliance issues which relate to different domains of the mine and its previous management.

Mining and processing activities are located within the catchments of Magazine Creek, Mill Creek and Esperanza Creek and are within proximity of 1.5 km from Gunpowder Creek. The mining leases are bounded by Magazine Creek in the east (impacted by the heap leach operations) and Gunpowder Creek in the north (impacted by legacy and existing mining operations). All runoff from these creeks are influenced to some degree by mining activities, and drain into Gunpowder Creek within 2 km of the mining lease boundary. The historic Mt Oxide Mine is situated 31 km downstream, which is considered to have a significant and ongoing environmental impact to Gunpowder Creek.

There are multiple domains at the mine that contain waste rock and ore (Figure 1.1):

- four waste rock dumps (WRD);
- two tailings storage facilities (TSF);
- one Direct Shipping Ore stockpile (DSOS); and
- two heap leach pads (HLP).

The stored waste rock and ore within the described domains is producing acid rock drainage (ARD). Acid rock drainage contains low pH water and high concentrations of metals and salts (Iron (Fe), Copper (Cu), Manganese (Mn)) and Sulfate (SO_4^{-2}) that have been released to the receiving environment. The release of acid rock drainage to the receiving environment has lead to non compliance with the mine Environmental Authority (EA) (EPML00911413) and ongoing legacy issues.

1.2 Legacy issues

The mine has a long history of environmental non compliance and has reported breaches of the EA to the Department of Environment and Heritage Protection (EHP) on a number of occasions during the time that the mine has been owned, operated and managed by Aditya Birla Minerals Limited (Aditya Birla).

Breaches of the EA have included constituent concentrations beyond trigger values described in the EA for sediment (Condition C4(1)(i)(ii)), receiving surface water (Schedule C – Table 4) and groundwater (Schedule C – Table 6) that have resulted in environmental harm. NRA Consultants evaluated the likely causes for environmental harm in 2012 in *Birla Mt Gordon Seepage Environmental Evaluation* (NRA 2013a) and identified the following causes:

- the Esperanza TSF is a major source for contamination of the Gunpowder Creek. Contamination has been from sulfate, metals and low pH water that have been detected in environmental monitoring at concentrations that exceed the surface water and sediment trigger values described in the EA. Contamination from the Esperanza TSF has been managed since 2012 by a seepage interception system;



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- the Mammoth TSF (Old TSF) and Heap Leach Pad number 2 (HLEP#2) freely discharge surface water to the receiving environment. The domains are not authorised discharge points under the EA (Schedule C – Table 1). Contamination has been from sulfate, metals and low pH water that have been detected in environmental monitoring at concentrations that exceed the surface water and sediment trigger values described in the EA (Schedule C – Table 2); and
- sulfate and metal rich sediment, low pH surface water discharge and groundwater seepage occur across a number of the mine domains which impact on the surface water and groundwater of the receiving environments of the Gunpowder Creek and Magazine Creek.

Due to previous environmental non compliance at the mine EHP requested that a Transitional Environmental Program (TEP) be prepared to provide a plan for how existing environmental harm will be reduced to a level so that the mine will come back into compliance with its EA. The TEP, *Draft Transitional Environmental Program - Surface Water Contamination and Impact on Receiving Environment* was prepared in early 2014 (Aditya Birla 2014) and outlined a series of actions for completion within a five year period, up to 2019, in order to satisfy the following objectives:

1. prevent unauthorised contaminant release from the Old TSF area to Gunpowder Creek;
2. return to compliance with water quality contaminant limits for Magazine Creek; and
3. return to compliance with water quality contaminant limits for Gunpowder Creek.

1.3 Legislative requirements

The TEP is a requirement of section 330 of the *Environmental Protection Act 1994* (EP Act) so that the mine reaches compliance with the EA:

A transitional environmental program is a specific program that, when complied with, achieves compliance with this Act for the activity to which it relates by doing 1 or more of the following:

- a) reducing environmental harm caused by the activity;
- b) detailing the transition of the activity to an environmental standard;
- c) detailing the transition of the activity to comply with:
 - i) a condition if an environmental authority; or
 - ii) a development condition; or
 - iii) a prescribed condition for carrying out a small scale mining activity.

Section 331 (c) of the EP Act states that the TEP must result in an outcome of preventing or minimising environmental harm:

A transitional environmental program must be in the approved form and, for the activity to which it relates...

...state how any environmental harm that may be caused by the activity will be prevented or minimised, including any interim measures that are to be implemented...

The TEP must include objectives to be achieved and maintained under the TEP for the activity (section 331 (a) of the EP Act).

The TEP must include actions to achieve the objectives (section 331 (b) of the EP Act). The actions must be specific, measureable, achievable, and relevant and time specific.

The TEP must detail how each action will be measured to indicate that the action was completed successfully and the objective of the TEP is achieved (section 331 (g) of the EP Act).

The TEP must provide details of the monitoring activities required to ensure compliance with the proposed TEP actions and dates (section 331 (h) of the EP Act).

The TEP must provide details of how compliance with the TEP is being met by reporting (section 331 (h) of the EP Act).

1.4 Scope

In the TEP the outcome is stated as follows:

...the actions proposed in the draft TEP shall result in substantial improvements to the Old TSF area and Heap Leach Pad #2 landforms and reduce their impact on the receiving environment, including avoidance of any unauthorised discharge (EA condition C2-1). The remaining aspects of the action program aims to reduce the contaminated load entering the groundwater and receiving environment.

Aditya Birla, the owner of the mine, have engaged the services of EMGA Mitchell McLennan (EMM) to addresses immediate actions (Table 1.1) that must be completed and sufficient evidence (performance indicator and reporting requirements) provided to EHP by 21 August 2015.

Table 1.1 Summary of immediate actions from the TEP action program

Objective	Description of action	Performance indicator	Reporting requirement
Prevent unauthorised contaminant release from Old TSF area to Gunpowder creek			
Define and implement an appropriate final landform and cover design for Old TSF.	Develop Old TSF final landform and cover design including engineering drawings to construction specifications for cover.	Verification that monitoring program has been implemented.	Submission of report.
Return to compliance with water quality contaminant limits of Table 4 for Magazine Creek			
Remediate all known point sources of contaminate generation impacting Magazine and Greenstone Creek.	Develop HLEP #2 final landform and cover design including engineering drawings to construction specifications for cover.	Verification that monitoring program has been implemented.	Submission of report.

1.4.1 Inclusions

EMMs engagement will result in a *Final Cover Design* report. The *Final Cover Design* report is further described in section 4 (monitoring and reporting) of the TEP.

The *Final Cover Design* report will include cover design options for the Old TSF and HLEP#2 as well as options for rehabilitation that do not include a cover ie moving tailings and heap leach ore to another area of the mine.

1.4.2 Exclusions

EMMs engagement does not include the execution of cover construction at the mine and therefore will not directly reduce the impact on the receiving environment, including avoidance of any unauthorised discharge. The proposed study alone will not meet the outcome of the TEP described in section 1.4 of the TEP.

The *Final Cover Design* report does not include engineering drawings.

1.5 Tasks

The project and report were broken into five tasks:

1. review;
2. field investigation;
3. cover options;
4. modelling; and
5. conclusions/ recommendations.

The report structure based on the described tasks are summarised as Figure 1.2.

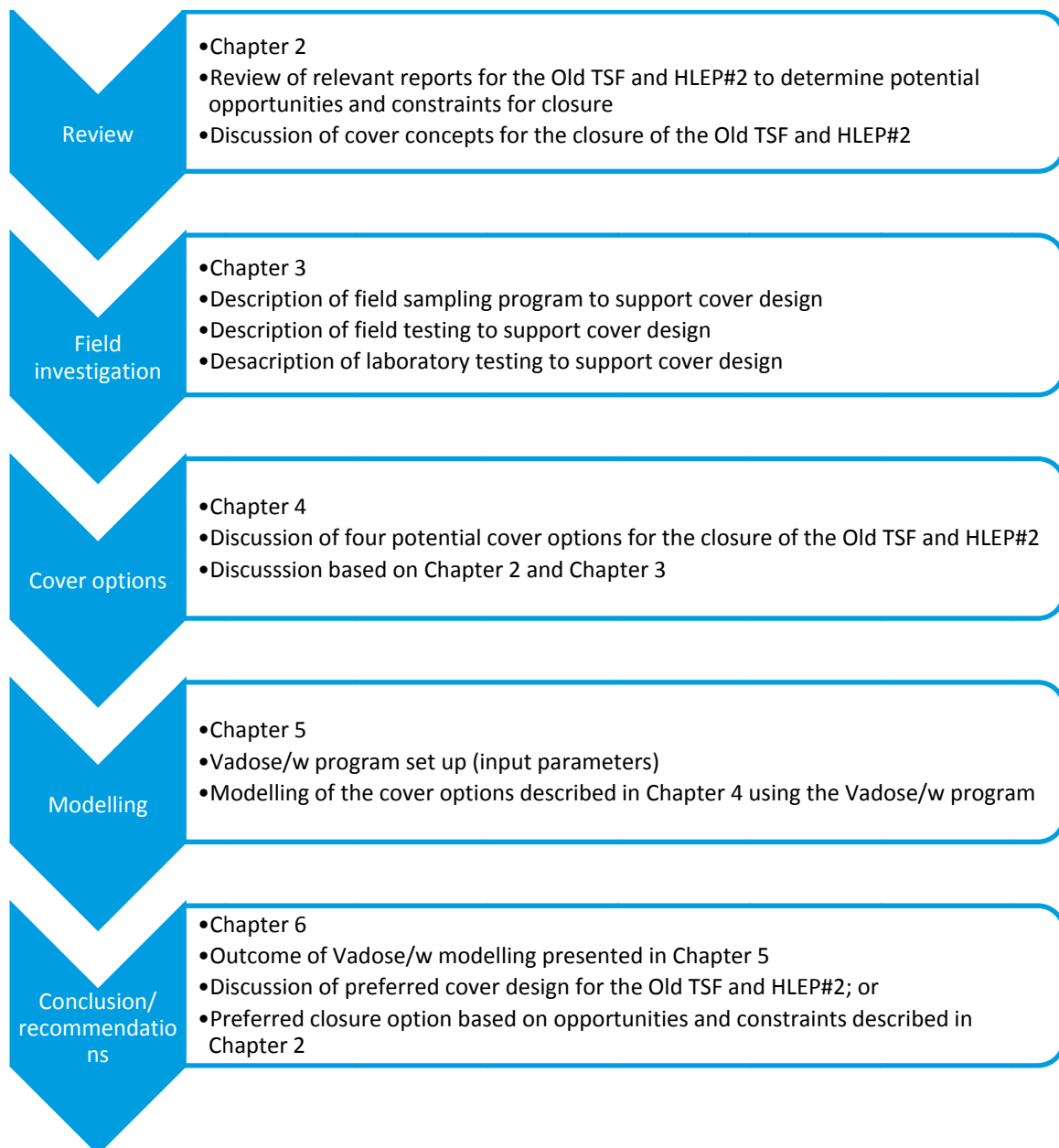


Figure 1.2 Summary of report chapters

2 Review

2.1 Climate

A highly variable subtropical climate is experienced at the Mt Gordon Mine and surrounding Gunpowder region. Generally the region has a semi-arid climate with a short, monsoonal wet season between November and March and a dry season from May to October. Intensive rainfall events characterise the wet season usually associated with cyclonic events. The majority of the mean annual rainfall of 480 millimetres (mm) falls between November and March. Mean temperatures range from 17 to over 45 degrees Celsius (°C). The region experiences a high evaporative demand with pan evaporation recorded at 3,104 mm per annum (mm/annum), creating a negative water balance of approximately 2,500 mm/mm (BOM 2015).

2.1.1 Engineered cover suitability

Comprehensive reviews of factors that must be considered when considering a cover for a mine domain eg TSF or HLP are presented in GARD (2009). In the long term the cover must interact with climate, hydrology, human activity, vegetation, animals, and settlement of the underlying waste. A chart of appropriate covers as a function of climate is reproduced in Figure 2.1 (from the GARD Guide, 2009).

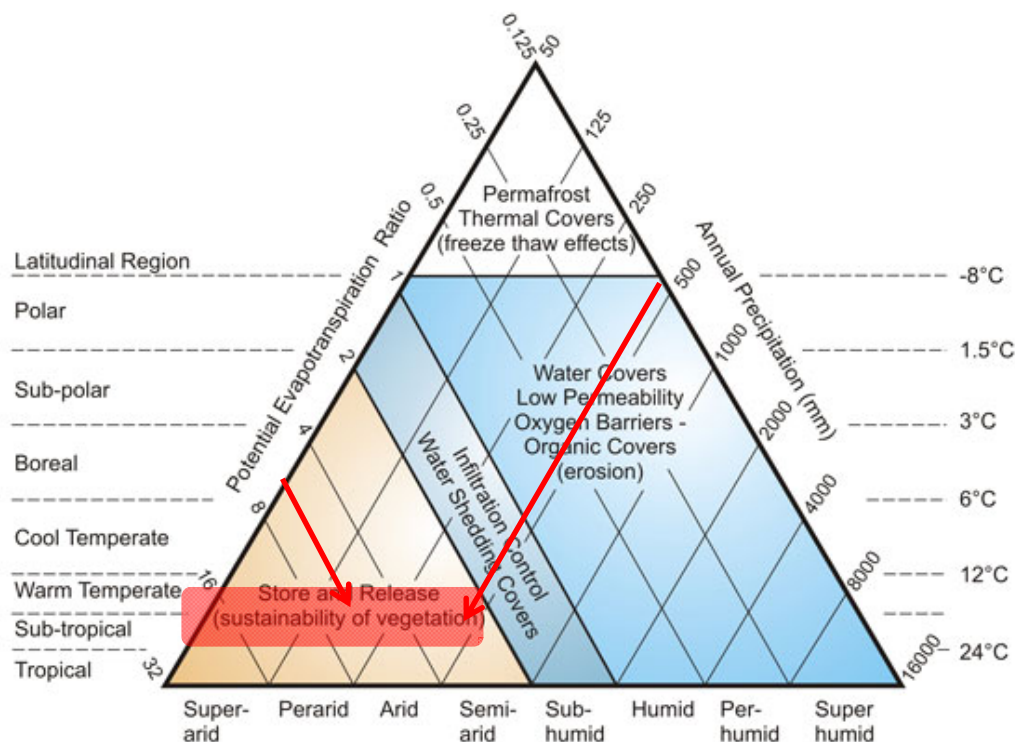


Figure 2.1 Covers and climate types

Figure 2.1 shows that a cover that can store infiltration and make it available for vegetation as plant available water will perform best in wet or dry climates where potential evapotranspiration is at least two times greater than rainfall, such as applies at the mine (average annual rainfall of 480 mm, and an average annual potential evaporation of 2,500 mm, which is highlighted in Figure 2.1).

2.2 Old tailings storage facility

2.2.1 General

i Location

The Old TSF is located immediately north of Gunpowder Creek with the northern embankment constructed on the creek floodplain (Figure 2.2). The facility was operated up to 1985 and since closure has had a lay down area constructed on its flat top surface.

ii Geometry

The Old TSF lies between two north-south aligned ridges and is approximately 500 meters (m) long (north-south) and 220 m wide and covers an area of approximately 11 hectares (ha) (NRA 2013b). The area calculation includes the northern and southern embankments.

The embankments were constructed from fill material which included weathered rock and soil (borrow material), and overburden that may have been potentially acid forming (PAF) or non acid forming (NAF).

The Old TSF has been raised three times during the operation of the mine resulting in a final landform height of approximately 27 m above ground level at its northern end.

The first two lifts of the Old TSF were constructed as downstream lifts by end dumping. The final lift was constructed as an upstream lift using coarse tailings excavated from the Old TSF. The construction methods of both the downstream and upstream lifts resulted in segregation of coarse and fine rock and soil particles throughout the northern embankment. Seepage from the northern embankment occurs throughout the year, but is most noticeable after rainfall.

iii Cover

The cover on the Old TSF is approximately 30 years old, with cover reportedly built between 1985 and 1986. The Old TSF was first reviewed by Spain et al (2005) in the report *Selected Properties of Materials in Relation to Their Capacity to Support Ecosystem Development, Mt Gordon Mine, Western Queensland – Final Report*. The cover is typically 90 centimetres (cm) deep and is made up of:

- 60 cm depth of plant growth medium layer (loamy sand and gravel); and
- 30 cm depth of reduced permeability layer (silty clay loam) (RPL).

The cover plant growth medium appears to comprise of either waste rock or locally sourced borrow material.

The cover was found to vary in places with some areas being made up of:

- 60 cm plant growth medium layer (loamy sand and gravel);
- 20 cm bridging layer/capillary break (gravel and boulders); and
- where a bridging layer/capillary break was recorded there was no RPL.



Old Tailings Storage Facility and Heap Leach Pad 2

Spain et al (2005) reviewed the geochemistry (reproduced in Appendix A) of the Old TSF for the following constituents:

- pH(Figure A.1);
- electrical conductivity (EC) (Figure A.2);
- Cadmium (Cd) (Figure A.3);
- Cobalt (Co) (Figure A.4);
- Chromium (Cr) (Figure A.5);
- Copper (Cu) (Figure A.6);
- Nickel (Ni) (Figure A.7);
- Zinc (Zn) (Figure A.8);
- Iron (Fe) (Figure A.9); and
- Manganese (Mn) (Figure A.10).

The following is a summary of results from Spain et al (2005). Where appropriate the results are compared to the *National Environment Protection (Assessment of Site Contamination) Measure 1999* (NEPM) for health investigation limits (HIL) for public open space and recreational areas (HIL C). HIL C land use includes a variety of exposure scenarios such as open space areas that are fully accessible to the public and where the public may potentially spend a significant amount of time. These open space areas may contain vegetated areas and some limited areas of hardstand or exposed soil.

It should be noted that schedule B7 replaces the repealed Schedules B7a and B7b to the NEPM.

pH indicates that both the tailings and the cover are acidic and likely have some PAF potential; however, EC has remained low and generally decreases in concentration from the tailings back to the surface of the cover.

Cd concentrations are low with a maximum concentration of 11.94 mg/kg recorded in Pit A. Normal values in agricultural soils are up to approximately 4 mg/kg for soils with extreme concentrations as high as 170 mg/kg for some agricultural soils (Spain et al 2005). Concentrations of Cd in the cover and the tailings are well below HIL C (90 mg/kg).

Co concentrations are relatively high with a maximum concentration of 546 mg/kg recorded in Pit E. This compares to an average concentration of 54 mg/kg in agricultural soils (Peverill and Judson 2005). The cover does not exceed HIL C (300 mg/kg). The tailings below a depth of about 150 cm bgl exceed HIL C.

Cr concentration is low with no clear profile trends. The maximum concentration is 341 mg/kg recorded in Pit A which exceeds the HIL (300 mg/kg) for Cr IV. Average concentrations in the world's soils are 54 mg/kg (Spain et al 2005).

Cu concentrations are extraordinarily low with an overall range between 0.01 to 1 mg/kg. Most soil values range between 13 to 24 mg/kg (Brennan and Best 2005). All sample values in the cover and tailings are below HIL C (17,000 mg/kg).

Ni concentrations ranged from 13.7 to 379.47 mg/kg with the highest values in Pit E. All sample values in the cover and tailings were less than HIL C (1,200 mg/kg).

Zn concentrations are low with values ranging from 23.2 to 1,217 mg/kg in comparison with a mean concentration of 64 mg/kg for agricultural soils (Armour and Brennan 2005). Concentrations were highest in Pit B but remain substantially less than HIL C (30,000 mg/kg) in the cover and tailings.

Fe concentrations ranged between 96 to 3,374 mg/kg with the highest concentrations recorded in Pit A.

v Water balance

The placement of the cover on the Old TSF in 1985 does not appear to have limited the seepage of water. The cover, if effective, could be expected to have some influence on the quantity of water seepage from the Old TSF. As no records of seepage rates have been maintained an assessment of the effectiveness of the cover cannot be made. Further after the construction of the cover the underlying tailings have continued to consolidate resulting in a number of low points in the cover which have been partially filled with fines washed from higher sections of the cover (Figure 2.3). Rainfall that has ponded in the low points has infiltrated through the cover and percolated into the underlying tailings and emerged as seepage from either the Old TSF northern and southern embankments.

Percolation is currently captured in an interception trench at the toe of the Old TSF. Percolation is pumped back to the Mill Creek Dam. The mine reportedly pumps approximately 70 cubic meters (m³) of percolation back to Mill Creek Dam per day.



Figure 2.3 Old tailings storage facility examples of ponding

2.2.2 Opportunities

The 2005 study (Spain et al 2005) indicates that the tailings and cover would be suitable for reuse in the construction of a new cover on the Old TSF because the constituent concentrations are below HIL C. This is advantageous because at least some of the borrow material for the new cover can be won directly from the Old TSF reducing the overall cost of construction, due to reduced haulage costs.

Using tailings and cover material in the new cover would be subject to confirmation sampling. Confirmation sampling results are discussed in chapter 3. Alternatively, assuming the tailings and cover are suitable for use in constructing a new cover, the entire facility could be used to build a cover on one of the existing waste rock dumps (section 1.1). The Old TSF would therefore be rehabilitated by removal.

This alternative is beyond the scope of this report and is not discussed further.

2.2.3 Constraints

After construction of the cover the tailings underwent further consolidation resulting in differential settlement of the surface that resulted in ponding of water. Water ponding compromised the ability of the cover to limit infiltration of rainfall and percolation into the underlying tailings. As a result the Old TSF has continued to seep water that is intercepted and pumped back to Mill Creek Dam.

The new cover would require a bridging layer directly above the tailings so that the new cover can be built on top of a solid platform that will not undergo further settlement. A suitable source of material for the bridging layer must be sourced from the mine.

There is insufficient borrow material in the cover to build a new cover on the Old TSF. Suitable sources of material for the new cover must be sourced from the mine.

2.2.4 Rehabilitation options

i Cover

Based on the review of the Old TSF it is likely that a cover is required in order to meet the objectives described in the TEP. Based on the known climate experienced at the mine, and existing knowledge regarding available materials for use it is likely that the cover will need to store rainfall infiltration and make it available to vegetation as plant available water so that percolation into the underlying tailings is limited.

The basic design principles for the cover are further described in section 2.4.

ii Other

Assuming the tailings and cover are suitable for use in constructing a new cover, the entire facility could be used to build a cover on one of the existing waste rock dumps (section 1.1). The Old TSF would therefore be rehabilitated by removal.

This alternative is beyond the scope of this report and is not discussed further.

2.3 Heap leach pad number 2

2.3.1 General

i Location

HLEP#2 is located immediately north of Magazine Creek with the eastern embankment constructed on the creek floodplain (Figure 2.4 and Figure 2.2). The facility was operated up to 1985, and was rehabilitated in 1986 (Spain et al 2005).



Figure 2.4 Heap leach pad number 2 eastern embankment

ii Geometry

HLEP#2 extends of the Mammoth WRD and is 2.67 ha (NRA 2013b). The area calculation includes the eastern, western and southern embankments.

The embankments were constructed from waste rock and ore, both of which are PAF. The PAF waste rock and ore is intermingled with NAF waste rock.

iii Geochemistry

The geochemistry of HLEP#2 has not been reviewed; however, it was noted during a mine inspection in February 2015 that the domain contained mostly PAF ore and waste rock and was a major source of copper-sulfate contamination and acid rock drainage to Magazine Creek (Figure 2.4).

iv Current status

HLEP#2 was operated up to 1985, and was rehabilitated in 1986 (Spain et al 2005). Initially the domain was rehabilitated by constructing a cover up to 1 m thick on its flat top surface. It is thought that cover was constructed mainly for dust suppression and was not intended to limit percolation into the ore or limit seepage from the domain. It was reported by the mine during a mine inspection in February 2015 that after rain events HLEP#2 would seep large volumes of water to Magazine Creek.

In 2008 a 1.79 ha evaporation pan was constructed on the flat top surface of HLEP#2 (Figure 2.5).



Figure 2.5 Heap leach pad number 2 evaporation pan

The evaporation pan is used to evaporate excess water stored in environmental ponds and from the Esperanza Pit. The evaporation pan is lined with a high-density polyethylene (HDPE) liner. The HDPE liner has limited percolation into the ore and limited seepage from the facility to some extent. However, it has not entirely eliminated the potential for ongoing acid rock drainage from the domain because there is a larger proportion of batter slope by comparison to flat top surface within the domain. The batter slopes have remained uncovered and are considered very difficult to cover, to limit infiltration, using conventional construction methods.

v Water balance

The water balance of the domain is not actively monitored. The volume of seepage released from the domain cannot be assessed.

2.3.2 Opportunities

The HDPE liner could be incorporated into the cover, assuming that it is not in a perished state from sun exposure. There would also be a need to assess the underlying material to determine if the HDPE liner can be trafficked without puncturing its surface.

2.3.3 Constraints

Rehabilitation of HLEP#2 is constrained by the fact that the domain geometry is predominately batter slope. The flat top areas make up less than half of the total area. Building a cover on the batter slopes is considered very difficult using conventional construction methods. Therefore, Aditya Birla are committed to excavating HLEP#2 and removing the PAF waste rock and ore to the underground mine, or another location where the excavated waste rock and ore can be selectively handled to create a final landform that is safe, stable, sustainable and non polluting.

The excavation and removal of HLEP#2 is beyond the scope of this report and will not be discussed further.

2.3.4 Rehabilitation options

i Cover

Rehabilitation of HLEP#2 is constrained by the fact that the domain geometry is predominately batter slope. Further, the batter slope on the eastern side of the domain sits on the flood plain for Magazine Creek. The flat top area makes up less half of the total area. Building a cover on the batter slopes is considered very difficult using conventional construction methods.

ii Other

Based on the review of the HLEP#2 it is considered that the best environmental outcome for the domain will be excavate the domain and selectively place the waste rock and ore either underground or in another location where it can be selectively handled to create a final landform that is safe, stable, sustainable and non polluting.

For the purposes of this report it is assumed that the cover will be developed and will be suitable for construction on both the Old TSF and HLEP#2. Note that it is not Aditya Birla's intention to build a cover on HLEP#2 because the domain is unlikely to meet the outcome described in the TEP (section 1.4) because the construction of a cover will not "*avoid an unauthorised environmental discharge*".

2.4 Cover options

A cover is required in order to meet the objectives described in the TEP (section 1.4). Based on the known climate experienced at the mine and existing knowledge regarding available materials for use we anticipate that a cover will need to store rainfall as infiltration and make it available to vegetation as plant available water so that percolation into the underlying tailings or heap leach ore is limited.

2.4.1 Objective

The objective of building the cover is to establish a series of engineered layers that mimics undisturbed soil by:

- allowing rainfall infiltration;
- maintaining a plant available water content that sustains vegetation; and
- limiting percolation to the underlying tailings or heap leach ore to a rate similar to the natural groundwater.

2.4.2 Concept

i Profile

The cover will aim to mimic an undisturbed soil profile. The cover and undisturbed soil profile may be roughly the same depth, and contain horizons that capture infiltration and additional horizons that reduce percolation (Figure 2.6).

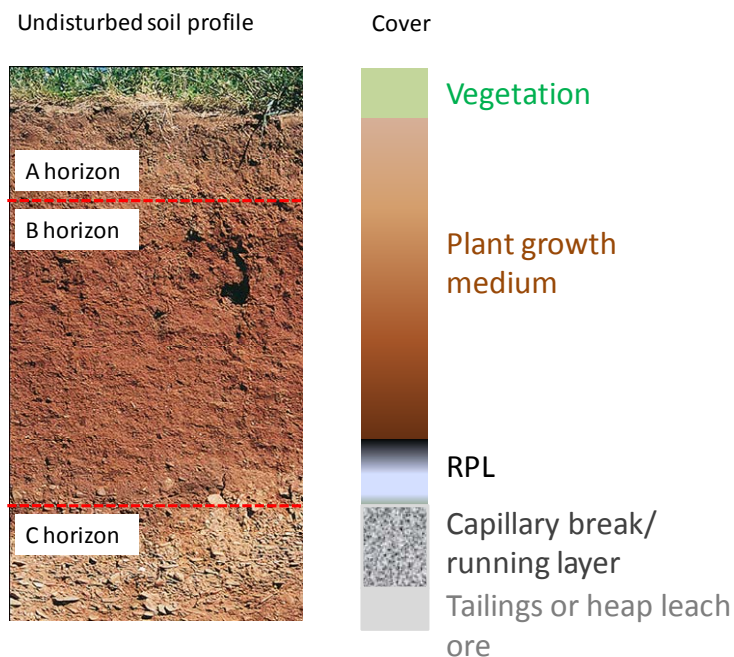


Figure 2.6 Illustration comparing a concept cover with an undisturbed soil profile

Where there is potential for the upward (capillary rise) of dissolved salts and metals into the cover a bridging layer/capillary break may be required. The bridging layer/capillary break when constructed over a TSF will also act as a running layer so that machinery can safely access the domain. This layer is very similar to a C horizon (weathered or partially decomposed rock) in an undisturbed soil system (Figure 2.6).

ii Performance

Cover will follow a typical engineering safety hierarchy of controls. Rainfall infiltration cannot be removed from design (as it cannot be eliminated), it is a naturally occurring event and cannot be substituted. The cover will therefore isolate rainfall infiltration by engineered design. The RPL will be central to the cover because it is required to control the rate of percolation into the underlying tailings or ore.

It is important to note that the cover will not stop percolation; rather it will aim to reduce percolation to an acceptable rate. That rate that percolation does occur must align with the objective of the TEP.

a. Potential infiltration storage

Assuming that the cover porosity is approximately equal to 0.3 (30% air filled voids) (Fredlund and Rahardjo 1993) the cover will be able to theoretically store approximately 300 mm of rainfall infiltration per meter of cover depth. This represents a 100% degree of saturation.

Time until seepage occurs will be controlled by preferential or secondary flow paths and the fact that the cover will begin to desaturate at a degree of saturation less than 100% (Rohde and Williams 2009).

b. Potential for percolation

Without an RPL the cover will continue to wet up, a point will eventually be reached at which continuum breakthrough occurs. At continuum breakthrough, which corresponds to a degree of saturation of about 60-80% (Rohde and Williams 2009), the rate of percolation from the cover will match the rate of rainfall infiltration.

It is important that the cover includes layers, such as an RPL, to manage the potential for percolation.

Percolation will not be zero and the aim will be to have a rate that is close to the natural rate of groundwater recharge. There is very little published data on groundwater recharge in Australia. One such study from South Australia can be used as a guide to determine what might be acceptable (Figure 2.7). Cook, Leaney and Miles (2004) suggest that natural groundwater recharge may be occurring at between 0.009 meters per year (m/yr) and 0.037 m/year (9 millimetres per year (mm/yr) to 37 mm/yr), assuming a mean annual rainfall of 480 mm. It should be noted that rainfall can range up to 1300 mm when extreme storm events have occurred. Recharge should be less than 10% of annual rainfall during periods of average annual rainfall.

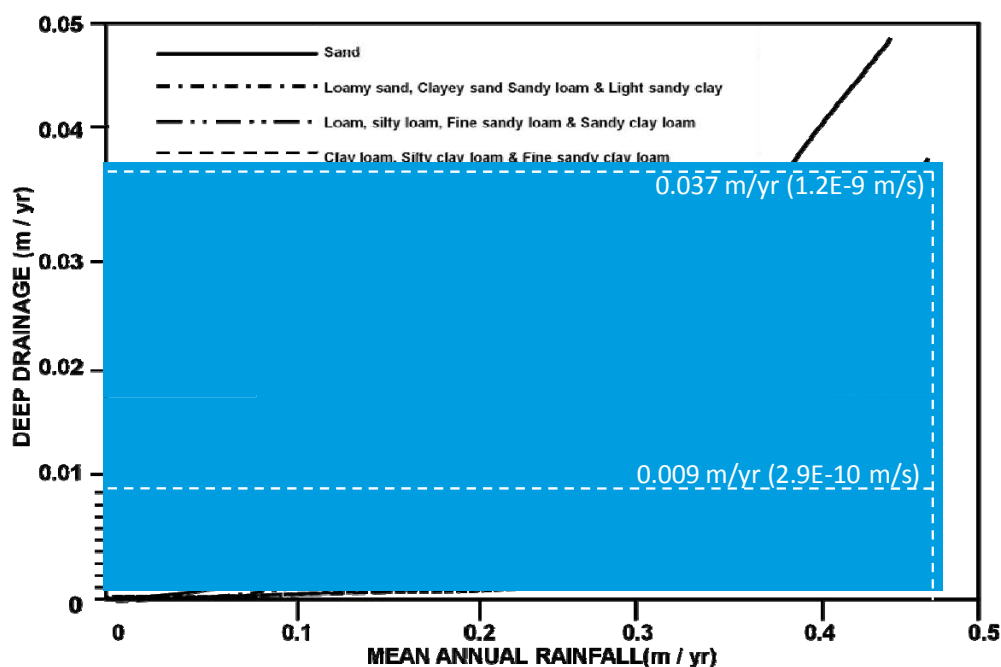


Figure 2.7 Relationship between mean annual rainfall and drainage for five soil texture groups in the North-East Mallee Region, South Australia on disturbed soil

Australian experience with similar covers has typically restricted infiltration to less than 10% of annual rainfall. At Kidston Mine (Williams et al 2003) the cover restricted infiltration to less than 1.5%. At Mt Whaleback Mine the cover restricted infiltration to between 5-13% (O’Kane and Waters 2003). At Cadia Mine (Rohde et al 2011) the cover restricted infiltration to less than 3%. Finally the covers at Century Mine (Defferrard et al) have restricted infiltration between 2-11% and averaged 5%.

3 Investigation

3.1 Sample locations

A field investigation was undertaken in June 2015 and comprised the excavation of bulk samples from the Old TSF and from other locations (potential quarries) in order to characterise the existing operational and rehabilitation areas and to identify potential borrow soil and rock (plant growth medium and bridging layer/capillary break) and clay (RPL) cover materials.

The objective of the field sampling program was to:

- characterise the physical and chemical properties of the Old TSF cover and tailings and changes in constituent chemistry that have occurred since 2005 (Spain et al 2005);
- identify potential quarries where borrow soil and rock (plant growth medium and bridging layer/capillary break) and clay (RPL) can be excavated from to build the covers; and
- collect borrow soil and rock (plant growth medium and bridging layer/capillary break) and clay (RPL) and tailings samples and analyse their physical and chemical properties to determine their suitability for use in the cover.

A field investigation of the mine identified potential quarries (the quarries) described in Table 3.1 for borrow soil and rock (plant growth medium and bridging layer/capillary break) and clay (RPL). Table 3.1 also describes opportunities and constraints for each quarry.

Table 3.1 Summary of quarries and their opportunities and/or constraints

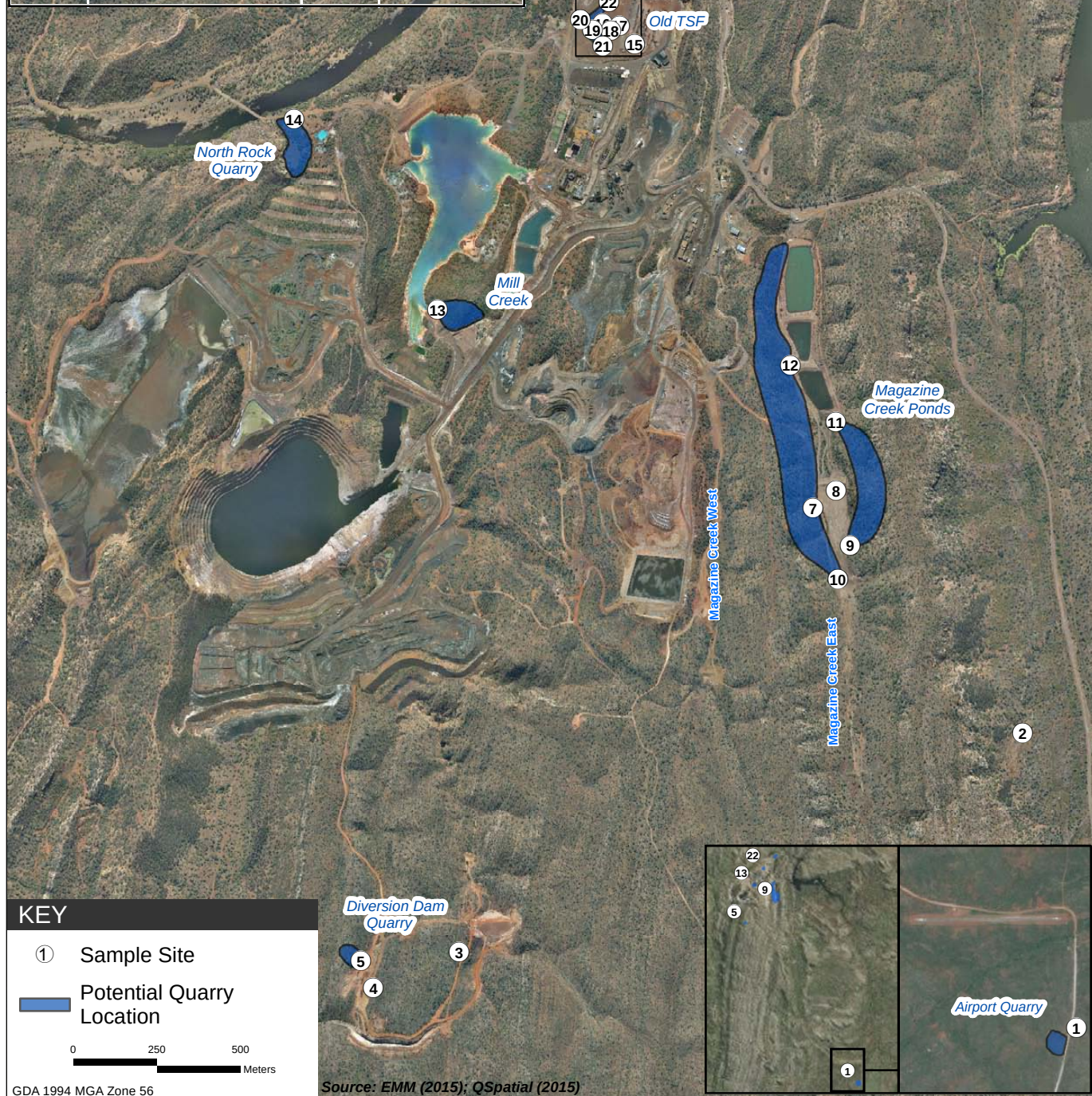
Quarry	Opportunities and/or constraint
Old TSF (Figure 3.1)	• clay, soil and rock can be quarried and reused for the new cover RPL provided they are not contaminated.
Diversion Dam (Figure 3.1)	• if this option is selected the dam floor would be quarried so that water flows away from the diversion dam wall and naturally spills over the spill way removing the need for a pump operation; • borrow soil and rock (plant growth medium and bridging layer/capillary break) and clay (RPL) within the dam would produce an insufficient volume to build the covers for the Old TSF and HLEP#2; and • the diversion dam is outside of the mining lease and approval would be required before the area can be mined.
Diversion Dam Quarry (Figure 3.1)	• borrow soil and rock and clay used for the construction of the dam wall was quarried from this location; • there is likely a large volume of soil and rock that can be used for the plant growth medium layer (plant growth medium) of the cover; and • an evaluation of the potential volume is required to determine if the cover can be constructed from quarried borrow soil and rock (plant growth medium and bridging layer/capillary break) and clay (RPL) from this location alone.

Table 3.1 Summary of quarries and their opportunities and/or constraints

Quarry	Opportunities and/or constraint
Magazine Creek Ponds (Figure 3.1)	- a number of potential quarries were identified in the valley where the Magazine Ponds have been built (identified as Magazine Creek Borrow 1, Magazine Creek Borrow 2, Magazine Creek Borrow 3, Magazine Creek Borrow 4 and Magazine Creek Borrow 5 in Figure 3.1); - two stockpiles were identified that can be used during quarrying (Magazine Creek Stockpile 1 and Magazine Creek Stockpile 2 in Figure 3.1); - the pond walls can be quarried between Pond 1 and 2 and Pond 2 and 3. It is estimated that 85,000 m³ can be quarried from the pond walls; - the access road that services the ponds can be quarried; - the mine is required to reinstate Magazine Creek as part of rehabilitating the mine. Quarrying from the ponds aligns with this requirement; and - the ponds will be required until after rehabilitation is completed. Construction of the covers is required well in advance of completing rehabilitation and therefore the schedule to achieve each objective is not aligned.
Mill Creek Dam Hill (Figure 3.1)	- soil and rock is suitable for the plant growth medium layer of the cover; and - limited volume would be available at the location.
Gunpowder borrow area (Figure 3.1)	quarry appears to be exhausted.
North Rock Quarry (Figure 3.1)	- active quarry; - likely to be a limited volume of clay available for the RPL of the cover; - likely to be a substantial volume available for the plant growth medium layer (plant growth medium) of the cover; and - difficult to quarry because of steep slope and high active quarry face.
Camp Quarry (Figure 3.1)	old mining camp landfill, not suitable.
Magazine Creek Causeway Quarry (Figure 3.1)	- used previously by local council to quarry rock for road repair; - quarry is off mining lease and would require additional approval before it can be used; and - likely to be limited volumes of rock and soil that can be quarried.
Airport Quarry (Figure 3.1)	- previously exhausted; - quarry is off mining lease and would require additional approval before it can be used; and - located too far away to be feasible.

Figure 3.1 shows the locations of the quarries.

Site ID	Name	Site ID	Name
1	Airport Quarry	13	Mill Creek Soil 1
2	Camp Quarry	14	North Rock Soil 1
3	Diversion Dam Soil 1	15	Pit A
4	Diversion Dam Soil 2	16	Pit B
5	Diversion Dam Soil 3	17	Pit B1
6	Gunpowder borrow area	18	Pit B2
7	Magazine Creek Borrow 1	19	Pit B3
8	Magazine Creek Borrow 2	20	Pit B4
9	Magazine Creek Borrow 3	21	Pit B5
10	Magazine Creek Borrow 4	22	Pit B6
11	Magazine Creek Borrow 5	23	Pit C
12	Magazine Creek Soil 1	24	Pit D



Potential Quarry Locations and Sample Sites

The following quarries were excluded during the field investigation (Figure 3.1) because they either had limited supply of borrow soil and rock (plant growth medium and bridging layer/capillary break) and clay (RPL) or were located too far away from the Old TSF and HLEP#2 (Table 3.1):

- Gunpowder borrow area;
- Camp Quarry; and
- Airport Quarry.

Based on the field investigation to determine the opportunities and potential constraints the following quarries were selected for further laboratory testing to describe the chemical and physical characteristics of the potential borrow soil and rock (plant growth medium), clay (RPL) and tailings. Physical characterisation was completed by Douglas Partners Consulting on 20 kg bulk samples and ALS Laboratories for additional particle size distribution analysis. The results are presented as Appendix B. Chemical characterisation was completed by ALS Laboratories. The results are presented as Appendix C:

- Old TSF (cover and tailings):
 - Pit A – plant growth medium;
 - Pit A – clay; and
 - Pit B – clay substitute for RPL.
- Quarries:
 - Diversion Dam Quarry – potential borrow soil and rock for plant growth medium;
 - Magazine Creek Ponds – potential borrow soil and rock for plant growth medium;
 - Mill Creek – potential borrow soil and rock for plant growth medium; and
 - North Rock Quarry – potential borrow soil and rock for plant growth medium and clay for RPL.

Of all the quarries North Rock Quarry (Figure 3.2) was considered to be the best quarry because of:

- its close proximity to both the Old TSF and HLEP#2; and
- its ample quantity of borrow soil and rock (plant growth medium and bridging layer/capillary break) and clay (RPL).



Figure 3.2 **North rock quarry**

3.2 Field description

The profile was surveyed using the *Australian Soil Classification* at a number of sample locations (Table 3.2 and Figure 3.1) for each quarry for the following parameters:

- condition of surface soil ie hard setting, self mulching, surface crusting;
- coarse fraction ie percentage particles (visual assessment) between 2 mm and 7 mm;
- colour ie hue and chroma using the Munsell colour chart;
- pedality ie the proportion of peds (aggregates or clods) in the soil;
- structure ie the arrangement of soil particles;
- consistence ie the resistance to deformation or rupture of soil material;
- fabric ie presence or absence of peds;
- drainage ie whether there are signs of water logging; and
- boundaries; the nature of changes between layers.

Table 3.2 **Field descriptions**

Quarry	Sample sites	Comments
Old TSF	Pit A	-
	Pit B	Six additional sample locations around Pit B to determine spatial extent of bridging layer/capillary break (Pit B1 to Pit B6)
	Pit C	-
	Pit D	-
Diversion Dam Quarry	Diversion Dam Soil 1	-
	Diversion Dam Soil 2	-
	Diversion Dam Soil 3	-
Magazine Creek Ponds	Magazine Creek Soil 1	-
	Magazine Creek Borrow 1	-
	Magazine Creek Borrow 2	-
	Magazine Creek Borrow 3	-
	Magazine Creek Borrow 4	-
Mill Creek	Magazine Creek Borrow 5	-
	Mill Creek Soil 1	-
North Rock Quarry	North Rock Soil 1	-

The survey logs for each sample site are presented as Appendix D.

3.2.1 Old tailings storage facility

Field investigation of the cover agreed with the Spain et al (2005) assessment and found that the cover is typically 90 centimetres (cm) deep and is made up of approximately:

- 60 cm depth of plant growth medium; and
- 30 to 40 cm RPL.

An example of a typical section of cover that has an RPL is shown in Figure 3.3.

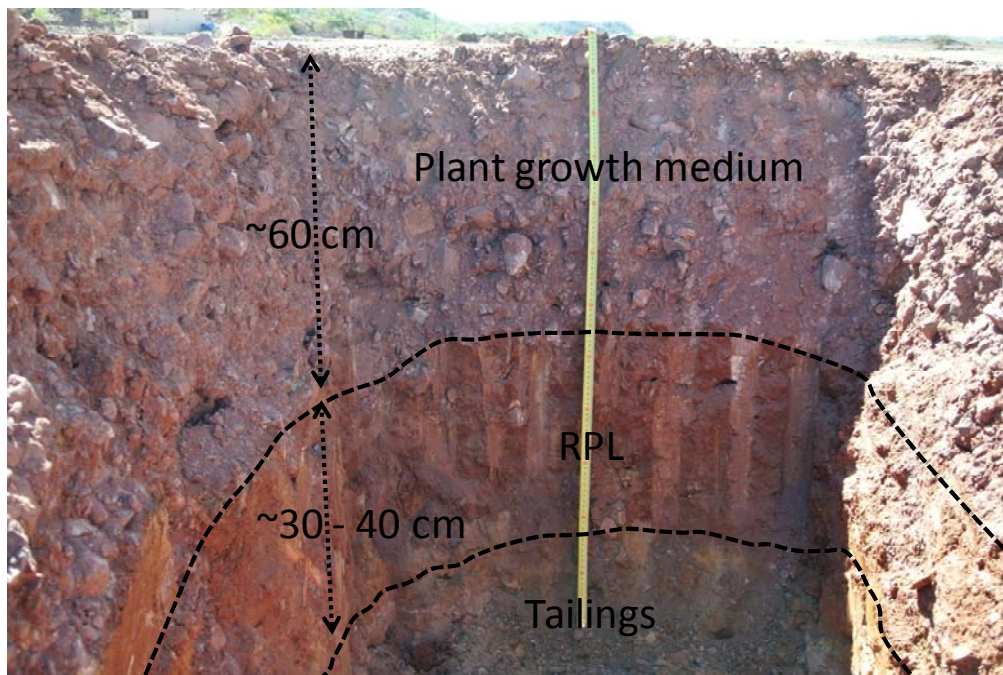


Figure 3.3 Old tailings storage facility cover with reduced permeability layer

The cover plant growth medium appears to comprise of either waste rock or locally sourced borrow material.

The cover was found to vary in the area surrounding Pit B (Figure 3.1) with some areas being made up of:

- 60 cm plant growth medium layer (loamy sand and gravel); and
- 20 cm bridging layer/capillary break (gravel and boulders).

The area of the Old TSF that has a bridging layer/capillary break in the cover instead of an RPL is shown as an inset of Figure 3.1. The cover variation covers an area of approximately 0.45 ha. An example of a typical section of cover that has a bridging layer/capillary break instead of an RPL is shown in Figure 3.4.

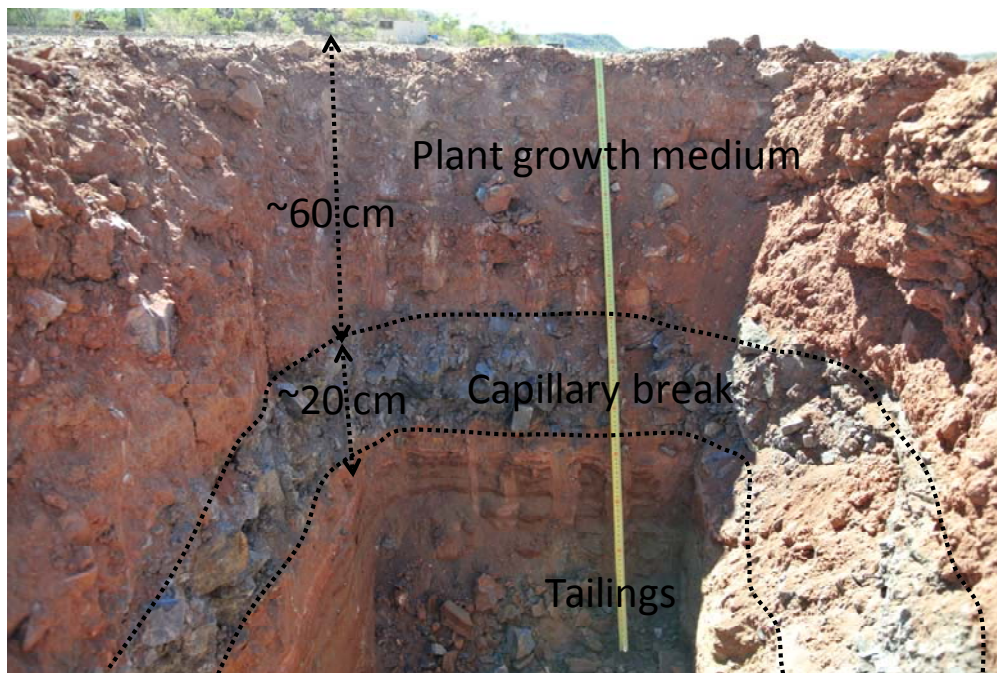


Figure 3.4 Old tailings storage facility cover with a bridging layer/capillary break

3.2.2 Quarries

Appendix D contains the survey logs of the soil profiles described at each quarry.

All soils encountered at all quarry locations are described as Rudosols using the *Australian Soil Classification*. Rudosol soils have rudimentary pedological organisation meaning that there are no soil horizons present in the growth medium, there is no texture change in the growth medium and aggregates of soil are not visible. The soils range from very shallow (approximately 30 cm) to deep (greater than 170 cm) (Figure 3.5).

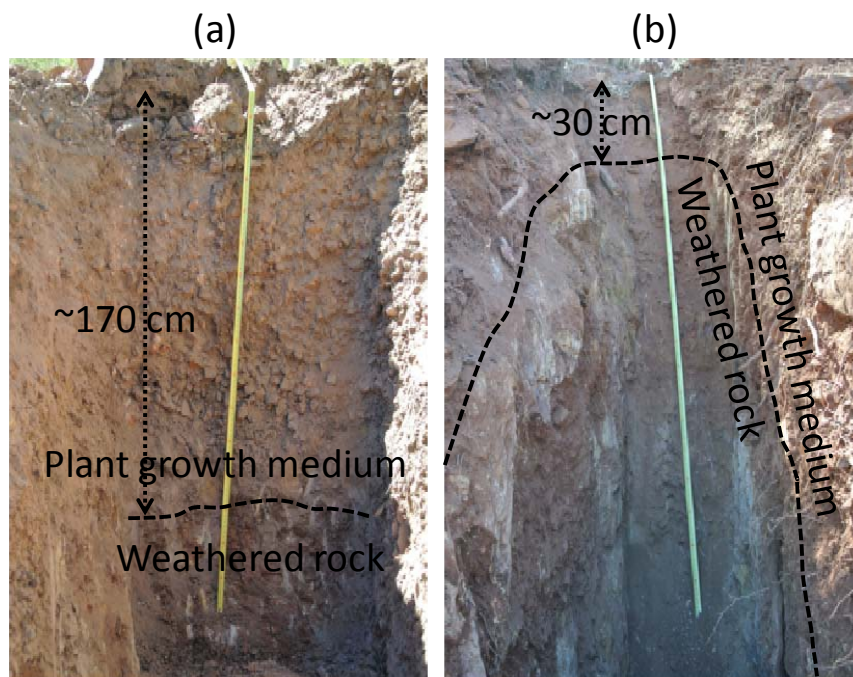


Figure 3.5 Quarries (a) shallow and (b) deep Rudosol soil profiles

3.3 Field analysis

3.3.1 Old tailings storage facility

The Old TSF was sampled to determine if:

- the soil and rock used in the cover is contaminated ie are constituent concentrations above the NEPM HIL C;
- if capillary rise has occurred within the cover in the past 30 years since it was constructed; and
- to assess the actual cover thickness. If suitable this material can also potentially be used as a cover resource.

i pH and electrical conductivity

Field measurements were collected for pH and EC. pH and EC field measurement results for the Old TSF are shown in Figure 3.6 and Figure 3.7 respectively. For comparison purposes they are plotted against the lower and upper constituent concentration limits that were recorded for the Old TSF in 2005 (Spain et al 2005).

The results show that the pH in the plant growth medium layer (to a depth of about 60 cm bgl) has become more acidic since 2004 (Figure 3.6). However the EC in the plant growth medium has increased by less than one-order-of-magnitude and is only just outside the upper trend line measured in 2005 (Spain et al 2005) suggesting that high concentrations of metals and salts (Iron (Fe), Copper (Cu), Manganese (Mn)) and Sulfate (SO_4^{-2}) have not become mobile from acid rock drainage ie they are not readily soluble under rain feed conditions. The potential for acid rock drainage is discussed further in section 3.4.1.

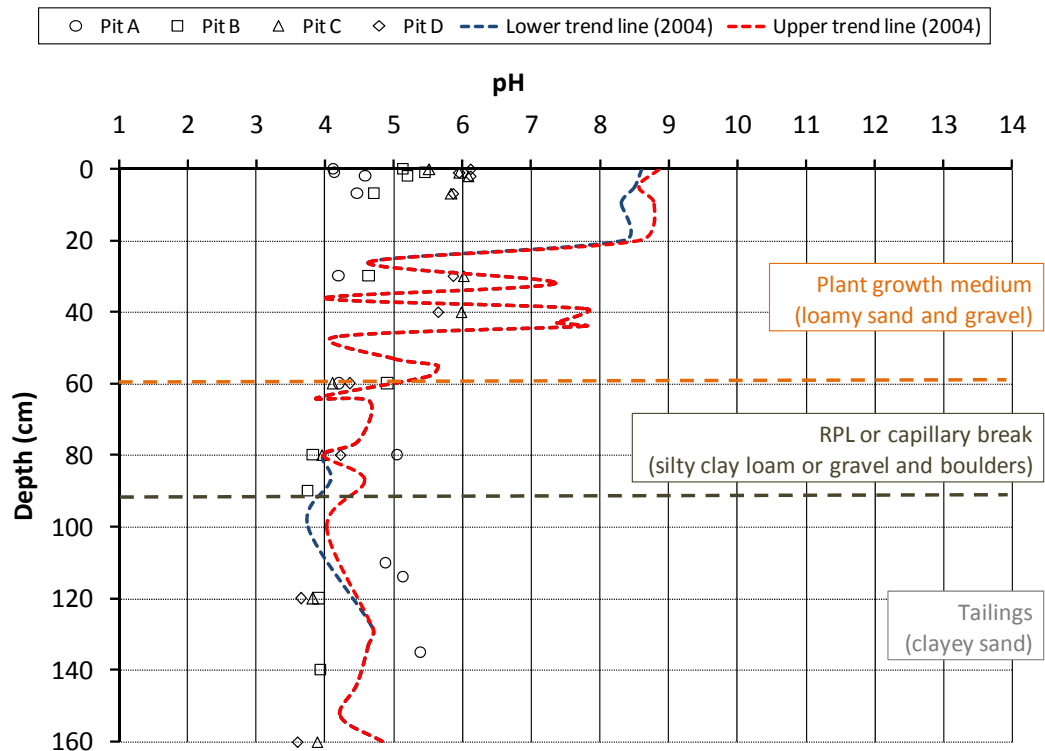


Figure 3.6 Old tailings storage facility pH versus depth

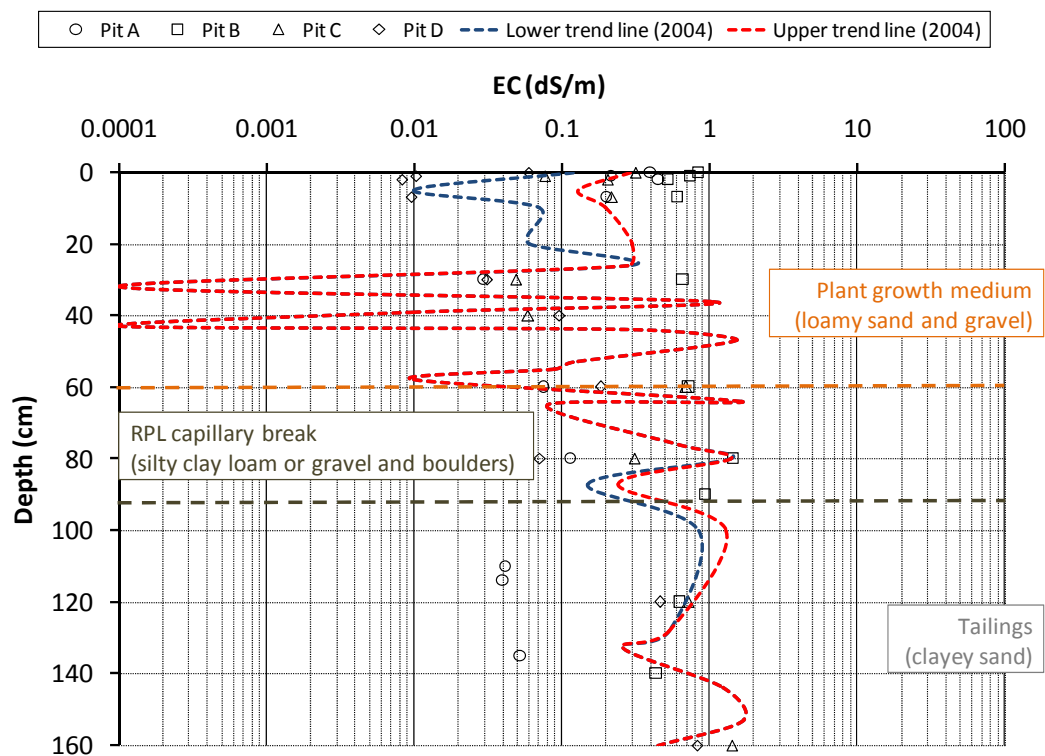


Figure 3.7 Old tailings storage facility electrical conductivity versus depth

3.3.2 Quarries

The quarries were sampled to determine if soil, rock and clay would be a suitable growth medium for the cover and RPL to be constructed on the Old TSF and HLEP#2.

i pH and electrical conductivity

Field measurements were collected for pH and EC. pH and EC field measurement results for the quarries are shown in Figure 3.8 and Figure 3.9 respectively.

The results show that the pH in the quarries plant growth medium and clay (to a maximum depth of approximately 160 cm bgl) is mildly acidic (Figure 3.6). The EC in the quarries plant growth medium and clay is very low indicating that there are very low concentrations of metals and salts (Iron (Fe), Copper (Cu), Manganese (Mn)) and Sulfate (SO_4^{-2})) and that the plant growth medium is unlikely to produce acid rock drainage. The potential for acid rock drainage is discussed further in section 3.4.2.

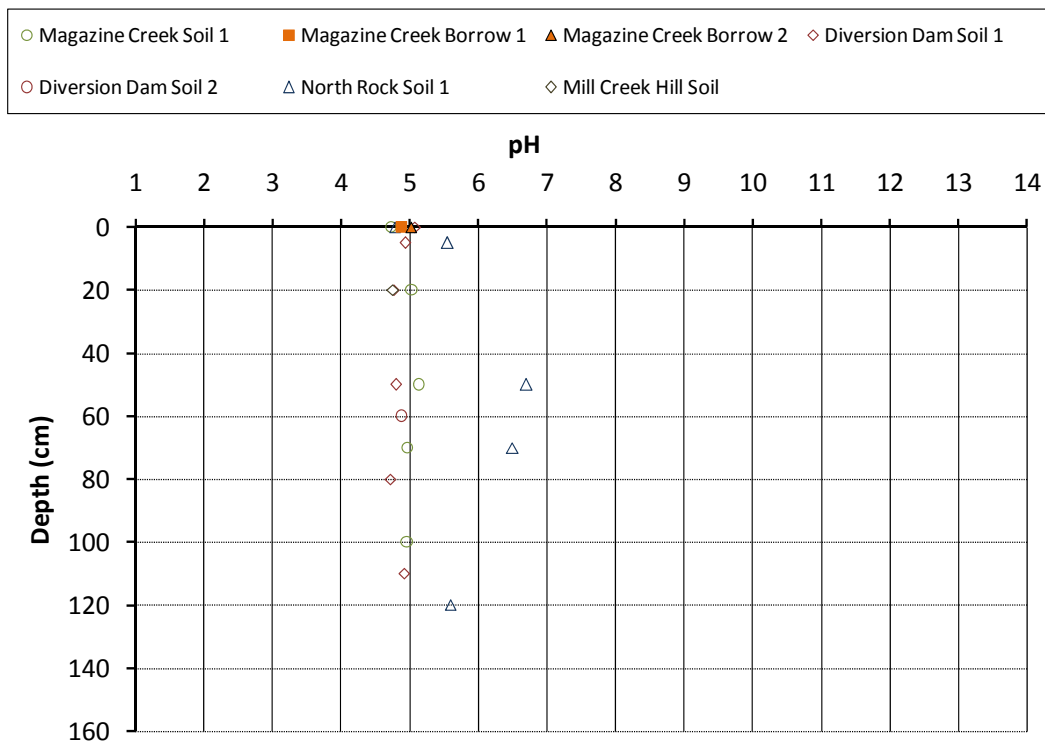


Figure 3.8 Quarries pH versus depth

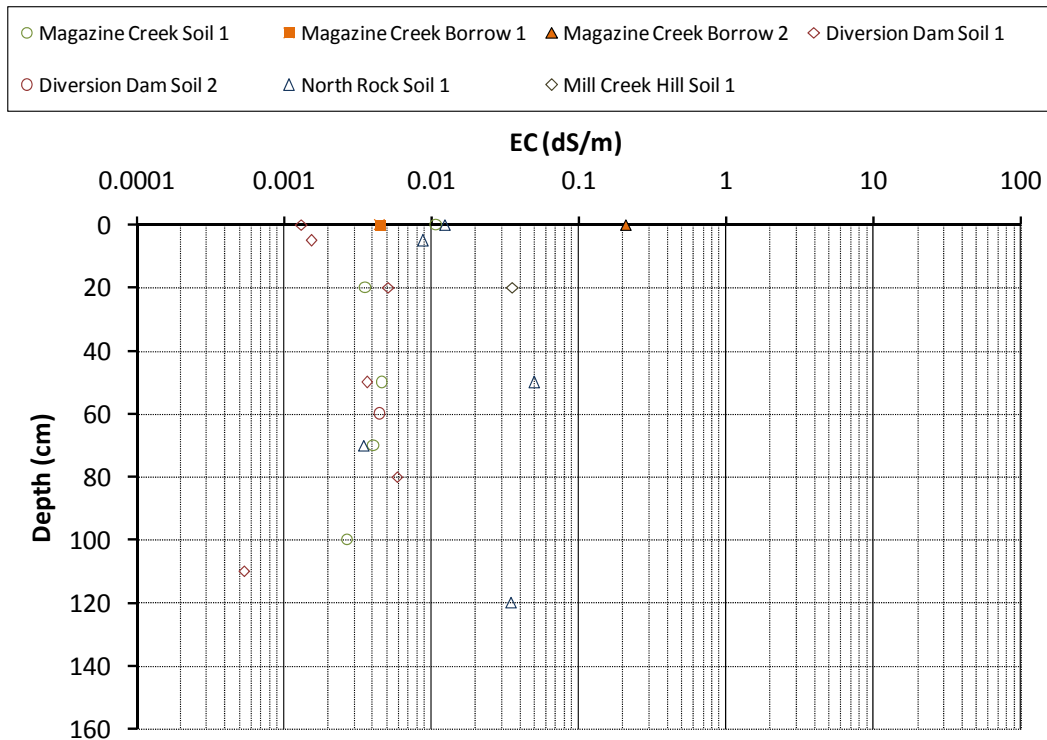


Figure 3.9 Quarries electrical conductivity versus depth

3.4 Laboratory analysis

Samples were collected down the profile of the Old TSF and quarries soil from the ground surface, 0 cm bgl to a maximum depth of approximately 160 cm bgl.

The sample sites for the Old TSF and quarries are shown in Figure 3.1.

3.4.1 Old tailings storage facility

The following analysis was completed for samples collected from Pit A, Pit B, Pit C and Pit D (Figure 3.1) from the Old TSF:

- acid base accounting (Total sulfur (S) and acid neutralising capacity) and water soluble sulfur;
- total metals/metalloids (Al, As, B, Cd, Cr, Co, Cu, Fe, P, Pb, Mn, Ni, Sb, V, Zn) in solids;
- soluble metals/metalloids (al, As, B, Cd, Cr, Co, Cu, Fe, P, Pb, Mn, Ni, Sb, V, Zn) in water extracts (1:5);
- total cations (Ca, Mg, Na, K); and
- exchangeable cations (Ca, Mg, Na, K, Al).

i Geochemistry

a. Acid base accounting

The acid base account involves static laboratory procedures that evaluate the balance between acid generating processes (oxidation of sulfide minerals) and acid neutralising processes (dissolution of alkaline carbonates, displacement of exchangeable bases, and weathering of silicates). The ALS acid base account results are presented as Appendix C.

The values arising from the acid base account are referred to as the maximum potential acidity (MPA) and the acid neutralising potential (ANP). The difference between the MPA and the ANC is referred to as the net acid producing potential (NAPP). The acid base account is calculated as kilograms of sulfuric acid per tonne ($\text{kg H}_2\text{SO}_4^{-2}/\text{t}$).

It should be noted that the ALS acid base account has been calculated using the Total Sulfur (S) value. The ALS calculation is conservative since it does not account for the oxidation of Sulfide to Sulfate (SO_4). Once Sulfide oxidises to Sulfate it is no longer able to create acid rock drainage.

Table 3.3 presents the acid base account results for Old TSF samples collected from Pit A, Pit B, Pit C and Pit D (Figure 3.1). pH and EC values shown were measured in the field. The acid base account has been calculated by first subtracting the oxidised Sulfate from the Total S using the method and equations described in Appendix E.

Table 3.3 shows that there is a very limited potential for acid rock drainage from the plant growth medium, RPL or tailings in the Old TSF:

- one sample of plant growth medium is classified as PAF ($\text{NAPP} > 5 \text{ kg H}_2\text{SO}_4^{-2}/\text{t}$);
- a further nine samples of plant growth medium were marginally PAF ($\text{NAPP} > 0 \text{ kg H}_2\text{SO}_4^{-2}/\text{t}$, $< 5 \text{ kg H}_2\text{SO}_4^{-2}/\text{t}$);
- the RPL and capillary (Pit B only) break is NAF and has some excess acid neutralising capacity; and
- the surface 0.5 to 1 m of tailings in the Old TSF is oxidised and has excess acid neutralising capacity. The neutralising capacity of the tailings is more than twice the potential acidity of the plant growth medium.

The current acid base account would not prevent the use of either the old cover or tailings in a new cover for the Old TSF or HLEP#2. This is further discussed in chapter 4.

Table 3.3 **Old tailings storage facility acid base accounting**

Pit	Cover layer	Liquor pH and salinity			Acid base account					
			pH	EC	Total S	Sulfur	Sulfide-sulfur	MPA	ANC	NAPP
		cm below ground level		dS/m	%	%	%	kg H ₂ SO ₄ ⁻² /t	kg H ₂ SO ₄ ⁻² /t	kg H ₂ SO ₄ ⁻² /t
A	Plant growth medium	0	4.12	0.40	0.56	0.39	0.17	5.11	12.70	-7.59
		0-10	4.14	0.22	0.58	0.28	0.30	9.15	7.70	1.45
		20-40	4.59	0.45	0.07	0.36	0.00	0.00	0.70	-0.70
		70-100	4.47	0.20	0.05	0.21	0.00	0.00	0.00	0.00
		300-350	4.2	0.03	0.04	0.05	-0.01	-0.37	0.00	-0.37
		600-650	4.21	0.08	0.04	0.05	-0.01	-0.34	0.00	-0.34
		800-850	5.05	0.11	0.14	0.28	-0.14	-4.25	-25.00	-4.25
		1100-1140	4.88	0.04	0.07	0.04	0.03	1.04	-20.00	1.04
	RPL	1140-1200	5.14	0.04	0.02	0.04	-0.02	-0.70	-14.10	-0.70
		1350-1400	5.39	0.05	0.03	0.05	-0.02	-0.52	-13.60	-0.52
B	Plant growth medium	0	5.14	0.84	0.20	0.60	0.00	0.00	-2.20	0.00
		0-10	5.46	0.75	0.32	0.87	-0.55	-16.95	0.90	-17.85
		20-40	5.2	0.53	0.26	0.97	0.00	0.00	-0.60	0.00
		70-100	4.71	0.61	0.30	0.72	-0.42	-12.85	1.00	-13.85
		300-350	4.64	0.66	0.41	0.72	-0.31	-9.45	4.60	-14.05
	Bridging layer/capillary break	600-650	4.91	0.72	1.51	0.88	0.63	19.15	46.20	-27.05
		800-850	3.83	1.45	1.74	1.47	0.27	8.26	53.20	-44.94
	Tailings	900-1000	3.75	0.94	0.80	1.13	-0.33	-10.09	24.50	-34.59
		1200-1300	3.91	0.63	0.56	0.67	-0.11	-3.49	16.00	-19.49
		1400-1500	3.94	0.44	0.45	0.70	-0.25	-7.65	11.40	-7.65

Table 3.3 **Old tailings storage facility acid base accounting**

Pit	Cover layer	Liquor pH and salinity				Acid base account				
		pH	EC	Total S	Sulfur	Sulfide-sulfur	MPA	ANC	NAPP	
		cm below ground level		dS/m	%	%	%	kg H ₂ SO ₄ ⁻² /t	kg H ₂ SO ₄ ⁻² /t	kg H ₂ SO ₄ ⁻² /t
C	Plant growth medium	0	5.52	0.32	0.17	0.18	-0.01	-0.43	-28.20	-0.43
		0-10	5.95	0.08	0.11	0.10	0.01	0.24	-30.20	0.24
		20-40	6.08	0.21	0.11	0.09	0.02	0.49	-39.50	0.49
		70-100	5.84	0.22	0.05	0.17	0.00	0.00	-26.80	0.00
		300-350	6.02	0.05	0.07	0.06	0.01	0.31	-34.00	0.31
	RPL	400-450	5.98	0.06	0.06	0.05	0.01	0.24	-15.70	0.24
		600-650	4.11	0.70	0.20	0.63	0.00	0.00	4.50	-4.50
	Tailings	800-850	3.95	0.31	1.08	0.82	0.26	7.95	33.00	-25.05
		1200-1300	3.83	0.72	1.42	1.14	0.28	8.57	43.40	-34.83
		1600-1700	3.89	1.43	1.63	1.14	0.49	14.99	49.90	-34.91
D	Plant growth medium	0	6.12	0.06	0.22	0.04	0.18	5.57	-8.30	5.57
		0-10	5.96	0.01	0.07	0.01	0.06	1.84	-4.40	1.84
		20-40	6.12	0.01	0.03	0.01	0.02	0.67	-6.90	0.67
		70-100	5.87	0.01	0.03	0.01	0.02	0.73	-6.10	0.73
		300-350	5.86	0.03	0.06	0.02	0.04	1.35	-6.60	1.35
	RPL	400-450	5.65	0.10	0.05	0.08	-0.03	-0.98	-11.60	-0.98
		600-650	4.36	0.18	0.14	0.30	-0.16	-5.02	-1.70	-5.02
	Tailings	800-850	4.22	0.07	0.43	0.06	0.38	11.47	12.20	-0.73
		1200-1300	3.65	0.47	1.04	0.66	0.38	11.72	31.80	-20.08
		1600-1700	3.6	0.83	2.24	1.24	1.00	30.59	68.50	-37.91

Notes: Where the ANC is negative it is not used in the NAPP calculation because in reality either a sample has ANC (ie it is positive) or it has none at all (ie equal to zero).

b. Total and water extract soluble metals

The following results for total and water extract soluble metals are compared to Spain et al (2005) and NEPM HIL C.

Cu concentrations have risen in the cover and tailings by up to five orders of magnitude from 0.01 to 1 mg/kg (shown as a lower and upper trend line in Figure 3.10a and Figure 3.10b) in 2005 (Spain et al 2005) to 100-9,000 mg/kg in 2015 (Figure 3.10a). The water extract soluble Cu concentration is high ranging between 0.01-1,000 mg/kg, resulting in accumulation of Cu in the cover and tailings due to capillary rise. In 2015 all sample values in the cover and tailings are below HIL C (17,000 mg/kg) (Figure 3.10a). The current Cu concentration would not prevent the use of either the cover or tailings in a new cover for the Old TSF or HLEP#2. This is further discussed in chapter 4.

Cd concentrations have decreased in the cover and tailings. In 2005 (Spain et al 2005) Cd concentration ranged between 5-11.94 mg/kg (shown as a lower and upper trend line in Figure 3.11a and Figure 3.11b). The water extract soluble Cd concentrations are very low (Figure 3.11b) ranging between 0.01-1 mg/kg, resulting in Cd being leached out of the cover and tailings. Concentrations of Cd in the cover and the tailings are well below HIL C (90 mg/kg). The current Cd concentration would not prevent the use of either the cover or tailings in a new cover for the Old TSF or HLEP#2. This is further discussed in chapter 4.

Co concentrations have decreased in the cover and tailings. In 2005 (Spain et al 2005) Co concentration was relatively high with a maximum concentration of 546 mg/kg. The 2005 Co concentration range is shown as an upper and lower trend line in Figure 3.12a and Figure 3.12b. The water extract soluble Co concentrations are very low (Figure 3.12b). A maximum concentration of approximately 500 mg/kg does occur in the tailings. The low solubility of Co has resulted in it being leached from the cover and the tailings. The cover and tailings does not exceed HIL C (300 mg/kg). The current Co concentration would not prevent the use of either the cover or tailings in a new cover for the Old TSF or HLEP#2. This is further discussed in chapter 4.

Cr concentration has remained low in the cover and tailings. In 2005 Spain et al (2005) recorded a maximum concentration of 341 mg/kg, compared to a maximum concentration of approximately 30 mg/kg in 2015 which is well below HIL C (300 mg/kg) for Cr IV. The upper and lower concentration trend lines from 2005 are shown in Figure 3.13a and Figure 3.13b. The low solubility (water extract soluble) of Cr has resulted in it being leached from the cover and the tailings. The current Cr concentration would not prevent the use of either the cover or tailings in a new cover for the Old TSF or HLEP#2. This is further discussed in chapter 4.

Fe concentrations ranged between 96 to 3,374 mg/kg in 2005 (Spain et al 2005). The 2005 lower and upper trend lines are shown in Figure 3.14a and Figure 3.14b. Water extract soluble Fe is very low (Figure 3.14b); however, Fe concentration has increased in the cover and tailings, probably a result of capillary rise. The current Fe concentration would not prevent the use of either the cover or tailings in a new cover for the Old TSF or HLEP#2. This is further discussed in chapter 4.

Mn concentrations in the cover and tailings have remained close to constant from 2005 to 2015 and have remained below HIL C (Figure 3.15a). Mn is very soluble under rain fed conditions with the water soluble concentration ranging between 0.1-200 mg/kg (Figure 3.15b). The current Mn concentration would not prevent the use of either the cover or tailings in a new cover for the Old TSF or HLEP#2. This is further discussed in chapter 4.

Ni concentrations ranged from approximately 13 to 380 mg/kg in 2005 (Spain et al 2005). The full range is shown as a lower and upper trend line in Figure 3.16a and Figure 3.16b. The water extract solubility of Ni has remained low (0.1-10 mg/kg) All sample values in the cover and tailings were less than HIL C (1,200 mg/kg). The current Ni concentration would not prevent the use of either the old cover or tailings in a new cover for the Old TSF or HLEP#2. This is further discussed in chapter 4.

Zn concentrations have remained low (5-200 mg/kg) compared to approximately 23-1,217 mg/kg in 2005 (Spain et al 2005) (Figure 3.17a and Figure 3.17b). Current concentrations remain substantially less than HIL C (30,000 mg/kg) in the cover and tailings. The current Zn concentration would not prevent the use of either the cover or tailings in a new cover for the Old TSF or HLEP#2. This is further discussed in chapter 4.

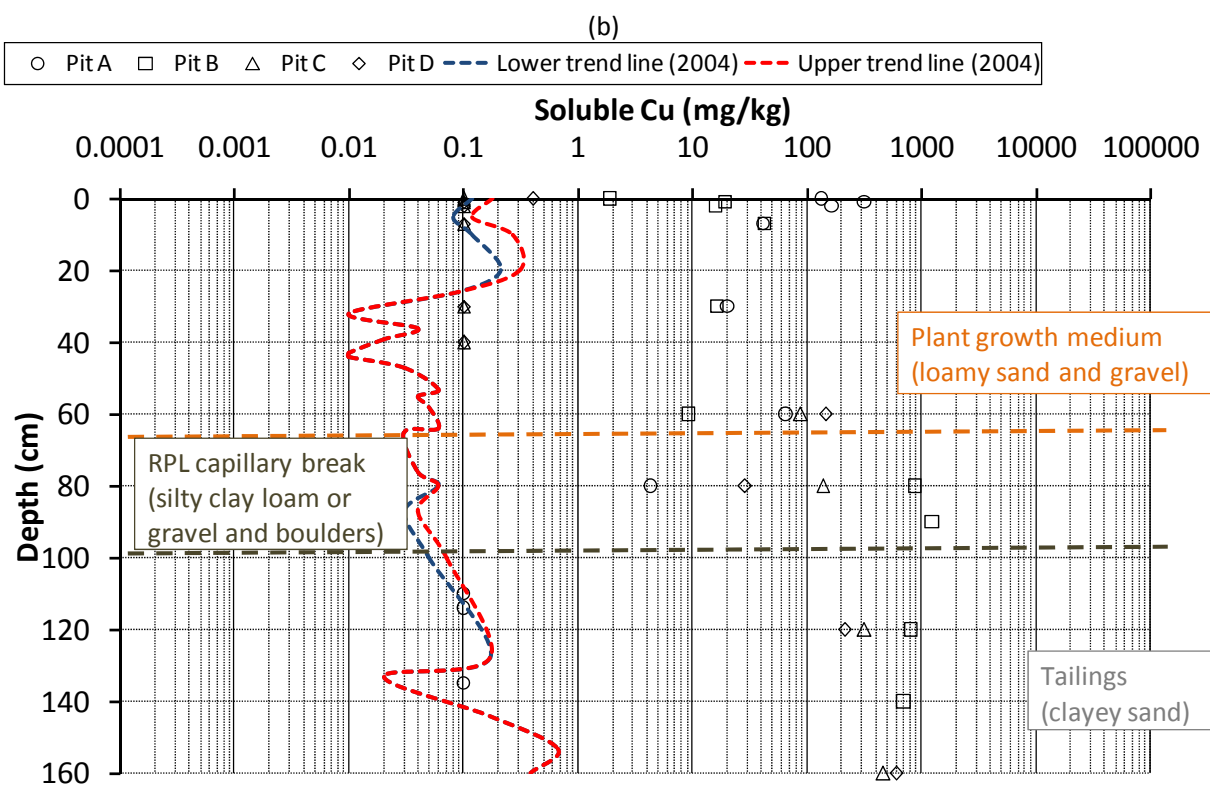
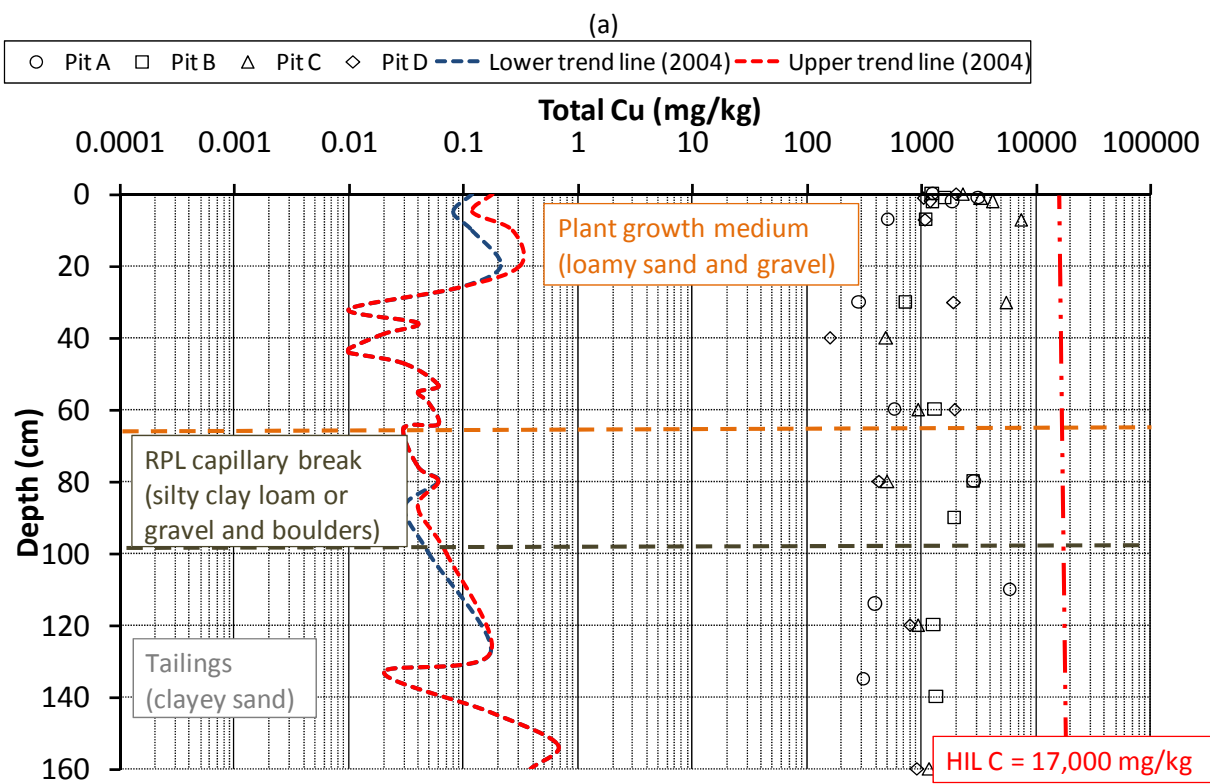


Figure 3.10 Old tailings storage facility Copper (a) total (b) water extract soluble versus depth

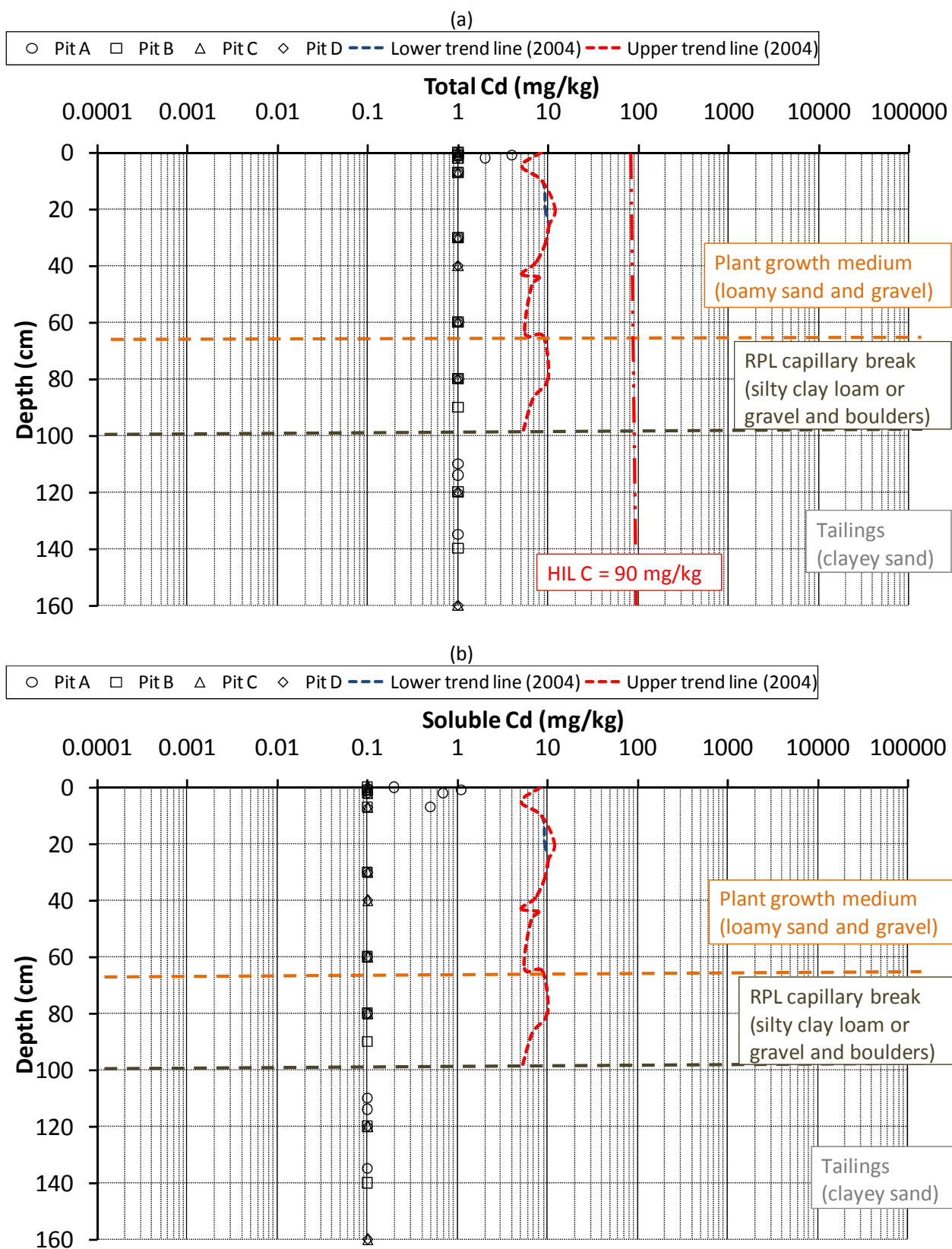


Figure 3.11 Old tailings storage facility Cadmium (a) total (b) water extract soluble versus depth

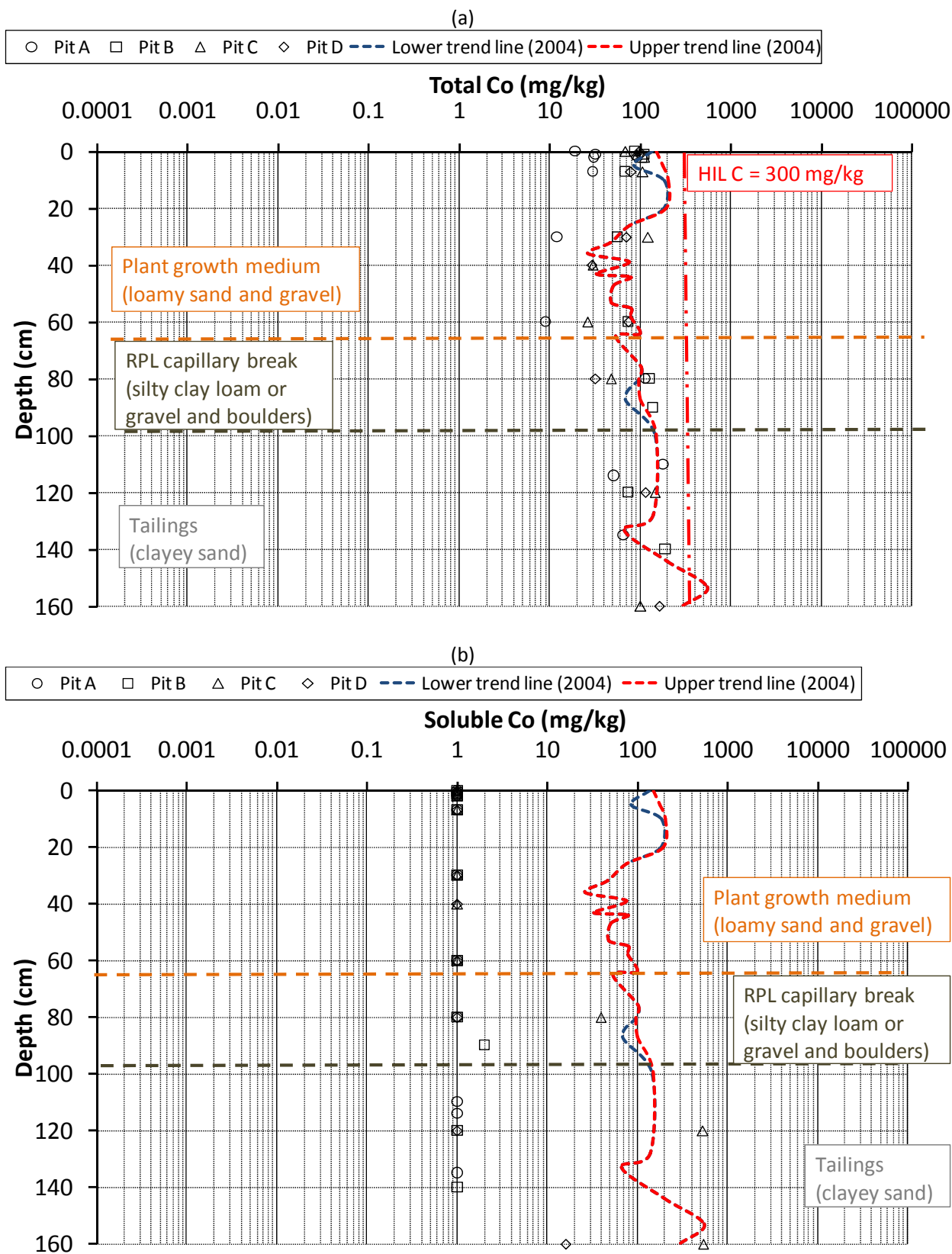


Figure 3.12 Old tailings storage facility Cobalt (a) total (b) water extract soluble versus depth

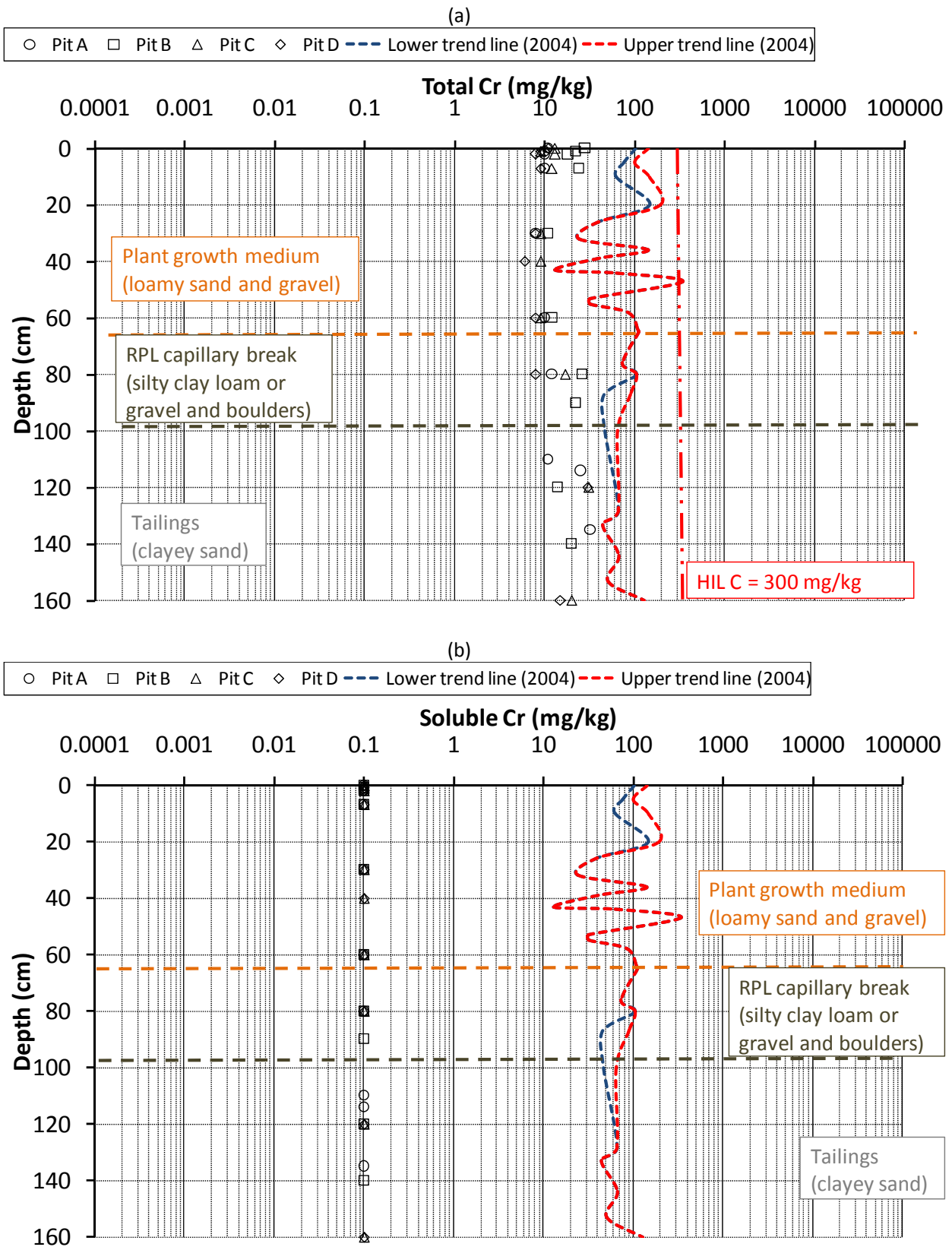


Figure 3.13 Old tailings storage facility Chromium (a) total (b) water extract soluble versus depth

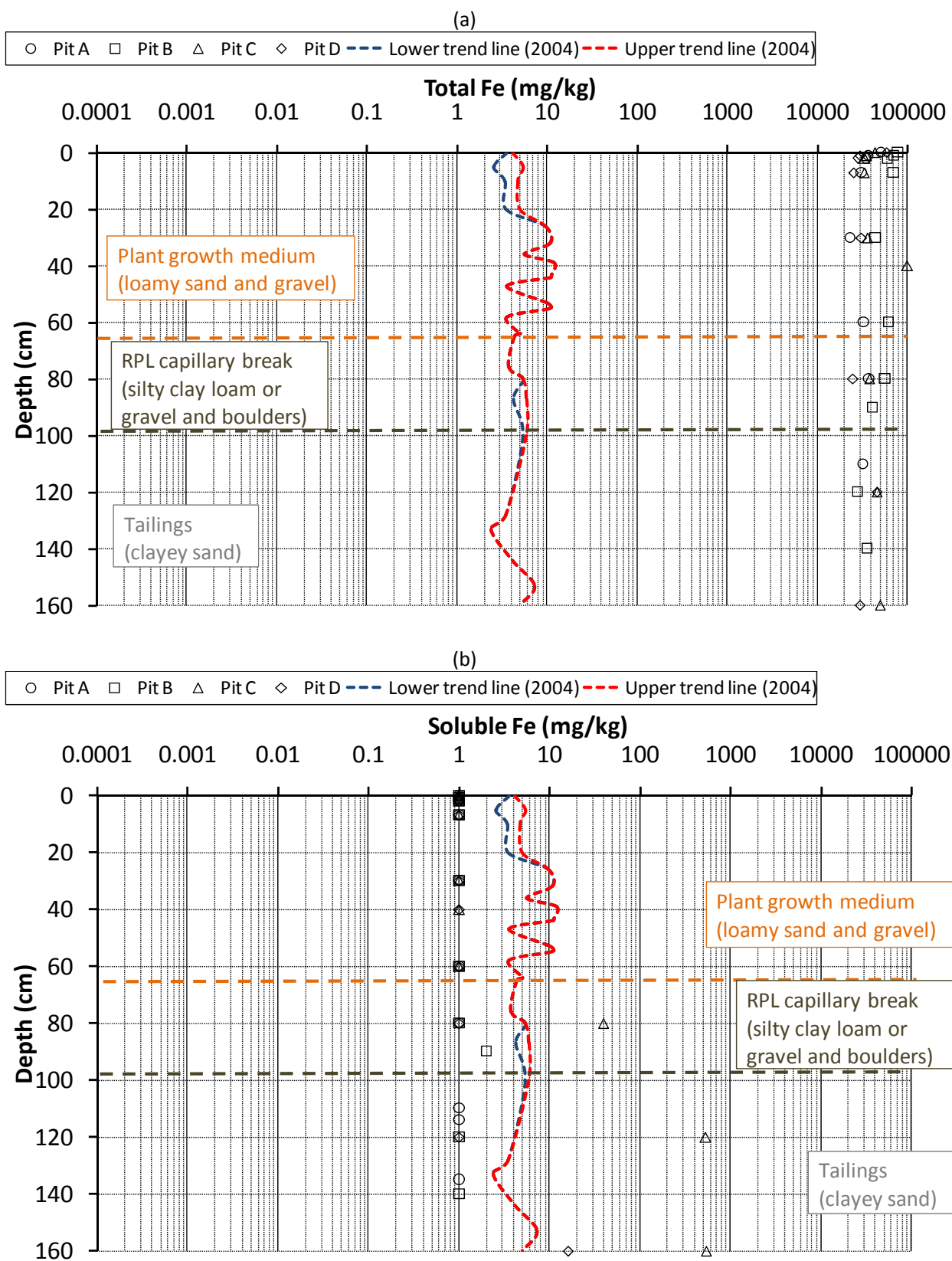


Figure 3.14 Old tailings storage facility Iron (a) total (b) water extract soluble versus depth

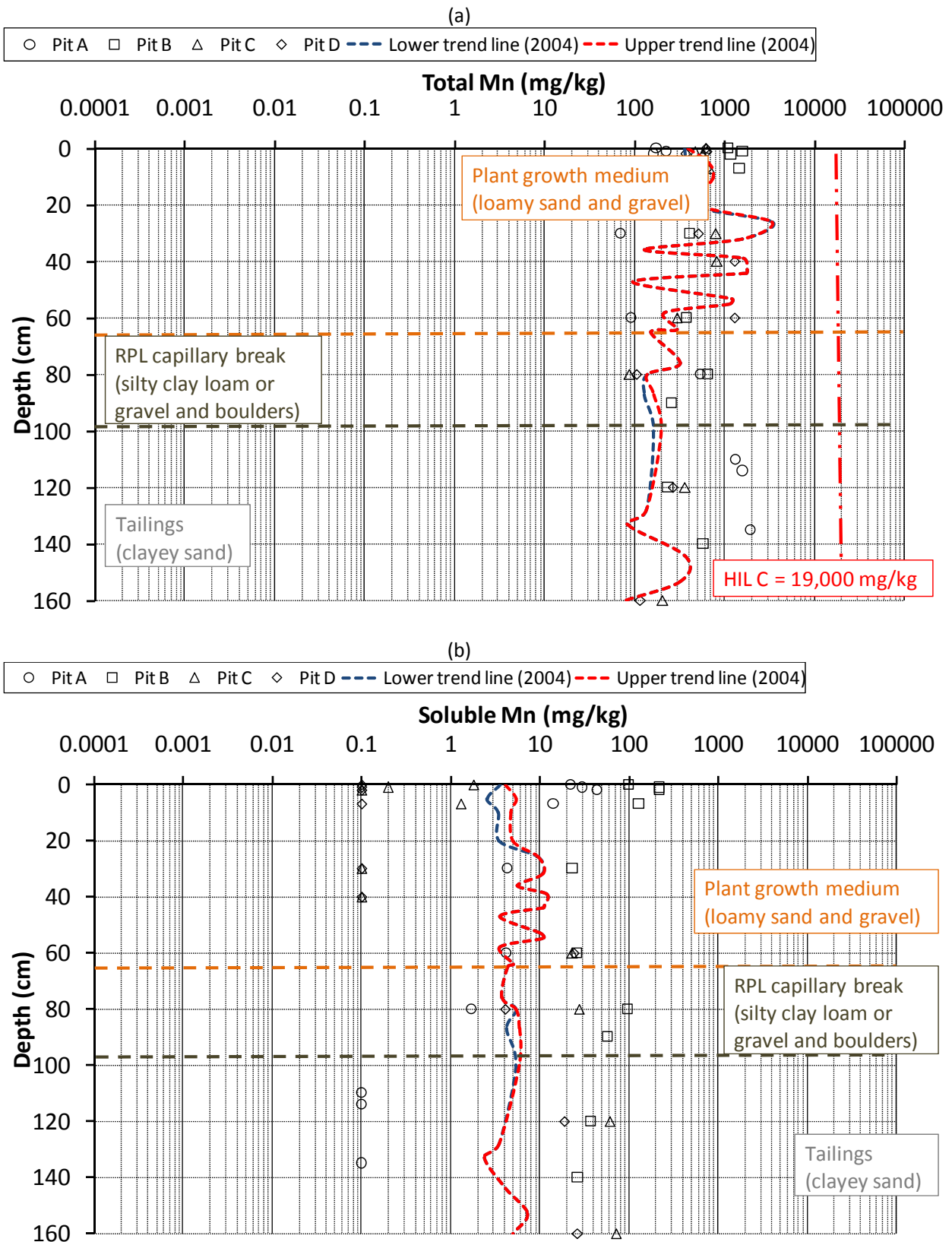


Figure 3.15 Old tailings storage facility Manganese (a) total (b) water extract soluble versus depth

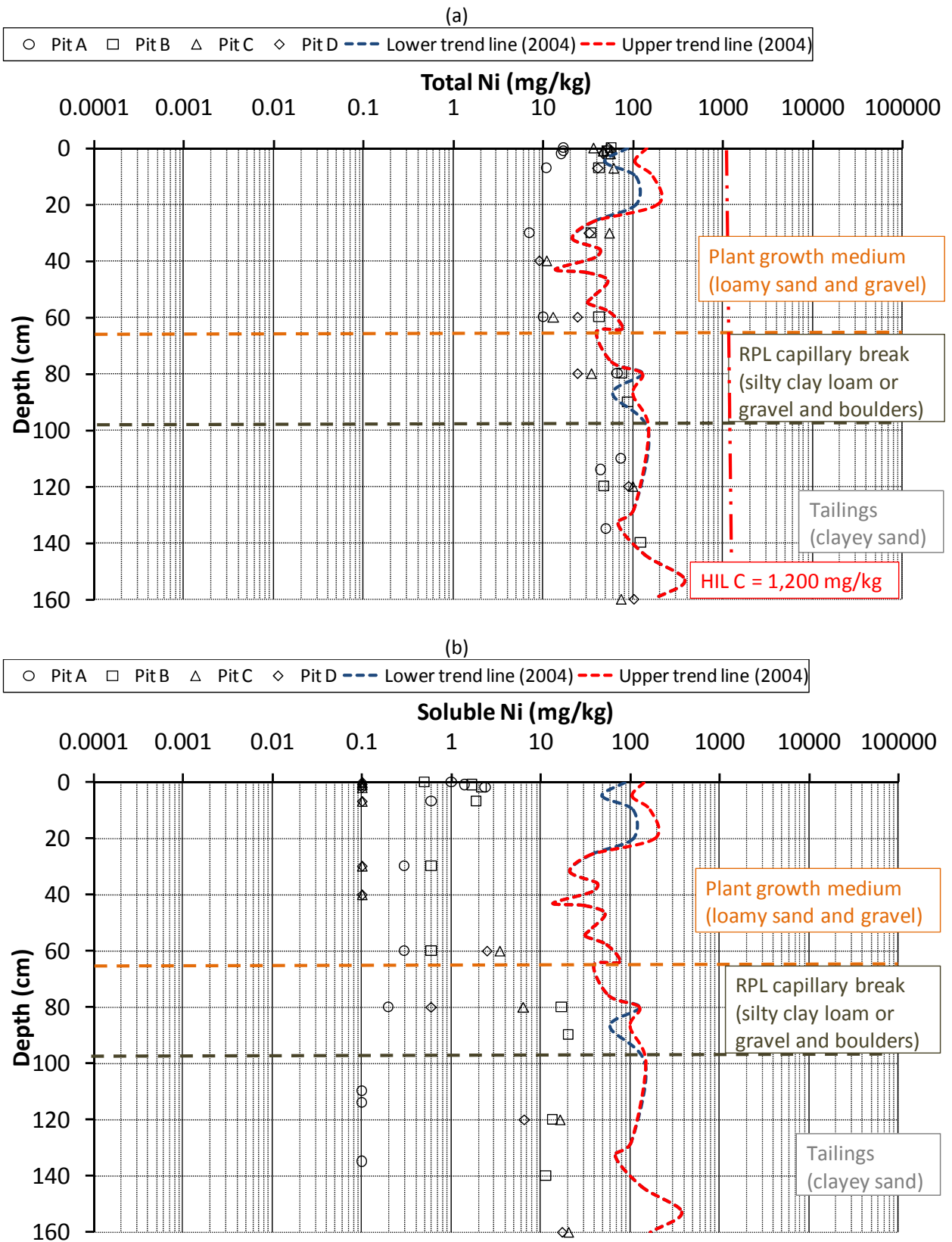


Figure 3.16 Old tailings storage facility Nickel (a) total (b) water extract soluble versus depth

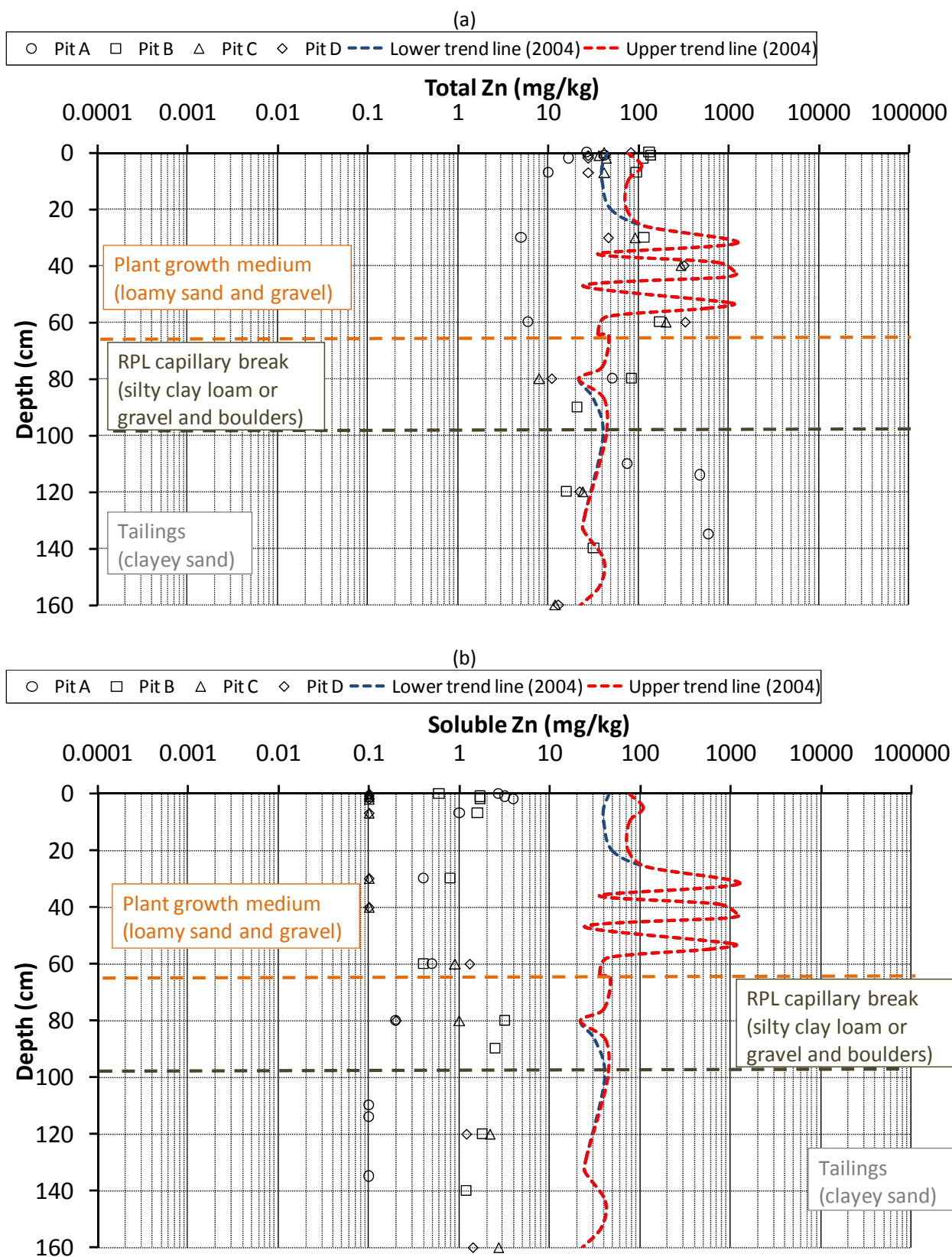


Figure 3.17 Old tailings storage facility Zinc (a) total (b) water extract soluble versus depth

c. Cation exchange capacity and major cations

The cation exchange capacity (CEC) is dominated by Calcium (Ca) and Magnesium (Mg) (Appendix C). The CEC capacity in the cover and tailings is very low ranging from approximately 1-10 meq/100 g (Figure 3.18). The current CEC concentration would not prevent the use of either the cover or tailings in a new cover for the Old TSF or HLEP#2. This is further discussed in Chapter 4.

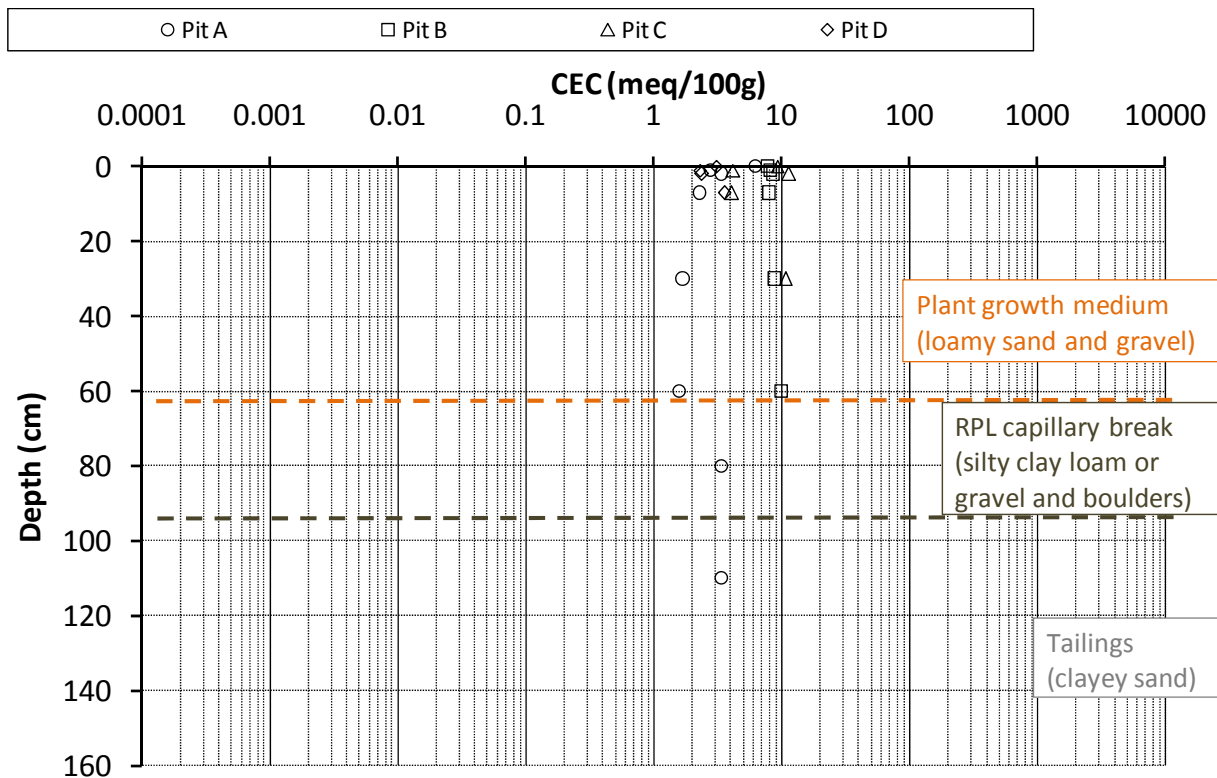


Figure 3.18 Old tailings storage facility cation exchange capacity

ii Physical characterisation

The following physical characterisation was completed on samples of the cover and tailings from the Old TSF:

- compaction curve including void ratio (e) and porosity (n) and saturated hydraulic conductivity;
- particle size distribution and specific gravity (particle density); and
- Emerson aggregate test.

Physical characterisation results formed the basis of the Vadose/w model (the model) (presented in Chapter 5).

a. Compaction, porosity and saturated hydraulic conductivity

Complete physical characterisation results for the Old TSF are presented as Appendix B. Table 3.4 provides a summary of physical characterisation results for bulk samples collected from the Old TSF submitted to Douglas Partners Consulting.

A target saturated hydraulic conductivity of 1E-8 m/s was used to determine if a material was suitable to be used as an RPL.

Table 3.4 Old tailings storage facility summary of compaction, porosity and saturated hydraulic conductivity results

Location	Maximum dry density	Dry density	Initial water content	Porosity (	Specific gravity	Saturated hydraulic conductivity
Units	%	(t/m ³)	%	-	-	(m/sec)
Pit A (20-1140)_2	100	2.02	11.9	0.25	2.76	2.00E-09
Pit A (1140-1400)_2	100	1.83	16.3	0.35	2.86	2.00E-09
Pit B (900-1500)_2	100	1.78	15.7	0.32	2.68	1.00E-09
1:5 Trafficked plant growth medium:Tailings	100	1.84	18.2	0.32	2.7	3.00E-10

b. Particle size distribution and specific gravity

Particle size distribution curves including hydrometer testing were completed by Douglas Partners Consulting and ALS laboratories. The full results are presented as Appendix B. A summary of the particle size distribution analysis of the Old TSF is presented as Figure 3.19.

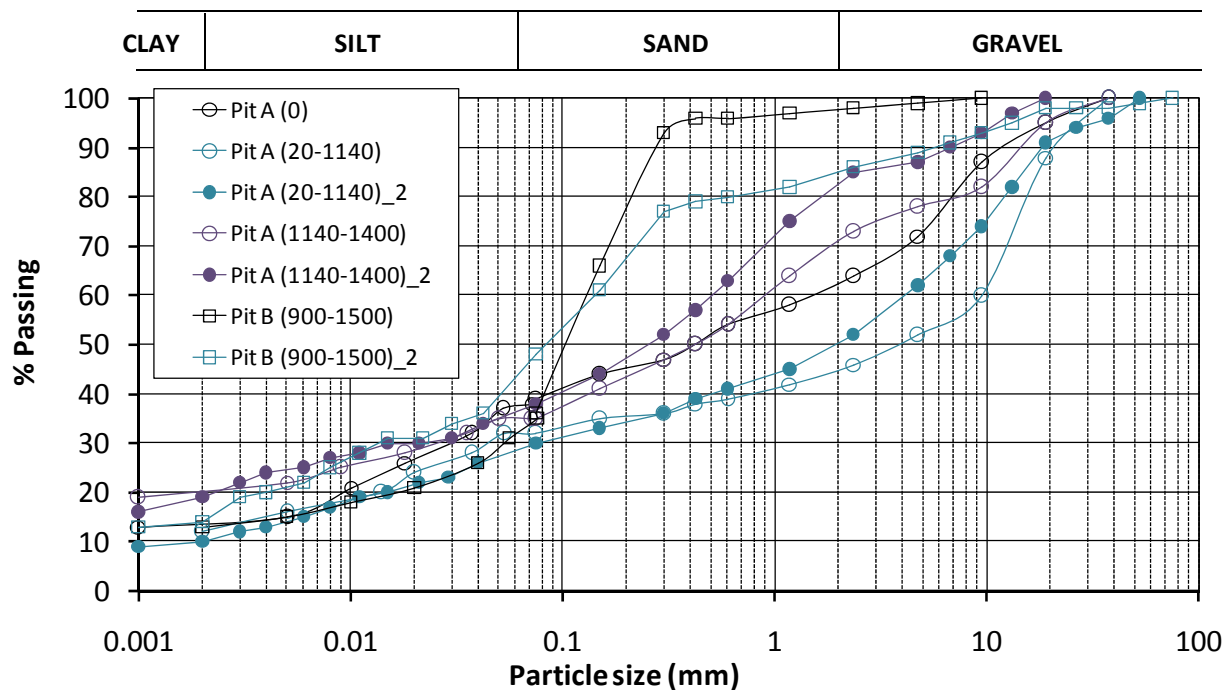


Figure 3.19 Old tailings storage facility summary of particle size distribution analysis

The particle size distribution analysis, saturated hydraulic conductivity, porosity and specific gravity were used to develop the soil water characteristic curves used in the model presented in Chapter 5.

c. Emerson aggregate test

Emerson aggregate testing was completed by Douglas Partners Consulting. The full results are presented as Appendix B.

The plant growth medium in Pit A was found to be dispersive near surface (20-114 cm). The RPL was found to be non dispersive in Pit A (114-140 cm) and the tailings in Pit B were also found to be non-dispersive.

3.4.2 Quarries

The following analysis was completed for samples collected from Diversion Dam Quarry, Magazine Creek Ponds, Mill Creek and North Rock Quarry for plant growth medium and clay for RPL. (Figure 3.1):

- acid base accounting (Total sulfur (S) and acid neutralising capacity) and water soluble sulfur;
- total metals/metalloids (Al, As, B, Cd, Cr, Co, Cu, Fe, P, Pb, Mn, Ni, Sb, V, Zn) in solids;
- soluble metals/metalloids (al, As, B, Cd, Cr, Co, Cu, Fe, P, Pb, Mn, Ni, Sb, V, Zn) in water extracts (1:5);
- total cations (Ca, Mg, Na, K); and
- exchangeable cations (Ca, Mg, Na, K, Al).

i Geochemistry

a. Acid base accounting

Table 3.5 presents the acid base account results for the samples collected from the quarries; Diversion Dam Quarry, Magazine Creek Ponds, Mill Creek and North Rock Quarry (Figure 3.1). pH and EC values shown were measured in the field. The acid base account has been calculated by first subtracting the oxidised Sulfate from the Total S using the method and equations described in Appendix E.

Table 3.5 shows that there is a very limited potential for acid rock drainage from the quarries:

- three samples from Magazine creek were marginally PAF (NAPP > 0 kg H₂SO₄-2/t, <5 kg H₂SO₄-2/t); and
- all other quarry samples have close to 0 NAPP and are considered to be NAF.

The current acid base account would not prevent the use of any of the quarries for the construction of a new cover for the Old TSF or HLEP#2. This is further discussed in Chapter 4.

Table 3.5 Quarries acid base accounting

Quarry	Sample	Liquor pH and salinity			Acid base account					
			pH	EC	Total S	Sulfur	Sulfide-sulfur	MPA	ANC	NAPP
		cm below ground level		dS/m	%	%	%	kg H ₂ SO ₄ ⁻² /t	kg H ₂ SO ₄ ⁻² /t	kg H ₂ SO ₄ ⁻² /t
Magazine Creek	Soil 1	0	4.73	10.76	0.09	0.00	0.09	2.69	0.5	2.19
Magazine Creek		200-300	5.03	3.56	0.04	0.00	0.04	1.19	0.04	1.15
Magazine Creek		500-600	5.14	4.66	0.04	0.00	0.04	1.19	0	1.19
Magazine Creek		700-800	4.97	4.06	0.01	0.00	0.01	0.18	-1.9	0.18
Magazine		1000-1100	4.96	2.71	0.01	0.00	0.01	0.28	-1.5	0.28
Magazine Creek		0-1900	-	-	0	0.00	0.00	0.00	0	0.00
North Rock	Soil 1	0	4.78	12.3	0.02	0.00	0.02	0.52	-1.7	0.52
North Rock		50-100	5.55	8.78	0.02	0.00	0.02	0.55	-0.9	0.55
North Rock		500-600	6.7	49.7	0.01	0.02	-0.01	-0.34	-1.8	0.00
North Rock		700-800	6.5	3.49	0.01	0.00	0.01	0.24	-2	0.24
North Rock	Soil 1	1200-1300	5.6	34.8	0.02	0.02	0.00	0.06	-3.6	0.06
North Rock		1700-1800	7.65	32.2	0.02	0.01	0.01	0.34	-137	0.34
Mill Creek Hill	Soil 1	200-300	4.76	35.6	0.03	0.01	0.02	0.67	-2.7	0.67
Diversion Dam	Soil 1	0	5.08	1.32	0.02	0.00	0.02	0.58	-4.2	0.58
Diversion Dam		50-80	4.94	1.54	0.02	0.00	0.02	0.58	-0.8	0.58
Diversion Dam		200-250	4.77	5.13	0.02	0.00	0.02	0.58	0	0.58
Diversion Dam		500-550	4.8	3.68	0.01	0.00	0.01	0.28	-1	0.28
Diversion Dam		800-850	4.72	5.89	0.01	0.00	0.01	0.24	0.5	-0.26
Diversion Dam		1100-1200	4.92	0.54	0.01	0.00	0.01	0.28	-1.1	0.28
Diversion Dam 700)	Soil 2	600-700	4.88	4.5	0.01	0.00	0.01	0.24	-1.3	0.24
Magazine Creek	Borrow 1	0-1400	5.65	2.83	0.01	0.00	0.01	0.28	-2.1	0.28
	Borrow 2	0-1700	5.02	209.4	0.01	0.00	0.01	0.28	-2.1	0.28

b. Total and water extractable metals

The following results for total and water extract soluble metals are compared to the 2015 results from the Old TSF and NEPM HIL C (HIL). Comparison to the 2015 Old TSF results is presented where relevant as an upper and lower trend line.

Cu concentrations in the quarries plant growth medium and clay ranges between 6-200 mg/kg (Figure 3.20a). By comparison the Cu concentration in the Old TSF in 2015 is 100-9,000 mg/kg (Figure 3.20a). The water extract soluble Cu concentrations are very low ranging between 0.01-1 mg/kg (Figure 3.20b). The plant growth medium Cu concentrations are below HIL C (17,000 mg/kg) (Figure 3.20a). The Cu concentration would not prevent the use of quarry plant growth medium and clay in a new cover for the Old TSF or HLEP#2. This is further discussed in Chapter 4.

Cd concentrations in the quarries plant growth medium and the clay ranges between 1-10 mg/kg (Figure 3.21a). By comparison the Cd concentration in the Old TSF is 0.1-1,000 mg/kg (Figure 3.21a). The water extractable Cd concentration is very low ranging between 0.1-1 mg/kg (Figure 3.21b). The concentrations of Cd in the quarries plant growth medium and clay are well below HIL C (90 mg/kg). The current Cd concentration would not prevent the use of either the quarries plant growth medium or clay in a new cover for the Old TSF or HLEP#2. This is further discussed in Chapter 4.

Co concentrations in quarries plant growth medium and clay ranges between 1-200 mg/kg (Figure 3.22a). The Co concentration in the quarries plant growth medium and clay is less than the Old TSF, which in 2015 has a maximum Co concentration of about 500 mg/kg (Figure 3.22a). The water extractable Co concentration is very low ranging between 0.1-0.2 mg/kg (Figure 3.22b). The concentrations of Co in the quarries plant growth medium and clay are well below HIL C (300 mg/kg). The current Co concentration would not prevent the use of either the quarries plant growth medium or clay in a new cover for the Old TSF or HLEP#2. This is further discussed in Chapter 4.

Cr concentrations in the plant growth medium and clay at the quarries ranges between 2-20 mg/kg (Figure 3.23a), which is very similar to the concentration profile within the Old TSF in 2015 (Figure 3.23a). The Cr concentration in the quarries plant growth medium and clay is well below HIL C (300 mg/kg) for Cr IV. Cr has a very low water solubility which is equal to or below the ALS laboratory limit of recording (LOR) of 0.1 mg/kg (Figure 3.23b). The current Cr concentration would not prevent the use of quarries plant growth medium or clay in the construction of a new cover for the Old TSF or HLEP#2. This is further discussed in Chapter 4.

Fe concentrations by comparison between the quarries and Old TSF is very similar ranging between 1,000-90,000 mg/kg (Figure 3.24a). Water extract soluble Fe is very low (Figure 3.24b). The current Fe concentration would not prevent the use of plant growth medium or clay in a new cover for the Old TSF or HLEP#2. This is further discussed in Chapter 4.

Mn concentrations in the plant growth medium and clay at the quarries ranges between 4-4,000 mg/kg, which is very similar to the concentration profile found in the Old TSF in 2015 (Figure 3.25a). Water solubility of Mn in quarries plant growth medium and clay is less than the Old TSF and ranges between 0.1-1 mg/kg (Figure 3.25b). The Mn concentration in the quarries plant growth medium and clay is well below HIL C (19,000 mg/kg). The current Mn concentration would not prevent the use of quarries plant growth medium or clay in a new cover for the Old TSF or HLEP#2. This is further discussed in Chapter 4.

Ni concentrations in the plant growth medium and clay at the quarries ranges between 1-50 mg/kg, which is below the concentration profile found in the Old TSF in 2015 (Figure 3.26a). The water extractable Ni concentration is equal to or less than the ALS laboratory LOR (Figure 3.26b) which is very low by comparison to the Old TSF which had a Ni concentration range of 0.1-10 mg/kg. All sample values in the cover and tailings were less than HIL C (1,200 mg/kg). The current Ni concentration would not prevent the use of quarries plant growth medium or clay in a new cover for the Old TSF or HLEP#2. This is further discussed in Chapter 4.

Zn concentrations are low (5-30 mg/kg) compared to approximately 5-200 mg/kg in the Old TSF in 2015 (Figure 3.27a). The water extractable Zn concentration is equal to or less than the ALS laboratory LOR (Figure 3.27b). Current concentrations are substantially less than HIL C (30,000 mg/kg) in the quarries plant growth medium and clay. The current Zn concentration would not prevent the use of quarries plant growth medium or clay in a new cover for the Old TSF or HLEP#2. This is further discussed in Chapter 4.

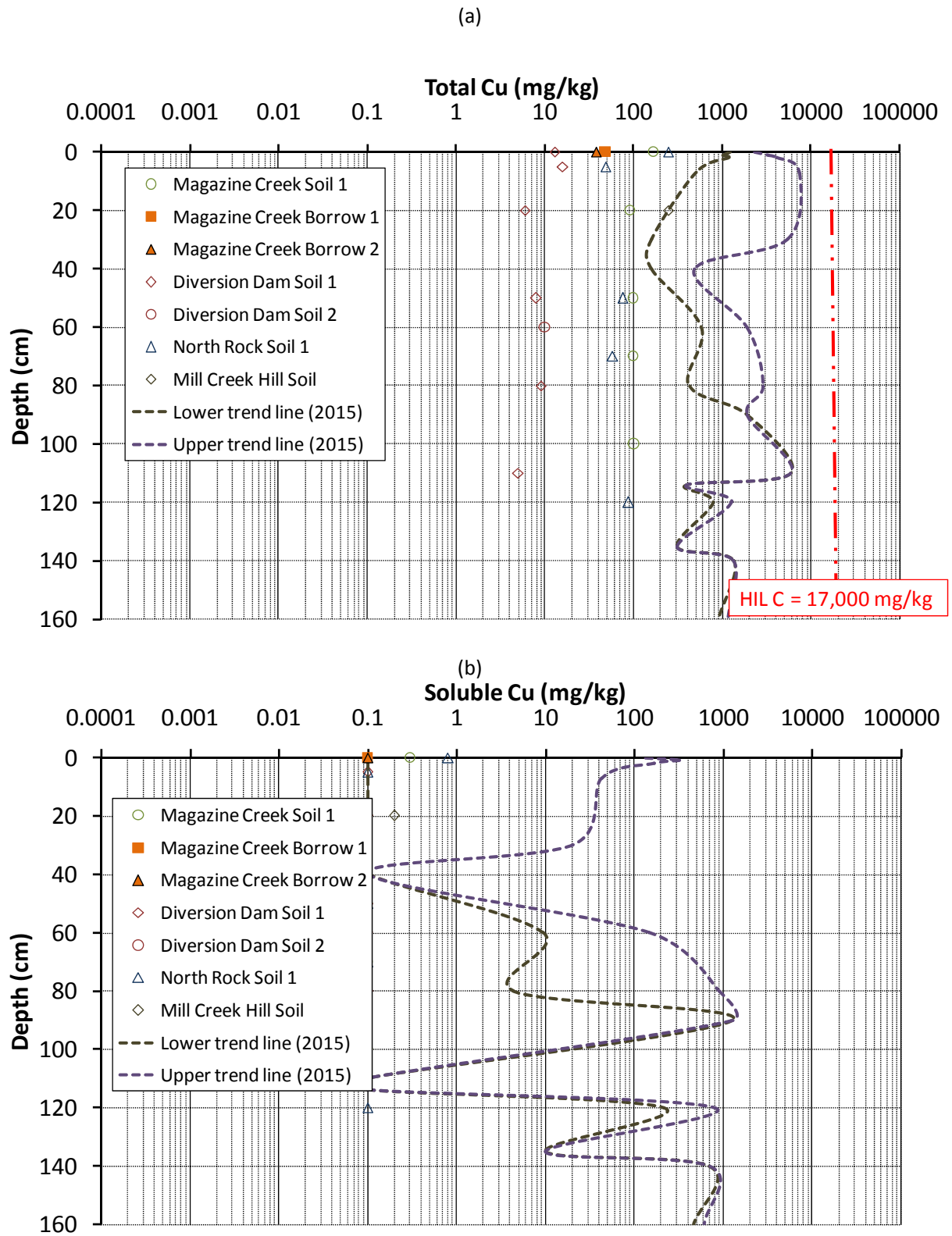


Figure 3.20 Quarries Copper (a) total (b) water extract soluble versus depth

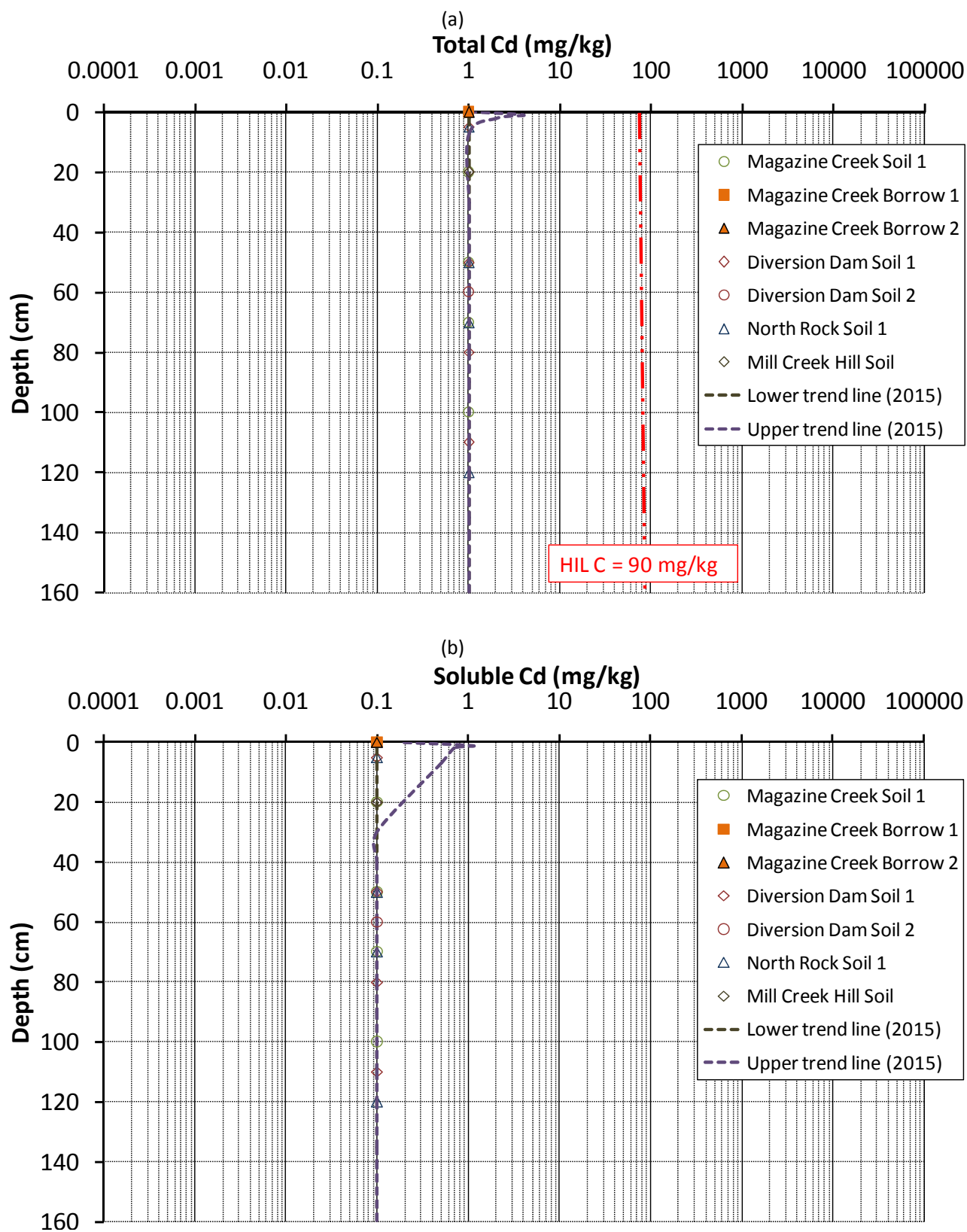


Figure 3.21 Quarries Cadmium (a) total (b) water extract soluble versus depth

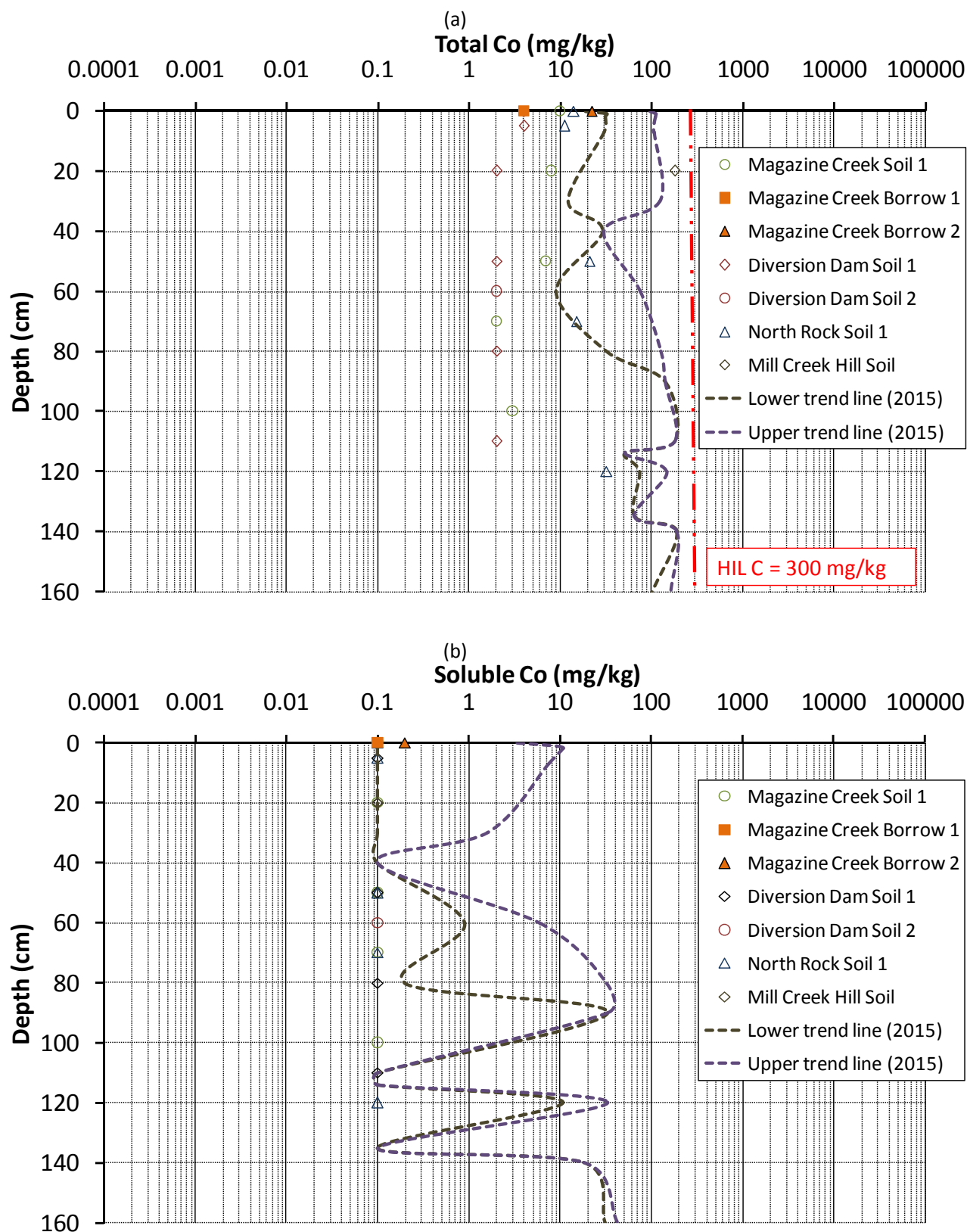


Figure 3.22 Quarries Cobalt (a) total (b) water extract soluble versus depth

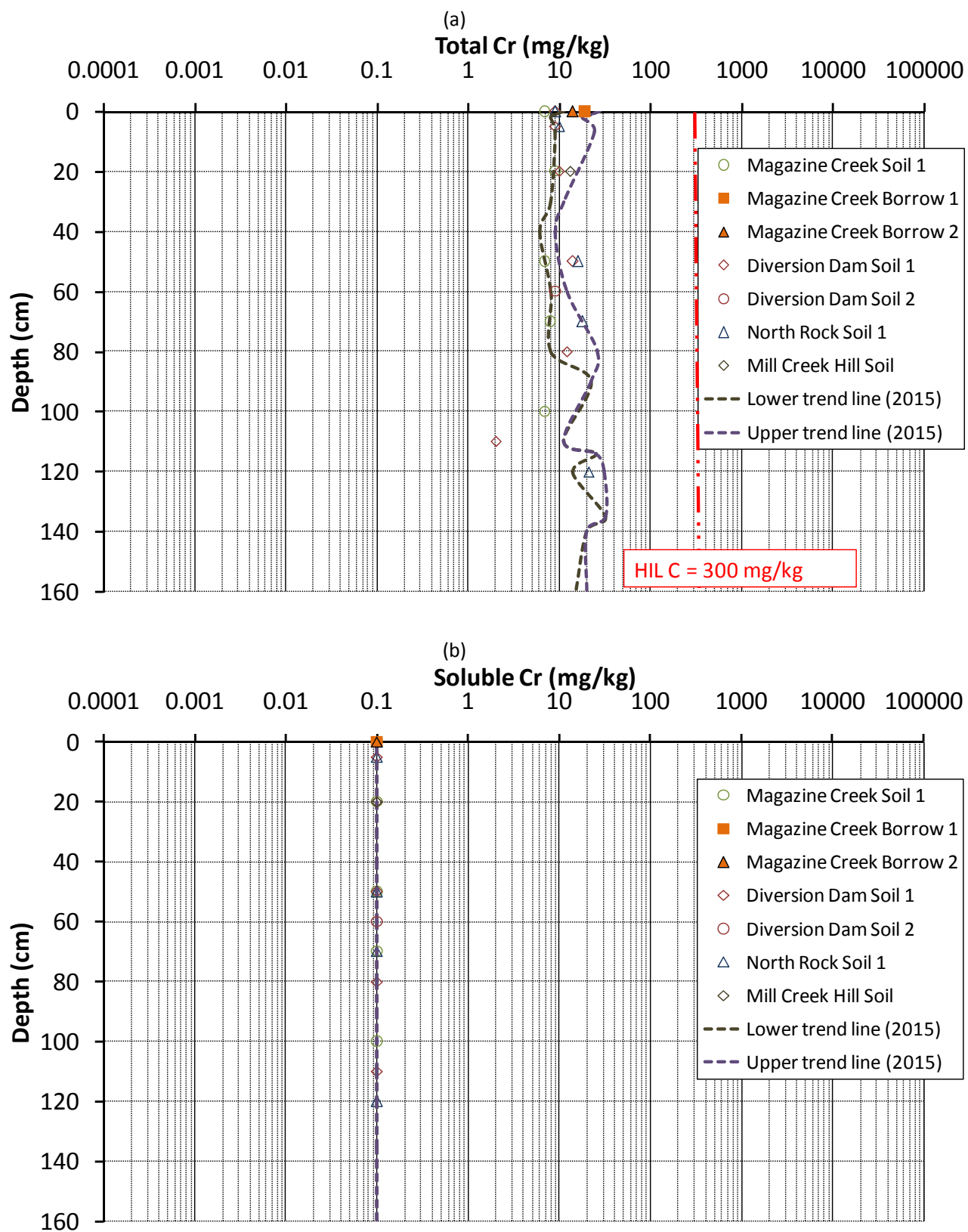


Figure 3.23 Quarries Chromium (a) total (b) water extract soluble versus depth

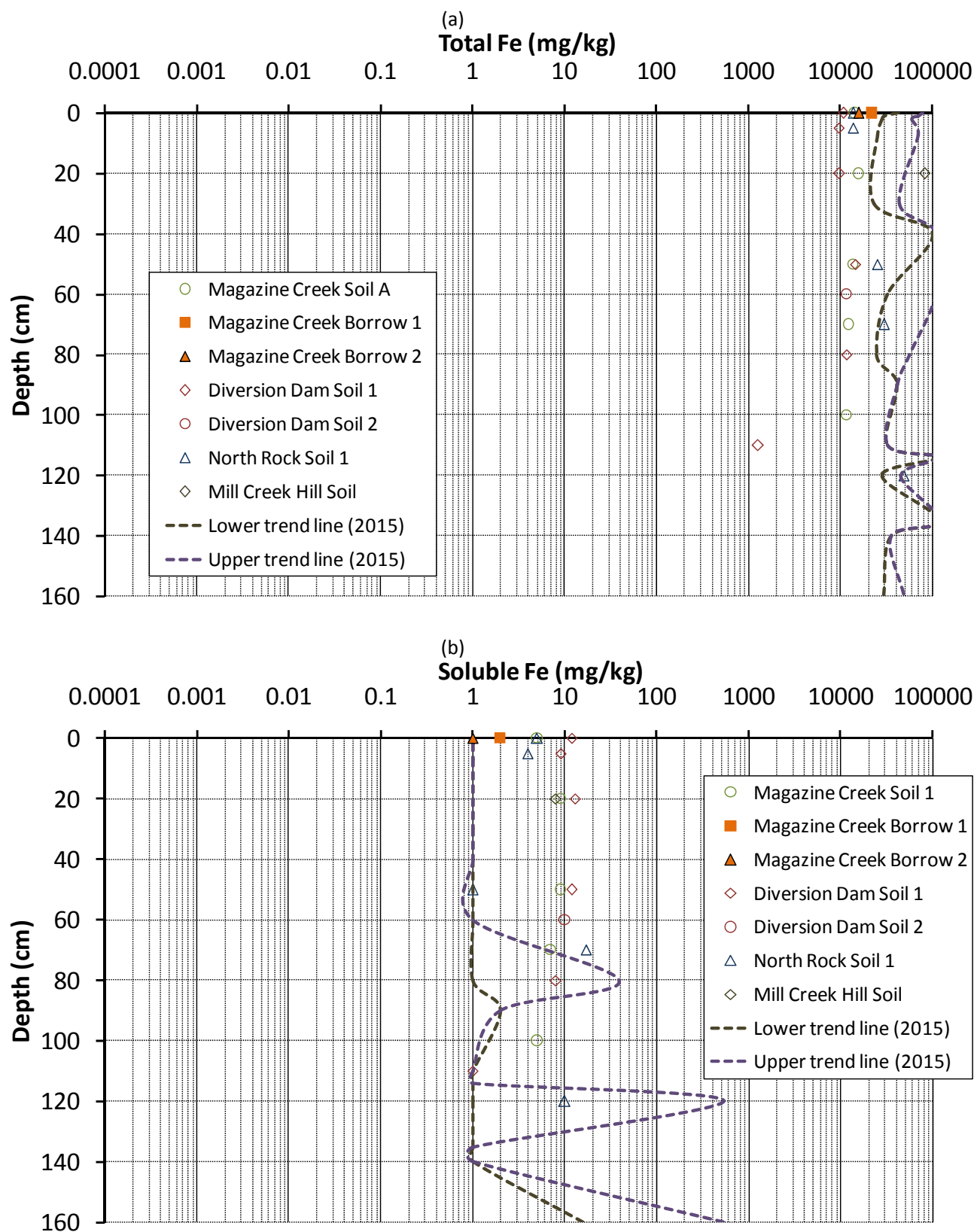


Figure 3.24 Quarries Iron (a) total (b) water extract soluble versus depth

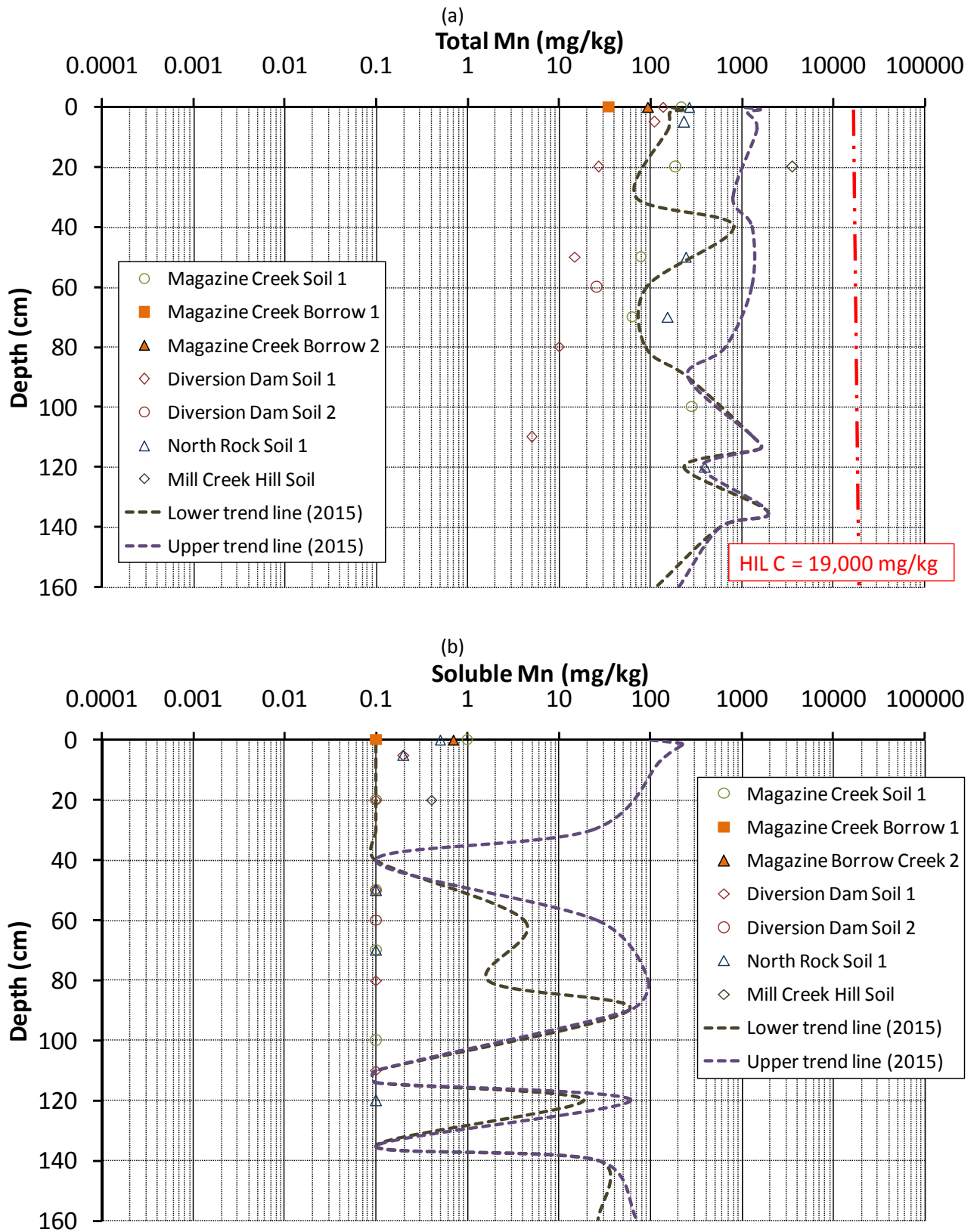


Figure 3.25 Quarries Manganese (a) total (b) water extract soluble versus depth

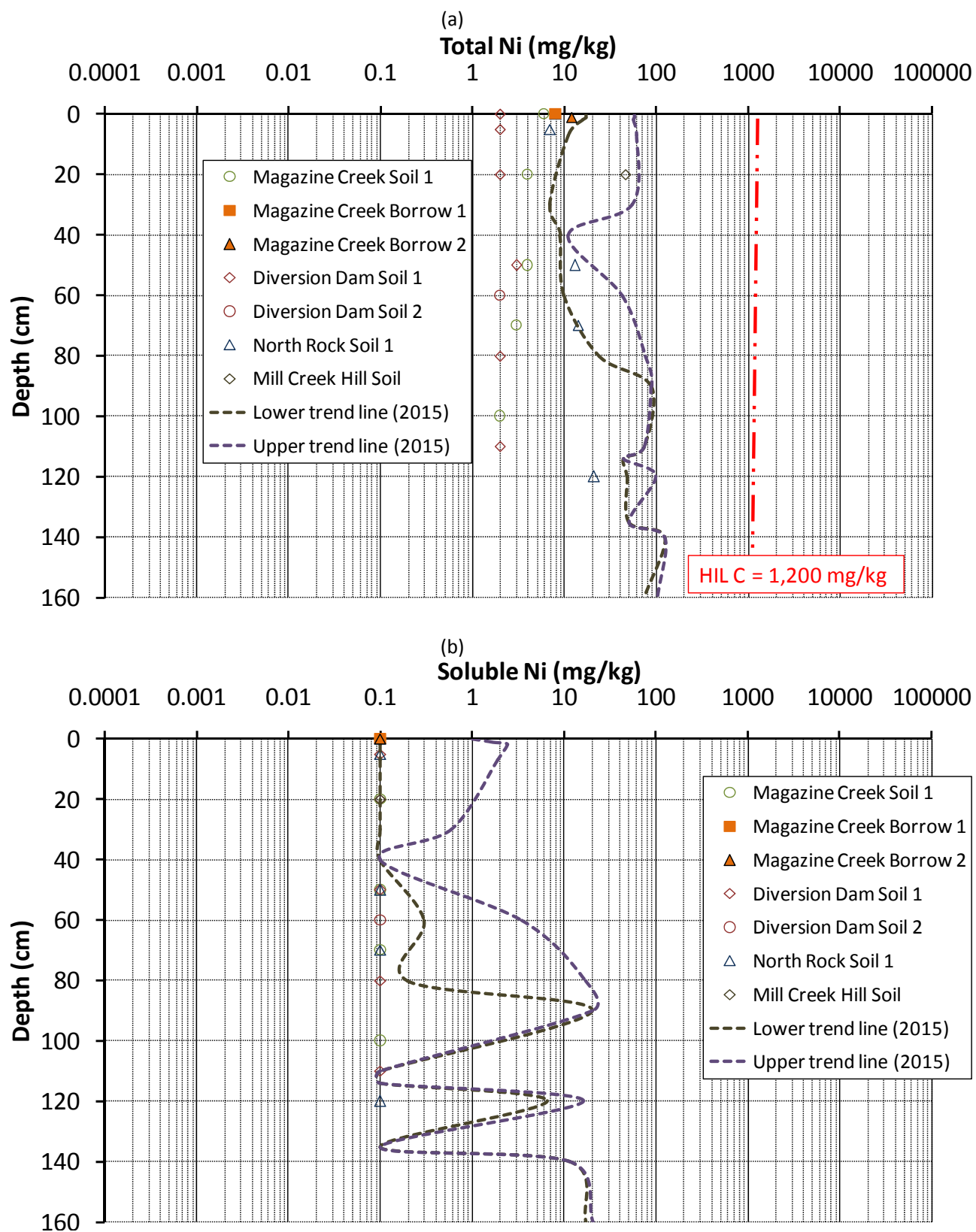


Figure 3.26 Quarries Nickel (a) total (b) water extract soluble versus depth

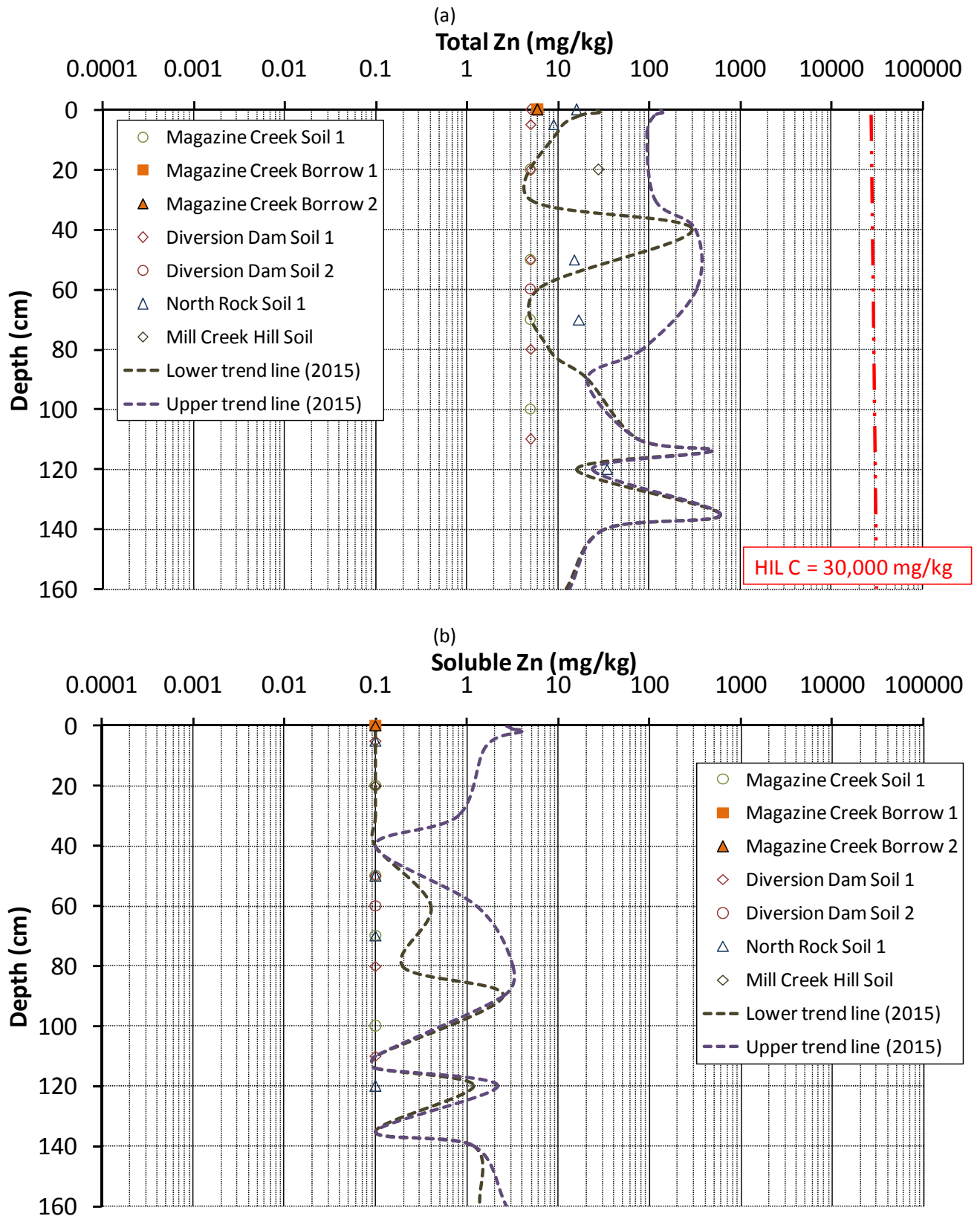


Figure 3.27 Quarries Zinc (a) total (b) water extract soluble versus depth

c. Cation exchange capacity and major cations

The cation exchange capacity (CEC) is dominated by Calcium (Ca) and Magnesium (Mg) (Appendix C). The CEC capacity in the quarries plant growth medium and clay is very low ranging from approximately 0.02-20 meq/100 g which is comparable to the 2015 Old TSF results (Figure 3.28). The current CEC concentration would not prevent the use of quarries plant growth medium and clay in a new cover for the Old TSF or HLEP#2. This is further discussed in Chapter 4.

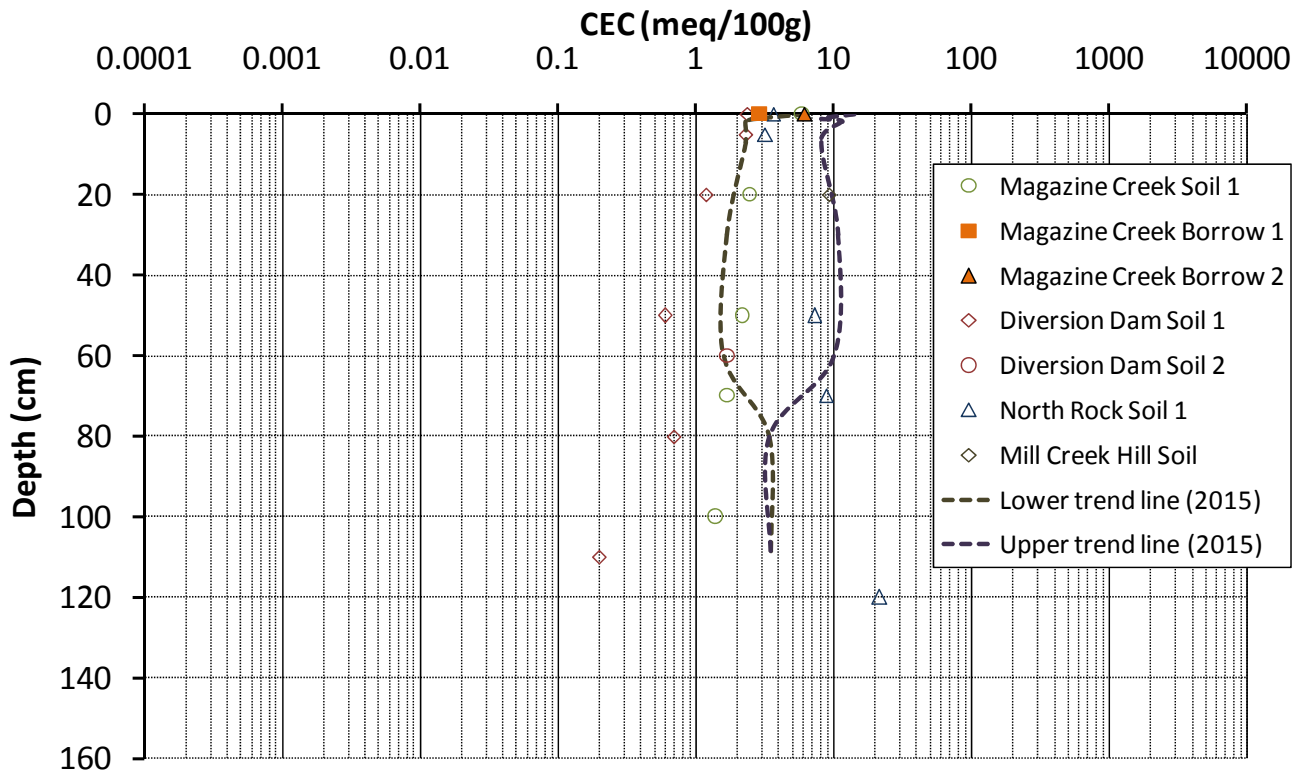


Figure 3.28 Quarries cation exchange capacity

ii Physical characterisation

The following physical characterisation was completed on samples of the quarries plant growth medium and clay:

- compaction curve including void ratio (e) and porosity (n) and saturated hydraulic conductivity;
- particle size distribution and specific gravity (particle density); and
- Emerson aggregate test.

Physical characterisation results formed the basis of the model (presented in chapter 5). Physical characterisation was completed for two 'mixed' samples in addition to bulk samples collected in the field:

- 1:5 trafficked plant growth medium and tailings mixture; and
- scalped North Rock Soil sample (<9.6 mm) with the addition of 15-30% fines passing <0.075 mm.

The two mixtures were tested as potential replacement to the clay RPL, which is currently part of the Old TSF cover.

a. **Compaction, porosity and saturated hydraulic conductivity**

Complete physical characterisation results for the quarries plant growth medium and clay are presented as Appendix B. Table 3.6 provides a summary of physical characterisation results for bulk samples collected from the quarries submitted to Douglas Partners Consulting.

A target saturated hydraulic conductivity of 1E-8 m/s was used to determine if a material was suitable to be used as an RPL.

Table 3.6 Quarries summary of compaction, porosity and saturated hydraulic conductivity results

Location	Maximum dry density	Dry density	Initial water content	Porosity	Specific gravity	Saturated hydraulic conductivity
Units	%	(t/m ³)	%	-	-	(m/sec)
Diversion Dam Soil 3 (0-1900)	100	1.94	11.2	0.25	2.64	2.00E-08
Diversion Dam Soil 3 (0-1900)	95	1.84	-	-	-	6.00E-08
Magazine Creek Borrow 2 (0-1700)	100	1.96	12.1	0.26	2.71	3.00E-10
Magazine Creek Borrow 2 (0-1700)	95	1.86	-	-	-	8.00E-10
Magazine Creek Soil 1 (0-1900)_2	100	2	9.1	0.28	2.63	6.00E-09
Magazine Creek Soil 1 (0-1900)_2	95	1.9	-	-	-	2.00E-09
Mill Creek Hill Soil 1 (0-1900)	100	1.88	15.2	0.3	2.74	3.00E-09
North Rock Soil 1 (0-1800)_2	100	1.85	11.2	0.3	2.67	2.00E-08
North Rock Soil 1 (0-1800)_2	95	1.76	-	-	-	4.00E-08
1:5 Trafficked plant growth medium:Tailings	100	1.84	14.5	0.31	2.7	3.00E-10
Scalped (<9.6 mm) + 15-30% fines passing (<0.075 mm)	100	1.95	12.3	0.27	2.7	1.00E-09

b. **Particle size distribution and specific gravity**

Particle size distribution curves including hydrometer testing were completed by Douglas Partners Consulting and ALS laboratories. The full results are presented as Appendix B.

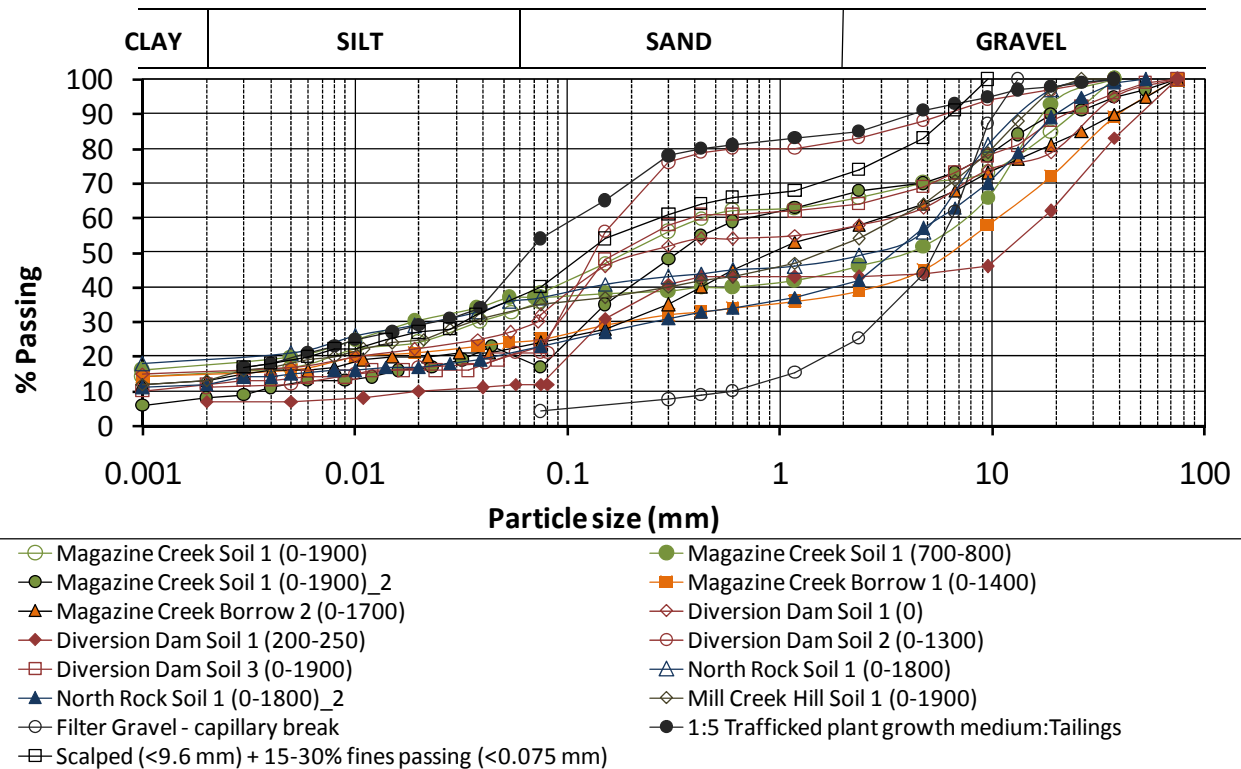


Figure 3.29 Quarries summary of particle size distribution analysis

The particle size distribution analysis, saturated hydraulic conductivity, porosity and specific gravity were used to develop the soil water characteristic curves used in the model presented in Chapter 5.

c. Emerson aggregate test

Emerson aggregate testing was completed by Douglas Partners Consulting and ALS laboratories. The full results are presented as Appendix B. All quarry plant growth medium and clay samples are classified as non dispersive.

3.5 Summary of investigation

3.5.1 Old tailings storage facility

pH and EC were measured in the field and found that the pH of the cover and tailings on the Old TSF has dropped from circum neutral conditions to mildly acidic (4-6) in the past 30 years. Over the same period EC concentration has remained low indicating that Fe, Cu, Mn and SO_4^{-2} have not been released from acid rock drainage.

Acid base accounting was completed on samples (cover and tailings) taken from the Old TSF. The results indicate that the cover plant growth medium has some potential to be PAF and create acid rock drainage, with NAPP values typically ranging between 0-5 kg H₂SO₄⁻²/t. In one instance a single sample of plant growth medium had a NAPP that exceeded the typical range. The results also showed that the top 0.5 m of the tailings is oxidised, is not PAF, and has excess ANC. The results indicate that the top 0.5 m of the tailings could be blended with the plant growth medium, which is believed to be trafficked plant growth medium, to make a suitable substitute for the RPL in the event that the volume of clay within the cover is not sufficient to build a new RPL on either the Old TSF or HLEP#2. Blending waste rock and tailings to create an RPL has been successfully trialled at other mines (Rohde et al 2011).

Laboratory analysis was completed for total and water extract soluble constituents (Cu, Cd, Co, Cr, Fe, Mn, Ni and Zn). The following trends are evident from the 30 year old cover:

- Cu concentration has increased in the cover as a result of capillary rise;
- Cd, Co, Cr concentrations have decreased in the cover as a result of leaching;
- Fe concentrations have increased in the cover, possible in response to capillary rise, but are comparable to concentrations in quarries plant growth medium and clay;
- Mn, Ni and Zn concentrations have remained unchanged;
- All constituent concentrations have remained below HIL C with the exception of one instance for Co in the tailings.

The CEC capacity of the cover is dominated by Ca and Mg and would not limit the potential use of the cover as borrow soil and rock (plant growth medium and bridging layer/capillary break) and clay (RPL) for a new cover.

The cover is suitable as borrow soil and rock (plant growth medium and bridging layer/capillary break) and clay (RPL) for the RPL for the new cover for the Old TSF and HLEP#2, noting that the preferred option for HLEP#2 is to relocate the waste rock and ore because of the constraints to placing a cover on the domain at its current location.

The new cover will require a bridging layer/capillary break to limit the potential for capillary rise of constituents (Cu and Fe) into the new cover.

3.5.2 Quarries

pH and EC were measured in the field and found that the pH of the quarries plant growth medium and clay is mildly acidic (4.5-6.5). EC concentrations are very low indicating that Fe, Cu, Mn and SO₄⁻² are not being released as acid rock drainage.

Acid base accounting was completed on samples of plant growth medium and clay taken from the quarries. All samples are considered to be NAF (NAPP approximately equal to 0 kg H₂SO₄⁻²/t), with the exception of three samples from Magazine Creek which had some PAF potential (NAPP >0 kg H₂SO₄⁻²/t, <5 kg H₂SO₄⁻²/t).

Laboratory analysis was completed for total and water extract soluble constituents (Cu, Cd, Co, Cr, Fe, Mn, Ni and Zn):

- Cu, Co, Mn and Zn concentrations are less than the concentrations in the Old TSF cover and are less than the HIL; and
- Cd, Cr, Fe and Ni concentrations are comparable to the Old TSF cover and is less than the HIL.

The CEC capacity of the cover is dominated by Ca and Mg and would not limit the potential use of the cover as borrow soil and rock (plant growth medium and bridging layer/capillary break) and clay (RPL) for a new cover.

The quarries plant growth medium and clay is suitable to be used as an RPL or plant growth medium for the new cover for the Old TSF and HLEP#2, noting that the preferred option for HLEP#2 is to relocate the waste rock and ore because of the constraints to placing a cover on the domain at its current location.

The new cover will require a bridging layer/capillary break to limit the potential for capillary rise of constituents (Cu and Fe) into the new cover.

4 Cover options

The following new cover options have been developed for the Old TSF and HLEP#2 based from the review and field investigation.

4.1 Option 1: 200 cm plant growth medium with no reduced permeability layer

Field description of soil profiles at the quarries (Appendix D) indicates that undisturbed soils range in depth from 30 cm to approximately 170 cm. The cover on the Old TSF is approximately 90 cm deep. Review of the cover has shown that the cover does not appear to have limited infiltration (described in section 2.2.3).

The base case cover option, Option 1: 200 cm plant growth medium with no reduced permeability layer (Option 1) for the Old TSF and HLEP#2 is therefore a 200 cm cover of plant growth medium sourced from North Rock Quarry. As discussed in section 3.1, North Rock Quarry is the preferred location to source plant growth medium because it is in close proximity to the Old TSF and HLEP#2.

4.2 Option 2a: 200 cm plant growth medium with a 50 cm reduced permeability layer

Field description of soil profiles at the mine (Appendix D) indicates that undisturbed soils typically have a weathered rock horizon beneath the plant growth medium. The weathered horizon is competent and acts as a low permeability layer.

It will not be practical to compact a layer of rock at the base of the plant growth medium layer. A RPL of compacted clay has been shown to be effective at restricting the infiltration of rainfall at other mines (described in section 2.1.1). Water conditioning of the clay for the RPL will be completed using a Pug Mill.

Option 2a: 200 cm plant growth medium with a 50 cm reduced permeability layer (Option 2a) for the Old TSF and HLEP#2 is therefore a 200 cm cover of plant growth medium underlain by 50 cm of compacted clay RPL. The plant growth medium will be sourced from North Rock Quarry. Clay will be sourced by harvesting the compacted clay layer in the Old TSF cover, the balance of clay will come from North Rock Quarry.

4.3 Option 2b: 200 cm plant growth medium with a 50 cm reduced permeability layer and 60 cm bridging layer/capillary break

After construction of the cover the tailings underwent further consolidation resulting in differential settlement of the surface that resulted in ponding of water. Water ponding compromised the ability of the cover to limit infiltration of rainfall and percolation into the underlying tailings (described in section 2.2.3).

The new cover will require a bridging layer directly above the tailings so that the new cover can be built on top of a solid platform that will not undergo further settlement. Further, the cover on the Old TSF has had constituents accumulate (Cu and Fe) over the past 30 years due to capillary rise (described in section 3.4.1).

Option 2b: 200 cm plant growth medium with a 50 cm reduced permeability layer and 60 cm bridging layer/capillary break (Option 2b) for the Old TSF and HLEP#2 is therefore a 200 cm cover of plant growth medium underlain by 50 cm of compacted clay RPL plus a 60 cm layer of gap graded clean rock directly above the tailings or heap leach ore and waste rock to act as a bridging layer and a bridging layer/capillary break.

Water conditioning of the clay for the RPL will be completed using a Pug Mill.

The bridging layer will be created by screening and possible crushing gravel and small boulders from plant growth medium from North Rock Quarry. The bridging layer/capillary break will be designed as a rock filter to prevent fines from washing into it and clogging it over time.

4.4 Option 3: 200 cm plant growth medium 50 cm 1:5 trafficked plant growth medium and tailings reduced permeability layer and 60 cm bridging layer/capillary break

Option 3: 200 cm plant growth medium 50 cm 1:5 trafficked plant growth medium and tailings reduced permeability layer and 60 cm bridging layer/capillary break (Option 3) is designed to provide an alternative in case clay is in short supply to cover the Old TSF and HLEP#2. Tailings can be harvested from the top 50 cm of the Old TSF prior to building the new cover. The tailings in the top 50 cm of the Old TSF are NAF and have excess ANC (described in section 3.4.1) and can therefore be blended with the trafficked plant growth medium, which may be PAF, from the Old TSF cover to create a 1:5 trafficked plant growth medium to tailings mixture that will be NAF for the RPL in the new cover.

Blending waste rock and tailings to create an RPL has been successfully trialled at other mines (Rohde et al 2011).

Option 3 for the Old TSF and HLEP#2 is therefore a 200 cm cover of plant growth medium underlain by 50 cm of compacted 1:5 trafficked plant growth medium and tailings blend RPL. Blending and water conditioning will be completed using a Pug Mill. Under the RPL there will be a 60 cm layer of gap graded clean rock directly above the tailings or heap leach ore and waste rock to act as a bridging layer and a bridging layer/capillary break.

The bridging layer will be created by screening and possible crushing gravel and small boulders from plant growth medium from North Rock Quarry. The bridging layer/capillary break will be designed as a rock filter to prevent fines from washing into it and clogging it over time.

4.5 Option 4: 200 cm plant growth medium 50 cm scalped (<9.6 mm) plus 15-30% fines passing (<0.075 mm) reduced permeability layer and 60 cm bridging layer/capillary break

Option 4: 200 cm plant growth medium 50 cm scalped (<9.6 mm) plus 15-30% fines passing (<0.075 mm) reduced permeability layer and 60 cm bridging layer/capillary break (Option 4) is designed to provide an alternative in case clay is in short supply to cover the Old TSF and HLEP#2 and can be used in the unlikely event that tailings and trafficked plant growth medium cannot be practically harvested from the Old TSF.

Adding additional fines to improve the compaction, thereby improving the restrictive nature of the RPL has been demonstrated at other mines (yet to be published results from Century Mine).

Option 4 for the Old TSF and HLEP#2 is therefore a 200 cm cover of plant growth medium underlain by 50 cm RPL of compacted scalped plant growth medium (<9.6 mm) plus 15-30% fines passing the 0.075 mm screen RPL. Underneath the RPL there will be a 60 cm layer of gap graded clean rock directly above the tailings or heap leach ore and waste rock to act as a bridging layer and a bridging layer/capillary break.

The scalped plant growth medium with added fines will be created by screening plant growth medium harvested from North Rock Quarry. Blending and water conditioning will be completed using a Pug Mill.

The bridging layer will be created by screening and possible crushing gravel and small boulders from plant growth medium from North Rock Quarry. The bridging layer/capillary break will be designed as a rock filter to prevent fines from washing into it and clogging it over time.

From a constructability standpoint, this is the least desirable cover option because of extra material handling requirements to screen, crush, water condition and place.

5 Cover modelling

5.1 Introduction

The cover options have been modelled using Vadose/w (the model) developed by Geoslope International which is a finite element model that simulates water transport through saturated and unsaturated soil. Derivations for saturated and unsaturated water transport can be found in *Vadose Zone Modelling with VADOSE/W* (Geoslope 2012). The program iterates the Darcy's and Fick's law equations to balance pressure and head at each node in each specified time step. A node is a user identified point in the cover sequence at which the model solves the equations to generate a solution. The model will account for the following factors:

- rainfall;
- evaporation;
- transpiration;
- water storage in soil and rock pores; and
- seepage.

5.1.1 Assumptions

Model assumptions are based on the field investigation results, including:

- the model is one dimensional and calculates the upward and downward movement of rainfall infiltration in the cover, it assumes no surface run off, but will allow for lateral flow of water below the surface of the cover;
- there is no run-on to either the Old TSF or HLEP#2 from the surrounding catchment;
- the Old TSF increases in depth from the southern embankment to the northern embankment, to a maximum depth of 27 m. The water table occurs at same depth under the Old TSF which is assumed to be 40 m; and
- HLEP#2 is similar in depth to the Old TSF, and it is assumed that the water table also occurs at a similar depth.

5.2 Model set up

5.2.1 Covers

The cover options are described in chapter 4 along with justification for choosing each cover option as well as a basic description for how each cover will be constructed on the Old TSF and HLEP#2. Noting that building a cover on HLEP#2 is not the preferred rehabilitation strategy of that domain, the preferred option for HLEP#2 is to relocate the waste rock and ore because of the constraints to placing a cover on the domain at its current location.

5.2.2 Model dimensions

The cover model has plan area dimensions of 1 x 1 m. The tailings in the Old TSF and waste rock and ore in HLEP#2 were modelled at a nominal 40 m thickness. The overall height of the model varied, depending on whether the cover included a RPL and/or bridging layer/capillary break.

5.2.3 Mesh geometry

The best shaped mesh elements for finite element analysis is squares or equilateral triangles. Slight derivations from these shapes, for example, rectangles are also acceptable, but these derivations should not be used in critical layers of the model. For this model, square elements and rectangle elements were used. Square elements were used in critical layers of the model including the plant growth medium, RPL and bridging layer/capillary break. Rectangle elements were used in less critical layers of the model ie the tailings in the Old TSF or ore and waste rock in HLEP#2, to reduce the computation time required to run each model.

5.2.4 Initial conditions

i Cover physical attributes

The initial water content conditions for the layers of the covers were taken based on laboratory analysis. The initial conditions for the plant growth medium, RPL, bridging layer/capillary break and tailings is presented as Table 3.4 and Table 3.6 for the Old TSF and Quarries borrow soil and rock (plant growth medium and bridging layer/capillary break) and clay (RPL) respectively including the two RPL mixtures.

The base of the model was set as a water table condition, in line with the assumptions described in this chapter.

a. Soil water characteristic curves

The model requires soil water characteristic curves. A soil water characteristic curve is the relationship between pore water and matric suction for a profile.

The computer program *Soilvision* was used using the soil index characteristics described in Table 3.4 and Table 3.6 and particle size distributions shown in Figure 3.19 and Figure 3.29 for the Old TSF and quarries borrow soil and rock (plant growth medium and bridging layer/capillary break) and clay (RPL) respectively to estimate the soil water characteristic curves (Fredlund and Xing 1994). The soil water characteristic curves for Old TSF borrow soil and rock (plant growth medium) and clay (RPL) is shown in Figure 5.1. The soil water characteristic curves for the Quarries borrow soil and rock (plant growth medium and bridging layer/capillary break) and clay/mixtures (RPL) is shown in Figure 5.2.

Notes on how to interpret a soil water characteristic curve have been attached as Appendix F.

b. Unsaturated hydraulic conductivity curves

Hydraulic conductivity is the ability of soil and rock (plant growth medium and bridging layer/capillary break) and clay/mixtures (RPL) to transmit water through its pore matrix and is defined in terms of velocity. The model derives the unsaturated hydraulic conductivity curves using the soil index characteristics described in Table 3.4 and Table 3.6 and the soil water characteristic curves presented as Figure 5.1 and Figure 5.2 for the Old TSF and quarries borrow soil and rock (plant growth medium and bridging layer/capillary break) and clay (RPL) respectively.

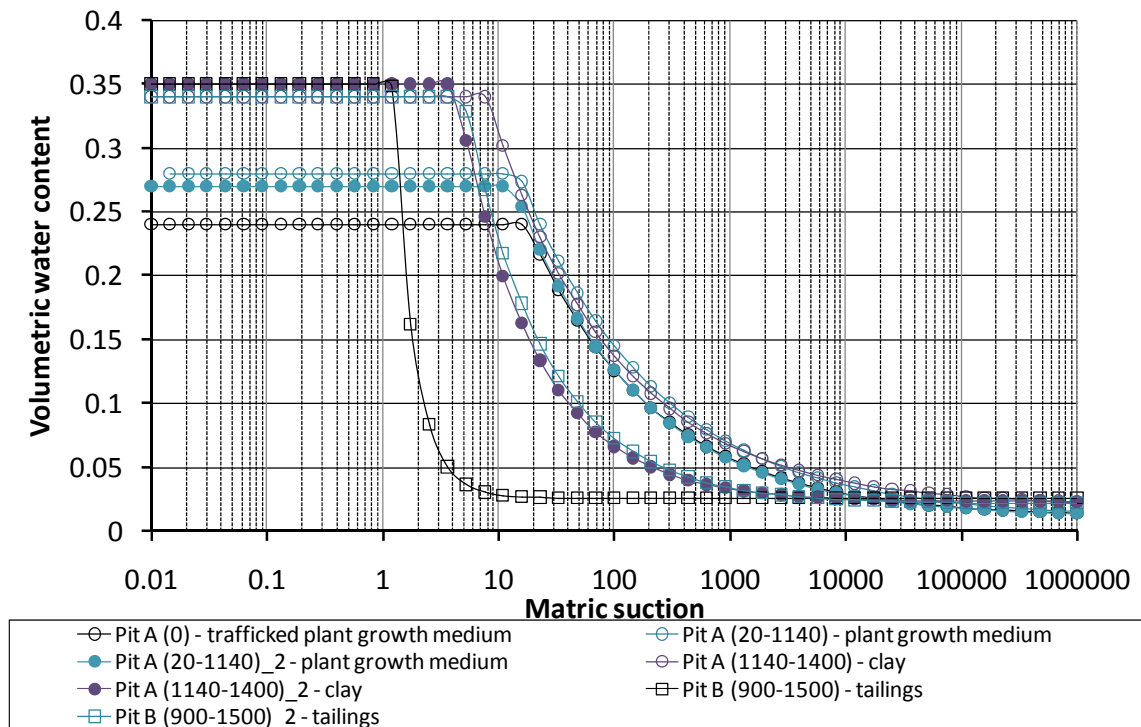


Figure 5.1 Old TSF soil water characteristic curves for borrow soil and rock (plant growth medium) and clay (RPL)

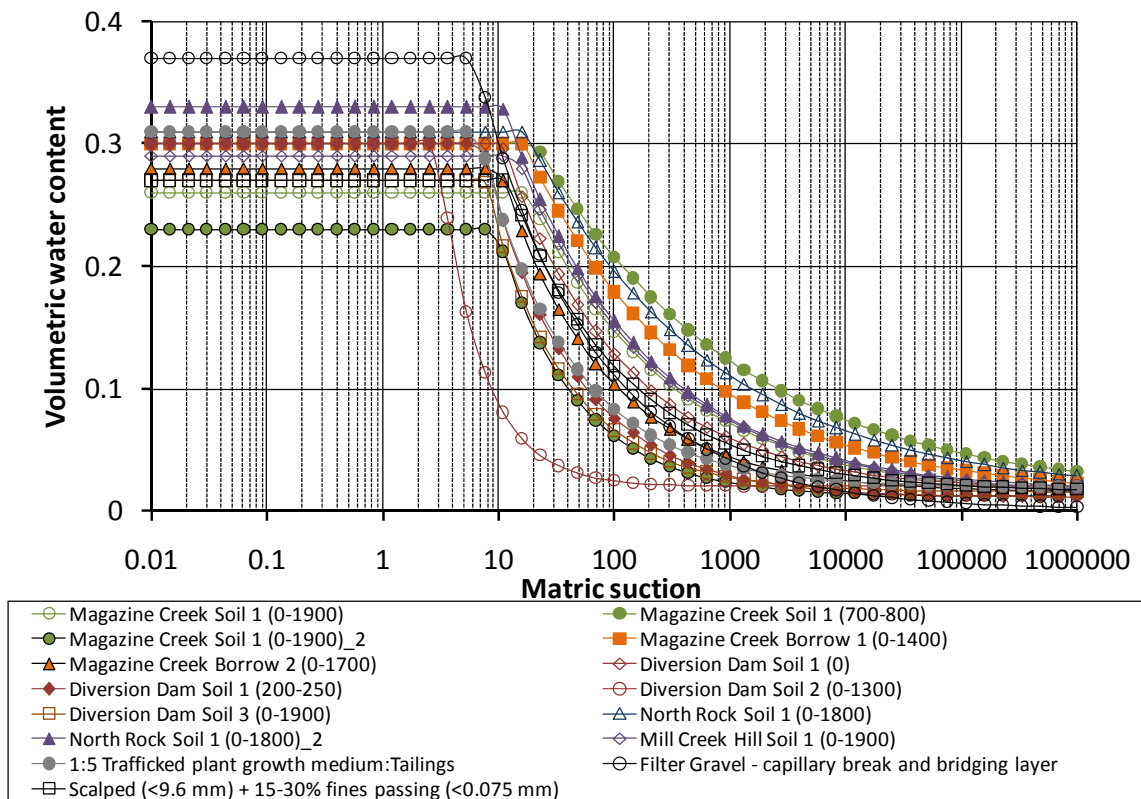


Figure 5.2 Quarries soil water characteristic curves for borrow soil and rock (plant growth medium and bridging layer/capillary break) and clay (RPL)

Figure 5.3 shows which soil water characteristic curves from Figure 5.1 and Figure 5.2 were used in the cover option models.

Depth	Option 1	Option 2a	Option 2b	Option 3	Option 4
200 cm	Plant growth medium ¹	Plant growth medium ¹	Plant growth medium ¹	Plant growth medium ¹	Plant growth medium ¹
50 cm	None	RPL – clay ²	RPL – clay ²	RPL – 1:5 trafficked plant growth medium: Tailings ³	RPL - scalped (<9.6 mm) plus 15-30% fines passing (<0.075 mm) RPL and 60 cm bridging layer/capillary break ⁴
60 cm	None	none	Capillary break/bridging layer ⁵	Capillary break/bridging layer ⁵	Capillary break/bridging layer ⁵

Notes: ¹used soil water characteristic curve for North Rock Soil 1.

²used soil water characteristic curve for Pit A (1140-1400) – clay and Pit A (1140-1400), 2 – clay.

³used soil water characteristic curve for 1:5 Trafficked plant growth medium: Tailings.

⁴used soil water characteristic curve for scalped (<9.6 mm) + 15-30% fines passing (<0.075 mm).

⁵used soil water characteristic curve for Filter gravel – capillary break and bridging layer.

Figure 5.3 Soil water characteristic curves used in the models

ii Climate

A climate record was applied to each cover and the water flux of each node assessed in the model. The climate data was applied for the past 100 year period (1915 to 2015). The 100 year data set has been developed from the Bureau of Meteorology SILO data drill (<https://www.longpaddock.qld.gov.au/silo/>).

For the cover options, a climate record was applied and the water flux of each node assessed.

Rainfall intensity is estimated within the model by the following assumptions:

- rainfall is a sinusoid distribution; and
- rainfall may occur between 6 am and 6 pm daily. This is a simplified view of what is actually occurring in nature. The assumption however is believed to be appropriate for conceptual level of modelling.

The model solves for estimated net solar radiation using the climate data and estimated net solar radiation. Net solar radiation is solved based on latitude (-20.6 for Mt Gordon mine) and time of year as well as internally calculated ground surface albedo.

The model was run assuming that the construction of the cover would finish directly before a wet season. Therefore the cover immediately undergoes wetting up by a wet season followed by a subsequent dry season and so forth over a 100 year period.

The annual 100 year daily rainfall record is shown in Figure 5.4 and Figure 5.5. The Annual Exceedance Probability (AEP) reported by GHD (2015) is shown on the graphs.

In general 1-50 years is drier than 50-100 years and 50-100 years experienced a number of significant rainfall events ie 50%, 20% and 5% AEPs.

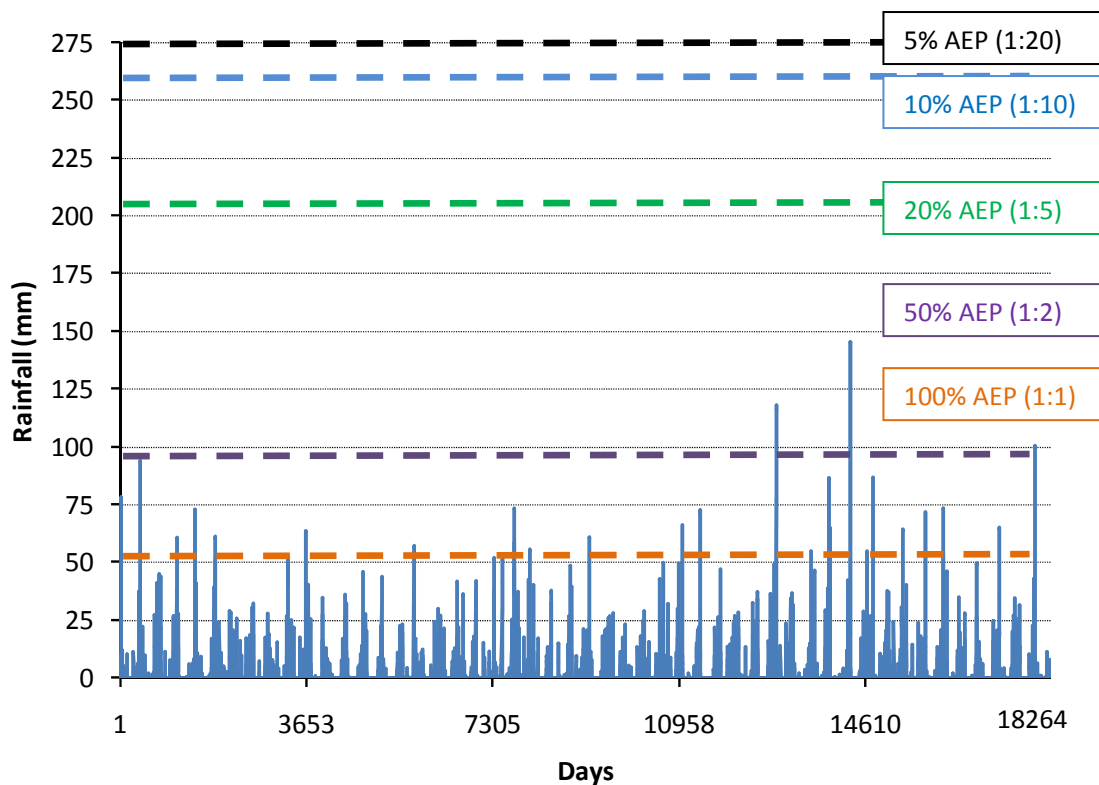


Figure 5.4 Rainfall (1-50 years)

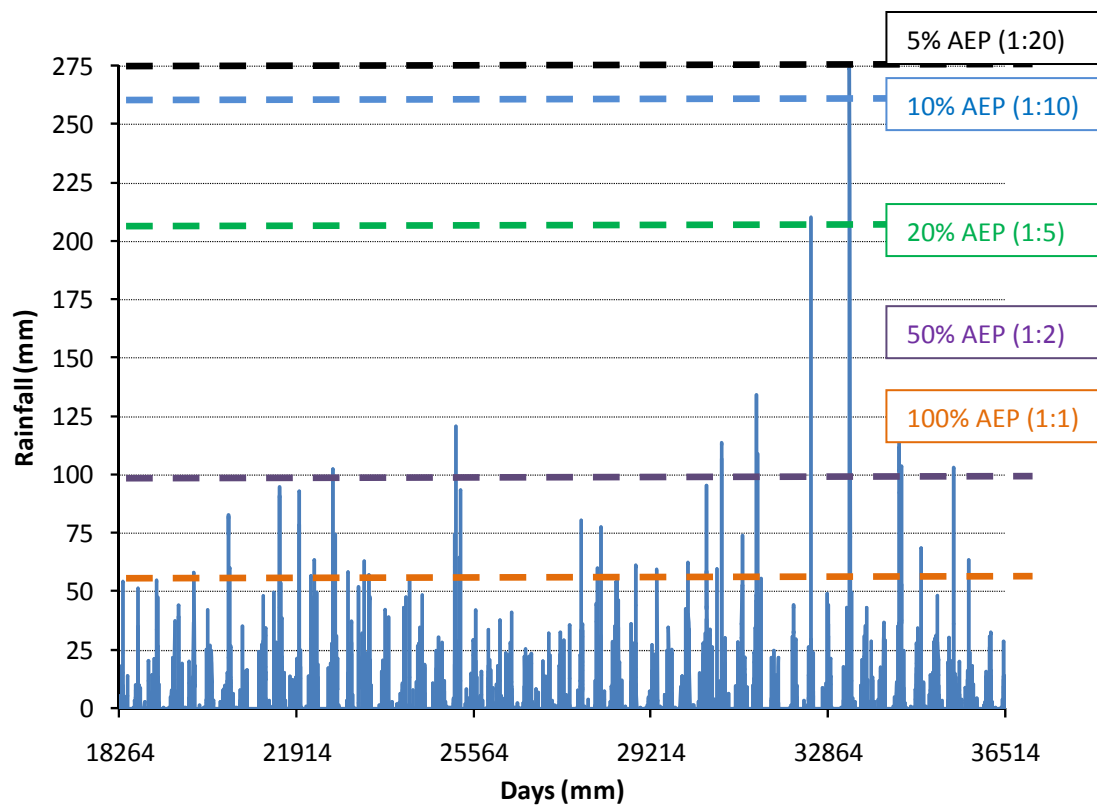


Figure 5.5 Rainfall (50-100 years)

5.2.5 Evaluation period

The cover option models were evaluated for different time periods as follows:

- Option 1 was only run for a 50 year period. The purpose of the model was to evaluate the steady state seepage rate (as a percentage of cumulative rainfall) for a plant growth medium without a RPL. The model reached a steady state by 50 years, and was terminated at this point;
- Option 2a was also only run for 50 years. The purpose of the model was to evaluate the effectiveness of an RPL against the base case, which was Option 1. The model was terminated at 50 years, at that point the seepage rate (as a percentage of cumulative rainfall) had reached a steady state;
- Option 2b was run for a 100 year period. The field investigation and review identified the need for a running layer and bridging layer/capillary break at the base of the cover to provide a stable platform for machine traffic and to prevent the capillary rise of constituents back into the cover. Option 2b was considered to be the base case, and the most desirable, because most soil and rock (plant growth medium), clay (RPL) and rock (bridging layer/capillary break) can be harvested directly from the Old TSF to cover. The purpose of running the model for a longer period was to determine the effectiveness of the cover over a more diverse series of rainfalls;

- Option 3 was run for a 100 year period. It should be noted that it is not the preferred strategy to cover HLEP#2 with a cover, the preferred option for HLEP#2 is to relocate the waste rock and ore because of the constraints to placing a cover on the domain at its current location. However, if a cover is required then using the tailings as a quarry to provide suitable cover material for the Old TSF and HLEP#2 is a viable option. Using tailings as part of the cover also addresses the additional volume requirement described in section 3.2.1; and
- Option 4 was run for a 100 year period. This option was evaluated as an alternative to Option 3. From a constructability standpoint, this is the least desirable cover option because of extra material handling requirements to screen, crush, water condition and place.

5.2.6 Runoff

The model is one dimensional and calculates the upwards and downwards movement of infiltration in the cover plus the downward movement of percolation once it has moved beyond the depth that it can be removed by either evaporation or plant transpiration. The model does not allow for surface run off ie any rainfall that lands on the cover either ponds, infiltrates or is evaporated. The model does not include surface run-on in line with the assumptions described in this chapter.

While the model does not allow for surface run off it will allow lateral flow of water beneath the surface of the cover. For example if there is excess infiltration above the RPL then water may move horizontally along the RPL surface.

5.2.7 Vegetation

The model has been run on the basis that vegetation will establish over a five year period:

- year 1 – vegetation will cover 10% of the cover and therefore evapotranspiration is 10% of the maximum;
- year 2– vegetation will cover 30% of the cover and therefore evapotranspiration is 30% of the maximum;
- year 3– vegetation will cover 50% of the cover and therefore evapotranspiration is 60% of the maximum;
- year 4– vegetation will cover 80% of the cover and therefore evapotranspiration is 70% of the maximum; and
- year 5– vegetation will cover 100% of the cover and therefore evapotranspiration is 80% of the maximum.

Note that it is assumed that 100% vegetation will never result in an evapotranspiration rate greater than 80%.

The cover performance without a vegetation cover was not modelled for any of the options because it is an important part of the cover. Without vegetation the cover will not meet its design standard and secondly a cover without vegetation will not be safe, stable, sustainable and non-polluting and therefore would be unacceptable to EHP and other stakeholders.

5.3 Evaluation of cover options

The evaluation of the cover options is presented as a range by running each cover option model for two scenarios:

1. assuming the 'best case scenario' that is cover is built to a design standard so that the physical properties of the cover closely match the physical characterisation results presented in Appendix B and summarised in Table 3.4 and Table 3.6 for the Old TSF and quarries borrow soil and rock (plant growth medium and bridging layer/capillary break) and clay (RPL) respectively; and
2. assuming that the design standard for the RPL is not met and that as a result the saturated hydraulic conductivity of the RPL increases by two orders of magnitude ie it becomes more permeable (Table 5.1). The RPL may also fail because it became desiccated resulting in preferential flow paths through cracks in the layer.

Table 5.1 summarises how the RPL saturated hydraulic conductivity was adjusted between model runs.

Table 5.1 Summary of changes to saturated hydraulic conductivity in the RPL

Option	RPL	Saturated hydraulic conductivity measured in the laboratory	Saturated hydraulic conductivity in the model as a result of design standard not being met
	Units	(m/sec)	(m/sec)
2a and 2b	Clay	2.00E-09	2.00E-07
3	1:5 Trafficked plant growth medium:Tailings	3.00E-10	3.00E-8
4	Scalped (<9.6 mm) + 15-30% fines passing (<0.075 mm)	1.00E-09	1.00E-7

The result of the cover is independent of whether the model is run for the Old TSF or HLEP#2 because the model column height is set so that the model can account for the effect of the water table on initial conditions. In both models the water table depth was set at 40 m bgl therefore the cover performance and measurement of volumetric water content and seepage arrives at the same result for both domains. The following results are presented as a single set of consolidated results for both the Old TSF and HLEP#2 noting that the preferred rehabilitation strategy for HLEP#2 is to relocate the waste rock and ore because of the constraints to placing a cover on the domain at its current location.

5.3.1 Option 1: 200 cm plant growth medium with no reduced permeability layer

The Option 1 model was only run for a 50 year period. The purpose of the model was to evaluate the cover of plant growth medium without a RPL. The model is representative of a thick soil profile which was noted at the mine during the field investigation. The model reached a steady state by 50 years, and was terminated at this point.

The volumetric water response of the cover is shown in Figure 5.6. As would be expected the near surface layer of plant growth medium (30 cm bgl) shows a highly variable response to rainfall. The near surface layer reaches a degree of saturation (S) equal to 1 (near saturation) almost every wet season, followed by a period of drying resulting in a residual S equal to approximately 0.33 at the end of each dry season. Most stored infiltration in the near surface layer is removed from the plant growth medium as vegetation transpiration or evaporation at the ground surface, because the model assumes ponding will occur ie no surface runoff. Some stored infiltration infiltrates further into the plant growth medium layer.

The middle of the plant growth medium layer (100 cm bgl) reaches a S approximately equal to 1 during the wet seasons because some stored infiltration from the near surface layer continues to infiltrate. The frequency of reaching near saturated conditions is less frequent by comparison to the near surface layer. The lower frequency of near saturated conditions is a result of rainfall being removed before it can infiltrate further into the plant growth medium. Stored infiltration in the middle of the plant growth medium layer is largely being removed by plant transpiration and evaporation at the ground surface; noting, that combined effect of plant transpiration and evaporation (evapotranspiration) is least pronounced in years one to four. After this time it is assumed that it will never be greater than 80% of the maximum. The residual S in the middle of the plant growth medium is greater than the layer of above (30 cm bgl) and below (200 cm bgl) indicating that there is more stored infiltration at this depth available to vegetation. Stored infiltration not removed by vegetation continues to infiltrate towards the base of the plant growth medium layer (200 cm bgl). Once infiltration percolates into the tailings it is assumed that it can no longer be removed by vegetation transpiration or evaporation and it becomes seepage.

The base of the plant growth medium layer reaches a S approximately equal to 1 less frequently; however, the period of drying after each wetting period is most pronounced by comparison to the near surface layer. This is because the removal of stored infiltration as plant transpiration is least pronounced at depth, as a result some infiltration percolates into the tailings and becomes seepage. The residual S at the base of the plant growth medium layer (S approximately equal to 0.42) is less than the plant growth medium layer above it (S approximately equal to 0.57) suggesting that infiltration is preferentially seeping from the cover rather than being held in storage and removed by vegetation transpiration.

Potential seepage from the cover is shown in Figure 5.7. The model shows that the potential evapotranspiration effect is greatest in the first five years, during the period that vegetation is establishing. After this time the volume of infiltration that reaches the base of the plant growth medium layer and become seepage is near constant resulting in a steady state percolation rate of 1% of cumulative rainfall. The effect of removing vegetation from the model would likely increase the potential seepage rate by one of order of magnitude, putting it in the range of 10%.

Australian experience with similar covers has typically restricted infiltration to less than 10% of annual rainfall. At Kidston Mine (Williams et al 2003) the cover restricted infiltration to less than 1.5%. At Mt Whaleback Mine the cover restricted infiltration to between 5-13% (O’Kane and Waters 2003). At Cadia Mine (Rohde et al 2011) the cover restricted infiltration to less than 3%. Finally the covers at Century Mine (Defferrard et al) have restricted infiltration between 2-11% and averaged 5%.

While the model indicates the cover may be acceptable by comparison to other Australian covers, any decrease in cover performance, because of poor vegetation establishment, would limit the effectiveness of the cover without an RPL.

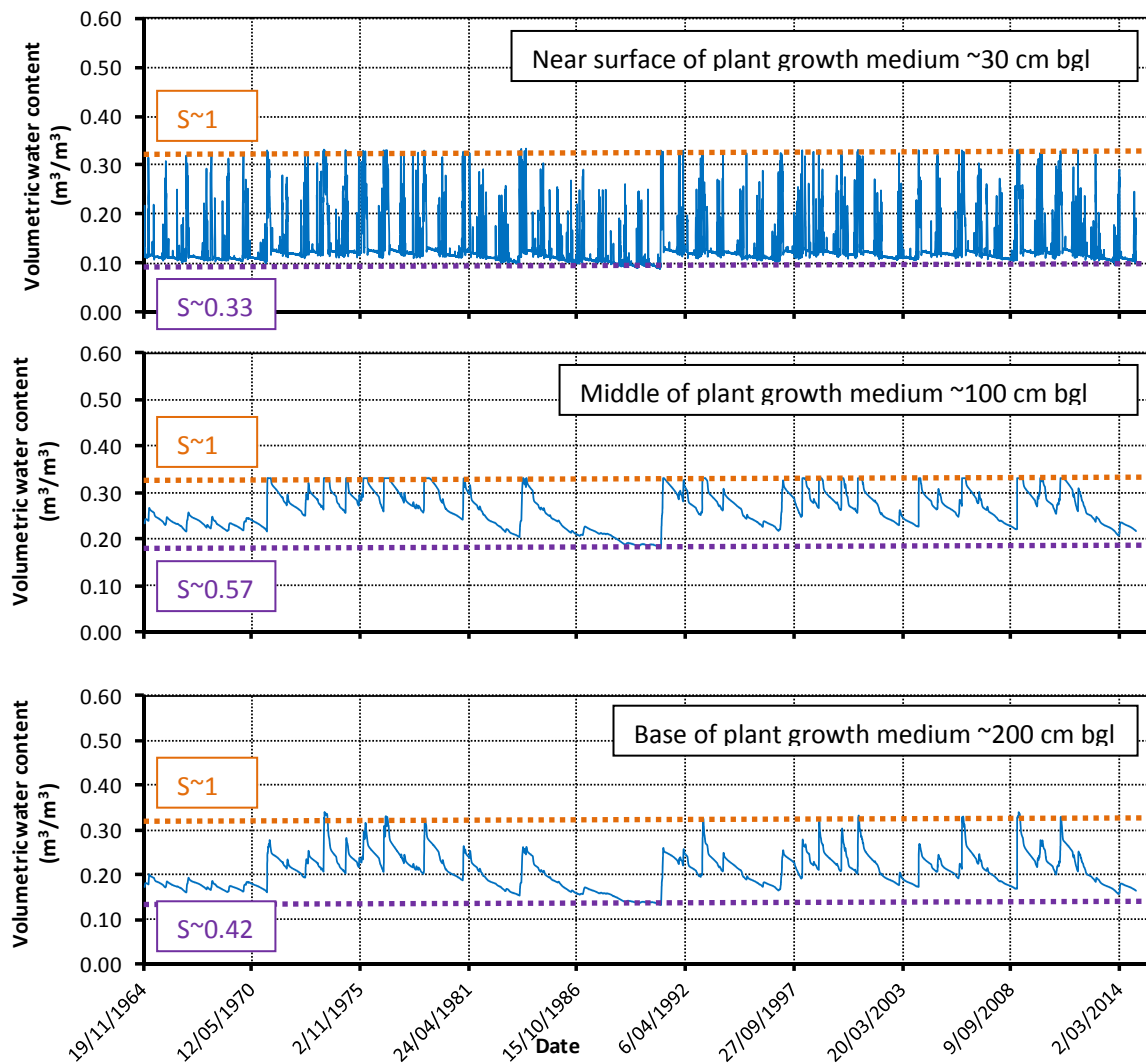


Figure 5.6 Option 1: 200 cm plant growth medium with no reduced permeability layer volumetric water content versus time

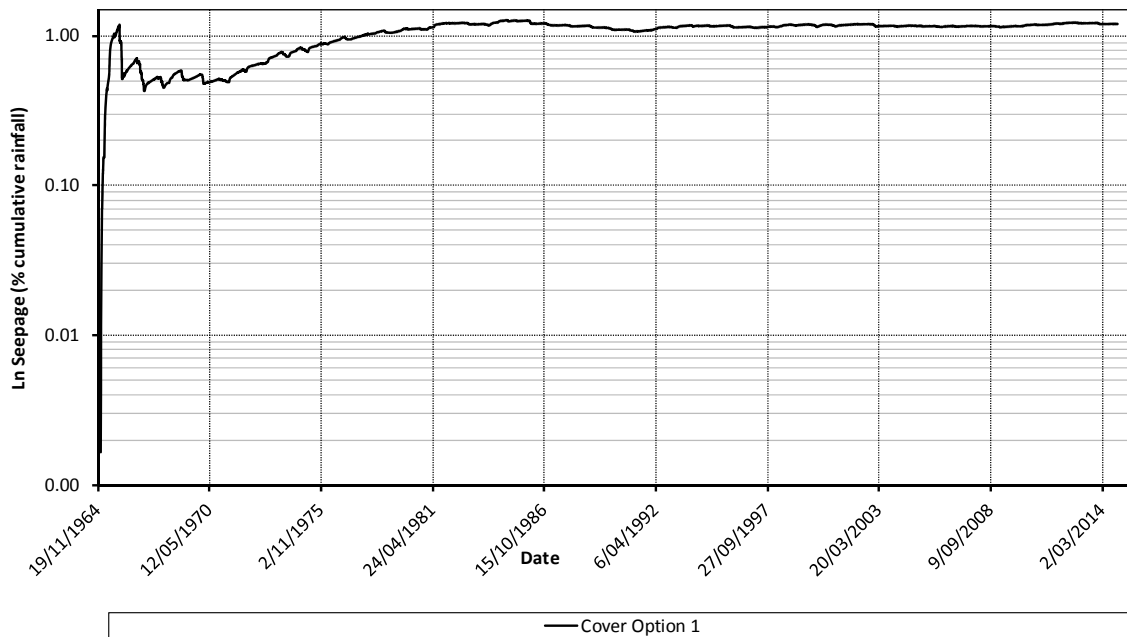


Figure 5.7 **Option 1: 200 cm plant growth medium with no reduced permeability layer volumetric seepage versus time**

5.3.2 Option 2a: 200 cm plant growth medium with a 50 cm reduced permeability layer

The Option 2a model was run for a 50 year period. Running the model for a 50 year period is comparable to the model output for Option 1.

The purpose of the model was to build upon Option 1 and evaluate the cover of plant growth medium with the addition of an RPL. The model is representative of a thick soil profile which was noted at the mine during the field investigation with a RPL which is an analogue for a weathered rock horizon (also noted in soil profiles).

The model set up is different to the model for Option 1 because the model results are presented as a range based on the assumption that the cover performance could be compromised by a failure of the RPL. The RPL may fail because of either development of preferential flow paths or because the RPL did not meet its initial design standard (section 5.3).

The volumetric water response of the cover is shown in Figure 5.8. As would be expected the near surface plant growth medium layer (30 cm bgl) shows a highly variable response to rainfall. The near surface layer reaches a S equal to 1 (near saturation) almost every wet season, followed by a period of drying resulting in a residual S equal to approximately 0.3 at the end of each dry season. Most stored infiltration in the near surface layer is removed from the plant growth medium as vegetation transpiration or evaporation at the ground surface.

The base of the plant growth medium layer (200 cm bgl) reaches a S approximately equal to 1 less frequently by comparison to the near surface layer; further, the period of drying after each wetting period is more pronounced. This is because the removal of stored infiltration as plant transpiration is least pronounced at depth, as a result some infiltration percolates into the RPL and eventually becomes seepage. The residual S at the base of the plant growth medium layer (S approximately equal to 0.36) is greater than the plant growth medium layer above it (S approximately equal to 0.3) suggesting that infiltration is being held up in the plant growth medium layer for longer, by comparison to Option 1, rather than contributing entirely to seepage.

The base of the RPL (250 cm bgl) is showing less frequent wetting up and drying out by comparison to the plant growth medium layer above it. As expected the frequency of wetting up and drying in response to wetting and drying of the plant growth medium above is less pronounced because most infiltration is removed as vegetation transpiration or evaporation at the ground surface before it has a chance to infiltrate into the RPL. None the less the RPL is undergoing wetting from infiltration and drying due to seepage into the underlying tailings. The frequency of wetting and drying is greatest when the RPL is more permeable. Wetting of the RPL is required so that the layer does not become desiccated and give rise to preferential flow paths; however, under more permeable conditions it is likely that seepage is greater, due to the reduced function of the RPL.

Potential seepage from the cover is shown in Figure 5.9. The model shows that the potential evapotranspiration effect is greatest for up to the first nine years depending on the permeability of the RPL. After this time the volume of infiltration that reaches the base of the RPL and becomes seepage is near constant resulting in a steady state percolation rate of up to approximately 1% of cumulative rainfall. The effect of removing vegetation from the model would likely increase the potential seepage rate by one of order of magnitude, putting it in the range of 10%.

The maximum seepage rate from a more permeable RPL results in a seepage rate that is not better than the base case, Option 1. The analysis shows that the construction method and quality control are critical to the overall performance potential of Option 2a.

While the model indicates the cover may be acceptable by comparison to other Australian covers, any decrease in cover performance, because of poor vegetation establishment or reduced performance of the RPL, would limit the effectiveness of the cover. The model shows that the cover will deliver sufficient infiltration to a RPL to keep it hydrated, so that it does not dry out, and performs optimally. Drying of a RPL leads to preferential flow paths, due to cracks, which would increase the seepage potential. The RPL may also fail because it was not built to a design standard (section 5.3).

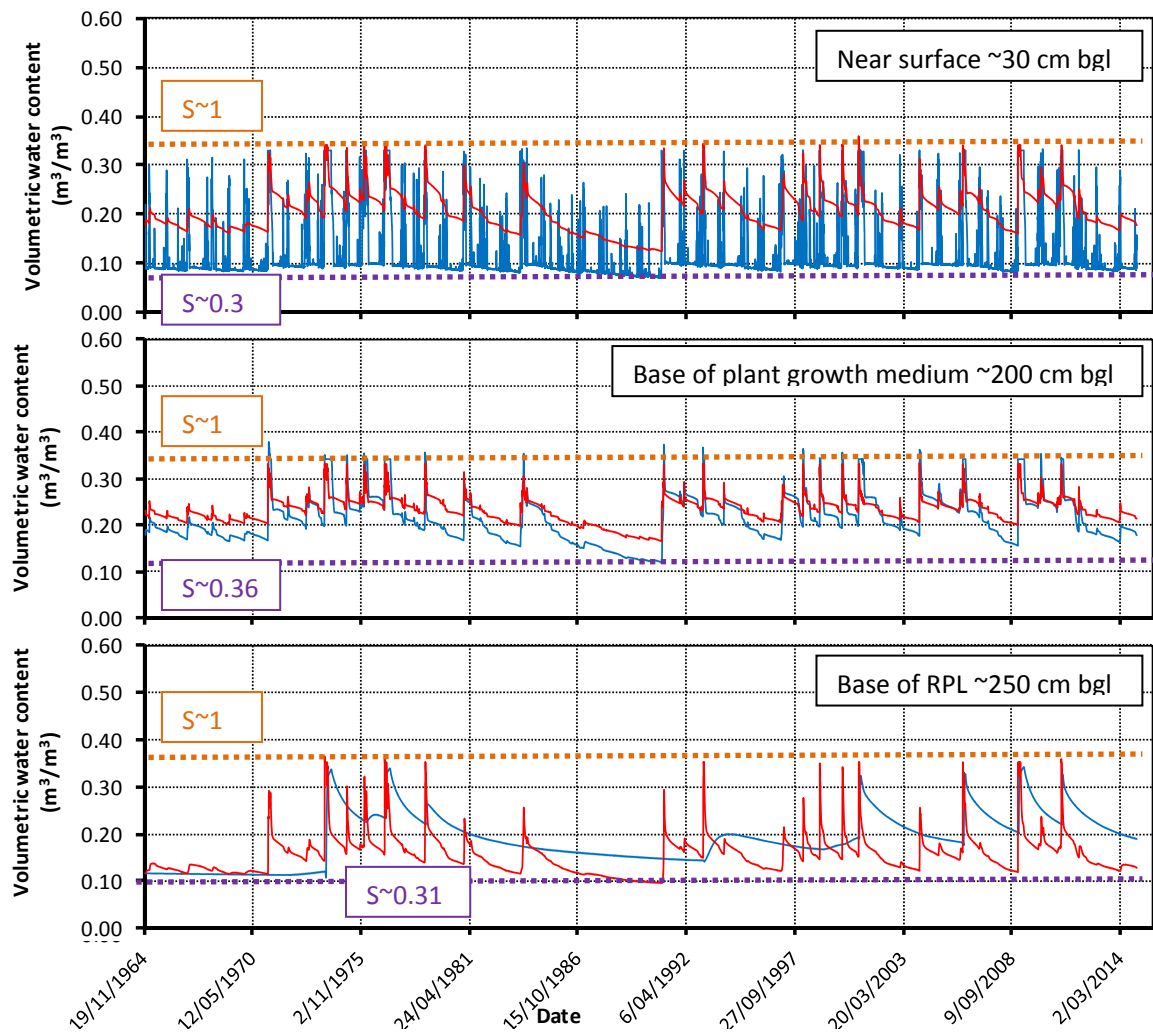


Figure 5.8 Option 2a: 200 cm plant growth medium with a 50 cm reduced permeability layer
volumetric water content versus time

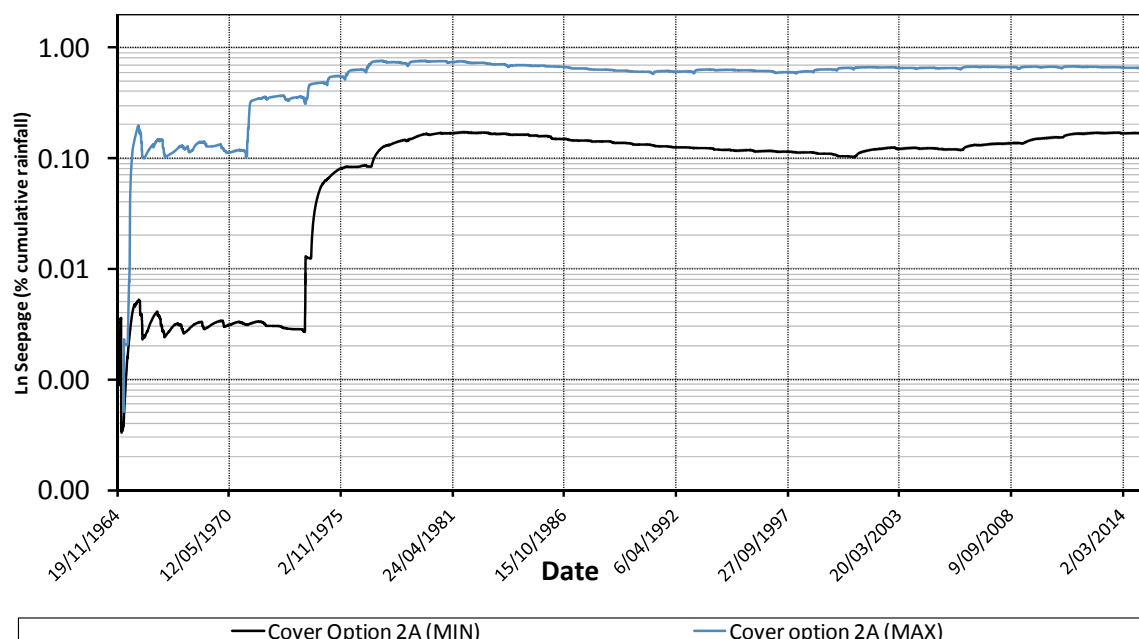


Figure 5.9 Option 2a: 200 cm plant growth medium with a 50 cm reduced permeability layer % seepage versus time

5.3.3 Option 2b: 200 cm plant growth medium with a 50 cm reduced permeability layer and 60 cm bridging layer/capillary break

The Option 2b model was run for a 100 year period. The model was run for a longer period because it is believed that Option 2b is the base case cover for the Old TSF and HLEP#2. Noting that it is not the preferred strategy to cover HLEP#2, the preferred option for HLEP#2 is to relocate the waste rock and ore because of the constraints to placing a cover on the domain at its current location. Examining the model over a longer period allows for performance to be compared against a more diverse range rainfall (described in section 5.2.4).

The model has been set up so that the results are presented as a range based on the assumption that cover performance could be compromised by a failure of the RPL. The RPL may fail because of either development of preferential flow paths or because the RPL did not meet its initial design standard (section 5.3).

Option 2b includes a capillary break/bridging layer directly above the tailings so that the cover can be built on top of a solid platform that will not undergo further settlement. Further, the cover on the Old TSF has had constituents accumulate (Cu and Fe) over the past 30 years due to capillary rise (described in section 3.4.1). The incorporation of a bridging layer/capillary break will prevent capillary rise. The bridging layer/capillary break may also have the added benefit of restricting percolation into the tailings because the layer will create a gap in the air entry values between the RPL and underlying tailings. The air entry value gap will prevent further percolation under unsaturated conditions only. In the event that the bridging layer/capillary break becomes fully saturated then it will allow free movement of constituents and percolation through the pores of the layer.

The purpose of the model was to build upon Option 2a and evaluate the cover with the addition of a bridging layer/capillary break. The model is representative of a thick soil profile which was noted at the mine during the field investigation with a RPL and bridging layer/capillary break which is an analogue for a weathered rock horizon (also noted in soil profiles).

The volumetric water response of the cover is shown in Figure 5.10. As would be expected the near surface layer of plant growth medium (30 cm bgl) shows a highly variable response to rainfall. The near surface layer reaches a degree of saturation (S) equal to 1 (near saturation) almost every wet season, followed by a period of drying resulting in a residual S equal to approximately 0.3 at the end of each dry season. Most stored infiltration in the near surface layer is removed from the plant growth medium as vegetation transpiration or evaporation at the ground surface. Some stored infiltration is infiltrating further into the plant growth medium layer.

The base of the plant growth medium layer (200 cm bgl) reaches a S approximately equal to 1 during the wet seasons because some stored infiltration from the near surface layer continues to infiltrate. The frequency of near saturated conditions is less frequent by comparison to the near surface layer. The lower frequency of near saturated conditions is a result of rainfall being removed before it can infiltrate further into the plant growth medium. The residual S in the base of the plant growth medium is greater than the layer of above (30 cm bgl) indicating that there is more stored infiltration at this depth available to vegetation. Stored infiltration not removed by vegetation continues to infiltrate towards the base of the plant growth medium layer and into the RPL (250 cm bgl).

The base of the RPL (250 cm bgl) is showing less frequent wetting up and drying out by comparison to the plant growth medium layer above it. As expected the frequency of wetting up and drying is less pronounced because most infiltration is removed as vegetation transpiration or evaporation at the ground surface before it has a chance to infiltrate into the RPL. The frequency of wetting and drying is greatest when the RPL is more permeable. Wetting of the RPL is required so that the layer does not become desiccated and give rise to preferential flow paths; however, under more permeable conditions it is likely that seepage is greater, due to the reduced function of the RPL.

As might be expected, the bridging layer/capillary (260 cm bgl) break generally remains unsaturated for most of the 100 year period; however, on four occasions during the 100 year model the bridging layer/capillary break has reached a S approximately equal to 1. At saturation the bridging layer/capillary break will allow free movement of percolation and constituents through the pores of the layer. Over the modelled period the bridging layer/capillary break generally remains below a S of approximately 0.8 (volumetric water content of approximately 0.3), the threshold value at which percolation would be expected from the layer (described in section 2.4.2). It should be noted that if the RPL is built to, and meets the design standard, then the capillary break will never become saturated and will effectively close down percolation to the underlying tailings because it will create a permanent air entry value break between the overlying RPL and underlying tailings.

Potential seepage from the cover is shown in Figure 5.11. The model shows that the potential evapotranspiration effect is greatest in approximately the first five years, depending on the permeability of the RPL. After this time the volume of infiltration that reaches the base of the bridging layer/capillary break and become seepage is near constant resulting in a maximum steady state percolation rate of 0.2% of cumulative rainfall assuming that the RPL has not been built to, and met the design standard. Assuming that the RPL has met the design standard then the maximum infiltration can be expected to be an order of magnitude lower at 0.025%. The effect of removing vegetation from the model would likely increase the potential seepage rate by one of order of magnitude, putting it in the range of 0.2-2% depending on the permeability of the RPL.

While the model indicates the cover may be acceptable by comparison to other Australian covers, any decrease in cover performance, because of poor vegetation establishment or reduced performance of the RPL, would limit the effectiveness of the cover. The model shows that the cover will deliver sufficient infiltration to a RPL to keep it hydrated, so that it does not dry out, and performs optimally. Drying of the RPL leads to preferential flow paths, due to cracks, which would increase the seepage potential. The RPL may also fail because it was not built to a design standard (section 5.3).

The maximum seepage rate from a more permeable RPL results in a seepage rate that is still better than the base case, Option 1 and Option 2a. The analysis shows that the construction method and quality control are critical to the overall performance potential of Option 2b; however, the presence of a bridging layer/capillary break will improve the overall performance because of its positive effect in limiting percolation into the tailings.

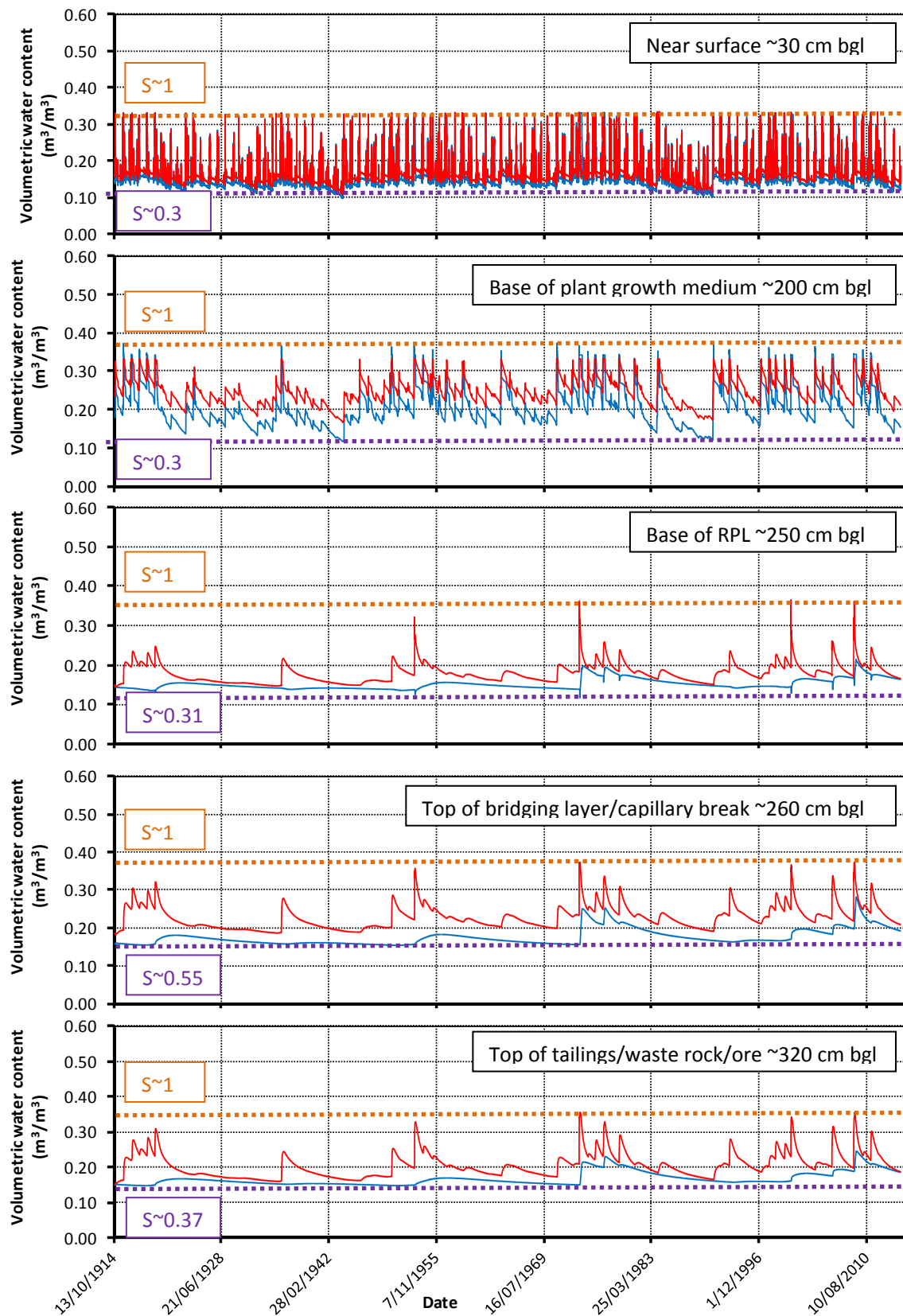


Figure 5.10 Option 2b: 200 cm plant growth medium with a 50 cm reduced permeability layer and 60 cm bridging layer/capillary break volumetric water content versus time

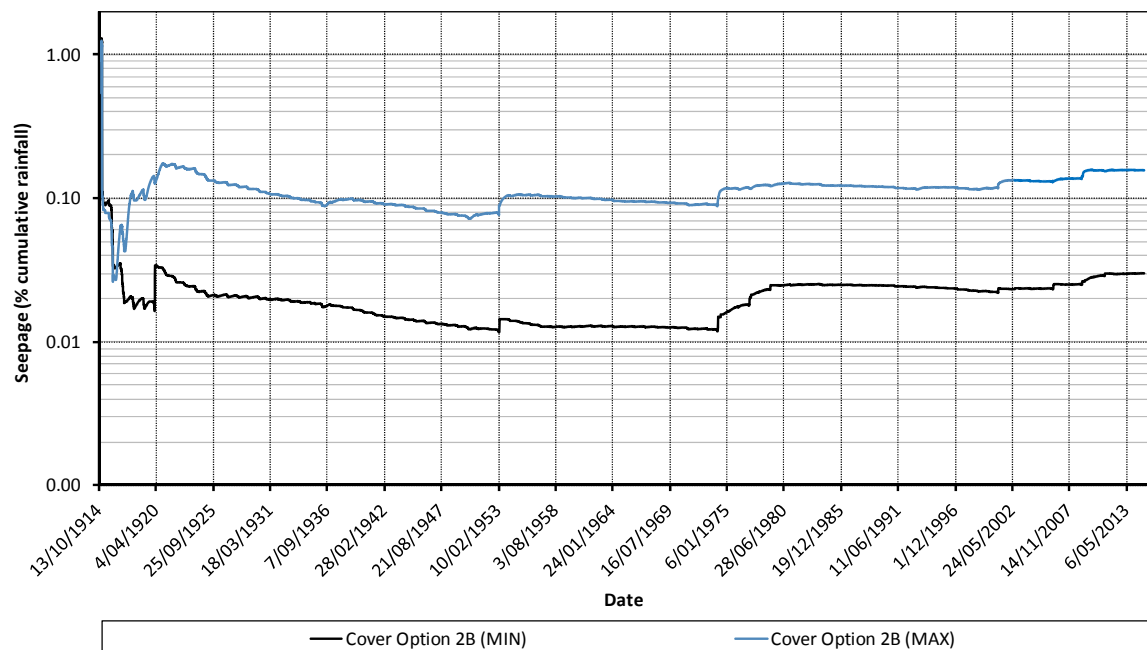


Figure 5.11 Option 2b: 200 cm plant growth medium with a 50 cm reduced permeability layer and 60 cm bridging layer/capillary break seepage versus time

5.3.4 Option 3: 200 cm plant growth medium 50 cm 1:5 trafficked plant growth medium and tailings reduced permeability layer and 60 cm bridging layer/capillary break

The Option 3 model was run for a 100 year period. Examining the model over a longer period allows for performance to be compared against a more diverse range rainfall (described in section 5.2.4).

The model period is comparable to Option 2b. This cover is proposed as an alternative to Option 2b. The alternative is desirable by comparison because it provides an alternative in case clay is in short supply to build the covers. Tailings can be harvested from the top 50 cm of the Old TSF prior to building the cover. The tailings in the top 50 cm of the Old TSF are NAF and have excess ANC (described in section 3.4.1) and can therefore be blended with the trafficked plant growth medium, which may be PAF to create a NAF RPL in the cover.

The model has been set up so that the results are presented as a range based on the assumption that cover performance could be compromised by a failure of the RPL (section 5.3).

Like Option 2b the option includes a capillary break. In addition to providing a competent surface for trafficking the bridging layer/capillary break may also have the added benefit of restricting percolation into the tailings because the layer will create a gap in the air entry values between the RPL and underlying tailings. The air entry value gap will prevent further percolation under unsaturated conditions only. In the event that the bridging layer/capillary break becomes fully saturated then it will allow free movement of constituents and percolation through the pores of the layer.

The volumetric water response of the cover is shown in Figure 5.12. By comparison to the other covers modelled the plant growth medium layer performance is exactly the same, this is because the layer has the same soil index characteristics, with only the RPL soil characteristics changed between the cover models. The model shows that the cover will deliver sufficient infiltration to a RPL to keep it hydrated, so that it does not dry out, and performs optimally. Drying of a RPL leads to preferential flow paths, due to cracks, which would increase the seepage potential. The RPL may also fail because it was not built to a design standard (section 5.3).

The base of the RPL (250 cm bgl) is showing less frequent wetting up and drying out by comparison to the plant growth medium layer above it. As expected the frequency of wetting up and drying is less pronounced because most infiltration is removed as vegetation transpiration or evaporation at the ground surface before it has a chance to infiltrate into the RPL. The frequency of wetting and drying is greatest when the RPL is more permeable. Wetting of the RPL is required so that the layer does not become desiccated and give rise to preferential flow paths; however, under more permeable conditions it is likely that seepage is greater, due to the reduced function of the RPL. By comparison the RPL in the cover has performed better than the RPL in Option 2b when the RPL is built to, and meets the design standard because the RPL remains close to a residual S of 0.34. In Option 2b the S ranges between 0.31-0.57 (volumetric water content range 0.1-0.2) which is greater than Option 3.

As might be expected, the bridging layer/capillary (260 cm bgl) break generally remains unsaturated for most of the 100 year period; however, on four occasions during the 100 year model the bridging layer/capillary break has reached a S approximately equal to 1. At saturation the bridging layer/capillary break will allow free movement of percolation and constituents through the pores of the layer. Over the modelled period the bridging layer/capillary break generally remains below a S of approximately 0.8 (volumetric water content approximately equal to 0.3), the threshold value at which percolation would be expected from the layer (described in section 2.4.2). It should be noted that if the RPL is built to, and meets the design standard, then the capillary break will never become saturated and will effectively close down percolation to the underlying tailings because it will create a permanent air entry value break between the overlying RPL and underlying tailings. In this instance the bridging layer/capillary break will remain very close to a residual S equal to 0.55.

Potential seepage from the cover is shown in Figure 5.13. The model shows that the potential evapotranspiration effect is greatest in approximately the first five years, depending on the permeability of the RPL. After this time the volume of infiltration that reaches the base of the bridging layer/capillary break and becomes seepage is near constant resulting in a maximum steady state percolation rate of 0.1% of cumulative rainfall assuming that the RPL has not been built to, and met the design standard. Assuming that the RPL has met the design standard then the maximum infiltration can be expected to be two orders of magnitude lower at 0.003%. The effect of removing vegetation from the model would likely increase the potential seepage rate by one of order of magnitude, putting it in the range of 0.03-1% depending on the permeability of the RPL. The seepage potential from the cover is better than Option 2b.

While the model indicates the cover may be acceptable by comparison to other Australian covers, any decrease in cover performance, because of poor vegetation establishment or reduced performance of the RPL, would limit the effectiveness of the cover. The model shows that the cover will deliver sufficient infiltration to the RPL to keep it hydrated, so that it does not dry out, and performs optimally. Drying of the RPL leads to preferential flow paths, due to cracks, which would increase the seepage potential. The RPL may also fail because it was not built to a design standard (section 5.3).

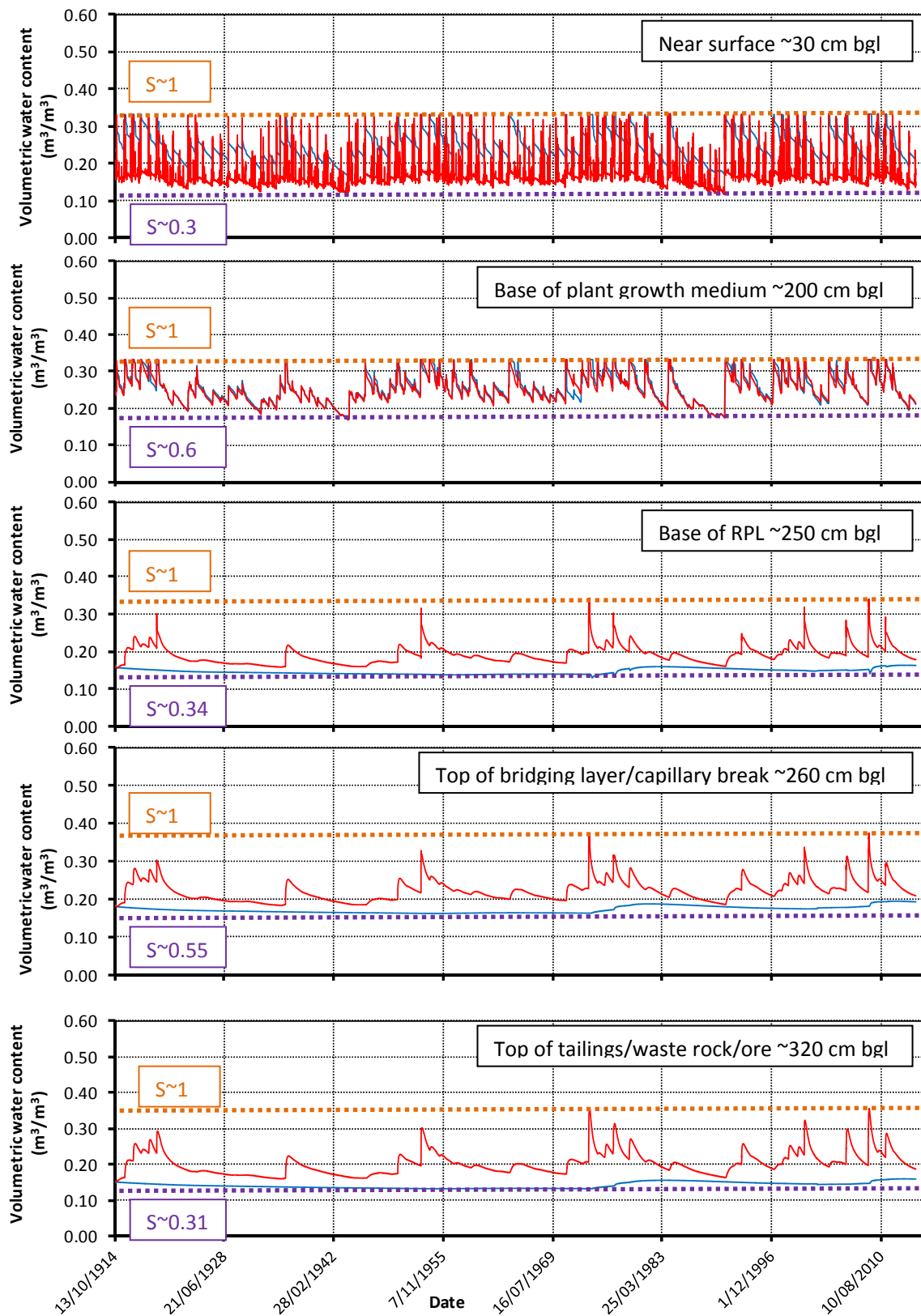


Figure 5.12 Option 3: 200 cm plant growth medium 50 cm 1:5 trafficked plant growth medium and tailings reduced permeability layer and 60 cm bridging layer/capillary break volumetric water content versus time

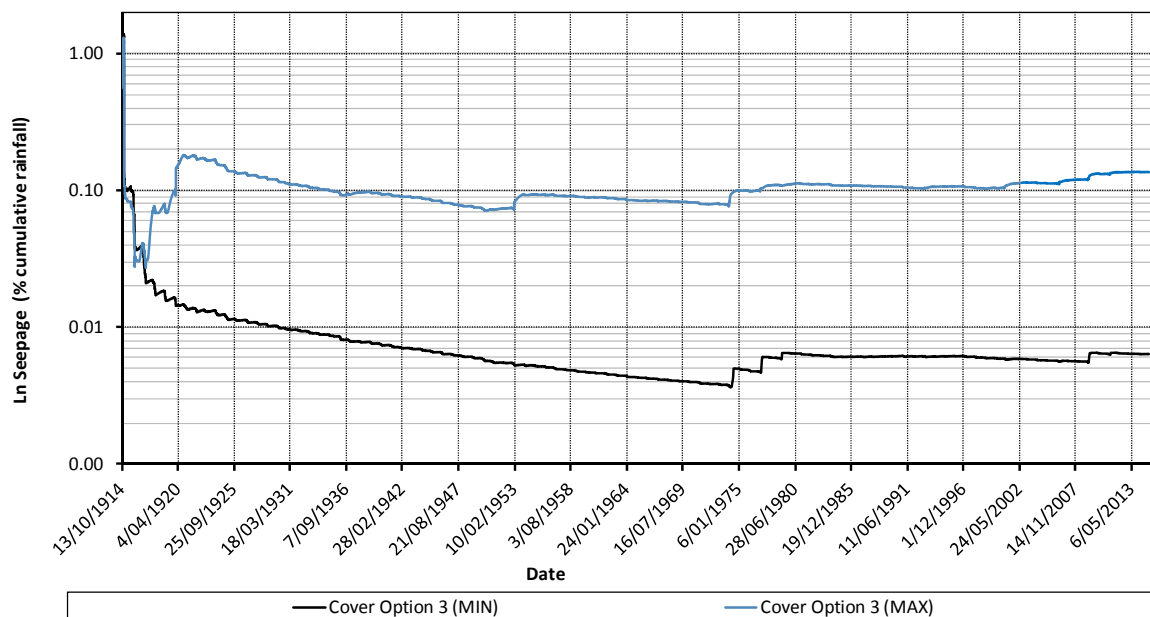


Figure 5.13 Option 3: 200 cm plant growth medium 50 cm 1:5 trafficked plant growth medium and tailings reduced permeability layer and 60 cm bridging layer/capillary break seepage versus time

5.3.5 Option 4: 200 cm plant growth medium 50 cm scalped (<9.6 mm) plus 15-30% fines passing (<0.075 mm) reduced permeability layer and 60 cm bridging layer/capillary break

The Option 4 model was run for a 100 year period. Examining the model over a longer period allows for performance to be compared against a more diverse range rainfall (described in section 5.2.4).

The model period is comparable to Option 2b. The cover is proposed as an alternative to Option 2b. The alternative is desirable by comparison because it provides an alternative in case clay is in short supply to build the covers. It provides an alternative to Option 3 in the event that is not practical to harvest tailings, clay and trafficked plant growth medium from the Old TSF.

The model has been set up so that the results are presented as a range based on the assumption that cover performance could be compromised by a failure of the RPL (section 5.3).

Like Option 2b and Option 3 the option includes a capillary break.

The volumetric water response of the cover is shown in Figure 5.12. By comparison to the other covers modelled the plant growth medium layer performance is exactly the same, this is because the layer has the same soil index characteristics, with only the RPL soil characteristics changed between the cover models. The model shows that the cover will deliver sufficient infiltration to a RPL to keep it hydrated, so that it does not dry out, and performs optimally.

The base of the RPL (250 cm bgl) is showing less frequent wetting up and drying out by comparison to the plant growth medium layer above it. As expected the frequency of wetting up and drying is less pronounced because most infiltration is removed as vegetation transpiration or evaporation at the ground surface before it has a chance to infiltrate into the RPL. By comparison the RPL in the cover has performed to a lesser standard when compared to the RPL in Option 2a, That is, when comparing performance for the RPLs that have been built to, and meet the design standard; the RPL in Option 3 remains at a higher residual S then the S for Option 2b (0.55 versus 0.31). The frequency of wetting and drying is greatest when the RPL is more permeable for both Option 4 and Option 2b by comparison.

As might be expected, the bridging layer/capillary (260 cm bgl) break generally remains unsaturated for most of the 100 year period; however, on seven occasions during the 100 year model the bridging layer/capillary break has reached a S approximately equal to 1. At saturation the bridging layer/capillary break will allow free movement of percolation and constituents through the pores of the layer. Over the modelled period the bridging layer/capillary break generally remains below a S of approximately 0.8 (volumetric water content approximately equal to 0.3), the threshold value at which percolation would be expected from the layer (described in section 2.4.2). It should be noted that if the RPL is built to, and meets the design standard, then the capillary break will never become saturated and will effectively close down percolation to the underlying tailings because it will create a permanent air entry value break between the overlying RPL and underlying tailings. In this instance the bridging layer/capillary break will remain very close to a residual S equal to 0.55.

Potential seepage from the cover is shown in Figure 5.15. The model shows that the potential evapotranspiration effect is greatest in approximately the first five years, depending on the permeability of the RPL. After this time the volume of infiltration that reaches the base of the bridging layer/capillary break and become seepage is near constant resulting in a maximum steady state percolation rate of 0.2% of cumulative rainfall assuming that the RPL has not been built to, and met the design standard. Assuming that the RPL has met the design standard then the maximum infiltration can be expected to be two orders of magnitude lower at 0.002%. The potential seepage from the cover is comparable to the performance of Option 2b which had a seepage range of 0.025-0.2%.

The effect of removing vegetation from the model would likely increase the potential seepage rate by one of order of magnitude, putting it in the range of 0.02-2% depending on the permeability of the RPL. The seepage potential from the cover is comparable to Option 2b.

While the model indicates the cover may be acceptable by comparison to other Australian covers, any decrease in cover performance, because of poor vegetation establishment or reduced performance of the RPL, would limit the effectiveness of the cover. The model shows that the cover will deliver sufficient infiltration to the RPL to keep it hydrated, so that it does not dry out, and performs optimally. Drying of the RPL leads to preferential flow paths, due to cracks, which would increase the seepage potential. The RPL may also fail because it was not built to a design standard (section 5.3).

From a constructability standpoint, this is the least desirable cover option because of extra material handling requirements to screen, crush, water condition and place (refer to Chapter 4).

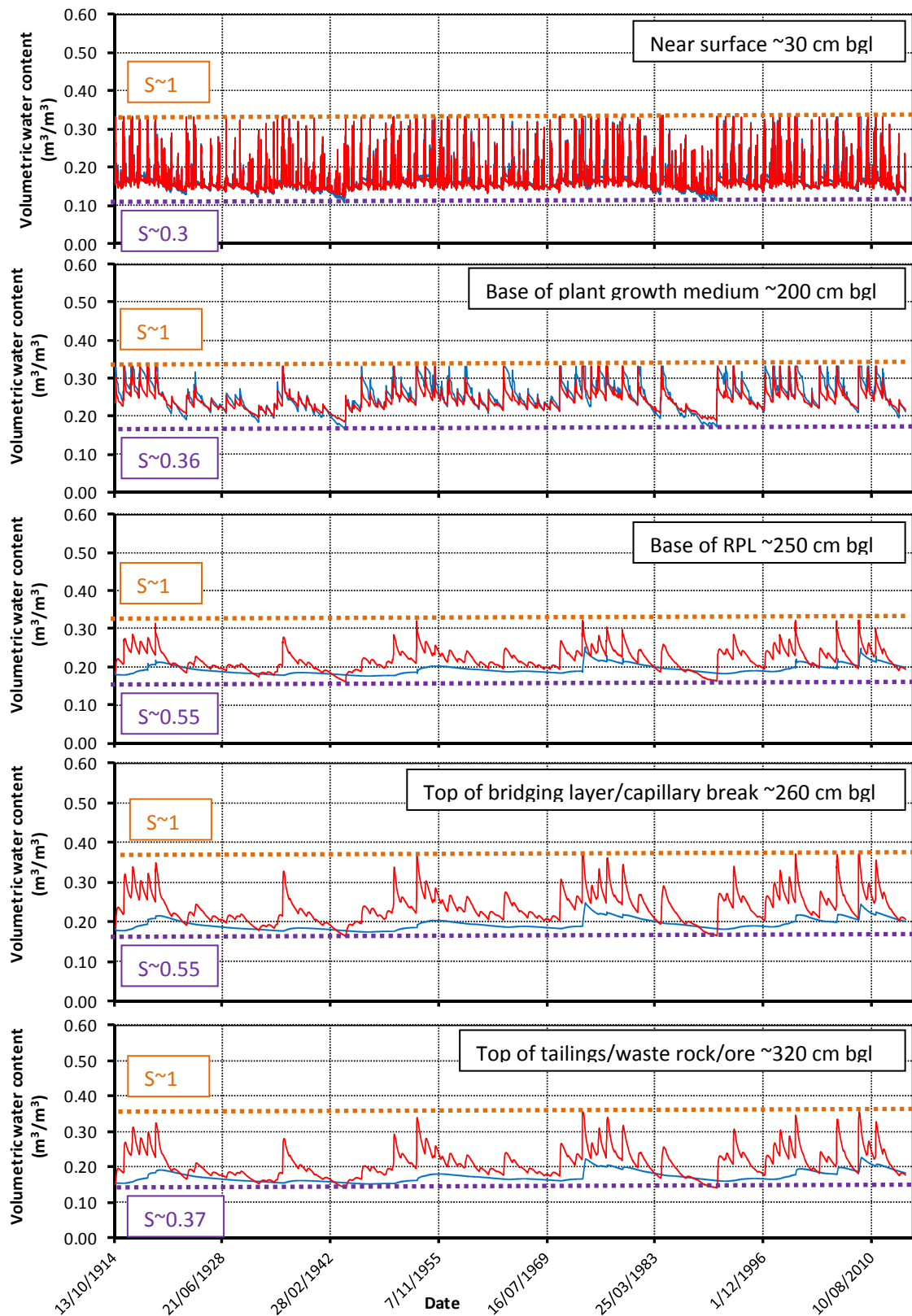


Figure 5.14 Option 4: 200 cm plant growth medium 50 cm scalped (<9.6 mm) plus 15-30% fines passing (<0.075 mm) reduced permeability layer and 60 cm bridging layer/capillary break volumetric water content versus time

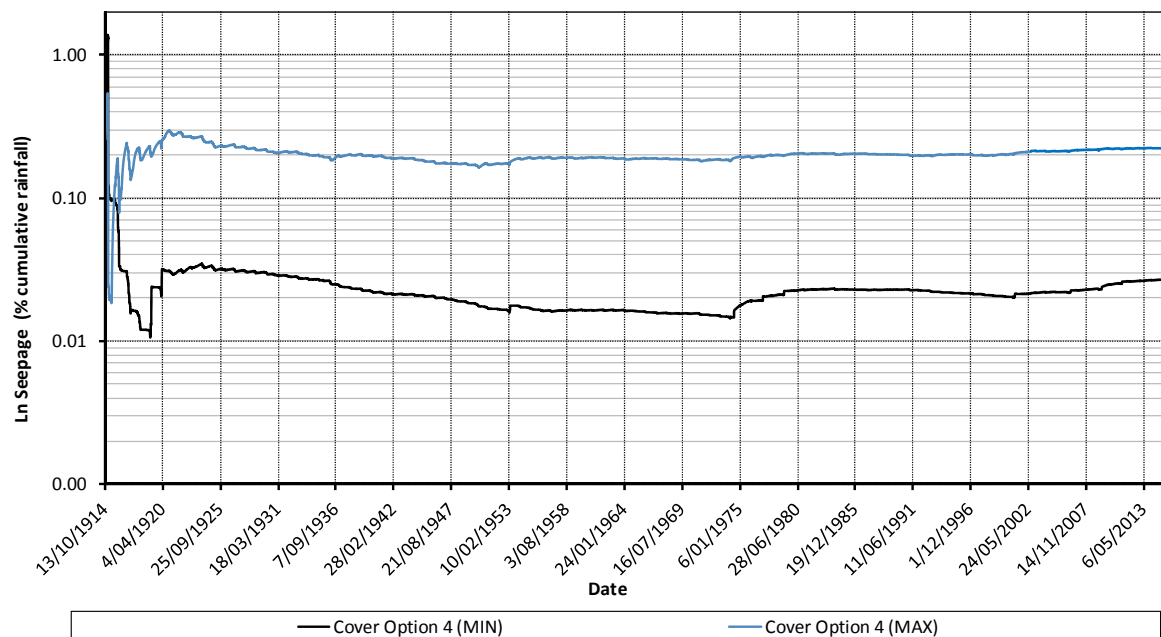


Figure 5.15 Option 4: 200 cm plant growth medium 50 cm scalped (<9.6 mm) plus 15-30% fines passing (<0.075 mm) reduced permeability layer and 60 cm bridging layer/capillary break seepage versus time

5.4 Summary of cover option performance

Australian experience with similar covers has typically restricted infiltration to less than 10% of annual rainfall. At Kidston Mine (Williams et al 2003) the cover restricted infiltration to less than 1.5%. At Mt Whaleback Mine the cover restricted infiltration to between 5-13% (O’Kane and Waters 2003). At Cadia Mine (Rohde et al 2011) the cover restricted infiltration to less than 3%. Finally the covers at Century Mine (Defferrard et al) have restricted infiltration between 2-11% and averaged 5%.

Cook, Leaney and Miles (2004) suggest that natural groundwater recharge may be occurring at between 0.009 meters per year (m/yr) and 0.37 m/year (9 millimetres per year (mm/yr) to 37 mm/yr), assuming a mean annual rainfall of 480 mm. It should be noted that rainfall can range up to 1300 mm when extreme storm events have occurred. Recharge should be less than 10% of annual rainfall during periods of average annual rainfall.

Four different cover option models were evaluated. The following is a summary of the performance results.

5.4.1 Option 1: 200 cm plant growth medium with no reduced permeability layer

The purpose of the model was to evaluate the steady state seepage rate (as a percentage of cumulative rainfall) for a plant growth medium without a RPL. The model reached a steady state by 50 years, and reported a seepage range maximum of 1%. The effect of removing vegetation from the model would likely increase the potential seepage rate by one of order of magnitude, putting it in the range of 10%. The expected seepage range is within the performance range of other Australian cover examples; however the upper potential seepage limit is close to exceeding the proposed limit for the mine ie 10% based on Cook, Leaney and Miles (2004).

5.4.2 Option 2a: 200 cm plant growth medium with a 50 cm reduced permeability layer

The purpose of the model was to evaluate the effectiveness of an RPL against the base case, which was Option 1. The model showed that seepage is near constant resulting in a steady state percolation rate of up to approximately 1% of cumulative rainfall. The maximum seepage rate from a more permeable RPL results in a seepage rate that is not better than the base case, Option 1. The analysis shows that the construction method and quality control are critical to the overall performance potential of Option 2a. Further, even if the RPL is constructed to and meets a design standard, effect of removing vegetation from the model would likely increase the potential seepage rate by one of order of magnitude, putting it in the range of 10%, which is again comparable to Option 1. The expected seepage range is within the performance range of other Australian cover examples; however the upper potential seepage limit is close to exceeding the proposed limit for the mine ie 10% based on Cook, Leaney and Miles (2004).

5.4.3 Option 2b: 200 cm plant growth medium with a 50 cm reduced permeability layer and 60 cm bridging layer/capillary break

The field investigation and review identified the need for a running layer and bridging layer/capillary break at the base of the cover to provide a stable platform for machine traffic and to prevent the capillary rise of constituents back into the cover. Option 2b was considered to be the base case, and the most desirable, because most soil and rock (plant growth medium), clay (RPL) and rock (bridging layer/capillary break) can be harvested directly from the Old TSF for the covers. The model showed that that bridging layer/capillary break (260 cm bgl) generally remains unsaturated for most of the 100 year period and generally remained below a S of approximately 0.8 (volumetric water content of approximately 0.3), the threshold value at which percolation would be expected from the layer (described in section 2.4.2). The model shows that the effectiveness of the cover option will be determined by how well the RPL is built to, and meets the design standard. Provided the RPL is built to the design standard then the capillary break will never become saturated and will effectively close down percolation to the underlying tailings because it will create a permanent air entry value break between the overlying RPL and underlying tailings. Provided there is an air entry value break percolation is expected to be limited to 0.025% and is not expected to exceed 2% if there is poor establishment of vegetation. The expected seepage range is within the performance range of other Australian cover examples; and the upper potential seepage limit is less than the proposed limit for the mine ie 10% based on Cook, Leaney and Miles (2004).

5.4.4 Option 3: 200 cm plant growth medium 50 cm 1:5 trafficked plant growth medium and tailings reduced permeability layer and 60 cm bridging layer/capillary break

The option evaluated using the Old TSF as a quarry to provide suitable cover. Using tailings as part of the cover addresses the additional volume requirement described in section 3.2.1. The model shows that the potential seepage becomes near constant at a maximum steady state percolation rate of 0.1% of cumulative rainfall assuming that the RPL has not been built to, and met the design standard. Assuming that the RPL has met the design standard then the maximum infiltration can be expected to be two orders of magnitude lower at 0.003%. The effect of removing vegetation from the model would likely increase the potential seepage rate by one of order of magnitude, putting it in the range of 0.03-1% depending on the permeability of the RPL. The seepage potential from the cover is better than Option 2b and the expected seepage range is within the performance range of other Australian cover examples. The upper potential seepage limit is one order of magnitude less than the proposed limit for the mine ie 10% based on Cook, Leaney and Miles (2004).

5.4.5 Option 4: 200 cm plant growth medium 50 cm scalped (<9.6 mm) plus 15-30% fines passing (<0.075 mm) reduced permeability layer and 60 cm bridging layer/capillary break

Option 4 was run for a 100 year period. This option was evaluated as an alternative to Option 3. From a constructability standpoint, this is the least desirable cover option because of extra material handling requirements to screen, crush, water condition and place. Potential seepage from the cover reaches a maximum steady state percolation rate of 0.2% of cumulative rainfall assuming that the RPL has not been built to, and met the design standard. Assuming that the RPL has met the design standard then the maximum infiltration can be expected to be two orders of magnitude lower at 0.002%. The effect of removing vegetation from the model would likely increase the potential seepage rate by one of order of magnitude, putting it in the range of 0.02-2% depending on the permeability of the RPL. The potential seepage from the cover is comparable to the performance of Option 2b which had a seepage range of 0.025-0.2%. The expected seepage range is within the performance range of other Australian cover examples. The upper potential seepage limit is one order of magnitude less than the proposed limit for the mine ie 10% based on Cook, Leaney and Miles (2004).

6 Conclusion

6.1 Review

Initially a review of the Old TSF and HLEP#2 was undertaken to identify potential opportunities and constraints to the rehabilitation of the domains.

The review identified that the tailings and cover would be suitable for reuse in the construction of a new cover subject to verification. This is advantageous because at least some of the borrow material for the new cover can be won directly from the Old TSF reducing the overall cost of construction. Alternatively, assuming the tailings and cover are suitable for use in constructing a new cover, the entire facility could be used to build a cover on one of the existing waste rock dumps, the Old TSF would therefore be rehabilitated by removal. This alternative is beyond the scope of this report and is not discussed further.

After construction of the cover the tailings underwent further consolidation resulting in differential settlement of the surface that resulted in ponding of water. It was identified that a new cover would require a bridging layer directly above the tailings so that the new cover can be built on top of a solid platform that will not undergo further settlement. The bridging layer would also act as a capillary break reducing the potential for capillary rise of constituents in the new cover. A suitable source of material for the bridging layer must be sourced from the mine.

The review of HLEP#2 found that rehabilitation of HLEP#2 is constrained by the fact that the domain geometry is predominately batter slope. The flat top areas make up less than half of the total area. Building a cover on the batter slopes is considered very difficult using conventional construction methods. Therefore, Aditya Birla are committed to excavating HLEP#2 and removing the PAF waste rock and ore to the underground mine, or another location where the excavated waste rock and ore can be selectively handled to create a final landform that is safe, stable, sustainable and non polluting. The excavation and removal of HLEP#2 is beyond the scope of this report and will not be discussed further.

6.2 Investigation

A field investigation was completed in June 2015 to:

- characterise the physical and chemical properties of the Old TSF cover and tailings and changes in constituent chemistry that have occurred since 2005 (Spain et al 2005); and
- identify potential quarries where borrow soil and rock (plant growth medium and bridging layer/capillary break) and clay (RPL) can be excavated from to build the covers and collect samples.

The field investigation identified a number of potential quarries; Diversion Dam Quarry; Magazine Creek Ponds; Mill Creek, and North Rock Quarry. North Rock Quarry was deemed the most suitable because of its close proximity to both the Old TSF and HLEP#2 and its ample quantity of borrow soil and rock (plant growth medium and bridging layer/capillary break) and clay (RPL).

Upon return from the field, samples of tailings and borrow soil and rock (plant growth medium and bridging layer/capillary break) and clay (RPL) were submitted to ALS Laboratories and Douglas Partners Consulting for chemical and physical characterisation.

Samples collected from the Old TSF (cover and tailings) were generally encouraging. The results indicate that the cover plant growth medium had some potential to be PAF and create acid rock drainage, with NAPP values typically ranging between 0-5 kg $\text{H}_2\text{SO}_4^{-2}/\text{t}$. The results also showed that the top 0.5 m of the tailings is oxidised, is not PAF, and has excess ANC. The results indicate that the top 0.5 m of the tailings could be blended with the trafficked plant growth medium to make a suitable substitute for the RPL in the event that the volume of clay within the cover is not sufficient to build a new RPL on either the Old TSF or HLEP#2. Further chemical analysis showed that the Old TSF cover had been impacted by capillary rise of constituents (Cu and Fe) and that Cd, Co, Cr concentrations have decreased in the cover as a result of leaching. All constituent concentrations have remained below HIL C with the exception of one instance for Co in the tailings.

The cover is suitable as borrow soil and rock (plant growth medium and bridging layer/capillary break) and clay (RPL) for the RPL for the new cover for the Old TSF and HLEP#2, noting that the preferred option for HLEP#2 is to relocate the waste rock and ore because of the constraints to placing a cover on the domain at its current location.

The new cover will require a bridging layer/capillary break to limit the potential for capillary rise of constituents (Cu and Fe) into the new cover.

Acid base accounting was completed on samples of plant growth medium and clay taken from the quarries. All samples are considered to be NAF (NAPP approximately equal to 0 kg $\text{H}_2\text{SO}_4^{-2}/\text{t}$), with the exception of three samples from Magazine Creek which had some PAF potential (NAPP >0 kg $\text{H}_2\text{SO}_4^{-2}/\text{t}$, <5 kg $\text{H}_2\text{SO}_4^{-2}/\text{t}$). Further chemical analysis showed that quarried plant growth medium and clay is suitable to be used as an RPL or plant growth medium for the new cover for the Old TSF and HLEP#2, noting that the preferred option for HLEP#2 is to relocate the waste rock and ore because of the constraints to placing a cover on the domain at its current location.

6.3 Cover options

The following new cover options were developed for the Old TSF and HLEP#2 based from the review and field investigation:

- Option 1: 200 cm plant growth medium with no reduced permeability layer. Option 1 was proposed because the cover would mimic deep soil profiles that were surveyed during the investigation.
- Option 2a: 200 cm plant growth medium with a 50 cm reduced permeability layer, Option 2 was chosen because field description of soil profiles at the mine indicated that undisturbed soils typically have a weathered rock horizon beneath the plant growth medium. The weathered horizon is competent and acts as an RPL. It will not be practical to compact a layer of rock at the base of the plant growth medium layer so the layer was substituted for a clay RPL.
- Option 2b: 200 cm plant growth medium with a 50 cm reduced permeability layer and 60 cm bridging layer/capillary break. Option 2b was chosen to address trafficking of the differentially consolidated Old TSF surface and the capillary rise potential of constituents.
- Option 3: 200 cm plant growth medium 50 cm 1:5 trafficked plant growth medium and tailings reduced permeability layer and 60 cm bridging layer/capillary break. Option 3 was chosen to provide an alternative in case clay is in short supply for the covers. Tailings can be harvested from the top 50 cm of the Old TSF prior to building the new cover. The tailings in the top 50 cm of the Old TSF are NAF and have excess ANC and can therefore be blended with the trafficked plant

growth medium, which may be PAF, from the Old TSF cover to create a mixture that will be NAF for the RPL in the new cover.

- Option 4: 200 cm plant growth medium 50 cm scalped (<9.6 mm) plus 15-30% fines passing (<0.075 mm) reduced permeability layer and 60 cm bridging layer/capillary break. Option 4 was also chosen to provide an alternative in case clay is in short supply for the covers and it was not practical to harvest tailings, clay and plant growth medium from the Old TSF. From a constructability standpoint, this is the least desirable cover option because of extra material handling requirements to screen, crush, water condition and place.

6.4 Cover modelling

There are two recommended cover options.

6.4.1 Option 2b: 200 cm plant growth medium with a 50 cm reduced permeability layer and 60 cm bridging layer/capillary break

The field investigation and review identified the need for a running layer and bridging layer/capillary break at the base of the cover to provide a stable platform for machine traffic and to prevent the capillary rise of constituents back into the cover. Option 2b is considered to be the base case, and the most desirable, because most soil and rock (plant growth medium), clay (RPL) and rock (bridging layer/capillary break) can be harvested directly from the Old TSF for the covers. The model showed that the bridging layer/capillary break (260 cm bgl) generally remains unsaturated for most of the 100 year period and generally remained below a S of approximately 0.8 (volumetric water content of approximately 0.3), the threshold value at which percolation would be expected from the layer. The model shows that the effectiveness of the cover option will be determined by how well the RPL is built to, and meets the design standard. Provided the RPL is built to the design standard then the capillary break will never become saturated and will effectively close down percolation to the underlying tailings because it will create a permanent air entry value break between the overlying RPL and underlying tailings. Provided there is an air entry value break percolation is expected to be limited to 0.025% and is not expected to exceed 2% if there is poor establishment of vegetation.

Figure 6.1 presents a summary of the proposed design standard for Option 2b.

6.4.2 Option 3: 200 cm plant growth medium 50 cm 1:5 trafficked plant growth medium and tailings reduced permeability layer and 60 cm bridging layer/capillary break

The option evaluated using the Old TSF as a quarry to provide suitable cover. Using tailings as part of the cover addresses the additional volume requirement described in section 3.2.1. The model shows that the potential seepage becomes near constant at a maximum steady state percolation rate of 0.1% of cumulative rainfall assuming that the RPL has not been built to, and met the design standard. Assuming that the RPL has met the design standard then the maximum infiltration can be expected to be two orders of magnitude lower at 0.003%. The effect of removing vegetation from the model would likely increase the potential seepage rate by one of order of magnitude, putting it in the range of 0.03-1% depending on the permeability of the RPL. The seepage potential from the cover is better than Option 2b.

Figure 6.2 presents a summary of the proposed design standard for Option 3.

Profile	Dimensions	Material description	Material source	Placement and compaction	Construction tolerance
Soil mulch	200 cm	Rudosols using the Australian Soil Classification	North Rock Quarry	Placed by end dumping	-
RPL	50 cm	Silty clay loam	Old TSF	Refer to compaction requirement below	+5 cm -0 cm
Bridging layer/ capillary break	60 cm	Gravel and boulders	Crushed and screened gravel and boulders from North Rock Quarry	Place by end dumping and spread with bulldozer. Compact with four passes using a 10 tonne with a smooth drum roller	+5 cm -0 cm

Compaction requirement:

- RPL to be moisture condition so that it is $\pm 3\%$ of optimum moisture condition;
- RPL to be placed and spread in uniform thicknesses;
- RPL to be compacted in 15 cm thicknesses;
- RPL to be compacted to at least 95% of maximum dry density;
- RPL to be water so that it maintains its moisture content until covered; and
- RPL to be covered within five days of placement.

Option 2b: 200 cm plant growth medium with a 50 cm reduced permeability layer and 60 cm bridging layer/capillary break summary of design standard

Mt Gordon

Figure 6.1

Profile	Dimensions	Material description	Material source	Placement and compaction	Construction tolerance
Soil mulch	200 cm	Rudosols using the Australian Soil Classification	North Rock Quarry	Placed by end dumping	-
RPL	50 cm	1:5 trafficked plant growth medium layer: Tailings Ratio measured by volume Maximum particle size 20 cm	Old TSF	Refer to compaction requirement below	+5 cm -0 cm
Bridging layer/ capillary break	60 cm	Gravel and boulders	Crushed and screened gravel and boulders from North Rock Quarry	Place by end dumping and spread with bulldozer. Compact with four passes using a 10 tonne with a smooth drum roller	+5 cm -0 cm

Compaction requirement:

- RPL to be moisture condition so that it is $\pm 3\%$ of optimum moisture condition;
- RPL to be placed and spread in uniform thicknesses;
- RPL to be compacted in 15 cm thicknesses;
- RPL to be compacted to at least 95% of maximum dry density;
- RPL to be water so that it maintains its moisture content until covered; and
- RPL to be covered within five days of placement.

Option 3: 200 cm plant growth medium 50 cm 1:5 trafficked plant growth medium and tailings reduced permeability layer and 60 cm bridging layer/capillary break summary of design standard

Mt Gordon

Figure 6.2

6.5 Recommendation on how to construct final landforms

The following discussion provides some basic recommendation on how the final landforms should be constructed for the Old TSF and HLEP#2, noting that detailed landform design is beyond the scope of this project. The proponent will require technical specification for the cover and landform which includes surface water management before progressing to construction.

While this section discusses covering HLEP#2, it should be noted that this is not the preferred option for this domain.

6.5.1 Reduced permeability layer

Option 2b and Option 3 require the reuse of the Old TSF cover to construct part of the new cover for the Old TSF and HLEP#2. Table 6.1 summarises the estimated volumes of trafficked plant growth medium, clay and tailings available from the Old TSF. The estimated volume of clay excludes the section of the old cover that was constructed with a bridging layer/capillary break instead of an RPL. The estimated volume of tailings assumes that only the top 40 cm of the tailings, which is fully oxidised, will be harvested.

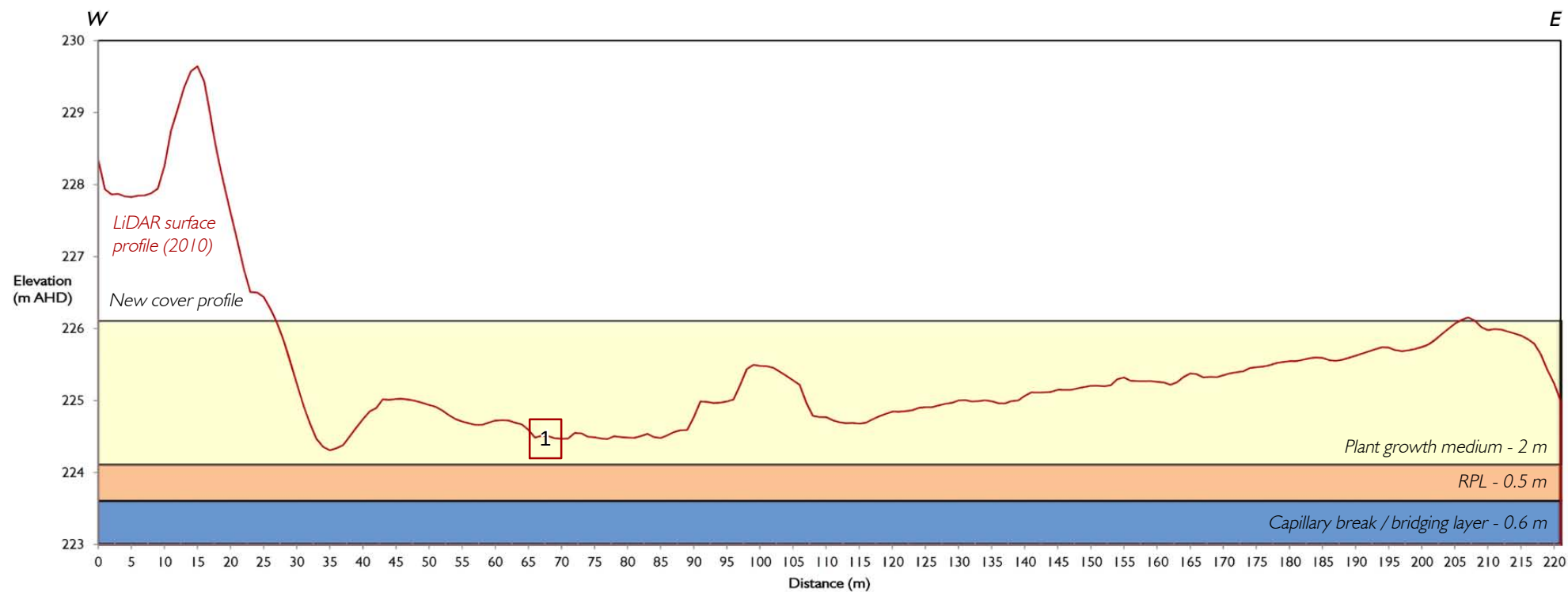
Table 6.1 Estimated plant growth medium and clay available from the old tailings storage facility cover

Material	Domain	Depth	Area (m ²)	Maximum volume (m ³)
Trafficked plant growth medium	Old TSF	60 cm (0.6 m)	119,762	71,857
Clay	Old TSF	30 cm (0.3 m)	115,292	34,587
Tailings	Old TSF	40 cm (0.4 m)	119,762	47,905

Option 2b assumes that the RPL will be constructed from 0.5 m of compacted clay; therefore, there is only enough clay available to cover 69,174 m² of the Old TSF. The remaining (flat top area) 50,588 m² of the Old TSF and the entire 32,222 m² flat top area of HLEP#2 will be covered with Option 3 that is, the RPL will require 41,405 m³ of 1:5 trafficked plant growth medium and tailings mixture. If it is assumed that there will be bulking factor of approximately 3, therefore, 124,215 m³ of 1:5 trafficked plant growth medium is required to build the remaining RPL that cannot be built from clay.

Approximately 25,000 m³ (less than the maximum available volume shown in Table 6.1) of tailings will be harvested from the Old TSF and mixed with 125,000 m³ of trafficked plant growth medium. There is only 71,857 m³ (from Table 6.1) of trafficked plant growth medium available to be harvested from the Old TSF. It is assumed that the difference (53,143 m³) will likely come from the trafficked surface of HLEP#2.

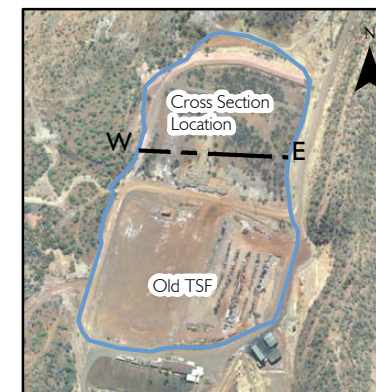
Harvesting trafficked plant growth medium, clay and tailings from the Old TSF and HLEP#2 will lower the existing surface. The estimated reduction in the height of the Old TSF and HLEP pad is shown in Figure 6.3 and Figure 6.4 for the Old TSF and Figure 6.6 and Figure 6.7 for HLEP#2.



1

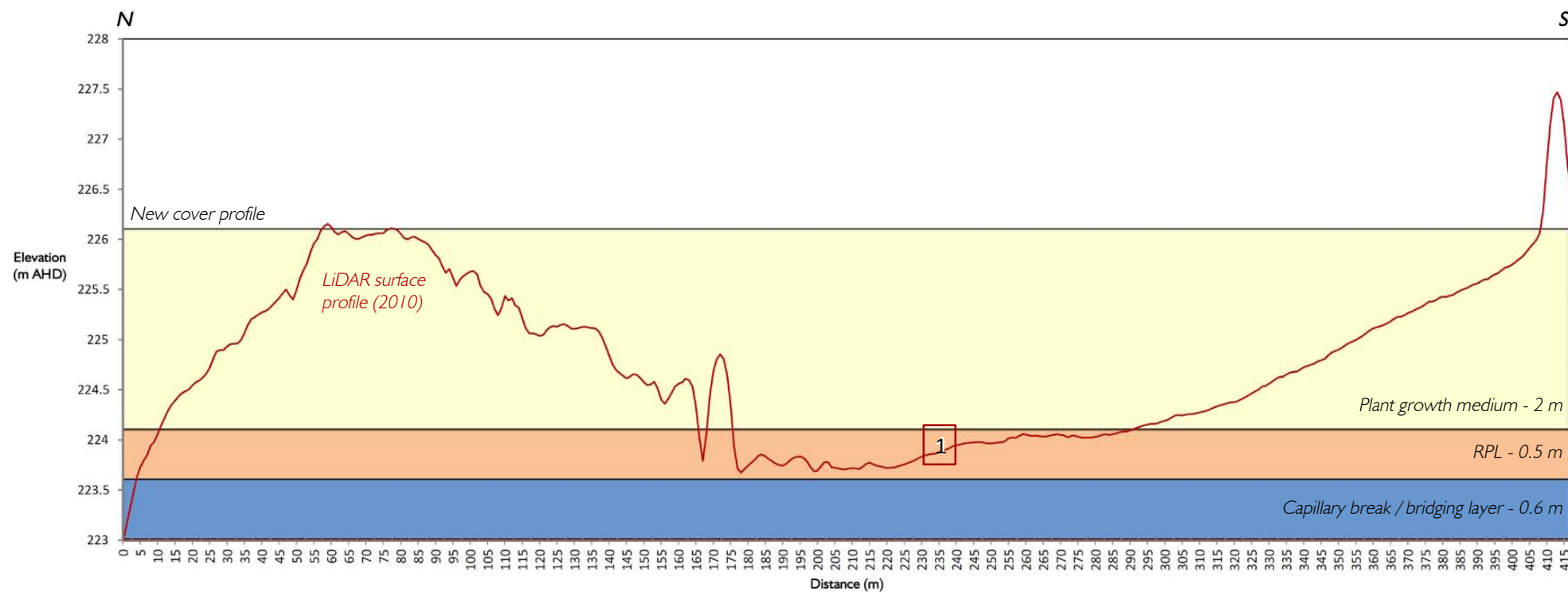
Current cover		
Plant growth medium layer (loamy sand and gravel)		0.6 m
Reduced permeability layer (silty clay loam) (RPL)		0.3 m
Bridging layer/capillary break (gravel and boulders)		0.4 m

NB: Current cover described from field sampling plan



Source: EMM (2015)

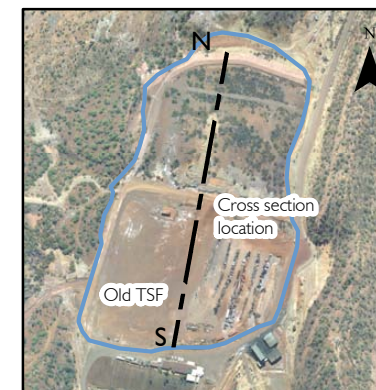
Old Tailings Storage Facility - West to East Section



1

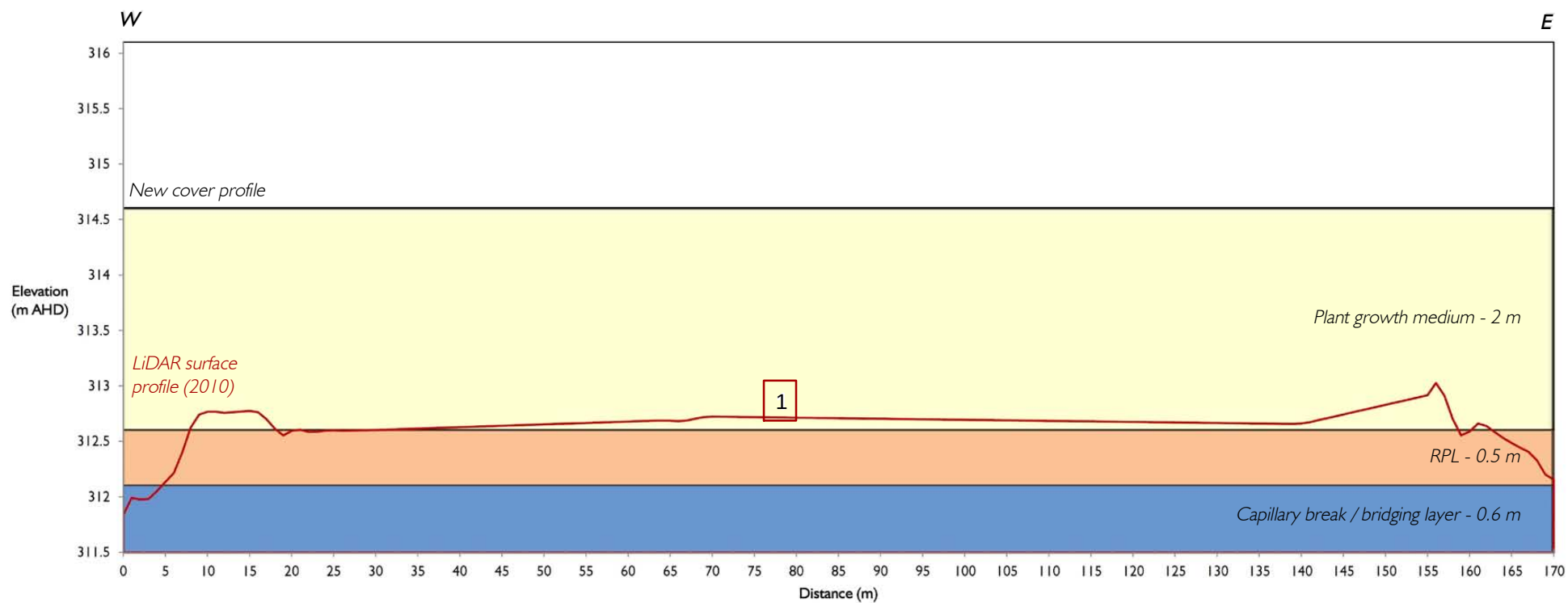
Current cover		
Plant growth medium layer (loamy sand and gravel)		0.6 m
Reduced permeability layer (silty clay loam) (RPL)		0.3 m
Bridging layer/capillary break (gravel and boulders)		0.4 m

NB: Current cover described from field sampling plan

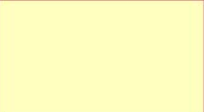
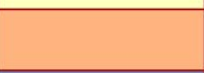


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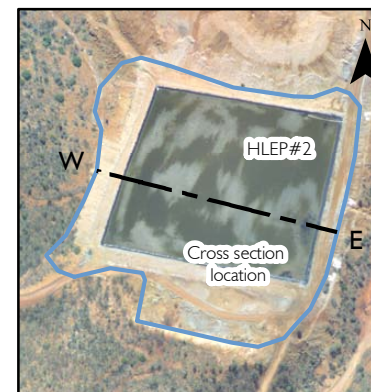
Old Tailings Storage Facility - North to South Section



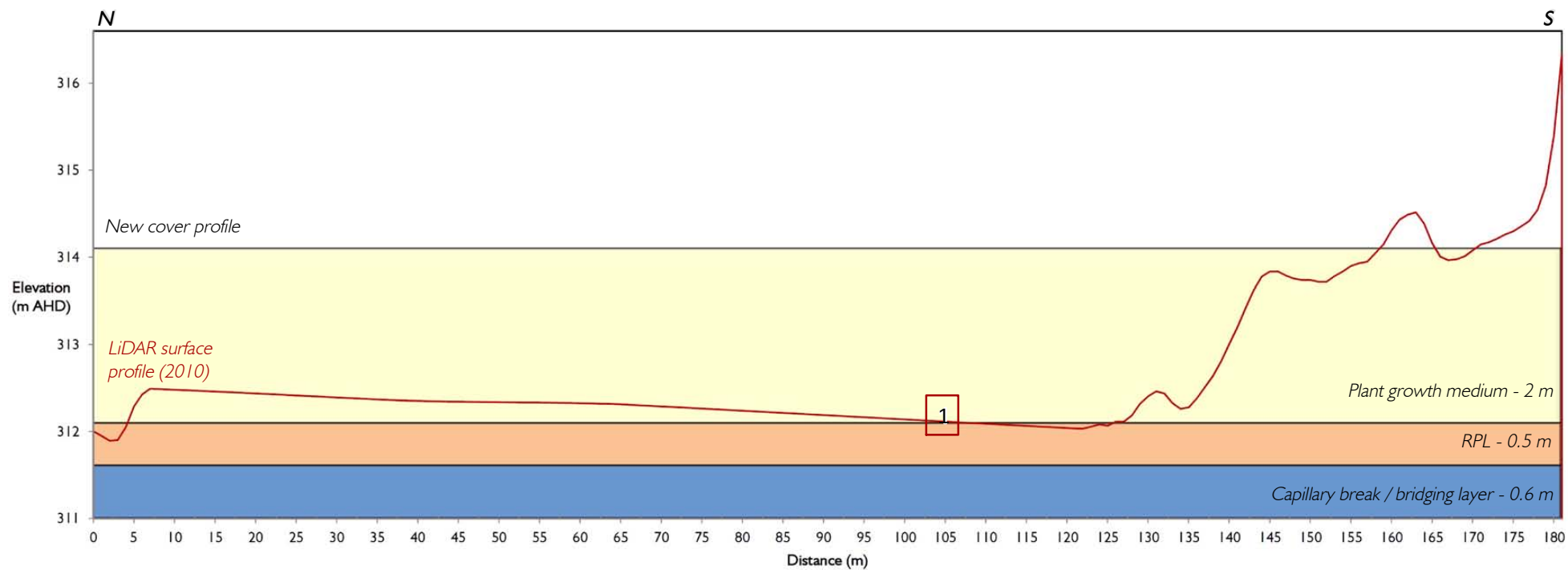
1

Current cover		
Plant growth medium layer (loamy sand and gravel)		0.6 m
Reduced permeability layer (silty clay loam) (RPL)		0.3 m
Bridging layer/capillary break (gravel and boulders)		0.4 m

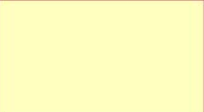
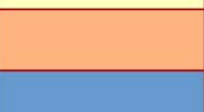
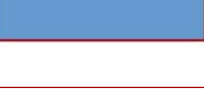
NB: Current cover described from field sampling plan



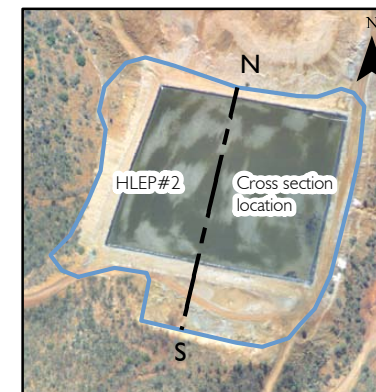
Source: EMM (2015)



1

Current cover		
Plant growth medium layer (loamy sand and gravel)		0.6 m
Reduced permeability layer (silty clay loam) (RPL)		0.3 m
Bridging layer/capillary break (gravel and boulders)		0.4 m

NB: Current cover described from field sampling plan



Source: EMM (2015)

Heap Leach Pad 2 - North to South Section

6.5.2 Plant growth medium

The Option 2b and Option 3 covers will require a 200 cm plant growth medium layer above the RPL. 303,968 m³ of plant growth medium will be harvested from the North Rock Quarry. If the quarry cannot yield the required volume then the remaining volume will be harvested from one of the other quarries. Further cost analysis is required before an alternative quarry can be chosen.

6.5.3 Bridging layer/capillary break

The Option 2b and Option 3 covers will require a 60 cm bridging layer/capillary break below the RPL. 91,190 m³ of gap graded gravel will be harvested from the North Rock Quarry by separating the required coarse fraction from the fines using a crusher and screen. If the quarry cannot yield the required volume then the remaining volume will be harvested from one of the other quarries. Further cost analysis is required before an alternative quarry can be chosen. Further design is required so that the bridging layer/capillary break is designed as a rock filter. This will prevent the layer from clogging with fines over time.

References

Aditya Birla Group 2014. Draft Transitional Environmental Program - Surface water contamination and impact on receiving environment

Defferrard P, Rohde T and Lord M 2015. Instrumentation and Early Monitoring Results of the South Waste Rock Dump at Century Mine. Proceedings of the 10th International Conference on Mine Closure, Vancouver, Canada, 1-3 June, Sustainable Mineral Institute

Fredlund, D and Xing, A 1998. Equations for the soil water characteristic curve. Canadian Geotechnical Journal, 31 (521-532)

Geoslope 2012. *Vadose Zone Modelling with VADOSE/W*, viewed <http://www.geoslope.com/products/vadosew.aspx>

Gard Guide 2009. Global acid rock drainage guide, viewed www.gardguide.com

GHD (2015) BMG Flooding January 2015 Flooding and Historic Pond Levels

Peverill K and Judson G 2005. 'Cobolt' in Peverill K, Sparrow L and Reuter D (eds), Soil Analysis and Interpretation Manual, CSIRO Publishing, Collingwood Victoria

Armour J and Brennan R 2005. 'Zinc' in Peverill K, Sparrow L and Reuter D (eds), Soil Analysis and Interpretation Manual, CSIRO Publishing, Collingwood Victoria

Fredlund DG and Rahardjo H 1993 Soil Mechanics for Unsaturated Soils

Spain A, Warren P and Rantucci D 2005. Selected Properties of Materials in Relation to Their Capacity to Support Ecosystem Development, Mt Gordon Mine, Western Queensland – Final Report

NRA Environmental Consultants (NRA) 2013a. Birla Mt Gordon Seepage Environmental Evaluation

NRA Environmental Consultants (NRA) 2013b. FA Disturbance Area Review. Letter prepared for Jonathan Cowie

O'Kane M and Waters P 2003. Dry cover trials at Mt Whaleback – a summary of overburden area cover system performance, in Proceedings Sixth International Conference on Acid Rock Drainage, 14-17 July 2003, pp. 419–426, Australian Centre for Mining Environmental Research, Brisbane

Peverill K and Judson G 2005. 'Cobolt' in Peverill K, Sparrow L and Reuter D (eds), Soil Analysis and Interpretation Manual, CSIRO Publishing, Collingwood Victoria

Rohde TK and Williams DJ 2009 Early hydrological monitoring of Cadia's instrumented trial waste rock dump. In: Proceedings of Securing the Future and Eighth International Conference on Acid Mine Drainage, Skelleftea, Sweden, 22-26 June 2009, 12 pp

Rohde T, Williams D and Burton J 2011. Store and release cover performance at Cadia Hill Gold Mine, Australia, in Proceedings Sixth International Conference on Mine Closure, 18-21 September 2011, Perth: Australian Centre for Geomechanics

Williams D, Currey N, Ritchie P and Wilson G 2003. Kidston waste rock dump design and store and release cover performance seven years on, in Proceedings Sixth International Conference on Acid Rock Drainage, 14-17 July 2003, Australian Centre for Mining Environmental Research, Brisbane

Appendix A

Results from Spain et al (2005)

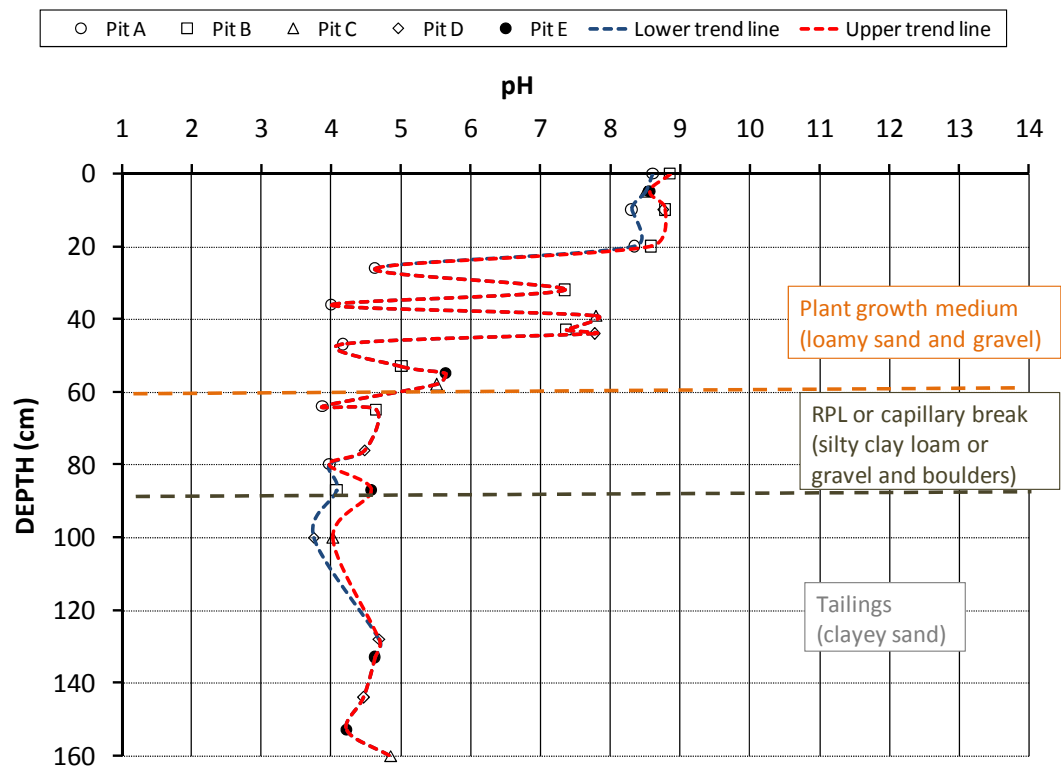


Figure A.1 Spain et al (2005) pH versus depth

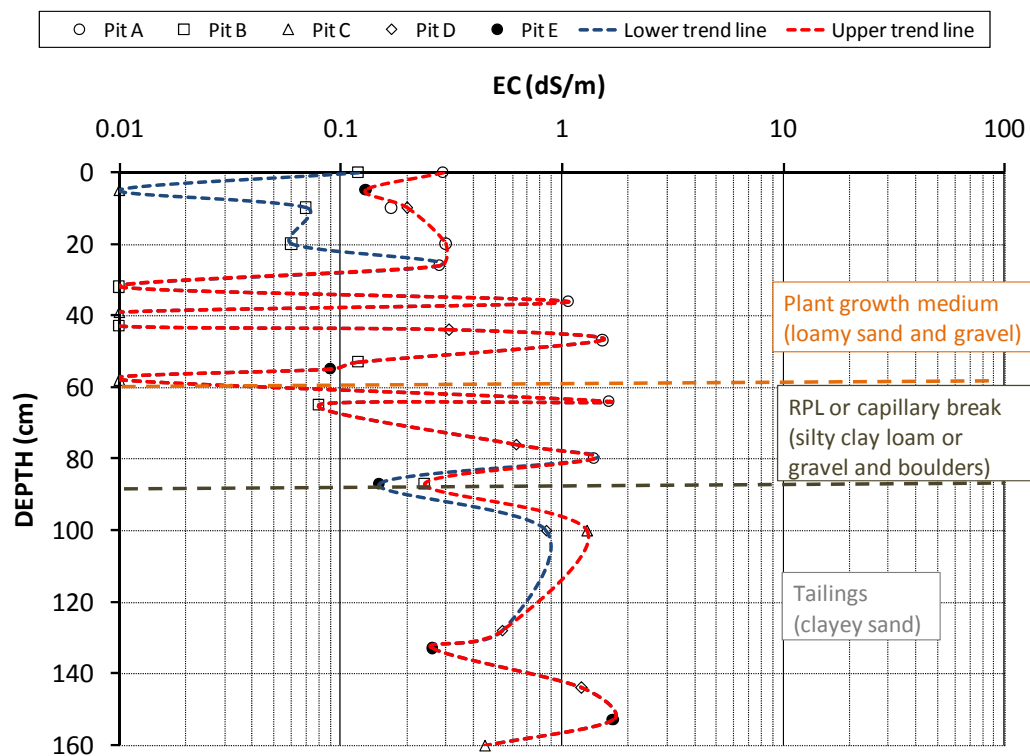


Figure A.2 Spain et al (2005) electrical conductivity versus depth

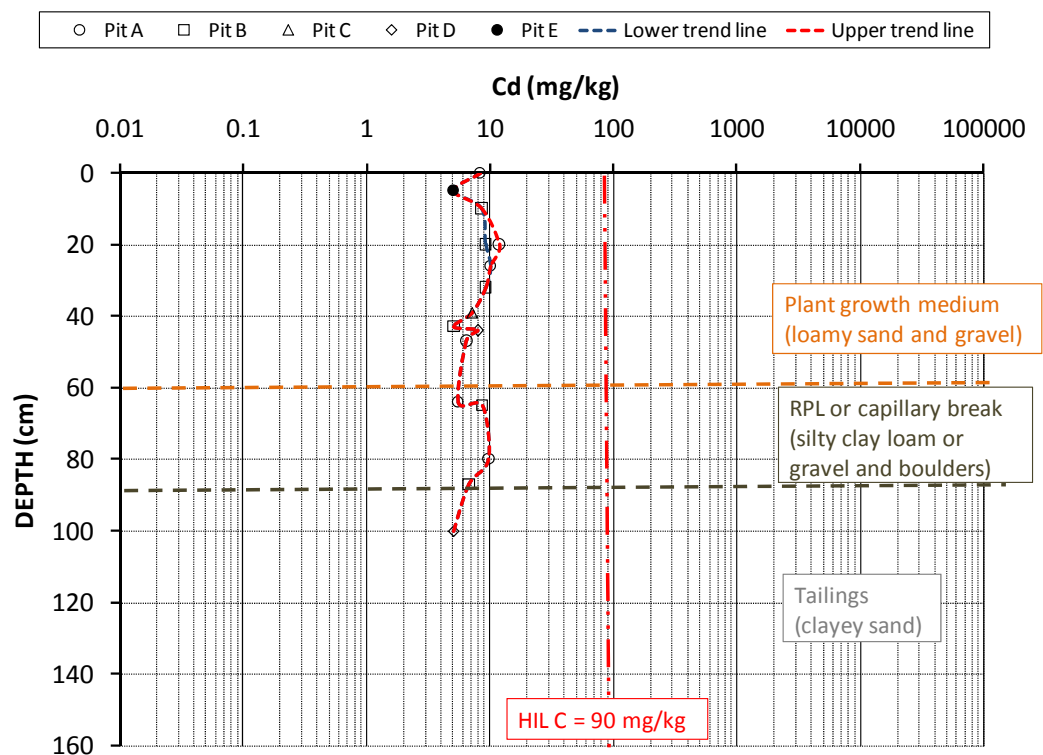


Figure A.3 Spain et al (2005) Cadmium versus depth

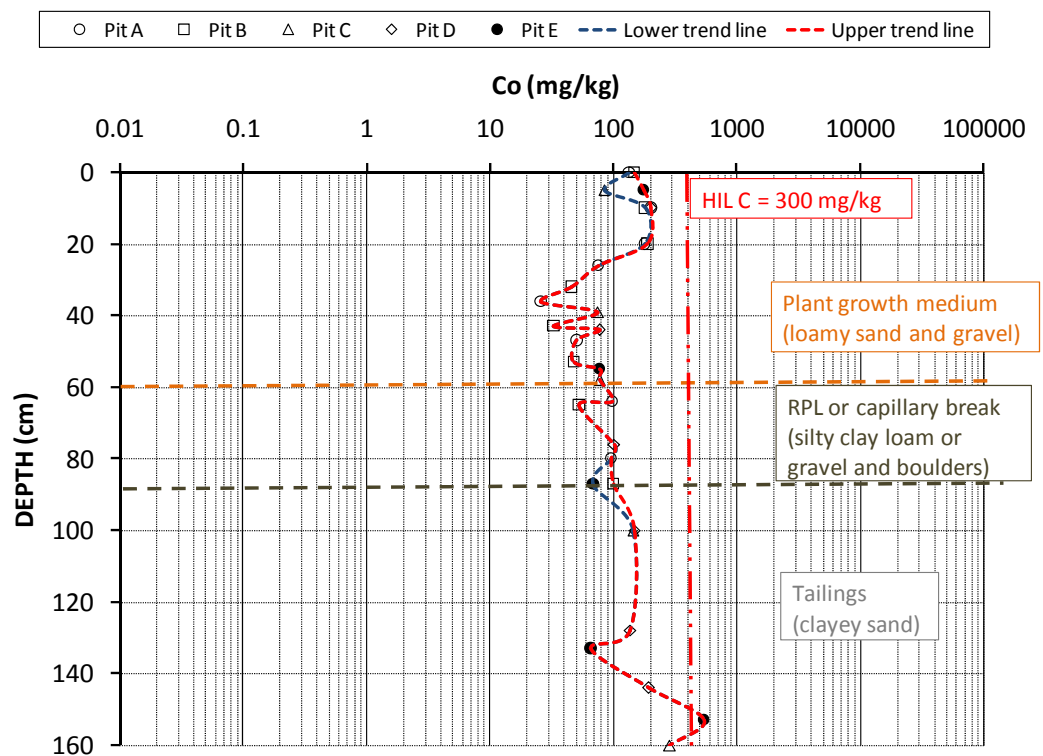


Figure A.4 Spain et al (2005) Cobalt versus depth

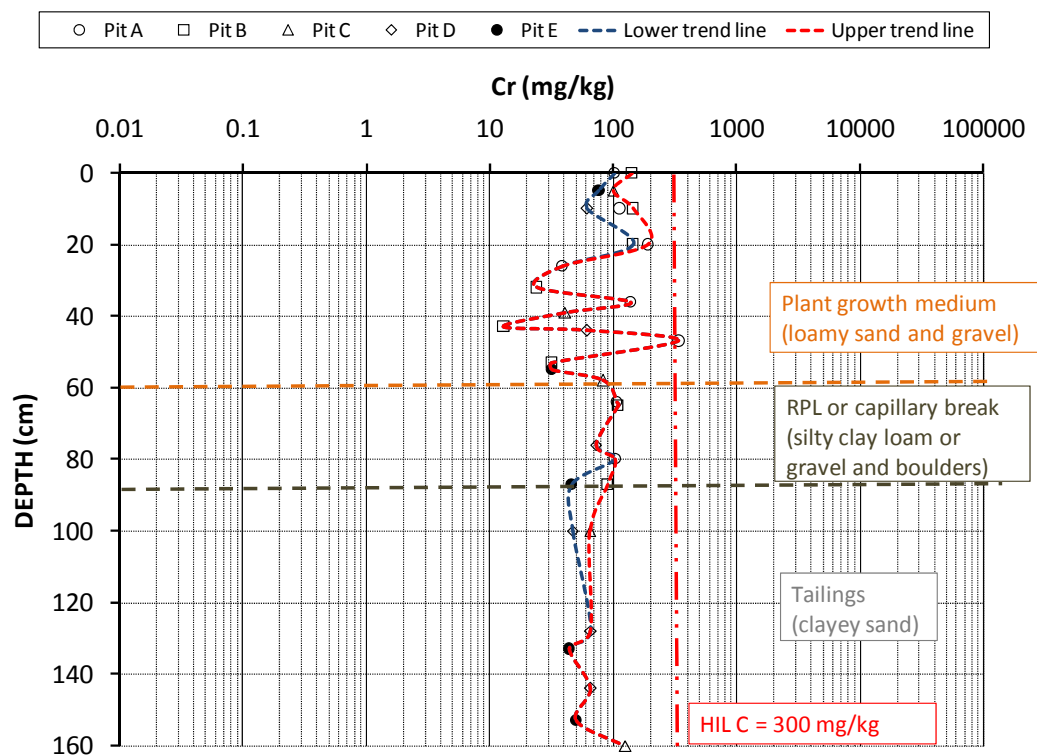


Figure A.5 Spain et al (2005) Chromium versus depth

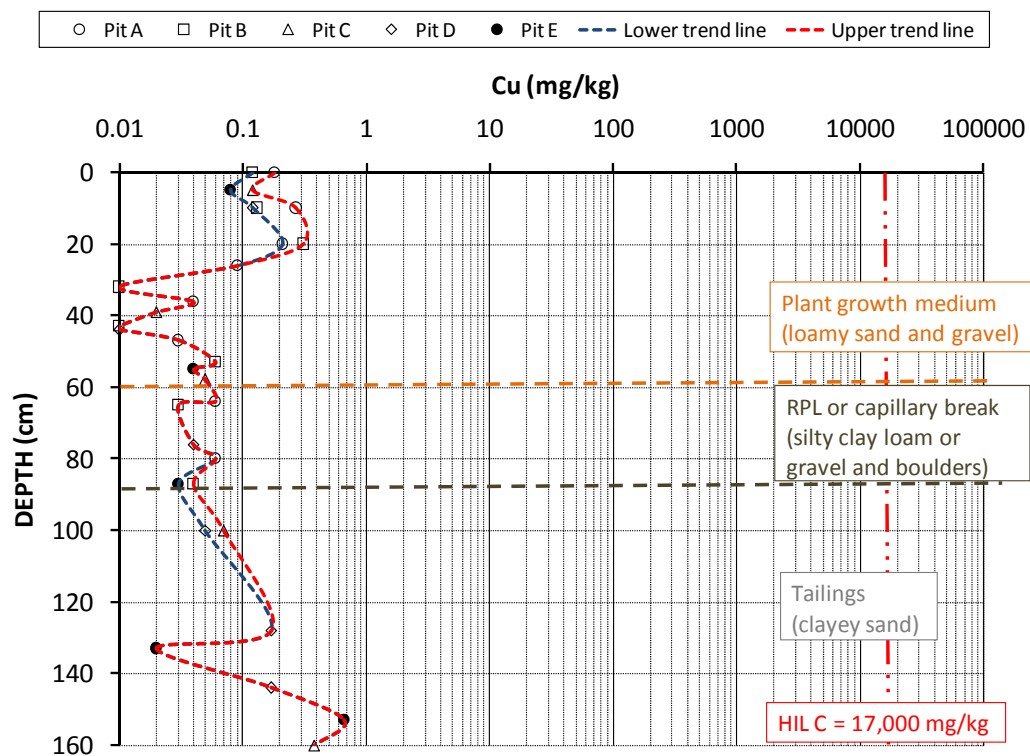


Figure A.6 Spain et al (2005) Copper versus depth

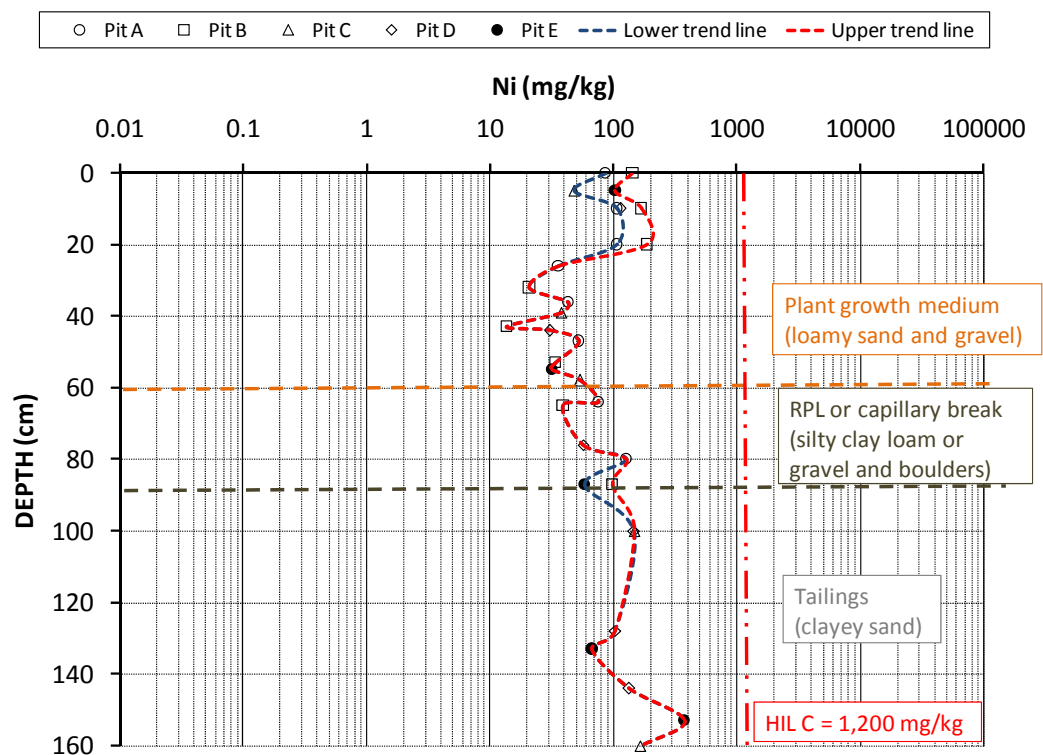


Figure A.7 Spain et al (2005) Nickel versus depth

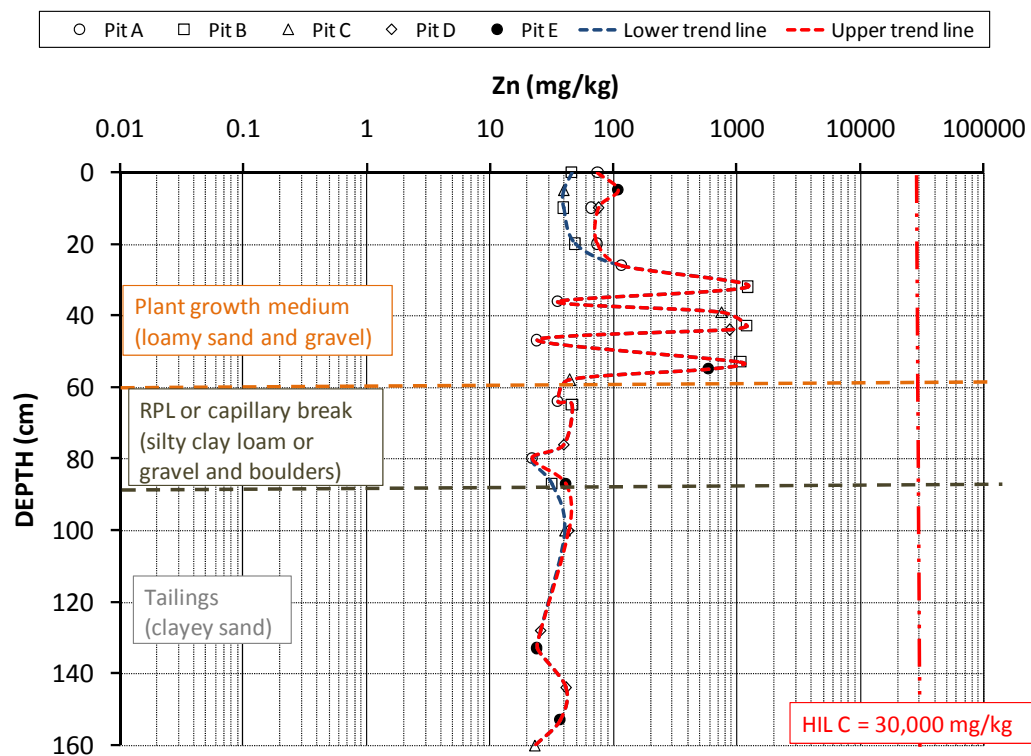


Figure A.8 Spain et al (2005) Zinc versus depth

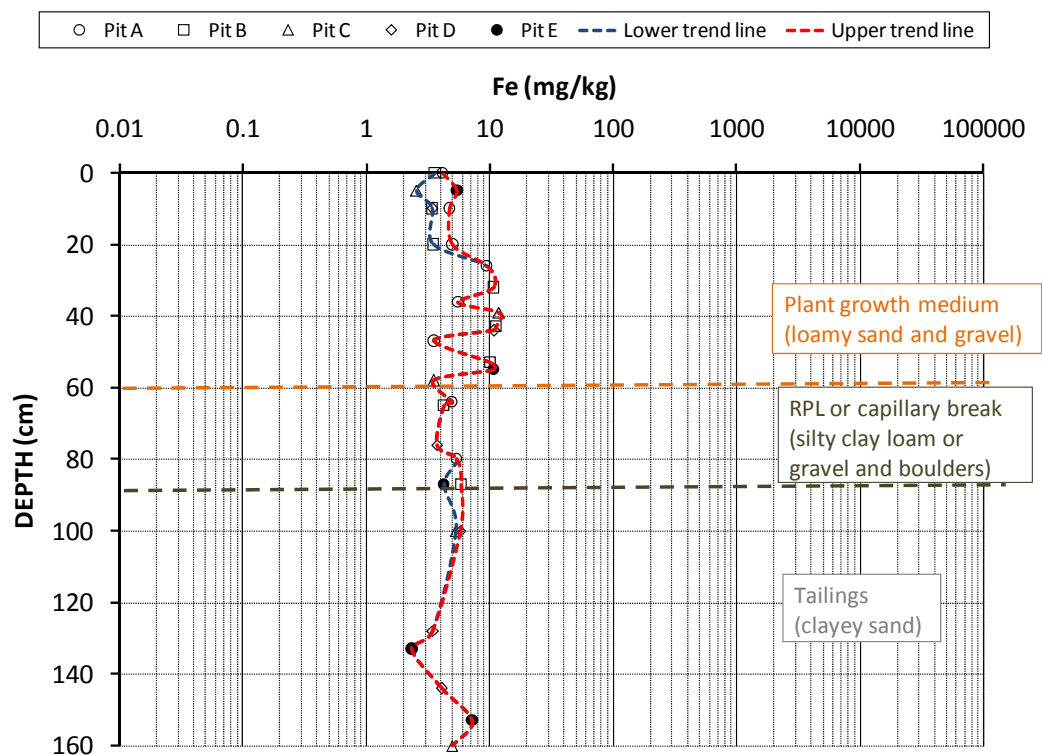


Figure A.9 Spain et al (2005) Iron versus depth

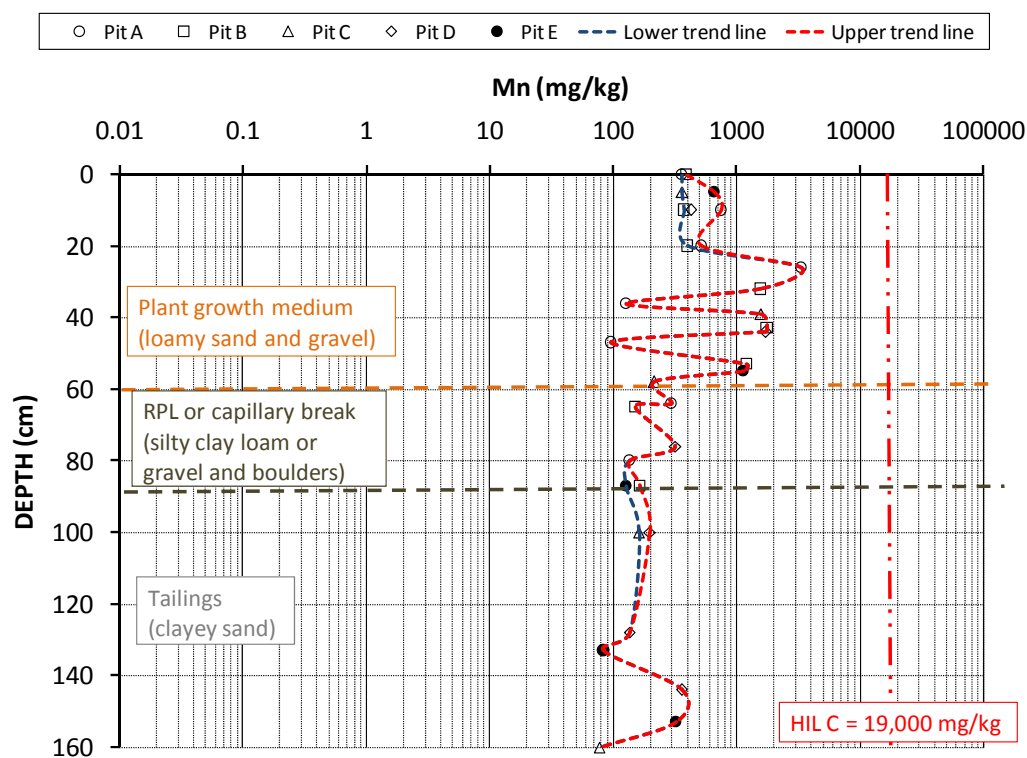


Figure A.10 Spain et al (2005) Manganese versus depth

Appendix B

Soil and rock physical characterisation

Certificate of Analysis

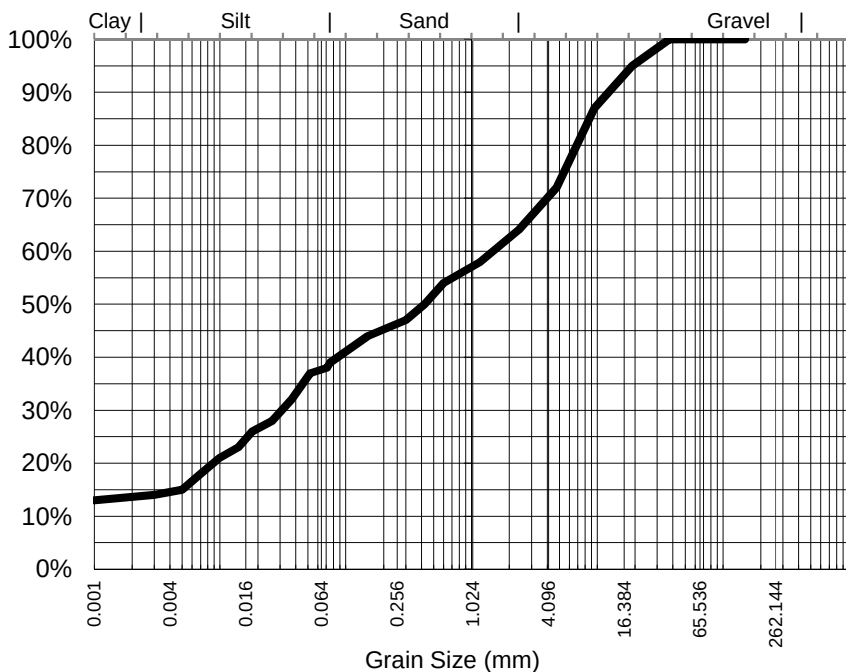
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Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

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Newcastle, NSW



CLIENT: Tim Rohde **DATE REPORTED:** 24-Jun-2015
COMPANY: Birla Mt Gordon Pty Ltd **DATE RECEIVED:** 12-Jun-2015
ADDRESS: Mt Isa **REPORT NO:** EB1520839-011 / PSD
PROJECT: Mt Gordon (cover design) **SAMPLE ID:** Pit A (0)

Particle Size Distribution



Particle Size (mm)	Percent Passing
37.5	100%
19.0	95%
9.50	87%
4.75	72%
2.36	64%
1.18	58%
0.600	54%
0.425	50%
0.300	47%
0.150	44%
0.075	39%
Particle Size (microns)	
71	38%
52	37%
37	32%
18	26%
10	21%
5	15%
1	13%

Samples analysed as received.

Median Particle Size (mm)*	0.425
----------------------------	-------

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Loss on Pretreatment NA

Sample Description: FINES, GRAVEL

Test Method: AS1289.3.6.3 2003

Soil Particle Density (<2.36mm) 2.8 g/cm3

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Analysed: 19-Jun-15

Limit of Reporting: 1%

Dispersion Method Shaker

Hydrometer Type ASTM E100

Dianne Blane
Inorganic Coordinator Newcastle
Authorised Signatory

Certificate of Analysis

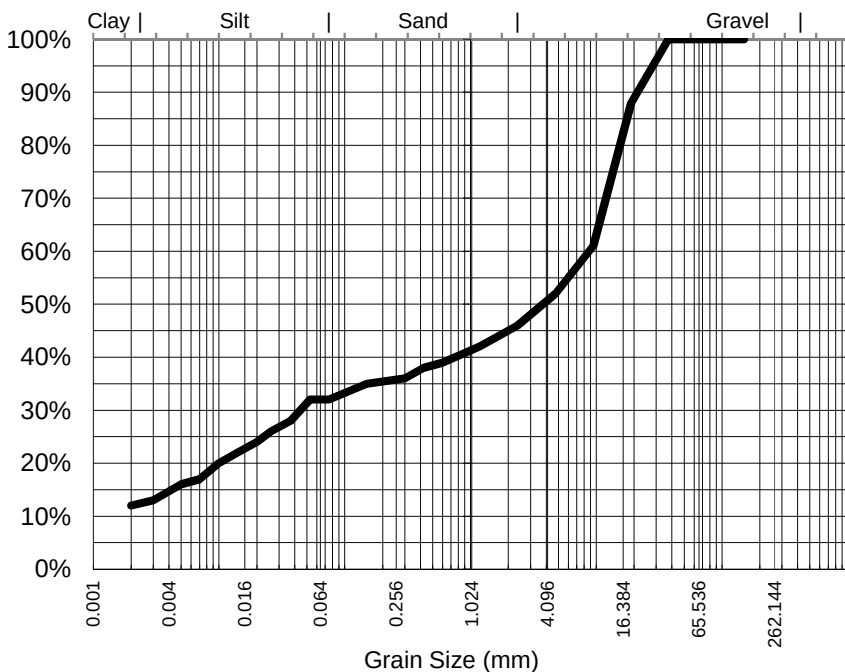
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Newcastle, NSW



CLIENT: Tim Rohde **DATE REPORTED:** 24-Jun-2015
COMPANY: Birla Mt Gordon Pty Ltd **DATE RECEIVED:** 12-Jun-2015
ADDRESS: Mt Isa **REPORT NO:** EB1520839-012 / PSD
PROJECT: Mt Gordon (cover design) **SAMPLE ID:** Pit A (20-1140)

Particle Size Distribution



Particle Size (mm)	Percent Passing
37.5	100%
19.0	88%
9.50	61%
4.75	52%
2.36	46%
1.18	42%
0.600	39%
0.425	38%
0.300	36%
0.150	35%
0.075	32%
Particle Size (microns)	
75	32%
53	32%
37	28%
20	24%
10	20%
5	16%
2	12%

Samples analysed as received.

Median Particle Size (mm)*	3.953
----------------------------	-------

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Loss on Pretreatment NA

Sample Description: FINES, GRAVEL

Test Method: AS1289.3.6.3 2003

Soil Particle Density (<2.36mm) 2.78 g/cm3

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Limit of Reporting: 1%

Dispersion Method Shaker

Hydrometer Type ASTM E100

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Inorganic Coordinator Newcastle
Authorised Signatory

Certificate of Analysis

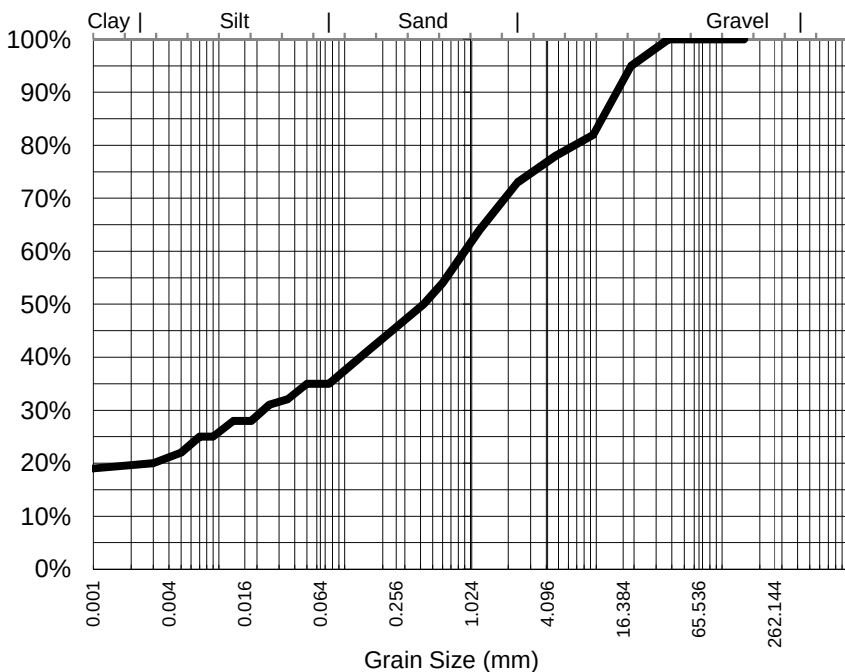
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COMPANY: Birla Mt Gordon Pty Ltd **DATE RECEIVED:** 12-Jun-2015
ADDRESS: Mt Isa **REPORT NO:** EB1520839-013 / PSD
PROJECT: Mt Gordon (cover design) **SAMPLE ID:** Pit A (1140-1400)

Particle Size Distribution



Particle Size (mm)	Percent Passing
37.5	100%
19.0	95%
9.50	82%
4.75	78%
2.36	73%
1.18	64%
0.600	54%
0.425	50%
0.300	47%
0.150	41%
0.075	35%
Particle Size (microns)	
70	35%
50	35%
35	32%
18	28%
9	25%
5	22%
1	19%

Samples analysed as received.

* Soil Particle Density results fell outside the scope of AS 1289.3.6.3. Typical sediment SPD values used for calculations and consequently, NATA endorsement does not apply to hydrometer results

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Loss on Pretreatment NA

Sample Description: CLAY, GRAVEL

Test Method: AS1289.3.6.3 2003

Soil Particle Density (<2.36mm) 2.96 g/cm3

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Limit of Reporting: 1%

Dispersion Method Shaker

Hydrometer Type ASTM E100

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Inorganic Coordinator Newcastle
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Certificate of Analysis

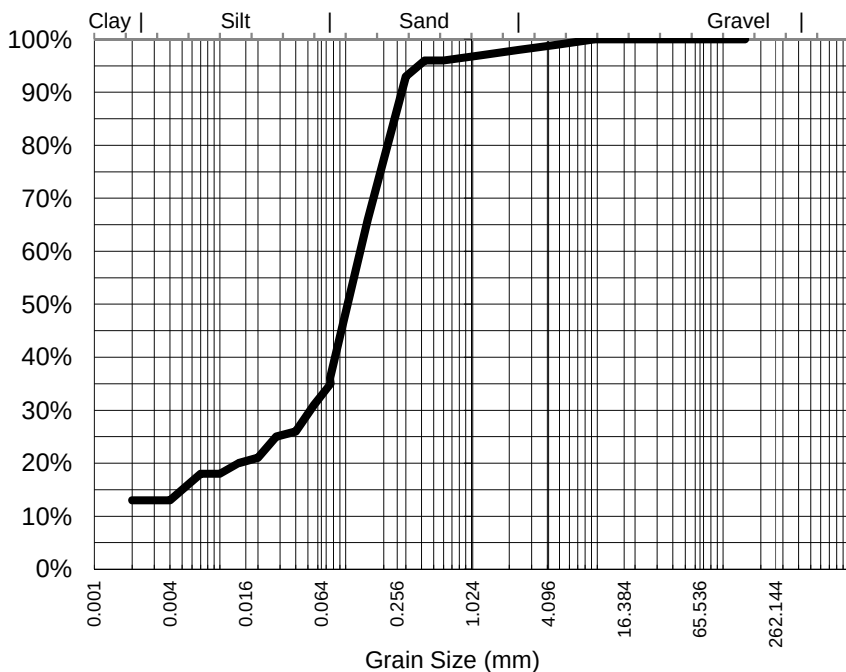
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COMPANY: Birla Mt Gordon Pty Ltd **DATE RECEIVED:** 12-Jun-2015
ADDRESS: Mt Isa **REPORT NO:** EB1520839-024 / PSD
PROJECT: Mt Gordon (cover design) **SAMPLE ID:** Pit B (900-1500)

Particle Size Distribution



Particle Size (mm)	Percent Passing
9.50	100%
4.75	99%
2.36	98%
1.18	97%
0.600	96%
0.425	96%
0.300	93%
0.150	66%
0.075	36%
Particle Size (microns)	
76	35%
56	31%
40	26%
20	21%
10	18%
5	15%
2	13%

Median Particle Size (mm)*	0.110
----------------------------	-------

Samples analysed as received.

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Loss on Pretreatment NA

Sample Description: FINES, GRAVEL

Test Method: AS1289.3.6.3 2003

Soil Particle Density (<2.36mm) 2.73 g/cm3

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Limit of Reporting: 1%

Dispersion Method Shaker

Hydrometer Type ASTM E100

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Inorganic Coordinator Newcastle
Authorised Signatory

Certificate of Analysis

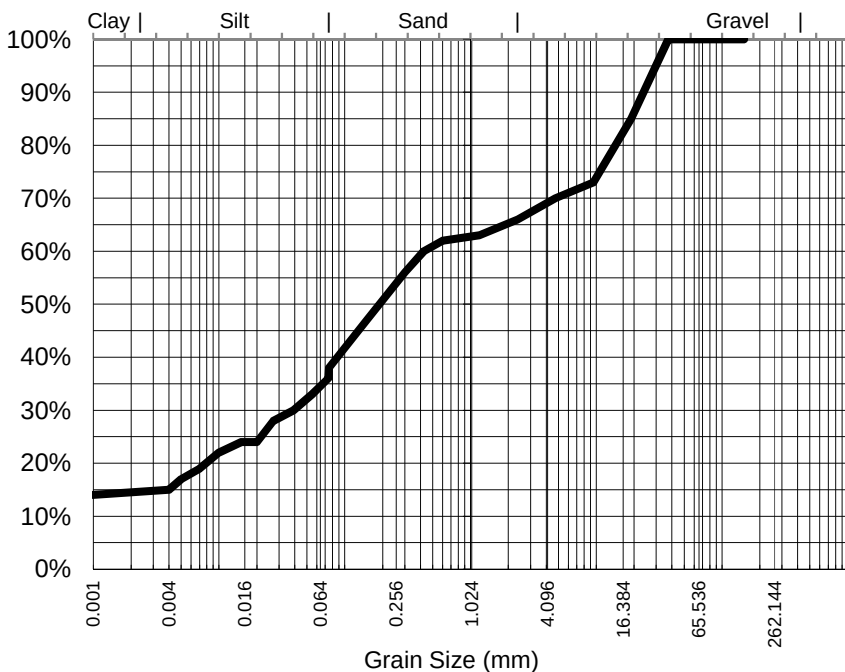
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CLIENT: Tim Rohde **DATE REPORTED:** 24-Jun-2015
COMPANY: Birla Mt Gordon Pty Ltd **DATE RECEIVED:** 12-Jun-2015
ADDRESS: Mt Isa **REPORT NO:** EB1520839-050 / PSD
PROJECT: Mt Gordon (cover design) **SAMPLE ID:** Magazine Creek Soil 1 (0-1900)

Particle Size Distribution



Particle Size (mm)	Percent Passing
37.5	100%
19.0	85%
9.50	73%
4.75	70%
2.36	66%
1.18	63%
0.600	62%
0.425	60%
0.300	56%
0.150	47%
0.075	38%
Particle Size (microns)	
74	36%
55	33%
39	30%
20	24%
10	22%
5	17%
1	14%

Samples analysed as received.

Median Particle Size (mm)*	0.200
----------------------------	-------

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Loss on Pretreatment NA

Sample Description: FINES, GRAVEL, VEG

Test Method: AS1289.3.6.3 2003

Soil Particle Density (<2.36mm) 2.67 g/cm3

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Dispersion Method Shaker

Hydrometer Type ASTM E100

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Certificate of Analysis

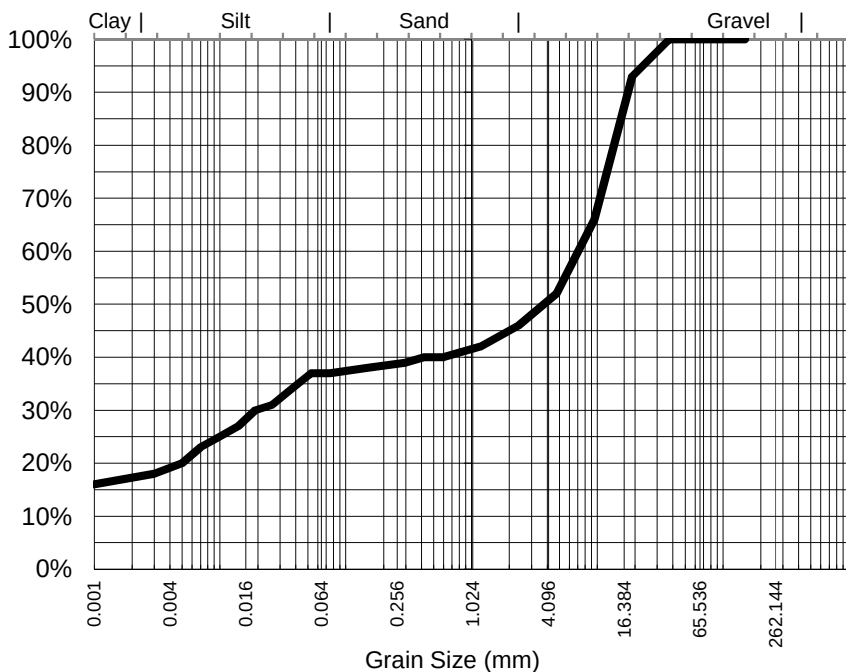
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CLIENT: Tim Rohde **DATE REPORTED:** 24-Jun-2015
COMPANY: Birla Mt Gordon Pty Ltd **DATE RECEIVED:** 12-Jun-2015
ADDRESS: Mt Isa **REPORT NO:** EB1520839-058 / PSD
PROJECT: Mt Gordon (cover design) **SAMPLE ID:** Magazine Creek Soil 1 (700-800)

Particle Size Distribution



Particle Size (mm)	Percent Passing
37.5	100%
19.0	93%
9.50	66%
4.75	52%
2.36	46%
1.18	42%
0.600	40%
0.425	40%
0.300	39%
0.150	38%
0.075	37%
Particle Size (microns)	
71	37%
53	37%
37	34%
19	30%
10	25%
5	20%
1	16%

Median Particle Size (mm)*	3.953
----------------------------	-------

Samples analysed as received.

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Loss on Pretreatment NA

Sample Description: FINES, GRAVEL, VEG

Test Method: AS1289.3.6.3 2003

Soil Particle Density (<2.36mm) 2.77 g/cm3

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Dispersion Method Shaker

Hydrometer Type ASTM E100

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Certificate of Analysis

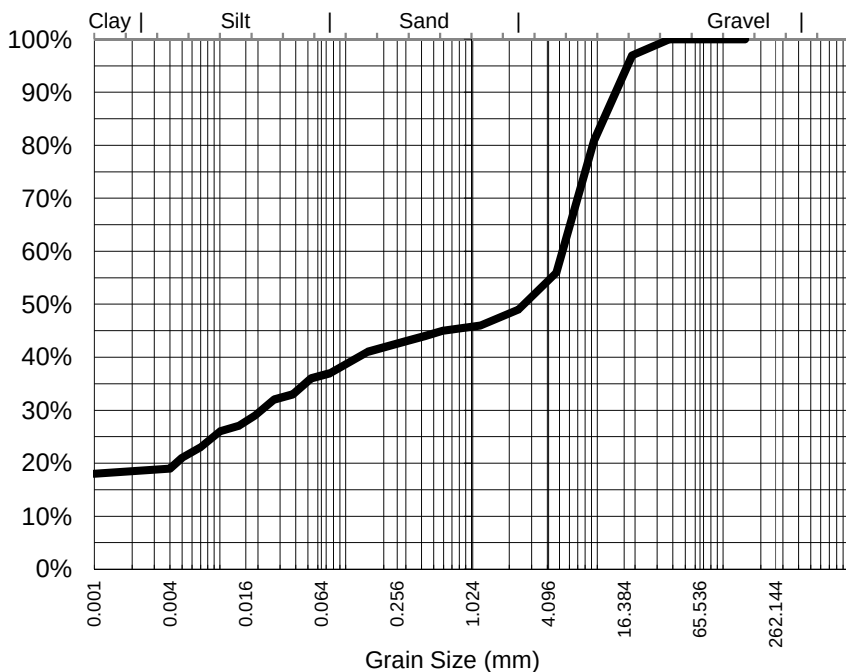
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COMPANY: Birla Mt Gordon Pty Ltd **DATE RECEIVED:** 12-Jun-2015
ADDRESS: Mt Isa **REPORT NO:** EB1520839-059 / PSD
PROJECT: Mt Gordon (cover design) **SAMPLE ID:** North Rock Soil 1 (0-1800)

Particle Size Distribution



Particle Size (mm)	Percent Passing
37.5	100%
19.0	97%
9.50	81%
4.75	56%
2.36	49%
1.18	46%
0.600	45%
0.425	44%
0.300	43%
0.150	41%
0.075	37%
Particle Size (microns)	
75	37%
53	36%
38	33%
19	29%
10	26%
5	21%
1	18%

Median Particle Size (mm)*	2.701
----------------------------	-------

Samples analysed as received.

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Loss on Pretreatment NA

Sample Description: CLAY, GRAVEL

Test Method: AS1289.3.6.3 2003

Soil Particle Density (<2.36mm) 2.71 g/cm3

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Dispersion Method Shaker

Hydrometer Type ASTM E100

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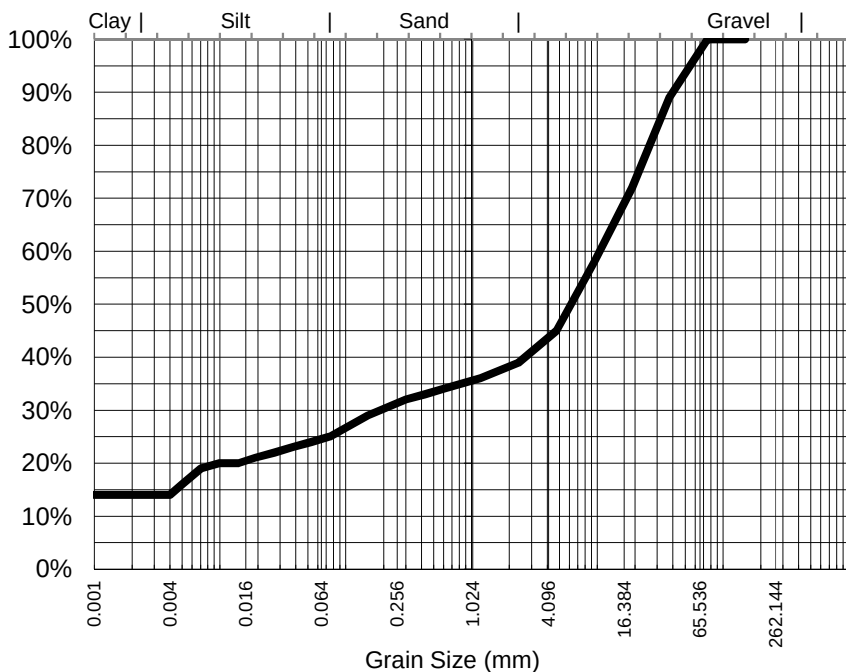
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COMPANY: Birla Mt Gordon Pty Ltd **DATE RECEIVED:** 12-Jun-2015
ADDRESS: Mt Isa **REPORT NO:** EB1520839-069 / PSD
PROJECT: Mt Gordon (cover design) **SAMPLE ID:** Borrow 1 (0-1400)

Particle Size Distribution



Particle Size (mm)	Percent Passing
75	100%
37.5	89%
19.0	72%
9.50	58%
4.75	45%
2.36	39%
1.18	36%
0.600	34%
0.425	33%
0.300	32%
0.150	29%
0.075	25%
Particle Size (microns)	
75	25%
53	24%
38	23%
19	21%
10	20%
5	16%
1	14%

Samples analysed as received.

Median Particle Size (mm)*	6.577
----------------------------	-------

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Loss on Pretreatment NA

Sample Description: CLAY, GRAVEL

Test Method: AS1289.3.6.3 2003

Soil Particle Density (<2.36mm) 2.74 g/cm3

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Dispersion Method Shaker

Hydrometer Type ASTM E100

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Inorganic Coordinator Newcastle
Authorised Signatory

Certificate of Analysis

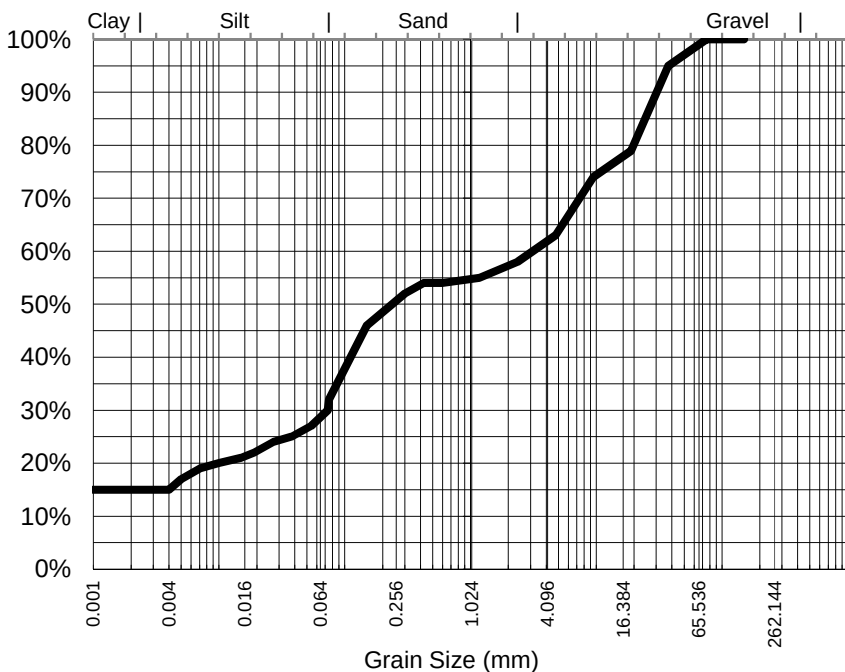
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CLIENT: Tim Rohde **DATE REPORTED:** 24-Jun-2015
COMPANY: Birla Mt Gordon Pty Ltd **DATE RECEIVED:** 12-Jun-2015
ADDRESS: Mt Isa **REPORT NO:** EB1520839-070 / PSD
PROJECT: Mt Gordon (cover design) **SAMPLE ID:** Diversion Dam Soil 1 (0)

Particle Size Distribution



Particle Size (mm)	Percent Passing
75	100%
37.5	95%
19.0	79%
9.50	74%
4.75	63%
2.36	58%
1.18	55%
0.600	54%
0.425	54%
0.300	52%
0.150	46%
0.075	32%
Particle Size (microns)	
73	30%
54	27%
38	25%
19	22%
10	20%
5	17%
1	15%

Samples analysed as received.

Median Particle Size (mm)*	0.250
----------------------------	-------

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Loss on Pretreatment NA

Sample Description: FINES, GRAVEL, VEG

Test Method: AS1289.3.6.3 2003

Soil Particle Density (<2.36mm) 2.68 g/cm3

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Limit of Reporting: 1%

Dispersion Method Shaker

Hydrometer Type ASTM E100

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Inorganic Coordinator Newcastle
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Certificate of Analysis

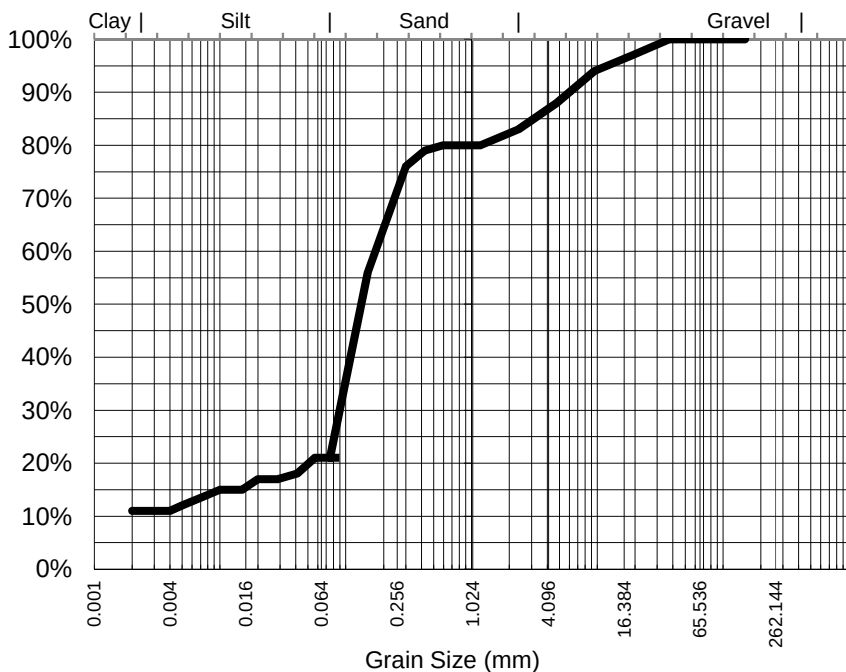
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CLIENT: Tim Rohde **DATE REPORTED:** 24-Jun-2015
COMPANY: Birla Mt Gordon Pty Ltd **DATE RECEIVED:** 12-Jun-2015
ADDRESS: Mt Isa **REPORT NO:** EB1520839-071 / PSD
PROJECT: Mt Gordon (cover design) **SAMPLE ID:** Diversion Dam Soil 2 (0-1300)

Particle Size Distribution



Particle Size (mm)	Percent Passing
37.5	100%
19.0	97%
9.50	94%
4.75	88%
2.36	83%
1.18	80%
0.600	80%
0.425	79%
0.300	76%
0.150	56%
0.075	21%
Particle Size (microns)	
81	21%
57	21%
41	18%
20	17%
10	15%
5	12%
2	11%

Median Particle Size (mm)*	0.137
----------------------------	-------

Samples analysed as received.

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Loss on Pretreatment NA

Sample Description: SAND, FINES, GRAVEL, VEG

Test Method: AS1289.3.6.3 2003

Soil Particle Density (<2.36mm) 2.64 g/cm3

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Limit of Reporting: 1%

Dispersion Method Shaker

Hydrometer Type ASTM E100

Dianne Blane
Inorganic Coordinator Newcastle
Authorised Signatory

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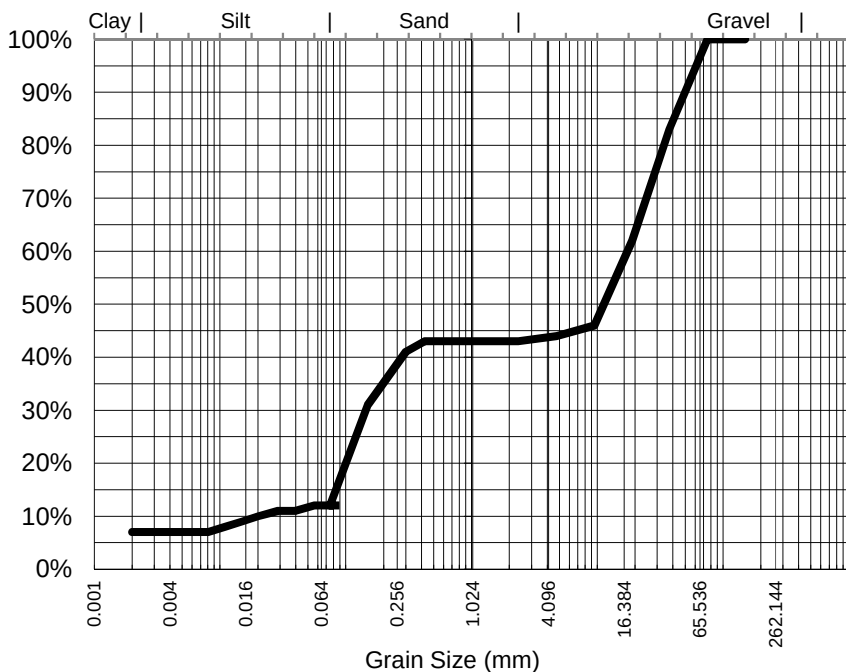
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COMPANY: Birla Mt Gordon Pty Ltd **DATE RECEIVED:** 12-Jun-2015
ADDRESS: Mt Isa **REPORT NO:** EB1520839-072 / PSD
PROJECT: Mt Gordon (cover design) **SAMPLE ID:** Diversion Dam Soil 1 (200-250)

Particle Size Distribution



Particle Size (mm)	Percent Passing
75	100%
37.5	83%
19.0	62%
9.50	46%
4.75	44%
2.36	43%
1.18	43%
0.600	43%
0.425	43%
0.300	41%
0.150	31%
0.075	12%
Particle Size (microns)	
81	12%
57	12%
40	11%
20	10%
11	8%
5	7%
2	7%

Median Particle Size (mm)*	11.875
----------------------------	--------

Samples analysed as received.

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Loss on Pretreatment NA

Sample Description: SAND, FINES, GRAVEL, VEG

Test Method: AS1289.3.6.3 2003

Soil Particle Density (<2.36mm) 2.62 g/cm3

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Analysed: 19-Jun-15

Limit of Reporting: 1%

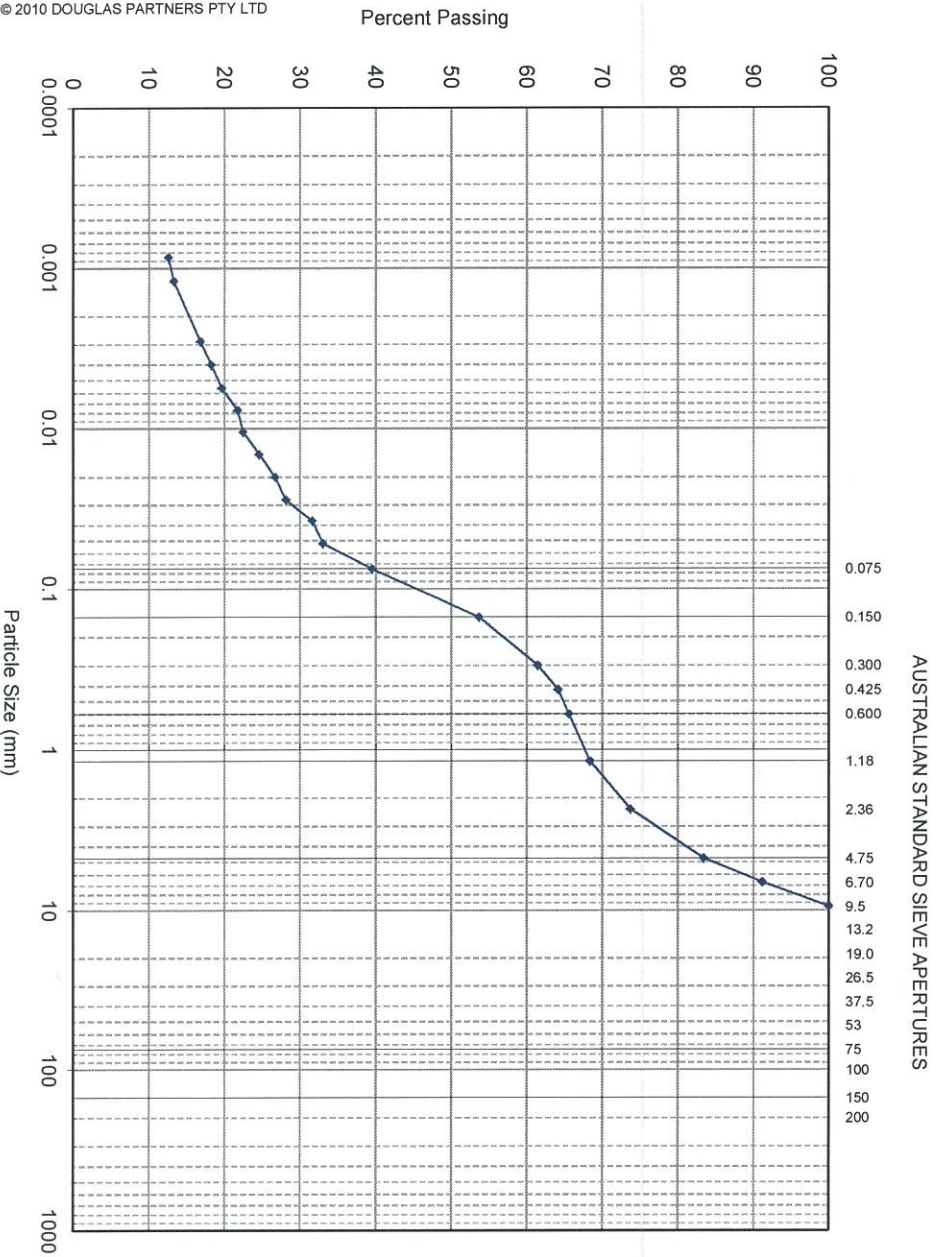
Dispersion Method Shaker

Hydrometer Type ASTM E100

Dianne Blane
Inorganic Coordinator Newcastle
Authorised Signatory

Results of Particle Size Distribution (Hydrometer)

Client :	Biria Mt. Gordon Pty Ltd	Project No. :	63386
Project :	B15035 - Mt Gordon	Report No. :	M15102025
Location :	Mt Gordon Mine, Mount Isa, QLD	Report Date :	06.08.2015
Test Location:	Div Dam3+Mill Creek1+Mag Creek1	Date Sampled:	-
Depth / Layer:	-	Date of Test:	29/07/2015
		Page:	1 of 1



Sieve Size (mm)	% Passing
75.0	~
53.0	~
37.5	~
26.5	~
19.0	~
13.2	~
9.5	100%
6.7	91%
4.75	83%
2.36	74%
1.18	68%
0.600	66%
0.425	64%
0.300	61%
0.150	54%
0.075	40%
0.037	32%
0.028	28%
0.020	27%
0.014	25%
0.010	22%
0.008	22%
0.006	20%
0.004	18%
0.003	17%
#N/A	-1%
#N/A	-1%

CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
	0.002	0.006	0.02	0.06	0.2	0.6	2.0	6.0	20	60

Description: Slightly silty, gravelly SAND some clay

Test Method(s): AS 1289.3.6.1, AS1289.3.6.3, AS1289.3.5.1

Sampling Method(s): Sampled by Client

Remarks: Soil Particle Density = 2.70 t/m³

Loss in pretreatment: 0%

Type of Hydrometer: g/l



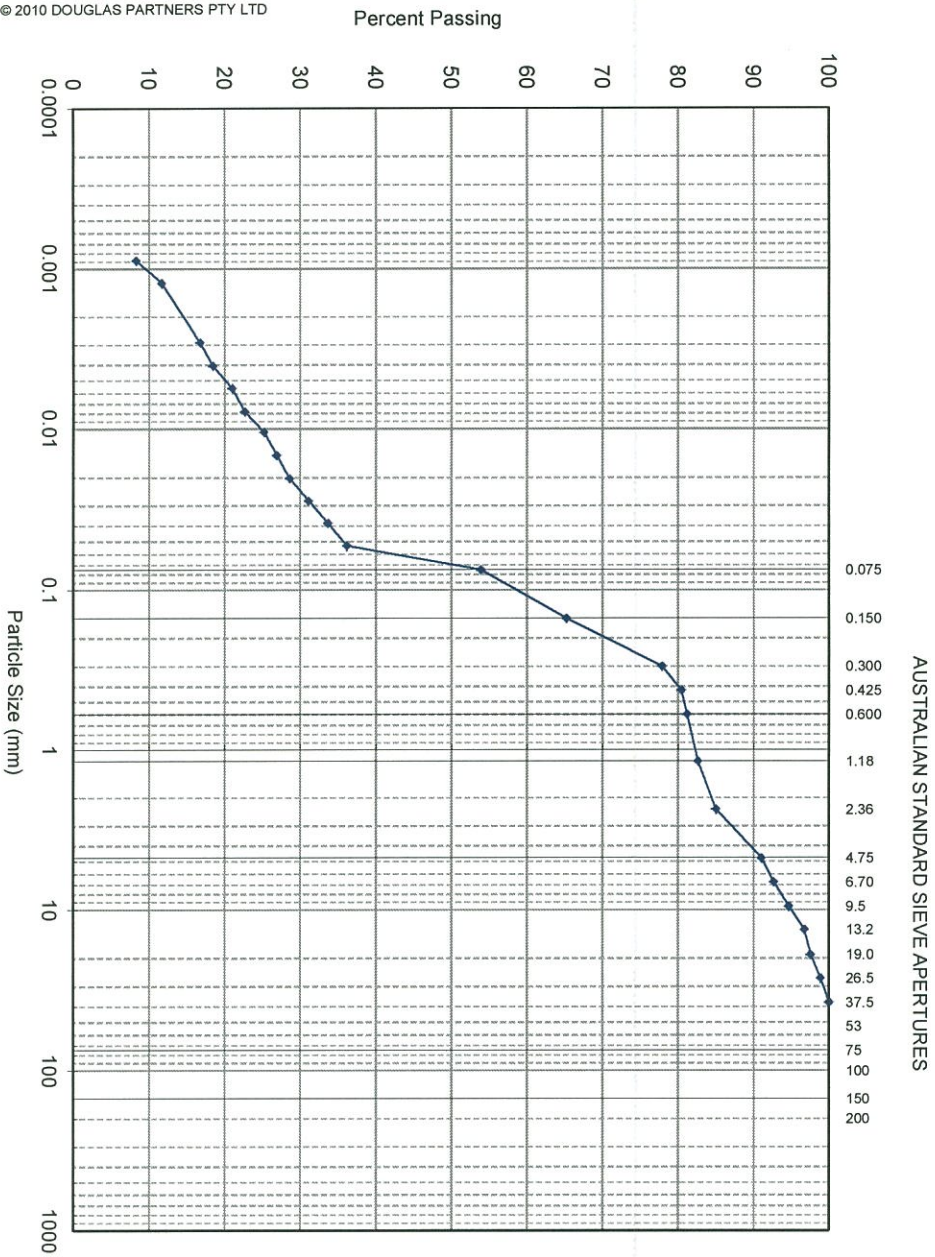
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Tested: SP
Checked: AD

Andrew Murphy
Senior Associate

Results of Particle Size Distribution (Hydrometer)

Client :	Birta Mt. Gordon Pty Ltd	Project No. :	63386
Project :	B15035 - Mt Gordon	Report No. :	M15102024
Location :	Mt Gordon Mine, Mount Isa, QLD	Report Date :	03.08.2015
Test Location:	PitA(20-1140)+PartB Tailings	Date Sampled:	-
Depth / Layer:	-	Date of Test:	22/07/2015
		Page:	1 of 1



Sieve Size (mm)	% Passing
75.0	~
53.0	~
37.5	100%
26.5	99%
19.0	98%
13.2	97%
9.5	95%
6.7	93%
4.75	91%
2.36	85%
1.18	83%
0.600	81%
0.425	80%
0.300	78%
0.150	65%
0.075	54%
0.039	34%
0.028	31%
0.020	29%
0.015	27%
0.010	25%
0.008	23%
0.006	21%
0.004	18%
0.003	17%
#N/A	-1%
#N/A	-1%

CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
	0.002	0.006	0.02	0.06	0.2	0.6	2.0	6.0	20	60

Description: Slightly clayey, slightly gravelly, silty SAND

Test Method(s): AS 1289.3.6.1, AS1289.3.6.3, AS1289.3.5.1

Sampling Method(s): Sampled by Client

Remarks: Soil Particle Density = 2.709 t/m³

Loss in pretreatment: 0%

Type of Hydrometer: g/l



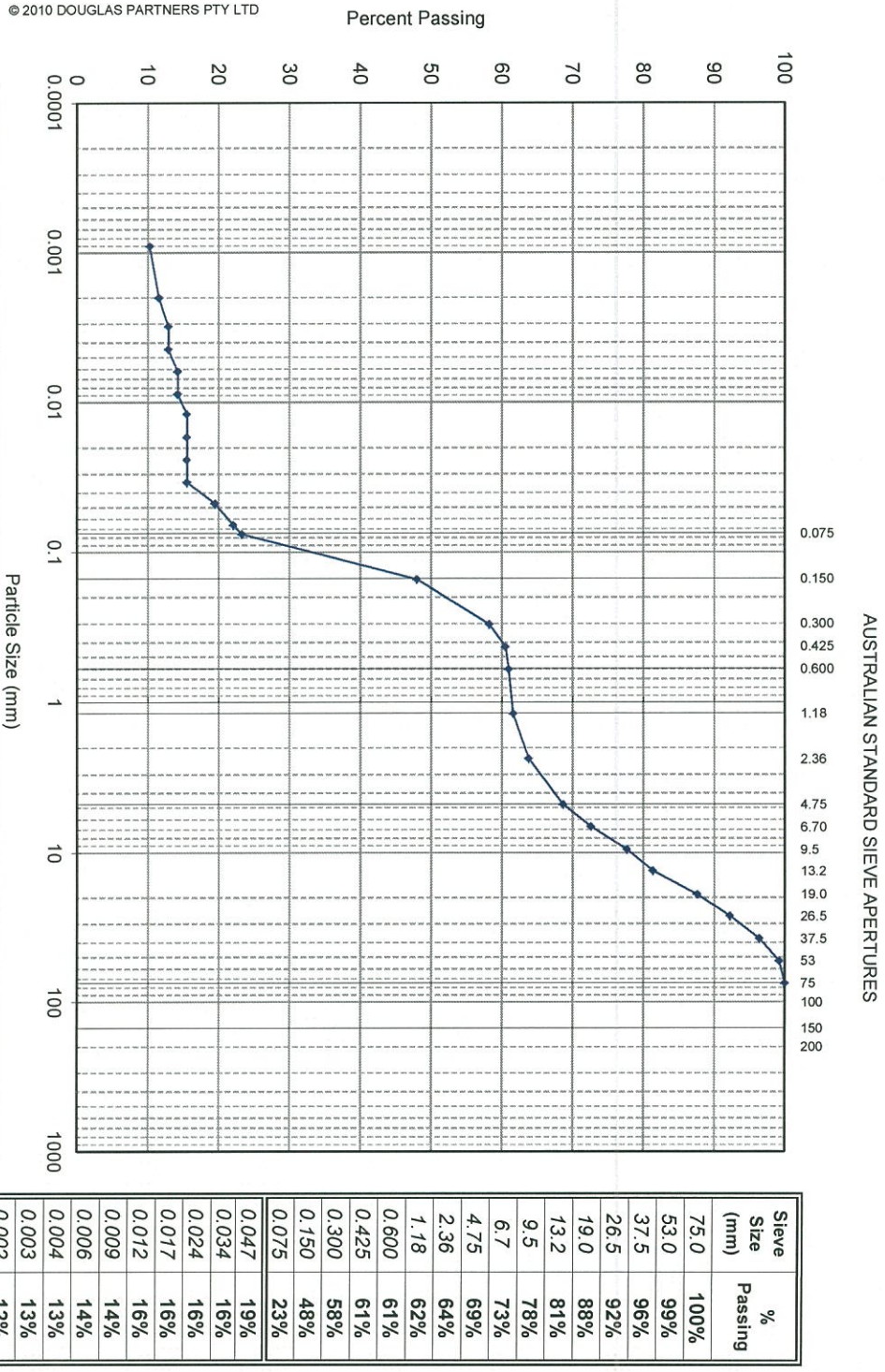
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Tested: YM
Checked: AD

Michael Broise
Principal

Results of Particle Size Distribution (Hydrometer)

Client :	Birla Mt. Gordon Pty Ltd	Project No. :	63386.00
Project :	B15035 - Mt Gordon	Report No. :	M15102002
Location :	Mt Gordon Mine, Mount Isa, QLD	Report Date :	20.07.2015
Test Location:	Diversion Dam Soil 3	Date Sampled:	-
Depth / Layer:	-	Date of Test:	10/07/2015
		Page:	1 of 1



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CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
	0.002	0.006	0.02	0.06	0.2	0.6	2.0	6.0	20	60

Description: GRAVEL and SAND, some silt, some clay

Test Method(s): AS 1289.3.6.1, AS1289.3.6.3

Sampling Method(s): Sampled by Client

Remarks: Soil Particle Density Passing 2.36mm sieve= 2.67 t/m³

Loss in pretreatment: 0%

Type of Hydrometer: g1



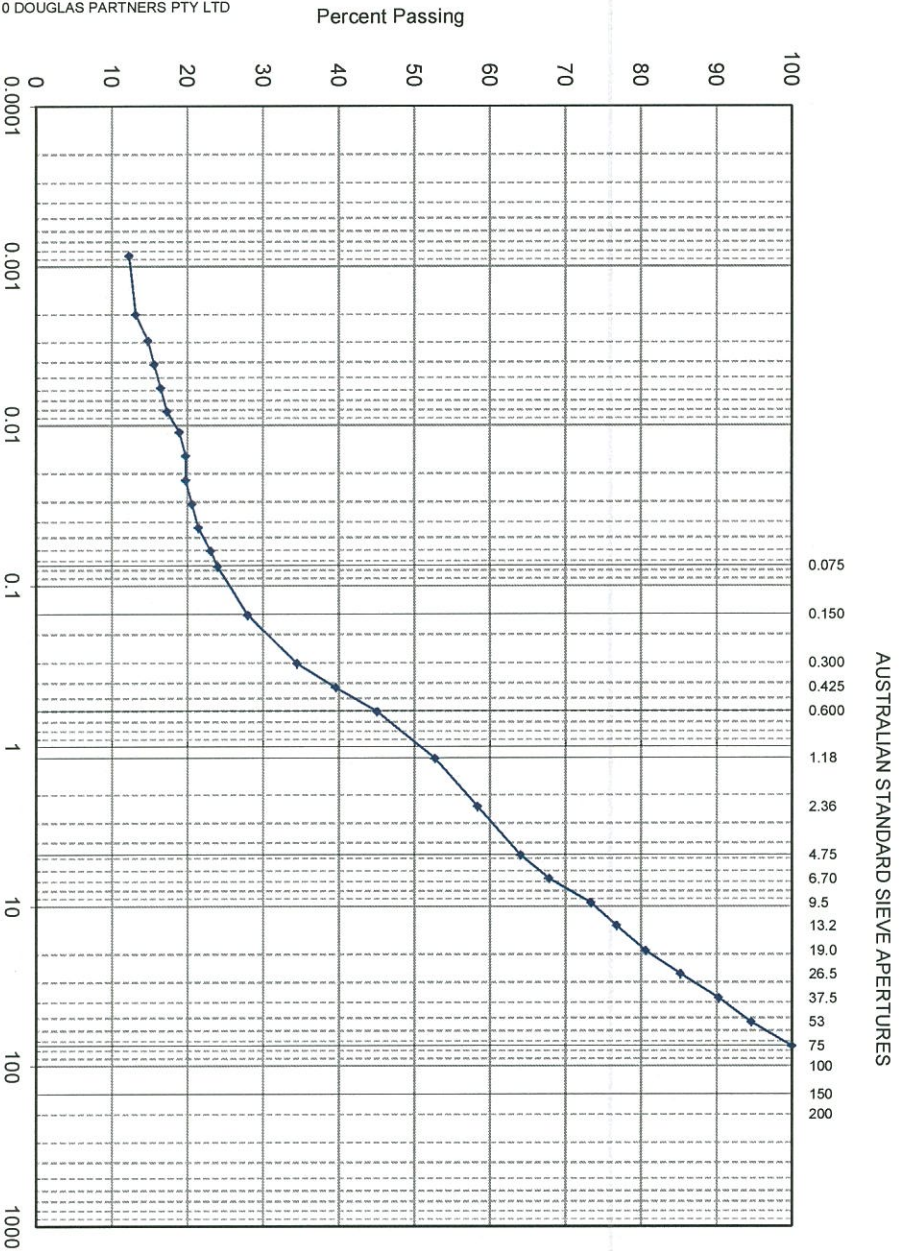
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Tested: AD
Checked: AG

Andrew Murphy
Senior Associate

Results of Particle Size Distribution (Hydrometer)

Client :	Birla Mt. Gordon Pty Ltd	Project No. :	63386.00
Project :	B15035 - Mt Gordon	Report No. :	M15102003
Location :	Mt Gordon Mine, Mount Isa, QLD	Report Date :	20.07.2015
Test Location:	Borrow 2	Date Sampled:	-
Depth / Layer:	-	Date of Test:	30/06/2015
		Page:	1 of 1



Sieve Size (mm)	% Passing
75.0	100%
53.0	95%
37.5	90%
26.5	85%
19.0	81%
13.2	77%
9.5	73%
6.7	68%
4.75	64%
2.36	58%
1.18	53%
0.600	45%
0.425	40%
0.300	35%
0.150	28%
0.075	24%
0.043	21%
0.031	21%
0.022	20%
0.015	20%
0.011	19%
0.008	17%
0.006	16%
0.004	16%
0.003	15%
0.002	13%
0.001	12%

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CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
	0.002	0.006	0.02	0.06	0.2	0.6	2.0	6.0	20	60

Description: Slightly clayey SAND and GRAVEL, some silt

Test Method(s): AS 1289.3.6.1, AS1289.3.6.3

Sampling Method(s): Sampled by Client.

Remarks: Soil Particle Density Passing 2.36mm sieve= 2.71 t/m³

Loss in pretreatment: 0%

Type of Hydrometer: g/I



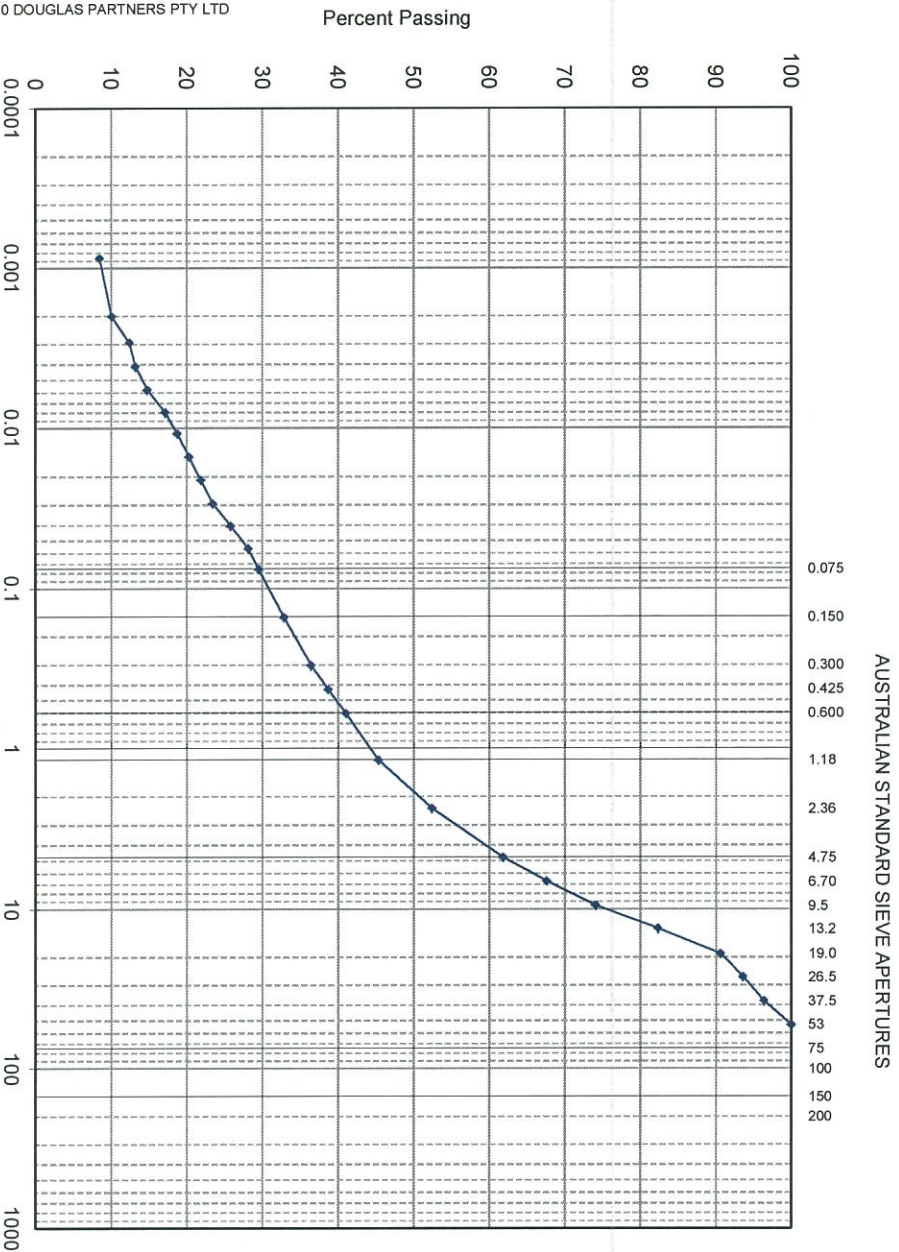
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Tested: AD
Checked: AG

Andrew Murphy
Senior Associate

Results of Particle Size Distribution (Hydrometer)

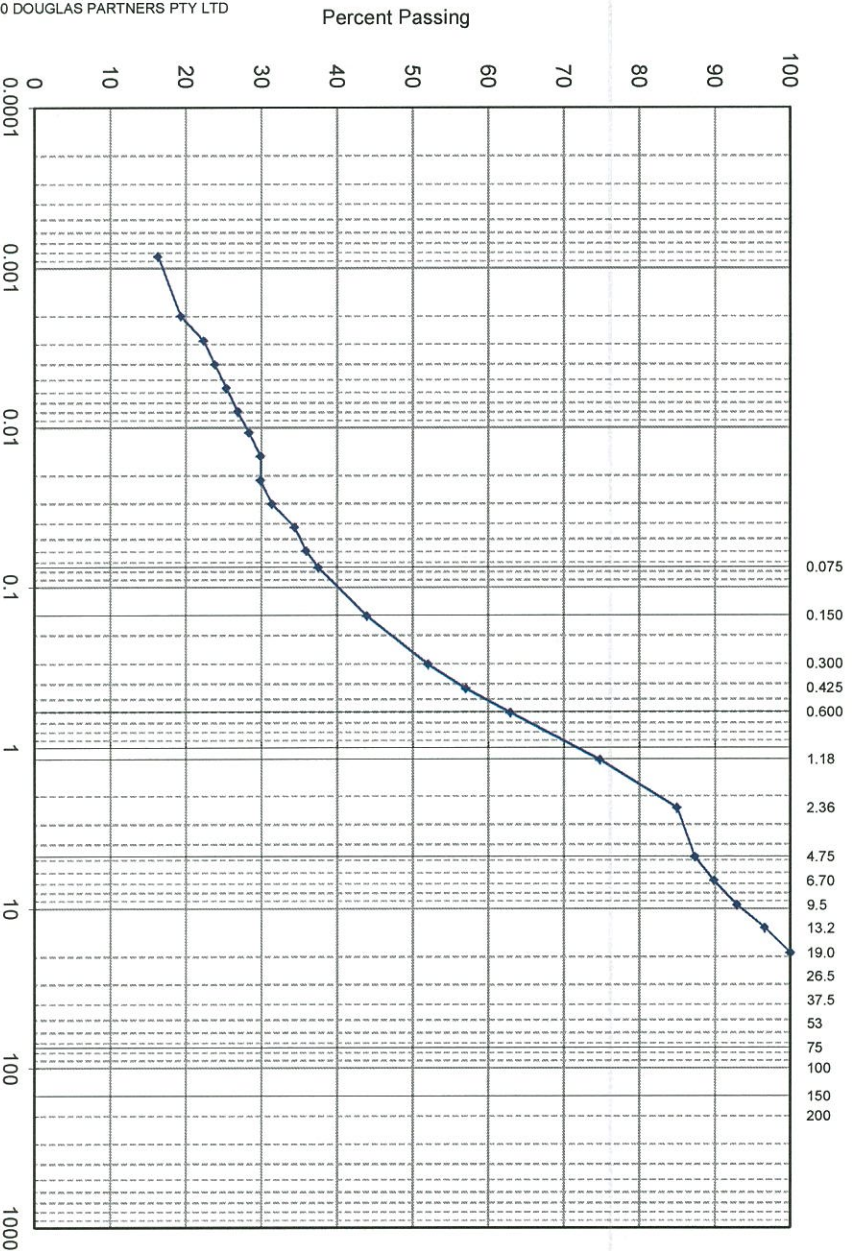
Client :	Birla Mt. Gordon Pty Ltd	Project No. :	63386.00
Project :	B15035 - Mt Gordon	Report No. :	M15102004
Location :	Mt Gordon Mine, Mount Isa, QLD	Report Date :	20.07.2015
Test Location:	Pit A (20-1140)	Date Sampled:	-
Depth / Layer:	-	Date of Test:	08/07/2015
		Page:	1 of 1



Results of Particle Size Distribution (Hydrometer)

Client :	Birla Mt. Gordon Pty Ltd	Project No. :	63386.00
Project :	B15035 - Mt Gordon	Report No. :	M15102005
Location :	Mt Gordon Mine, Mount Isa, QLD	Report Date :	20.07.2015
Test Location:	PitA(1140-1400)	Date Sampled:	-
Depth / Layer:	-	Date of Test:	30/06/2015
		Page:	1 of 1

AUSTRALIAN STANDARD SIEVE APERTURES



Particle Size (mm)

CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
	0.002	0.006	0.02	0.06	0.2	0.6	2.0	6.0	20	60

Sieve Size (mm)	% Passing
75.0	~
53.0	~
37.5	~
26.5	~
19.0	100%
13.2	97%
9.5	93%
6.7	90%
4.75	87%
2.36	85%
1.18	75%
0.600	63%
0.425	57%
0.300	52%
0.150	44%
0.075	38%
0.042	34%
0.030	31%
0.021	30%
0.015	30%
0.011	28%
0.008	27%
0.006	25%
0.004	24%
0.003	22%
0.002	19%
0.001	16%

Description: Slightly gravelly clayey silty SAND

Test Method(s): AS 1289.3.6.1, AS1289.3.6.3

Sampling Method(s): Sampled by Client

Remarks: Soil Particle Density Passing 2.36mm sieve= 2.86 t/m³

Loss in pretreatment: 0%

Type of Hydrometer: g/l



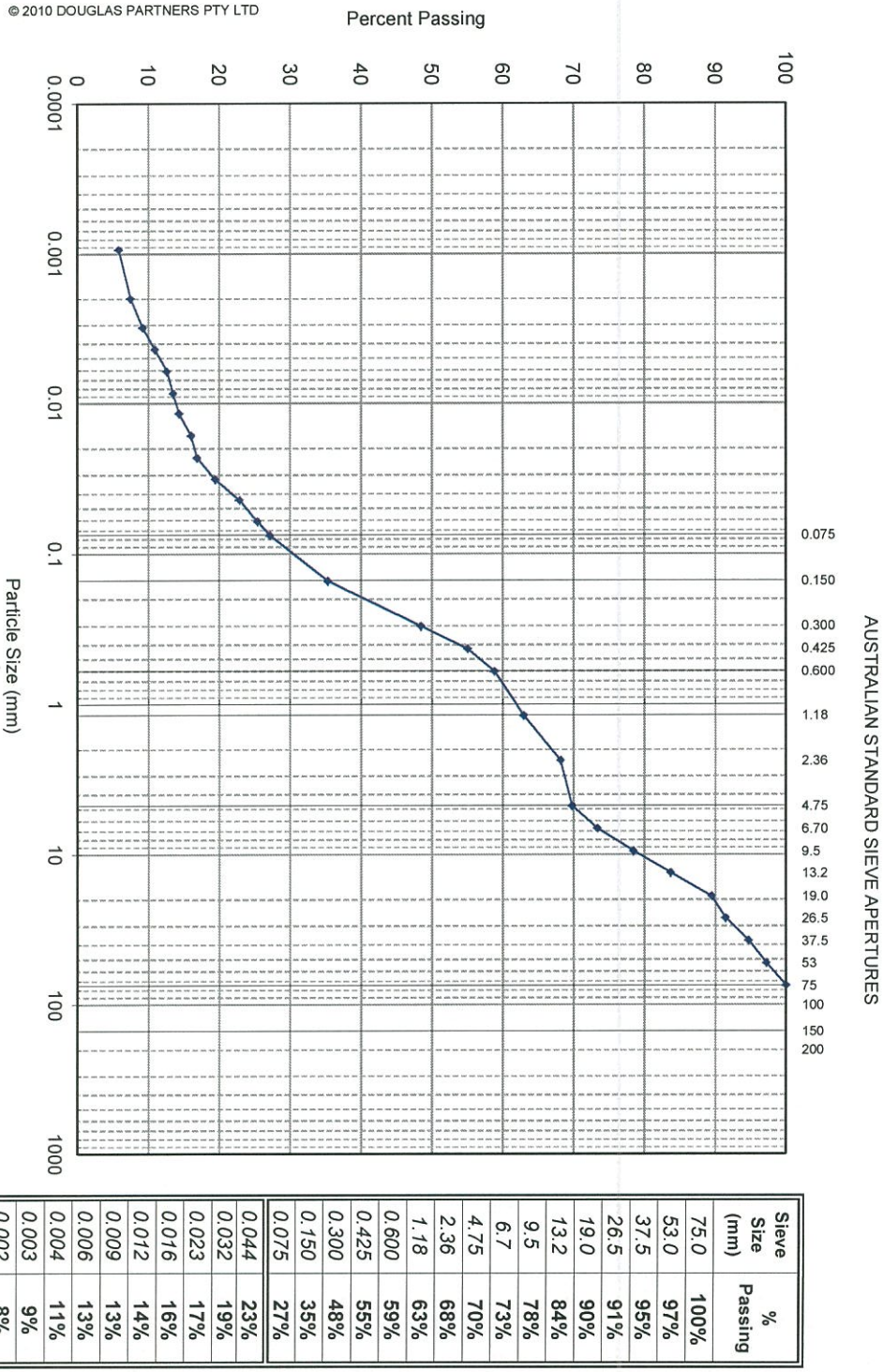
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Tested: AD
Checked: AG

Andrew Murphy
Senior Associate

Results of Particle Size Distribution (Hydrometer)

Client :	Birla Mt. Gordon Pty Ltd	Project No. :	63386.00
Project :	B15035 - Mt Gordon	Report No. :	M15102006
Location :	Mt Gordon Mine, Mount Isa, QLD	Report Date :	20.07.2015
Test Location:	Magazine Creek Soil	Date Sampled:	-
Depth / Layer:	-	Date of Test:	01/07/2015
		Page:	1 of 1



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CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
	0.002	0.006	0.02	0.06	0.2	0.6	2.0	6.0	20	60

Description: Silty gravelly SAND, some clay

Test Method(s): AS 1289.3.6.1, AS1289.3.6.3

Sampling Method(s): Sampled by Client

Remarks: Soil Particle Density Passing 2.36mm sieve= 2.63 t/m³

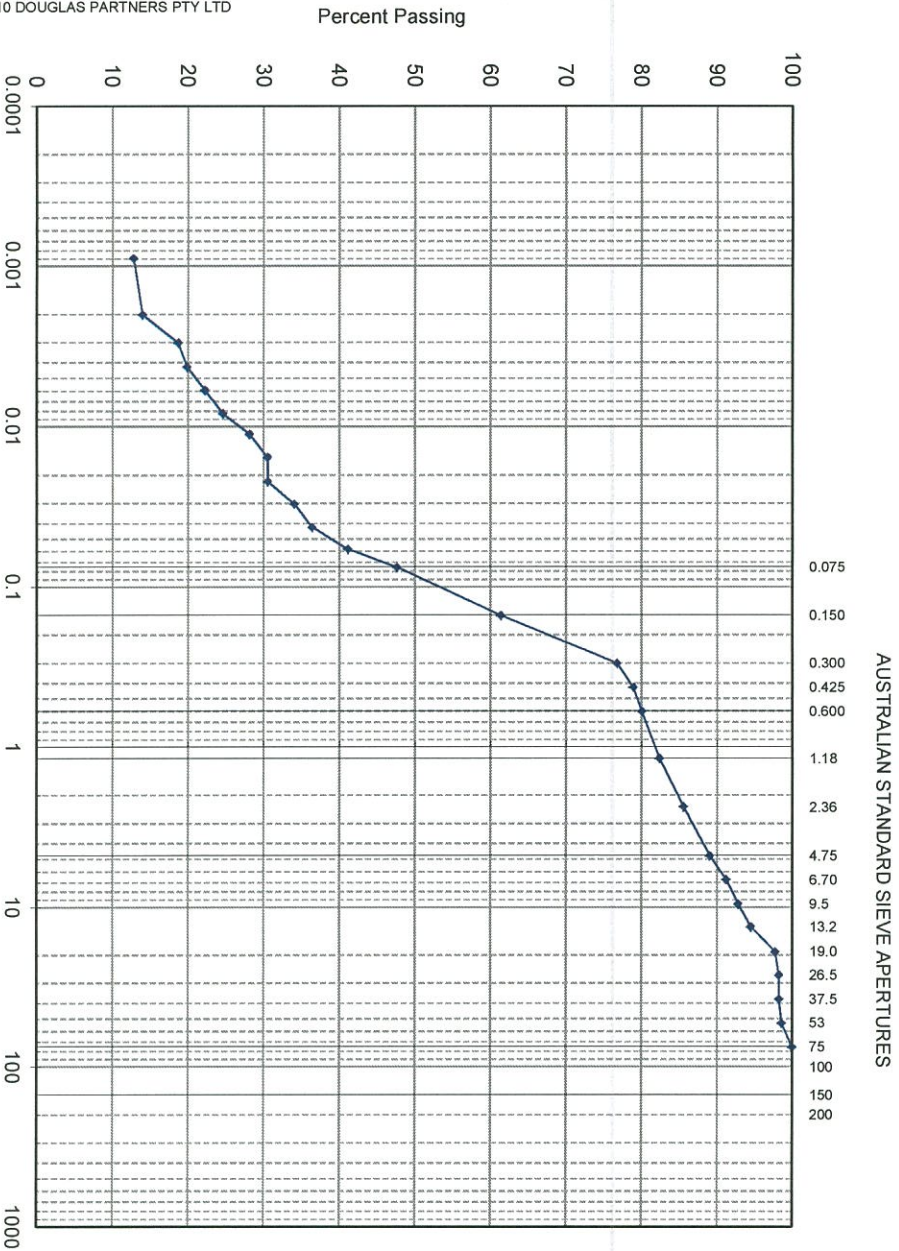
Loss in pretreatment: 0%

Type of Hydrometer: g/



Results of Particle Size Distribution (Hydrometer)

Client :	Birla Mt. Gordon Pty Ltd	Project No. :	63386.00
Project :	B15035 - Mt Gordon	Report No. :	M15102007
Location :	Mt Gordon Mine, Mount Isa, QLD	Report Date :	00.01.1900
Test Location:	Part B Tailings	Date Sampled:	-
Depth / Layer:	-	Date of Test:	01/07/2015
		Page:	1 of 1



Sieve Size (mm)	% Passing
75.0	100%
53.0	99%
37.5	98%
26.5	98%
19.0	98%
13.2	95%
9.5	93%
6.7	91%
4.75	89%
2.36	86%
1.18	82%
0.600	80%
0.425	79%
0.300	77%
0.150	61%
0.075	48%
0.042	36%
0.030	34%
0.022	31%
0.015	31%
0.011	28%
0.008	25%
0.006	22%
0.004	20%
0.003	19%
0.002	14%
0.001	13%

CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
	0.002	0.006	0.02	0.06	0.2	0.6	2.0	6.0	20	60

Description: Slightly clayey gravelly silty SAND

Test Method(s): AS 1289.3.6.1, AS1289.3.6.3

Sampling Method(s): Sampled by Client

Remarks: Soil Particle Density Passing 2.36mm sieve= 2.68 t/m³

Loss in pretreatment: 0%

Type of Hydrometer: g/1



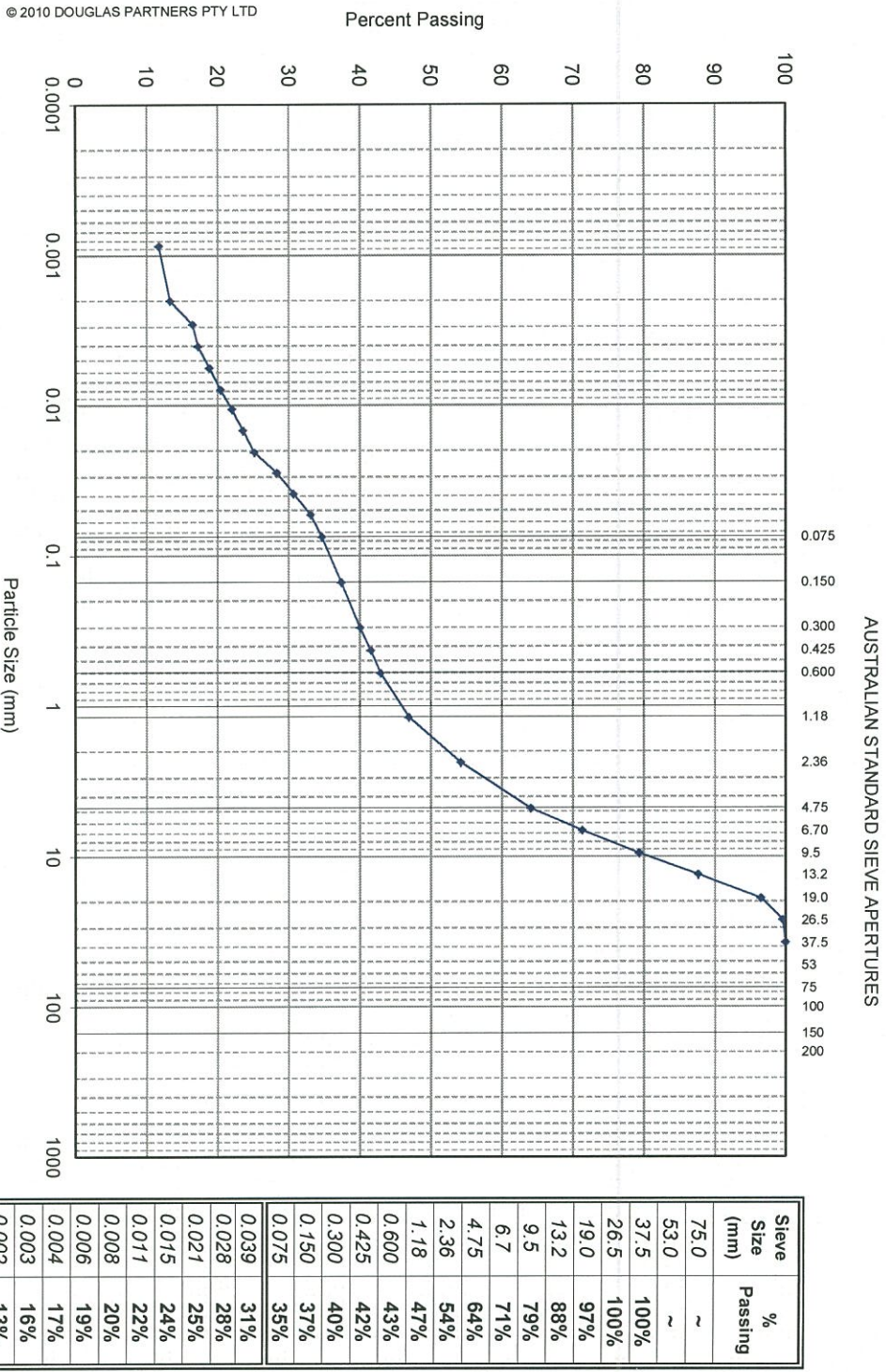
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Tested: AD
Checked: AG

Andrew Murphy
Senior Associate

Results of Particle Size Distribution (Hydrometer)

Client :	Birta Mt. Gordon Pty Ltd	Project No. :	63386.00
Project :	B15035 - Mt Gordon	Report No. :	M15102008
Location :	Mt Gordon Mine, Mount Isa, QLD	Report Date :	20.07.2015
Test Location:	Mill Creek Soil 1	Date Sampled:	-
Depth / Layer:	-	Date of Test:	08/07/2015
		Page:	1 of 1



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CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
	0.002	0.006	0.02	0.06	0.2	0.6	2.0	6.0	20	60

Description: Sandy silty GRAVEL, some clay

Test Method(s): AS 1289.3.6.1, AS1289.3.6.3

Sampling Method(s): Sampled by Client

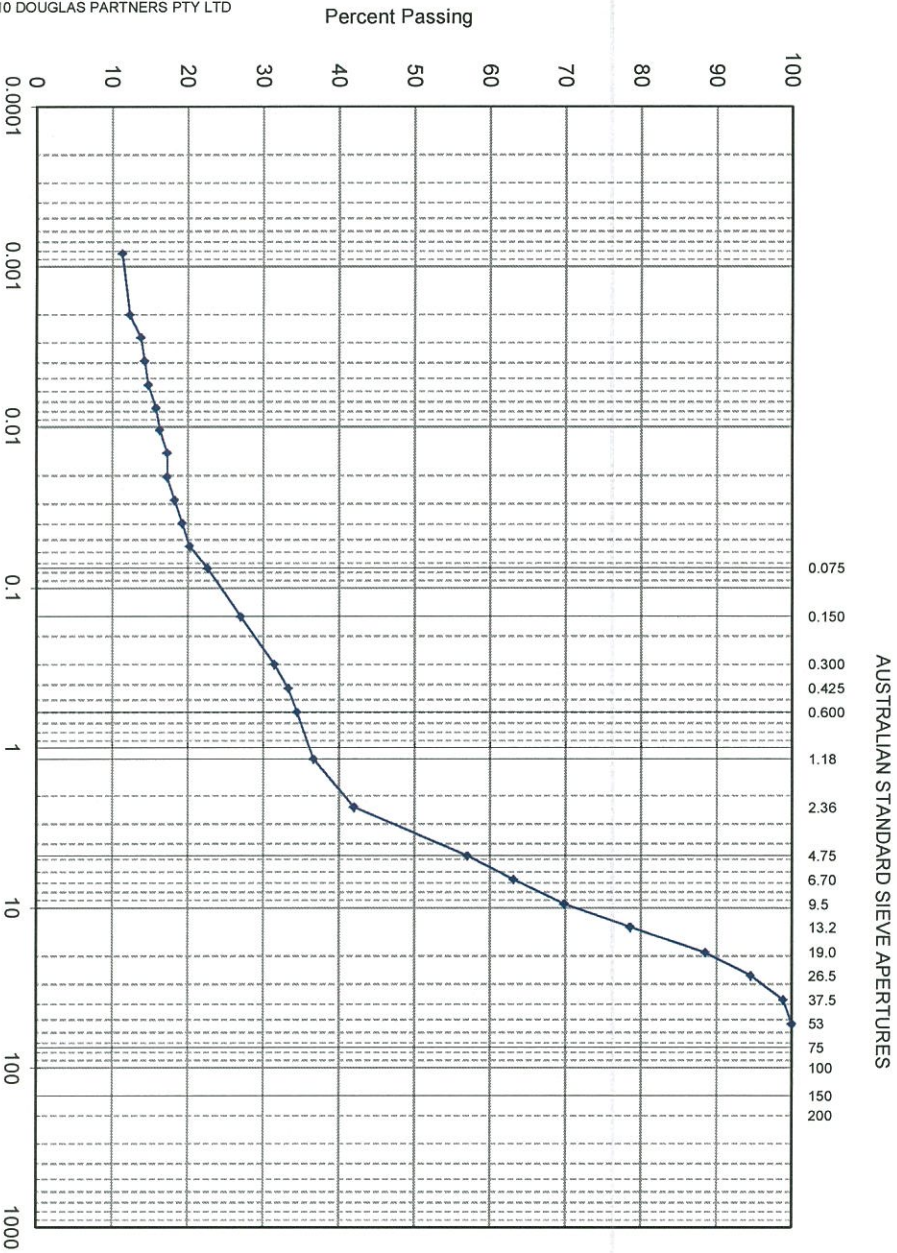
Remarks: Soil Particle Density Passing 2.36mm sieve= 2.74 t/m³

Loss in pretreatment: 0%

Type of Hydrometer: g/l

Results of Particle Size Distribution (Hydrometer)

Client :	Birla Mt. Gordon Pty Ltd	Project No. :	63386.00
Project :	B15035 - Mt Gordon	Report No. :	M15102009
Location :	Mt Gordon Mine, Mount Isa, QLD	Report Date :	20.07.2015
Test Location:	North Rock Soil 1	Date Sampled:	-
Depth / Layer:	-	Date of Test:	01/07/2015
		Page:	1 of 1



Sieve Size (mm)	% Passing
75.0	~
53.0	100%
37.5	99%
26.5	95%
19.0	89%
13.2	79%
9.5	70%
6.7	63%
4.75	57%
2.36	42%
1.18	37%
0.600	34%
0.425	33%
0.300	31%
0.150	27%
0.075	23%
0.039	19%
0.028	18%
0.020	17%
0.014	17%
0.010	16%
0.008	16%
0.005	15%
0.004	14%
0.003	14%
0.002	12%
0.001	11%

CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
	0.002	0.006	0.02	0.06	0.2	0.6	2.0	6.0	20	60

Description: Sandy GRAVEL, some silt, some clay

Test Method(s): AS 1289.3.6.1, AS1289.3.6.3

Sampling Method(s): Sampled by Client

Remarks: Soil Particle Density Passing 2.36mm sieve= 2.67 t/m³

Loss in pretreatment: 0%

Type of Hydrometer: g/l



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Results of Falling Head Permeability Test

Client:	Birla Mt. Gordon Pty Ltd	Project No:	633386
Project:	B15035 - Mt Gordon	Report No:	M15102027
		Report Date:	07-Aug-2015
Location:	Mt Gordon Mine, Mount Isa, QLD	Date Sampled:	-
		Date of Test:	04-Aug-2015
		Page:	1 of 1
Location:	Div Dam3+Mill Creek1+Mag Creek1		
Depth	-		
Sample Description:	Slightly silty, gravelly SAND some clay		
Sample Preparation:	Remoulded to 100% Standard Maximum Dry Density @ 100% Optimum Moisture Content		
Placement Dry Density:	1.94 t/m ³		
Placement Moisture Content:	12.9 %		
Final Moisture Content:	13.7 %		
Maximum Hydraulic Gradient:	10		
Minimum Hydraulic Gradient:	4		
Coefficient of Permeability:	3x10 ⁻⁹ m/sec		

Test Method(s): AS 1289.6.7.2

Sampling Method(s): Sampled by client

Remarks: Combined soil from Diversion Dam 3, Mill Creek 1 and Magazine Creek 1
Scalped over 19.5mm



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Tested: DC
Checked: AD

Andrew Murphy
Senior Associate



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Results of Falling Head Permeability Test

Client:	Birla Mt. Gordon Pty Ltd	Project No:	63386.00
Project:	B15035 - Mt Gordon	Report No:	M15102010
		Report Date:	20-Jul-2015
Location:	Mt Gordon Mine, Mount Isa, QLD	Date Sampled:	-
		Date of Test:	02-Jul-2015
		Page:	1 of 1
Location:	Diversion Dam Soil 3		
Depth	-		
Sample Description:	GRAVEL and SAND, some silt, some clay		
Sample Preparation:	Remoulded to 100% Standard Maximum Dry Density @ 100% Optimum Moisture Content		
Placement Dry Density:	1.94 t/m ³		
Placement Moisture Content:	10.9 %		
Final Moisture Content:	12.8 %		
Maximum Hydraulic Gradient:	8		
Minimum Hydraulic Gradient:	2		
Coefficient of Permeability:	2x10 ⁻⁸ m/sec		

Test Method(s): AS 1289.6.7.2, AS 1289.2.1.1

Sampling Method(s): Sampled by Client

Remarks:



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Tested: VM
Checked: AG

Andrew Murphy
Senior Associate



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Results of Falling Head Permeability Test

Client:	Birla Mt. Gordon Pty Ltd	Project No:	63386.00
Project:	B15035 - Mt Gordon	Report No:	M15102011
		Report Date:	24-Jul-2015
Location:	Mt Gordon Mine, Mount Isa, QLD	Date Sampled:	-
		Date of Test:	21-Jul-2015
		Page:	1 of 1
Location:	Diversion Dam Soil 3		
Depth	-		
Sample Description:	GRAVEL and SAND, some silt, some clay		
Sample Preparation:	Remoulded to 95% Standard Maximum Dry Density @ 100% Optimum Moisture Content		
Placement Dry Density:	1.84 t/m ³		
Placement Moisture Content:	11.1 %		
Final Moisture Content:	13.7 %		
Maximum Hydraulic Gradient:	8		
Minimum Hydraulic Gradient:	4		
Coefficient of Permeability:	6x10 ⁻⁸ m/sec		

Test Method(s): AS 1289.6.7.2, AS 1289.2.1.1

Sampling Method(s): Sampled by Client

Remarks:



NATA Accredited Laboratory Number: 828

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Tested:	YM
Checked:	AG

Peter Chan
Associate



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Results of Falling Head Permeability Test

Client:	Birla Mt. Gordon Pty Ltd	Project No:	63386.00
Project:	B15035 - Mt Gordon	Report No:	M15102012
		Report Date:	20-Jul-2015
Location:	Mt Gordon Mine, Mount Isa, QLD	Date Sampled:	-
		Date of Test:	02-Jul-2015
		Page:	1 of 1
Location:	Borrow 2		
Depth	-		
Sample Description:	Slightly clayey SAND and GRAVEL, some silt		
Sample Preparation:	Remoulded to 100% Standard Maximum Dry Density @ 100% Optimum Moisture Content.		
Placement Dry Density:	1.96 t/m ³		
Placement Moisture Content:	12.0 %		
Final Moisture Content:	12.9 %		
Maximum Hydraulic Gradient:	10		
Minimum Hydraulic Gradient:	7		
Coefficient of Permeability:	3x10 ⁻¹⁰ m/sec		

Test Method(s): AS 1289.6.7.2, AS 1289.2.1.1

Sampling Method(s): Sampled by Client

Remarks:



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Tested: YM
Checked: AG

Andrew Murphy
Senior Associate



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Results of Falling Head Permeability Test

Client:	Birla Mt. Gordon Pty Ltd	Project No:	63386.00
Project:	B15035 - Mt Gordon	Report No:	M15102013
		Report Date:	24-Jul-2015
Location:	Mt Gordon Mine, Mount Isa, QLD	Date Sampled:	-
		Date of Test:	21-Jul-2015
		Page:	1 of 1

Location:	Borrow 2
Depth	-
Sample Description:	Slightly clayey SAND and GRAVEL, some silt

Sample Preparation:	Remoulded to 95% Standard Maximum Dry Density @ 100% Optimum Moisture Content
----------------------------	---

Placement Dry Density:	1.86 t/m ³
Placement Moisture Content:	12.0 %
Final Moisture Content:	14.6 %
Maximum Hydraulic Gradient:	9
Minimum Hydraulic Gradient:	7
Coefficient of Permeability:	8x10 ⁻¹⁰ m/sec

Test Method(s): AS 1289.6.7.2, AS 1289.2.1.1

Sampling Method(s): Sampled by Client

Remarks:



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Checked: AG

Peter Chan
Associate



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Results of Falling Head Permeability Test

Client:	Birla Mt. Gordon Pty Ltd	Project No:	63386.00
Project:	B15035 - Mt Gordon	Report No:	M15102014
		Report Date:	20-Jul-2015
Location:	Mt Gordon Mine, Mount Isa, QLD	Date Sampled:	-
		Date of Test:	10-Jul-2015
		Page:	1 of 1
Location:	Pit A (20-1140)		
Depth	-		
Sample Description:	Slightly silty sandy GRAVEL, some clay		
Sample Preparation:	Remoulded to 100% Standard Maximum Dry Density @ 100% Optimum Moisture Content		
Placement Dry Density:	2.02 t/m ³		
Placement Moisture Content:	12.1 %		
Final Moisture Content:	13.1 %		
Maximum Hydraulic Gradient:	8		
Minimum Hydraulic Gradient:	3		
Coefficient of Permeability:	2x10 ⁻⁹ m/sec		

Test Method(s): AS 1289.6.7.2, AS 1289.2.1.1

Sampling Method(s): Sampled by Client

Remarks:



NATA Accredited Laboratory Number: 828

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Tested: YM
Checked: AG

Andrew Murphy
Senior Associate



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PO Box 5051
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Results of Falling Head Permeability Test

Client:	Birla Mt. Gordon Pty Ltd	Project No:	63386.00
Project:	B15035 - Mt Gordon	Report No:	M15102015
		Report Date:	20-Jul-2015
Location:	Mt Gordon Mine, Mount Isa, QLD	Date Sampled:	-
		Date of Test:	10-Jul-2015
		Page:	1 of 1
Location:	PitA(1140-1400)		
Depth	-		
Sample Description:	Slightly gravelly clayey silty SAND		
Sample Preparation:	Remoulded to 100% Standard Maximum Dry Density @ 100% Optimum Moisture Content		
Placement Dry Density:	1.83 t/m ³		
Placement Moisture Content:	16.5 %		
Final Moisture Content:	19.3 %		
Maximum Hydraulic Gradient:	8		
Minimum Hydraulic Gradient:	5		
Coefficient of Permeability:	2x10 ⁻⁹ m/sec		

Test Method(s): AS 1289.6.7.2, AS 1289.2.1.1

Sampling Method(s): Sampled by Client

Remarks:



NATA Accredited Laboratory Number: 828

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Results of Falling Head Permeability Test

Client:	Birla Mt. Gordon Pty Ltd	Project No:	63386.00
Project:	B15035 - Mt Gordon	Report No:	M15102016
		Report Date:	20-Jul-2015
Location:	Mt Gordon Mine, Mount Isa, QLD	Date Sampled:	-
		Date of Test:	02-Jul-2015
		Page:	1 of 1
Location:	Magazine Creek Soil1		
Depth	-		
Sample Description:	Silty gravelly SAND, some clay		
Sample Preparation:	Remoulded to 100% Standard Maximum Dry Density @ 100% Optimum Moisture Content		
Placement Dry Density:	2.00 t/m ³		
Placement Moisture Content:	9.0 %		
Final Moisture Content:	10.9 %		
Maximum Hydraulic Gradient:	8		
Minimum Hydraulic Gradient:	4		
Coefficient of Permeability:	2x10 ⁻⁹ m/sec		

Test Method(s): AS 1289.6.7.2, AS 1289.2.1.1

Sampling Method(s): Sampled by Client

Remarks:



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Results of Falling Head Permeability Test

Client:	Birla Mt. Gordon Pty Ltd	Project No:	63386.00
Project:	B15035 - Mt Gordon	Report No:	M15102017
		Report Date:	24-Jul-2015
Location:	Mt Gordon Mine, Mount Isa, QLD	Date Sampled:	-
		Date of Test:	21-Jul-2015
		Page:	1 of 1
Location:	Magazine Creek Soil1		
Depth	-		
Sample Description:	Silty gravelly SAND, some clay		
Sample Preparation:	Remoulded to 95% Standard Maximum Dry Density @ 100% Optimum Moisture Content		
Placement Dry Density:	1.90 t/m ³		
Placement Moisture Content:	9.0 %		
Final Moisture Content:	12.3 %		
Maximum Hydraulic Gradient:	9		
Minimum Hydraulic Gradient:	3		
Coefficient of Permeability:	6x10 ⁻⁹ m/sec		

Test Method(s): AS 1289.6.7.2, AS 1289.2.1.1

Sampling Method(s): Sampled by Client

Remarks:



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Checked: AG

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Results of Falling Head Permeability Test

Client:	Birla Mt. Gordon Pty Ltd	Project No:	633386.00
Project:	B15035 - Mt Gordon	Report No:	M15102018
		Report Date:	20-Jul-2015
Location:	Mt Gordon Mine, Mount Isa, QLD	Date Sampled:	-
		Date of Test:	10-Jul-2015
		Page:	1 of 1

Location:	Part B Tailings
Depth	-
Sample Description:	Slightly clayey gravelly silty SAND

Sample Preparation:	Remoulded to 100% Standard Maximum Dry Density @ 100% Optimum Moisture Content
----------------------------	--

Placement Dry Density:	1.78 t/m ³
Placement Moisture Content:	15.6 %
Final Moisture Content:	18.2 %
Maximum Hydraulic Gradient:	8
Minimum Hydraulic Gradient:	6
Coefficient of Permeability:	1x10 ⁻⁹ m/sec

Test Method(s): AS 1289.6.7.2, AS 1289.2.1.1

Sampling Method(s): Sampled by Client

Remarks:



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Results of Falling Head Permeability Test

Client:	Birla Mt. Gordon Pty Ltd	Project No:	63386.00
Project:	B15035 - Mt Gordon	Report No:	M15102019
		Report Date:	20-Jul-2015
Location:	Mt Gordon Mine, Mount Isa, QLD	Date Sampled:	-
		Date of Test:	02-Jul-2015
		Page:	1 of 1
Location:	Mill Creek Soil 1		
Depth	-		
Sample Description:	Sandy silty GRAVEL, some clay		
Sample Preparation:	Remoulded to 100% Standard Maximum Dry Density @ 100% Optimum Moisture Content		
Placement Dry Density:	1.88 t/m ³		
Placement Moisture Content:	14.9 %		
Final Moisture Content:	16.8 %		
Maximum Hydraulic Gradient:	8		
Minimum Hydraulic Gradient:	3		
Coefficient of Permeability:	3x10 ⁻⁹ m/sec		

Test Method(s): AS 1289.6.7.2, AS 1289.2.1.1

Sampling Method(s): Sampled by Client

Remarks:

Andrew Murphy
Senior Associate



NATA Accredited Laboratory Number: 828

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Results of Falling Head Permeability Test

Client:	Birla Mt. Gordon Pty Ltd	Project No:	633386.00
Project:	B15035 - Mt Gordon	Report No:	M15102020
		Report Date:	20-Jul-2015
Location:	Mt Gordon Mine, Mount Isa, QLD	Date Sampled:	-
		Date of Test:	02-Jul-2015
		Page:	1 of 1
Location:	North Rock Soil 1		
Depth	-		
Sample Description:	Sandy GRAVEL, some silt, some clay		
Sample Preparation:	Remoulded to 100% Standard Maximum Dry Density @ 100% Optimum Moisture Content		
Placement Dry Density:	1.85 t/m ³		
Placement Moisture Content:	12.5 %		
Final Moisture Content:	14.2 %		
Maximum Hydraulic Gradient:	8		
Minimum Hydraulic Gradient:	2		
Coefficient of Permeability:	2x10 ⁻⁸ m/sec		

Test Method(s): AS 1289.6.7.2, AS 1289.2.1.1

Sampling Method(s): Sampled by Client

Remarks:

Andrew Murphy
Senior Associate



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Results of Falling Head Permeability Test

Client:	Birla Mt. Gordon Pty Ltd	Project No:	63386.00
Project:	B15035 - Mt Gordon	Report No:	M15102021
		Report Date:	24-Jul-2015
Location:	Mt Gordon Mine, Mount Isa, QLD	Date Sampled:	-
		Date of Test:	21-Jul-2015
		Page:	1 of 1
Location:	North Rock Soil 1		
Depth	-		
Sample Description:	Sandy GRAVEL, some silt, some clay		
Sample Preparation:	Remoulded to 95% Standard Maximum Dry Density @ 100% Optimum Moisture Content		
Placement Dry Density:	1.76 t/m ³		
Placement Moisture Content:	12.4 %		
Final Moisture Content:	15.0 %		
Maximum Hydraulic Gradient:	8		
Minimum Hydraulic Gradient:	2		
Coefficient of Permeability:	4x10 ⁻⁸ m/sec		

Test Method(s): AS 1289.6.7.2, AS 1289.2.1.1

Sampling Method(s): Sampled by Client

Remarks:



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Peter Chan
Associate



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Results of Falling Head Permeability Test

Client:	Birla Mt. Gordon Pty Ltd	Project No:	63386
Project:	B15035 - Mt Gordon	Report No:	M15102026
		Report Date:	03-Aug-2015
Location:	Mt Gordon Mine, Mount Isa, QLD	Date Sampled:	-
		Date of Test:	27-Jul-2015
		Page:	1 of 1
Location:	PitA(20-1140)+PartB Tailings		
Depth	-		
Sample Description:	Slightly clayey, slightly gravely, silty SAND		
Sample Preparation:	Remoulded to 100% Standard Maximum Dry Density @ 100% Optimum Moisture Content		
Placement Dry Density:	1.84 t/m ³		
Placement Moisture Content:	15.9 %		
Final Moisture Content:	16.5 %		
Maximum Hydraulic Gradient:	9		
Minimum Hydraulic Gradient:	7		
Coefficient of Permeability:	3x10 ⁻¹⁰ m/sec		

Test Method(s): AS 1289.6.7.2

Sampling Method(s): Sampled by client

Remarks:

Michael Broise
Principal



NATA Accredited Laboratory Number: 828

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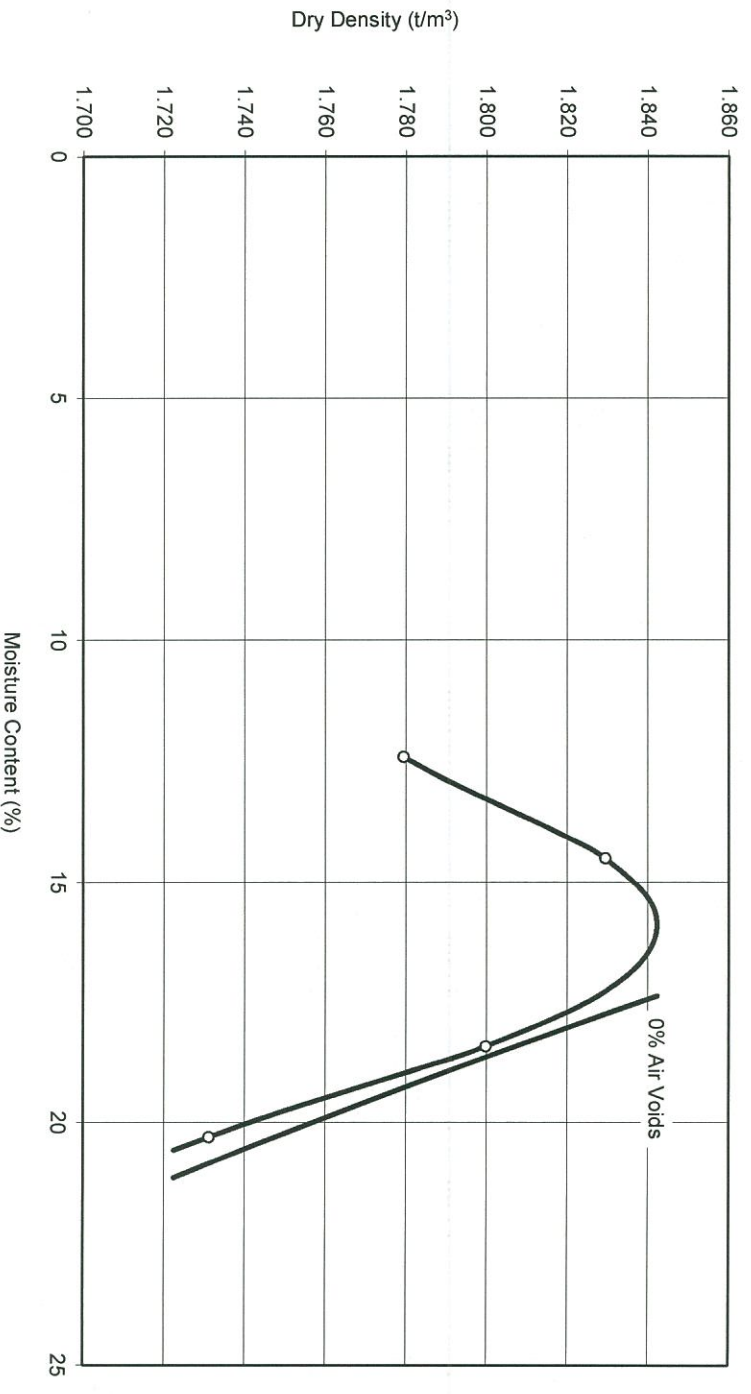
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Tested: DC
Checked: AD



Results of Compaction Test

Client :	Birla Mt. Gordon Pty Ltd	Project No. :	63386
Project :	B15035 - Mt Gordon	Report No. :	M15102022
Location :	Mt Gordon Mine, Mount Isa, QLD	Report Date :	03/08/2015
		Date of Test:	23/07/2015
		Page:	1 of 1



Sample Details: Location: Pita(20-1140)+PartB Tailings

Particles > 19mm: 0%

Depth: -

Description: Slightly clayey, slightly gravely, silty SAND

Maximum Dry Density:	1.84 t/m³
Optimum Moisture Content:	16.0 %

Remarks:

Test Methods: AS 1289.2.1.1, AS 1289.5.1.1

Sampling Methods: Sampled by Client



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Tested:	SP
Checked:	AD

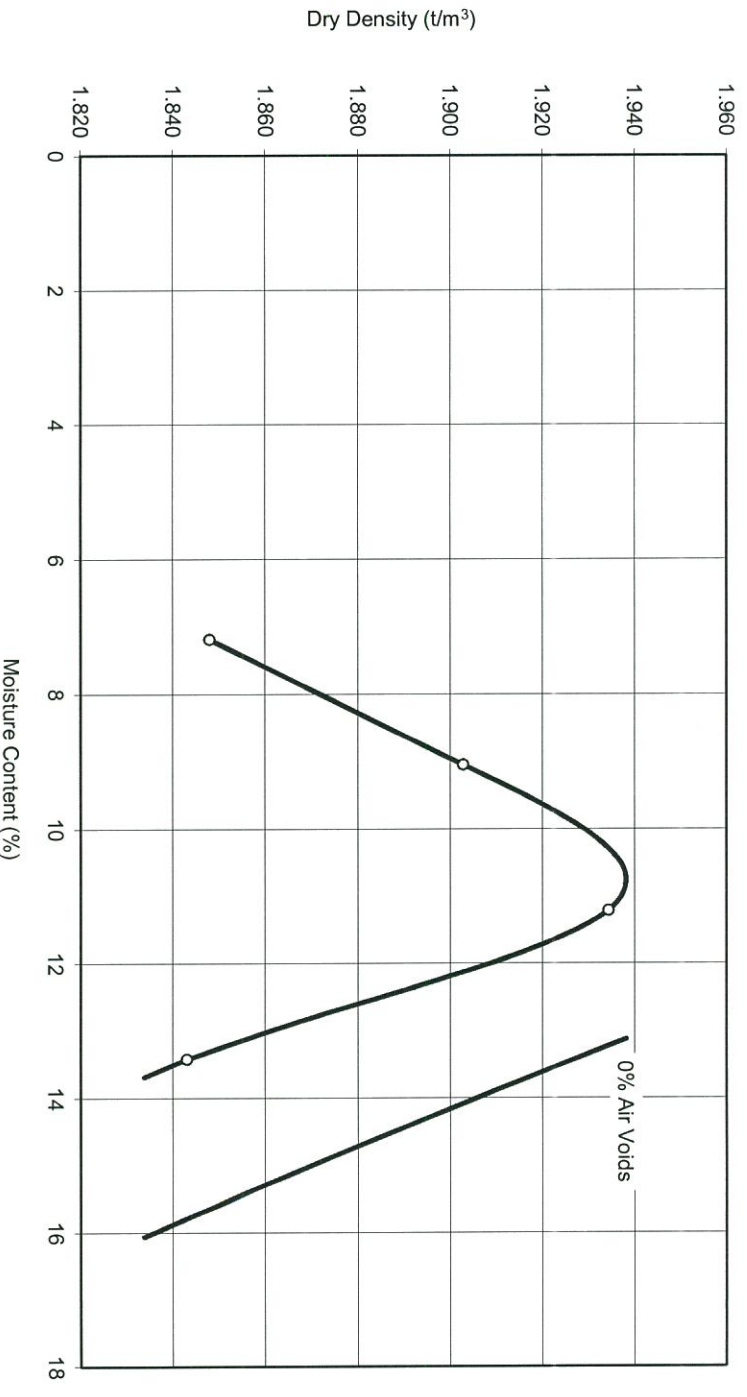
Michael Broise
Principal



Results of Compaction Test

Client : Birla Mt. Gordon Pty Ltd
Project : B15035 - Mt Gordon
Location : Mt Gordon Mine, Mount Isa

Project No. : 63386
Report No. : T15-615
Report Date : 25/06/2015
Date of Test: 23/06/2015
Page: 1 of 1



Sample Details: **Location:** Diversion Dam Soil 3
Depth:

Particles > 19mm: 12%

Description: Gravel and sand, some silt, some clay

Maximum Dry Density: 1.94 t/m³
Optimum Moisture Content: 11.0 %

Remarks:

Test Methods: AS 1289.2.1.1, AS 1289.5.1.1

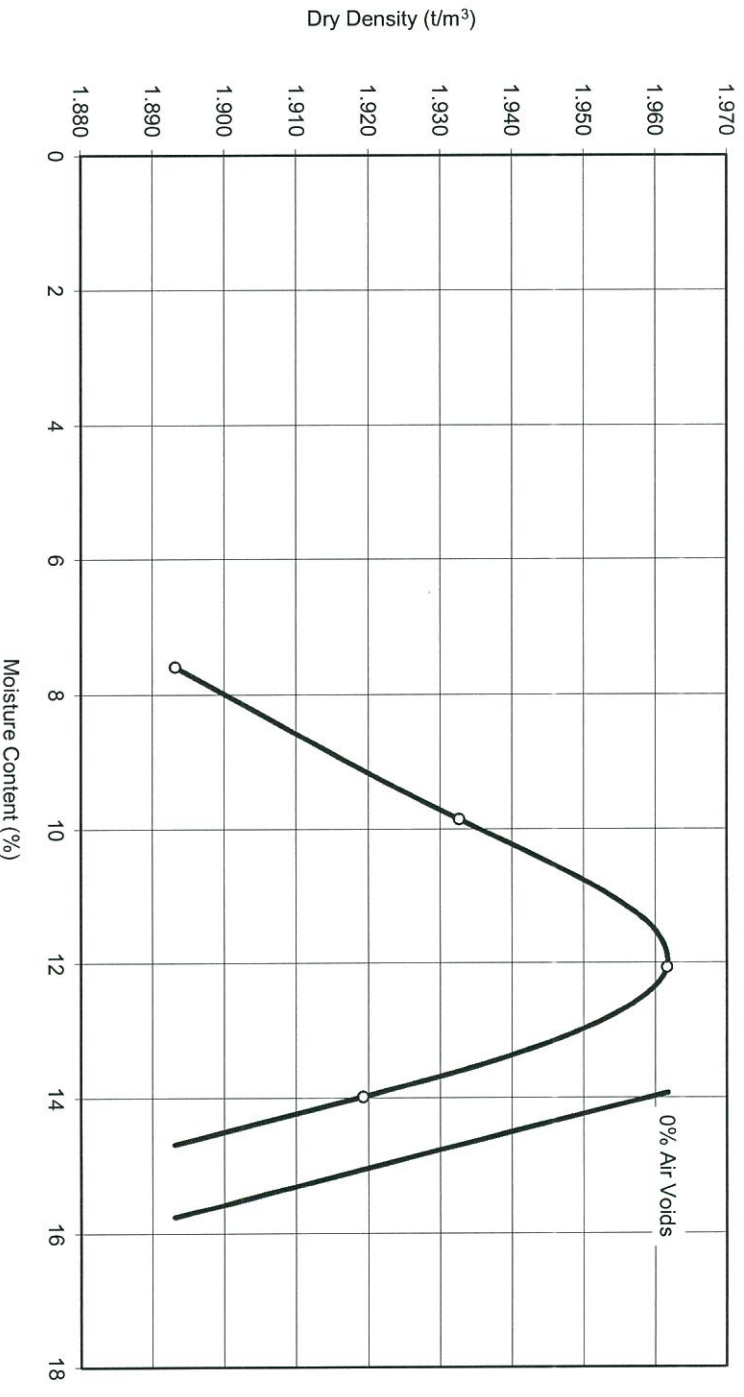
Sampling Methods: Sampled by Client



Results of Compaction Test

Client : Birla Mt. Gordon Pty Ltd
Project : B15035 - Mt Gordon
Location : Mt Gordon Mine, Mount Isa

Project No. : 63386
Report No. : T15-612
Report Date : 25/06/2015
Date of Test: 23/06/2015
Page: 1 of 1



Sample Details: Location: Borrow 2
Depth:

Particles > 19mm: 19%

Description: Slightly clayey sand and gravel, some silt

Maximum Dry Density: 1.96 t/m³
Optimum Moisture Content: 12.0 %

Remarks:

Test Methods: AS 1289.2.1.1, AS 1289.5.1.1

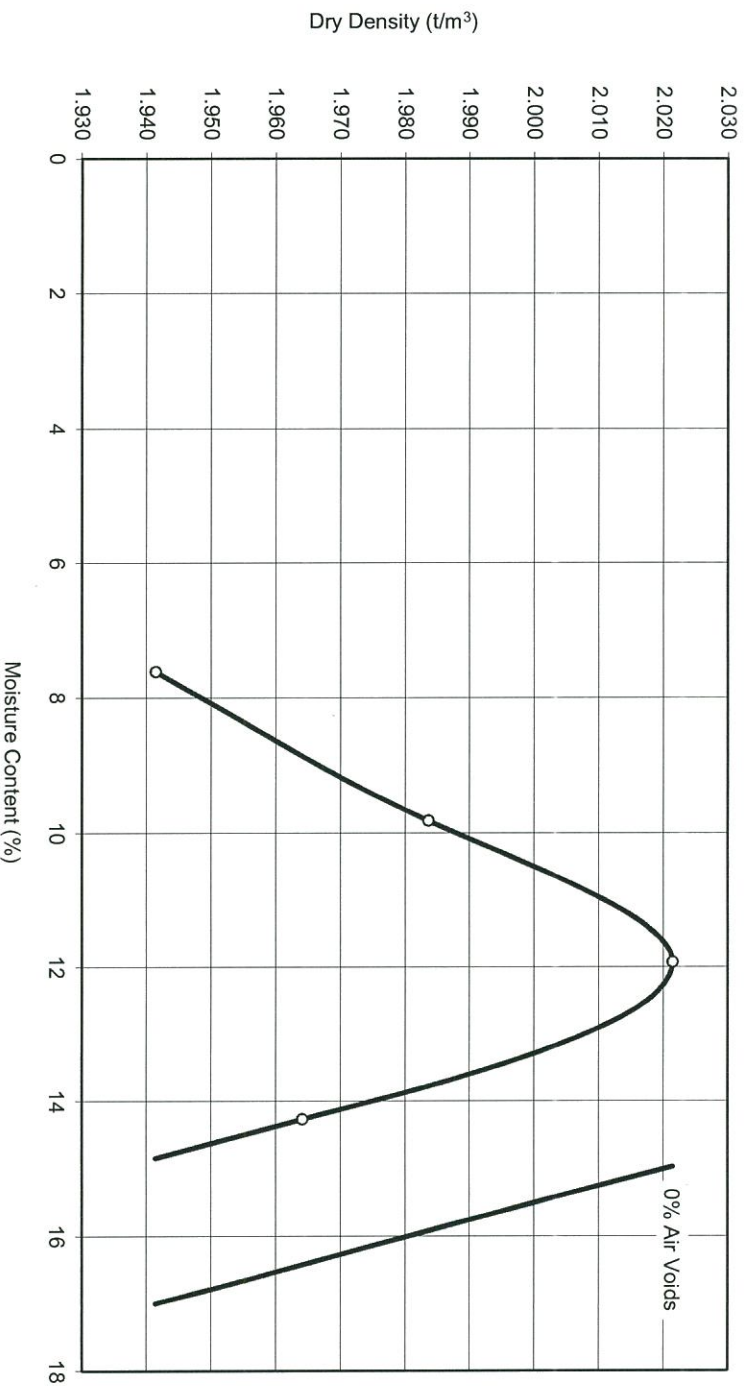
Sampling Methods: Sampled by Client



Results of Compaction Test

Client : Birla Mt. Gordon Pty Ltd
Project : B15035 - Mt Gordon
Location : Mt Gordon Mine, Mount Isa

Project No. : 63386
Report No. : T15-620
Report Date : 25/06/2015
Date of Test: 23/06/2015
Page: 1 of 1



Sample Details: Location: Pit A (20-1140)

Depth:

Particles > 19mm: 9%

Description: Slightly silty sandy gravel, some clay

Maximum Dry Density: 2.02 t/m³
Optimum Moisture Content: 12.0 %

Remarks:

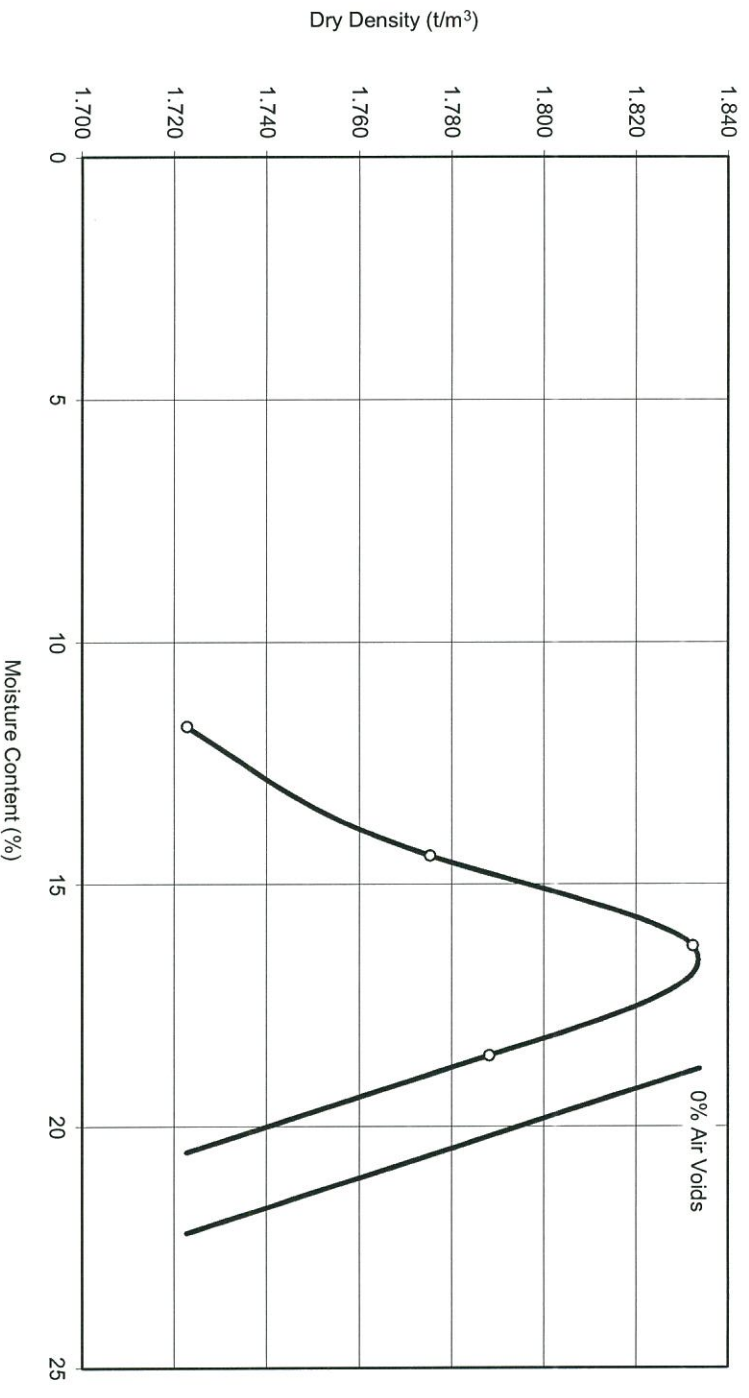
Test Methods: AS 1289.2.1.1, AS 1289.5.1.1

Sampling Methods: Sampled by Client



Results of Compaction Test

Client :	Birla Mt. Gordon Pty Ltd	Project No. :	63386
Project :	B15035 - Mt Gordon	Report No. :	T15-616
Location :	Mt Gordon Mine, Mount Isa	Report Date :	25/06/2015
		Date of Test:	23/06/2015
		Page:	1 of 1



Sample Details: Location: Pit A (1140-1400)
Depth:

Particles > 19mm: 0%

Description: Slightly gravelly clayey silty sand

Maximum Dry Density:	1.83 t/m³
Optimum Moisture Content:	16.5 %

Remarks:

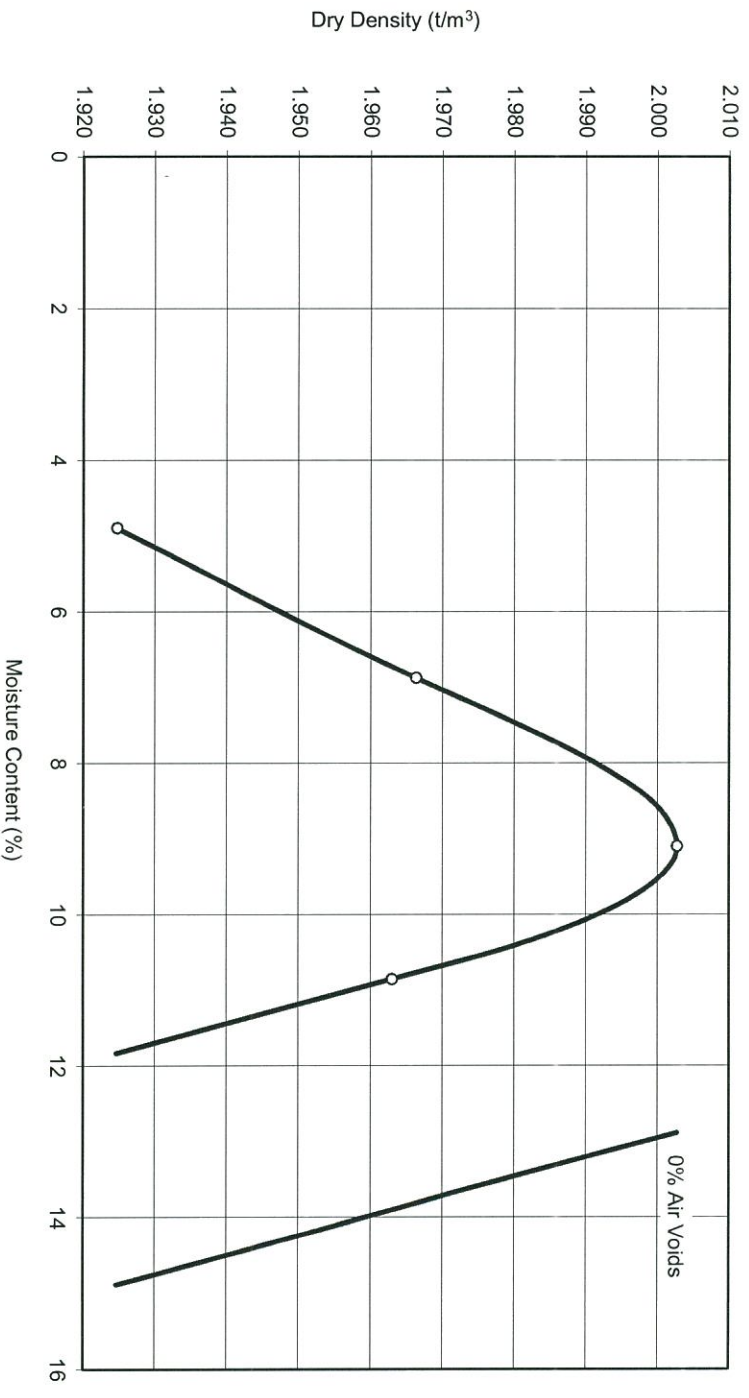
Test Methods: AS 1289.2.1.1, AS 1289.5.1.1

Sampling Methods: Sampled by Client



Results of Compaction Test

Client :	Birla Mt. Gordon Pty Ltd	Project No. :	63386
Project :	B15035 - Mt Gordon	Report No. :	T15-618
Location :	Mt Gordon Mine, Mount Isa	Report Date :	25/06/2015
		Date of Test:	23/06/2015
		Page:	1 of 1



Sample Details: Location: Magazine Creek Soil 1
Depth:

Particles > 19mm: 10%

Description: Silty gravelly sand, some clay

Maximum Dry Density: 2.00 t/m³
Optimum Moisture Content: 9.0 %

Remarks:

Test Methods: AS 1289.2.1.1, AS 1289.5.1.1

Sampling Methods: Sampled by Cleint

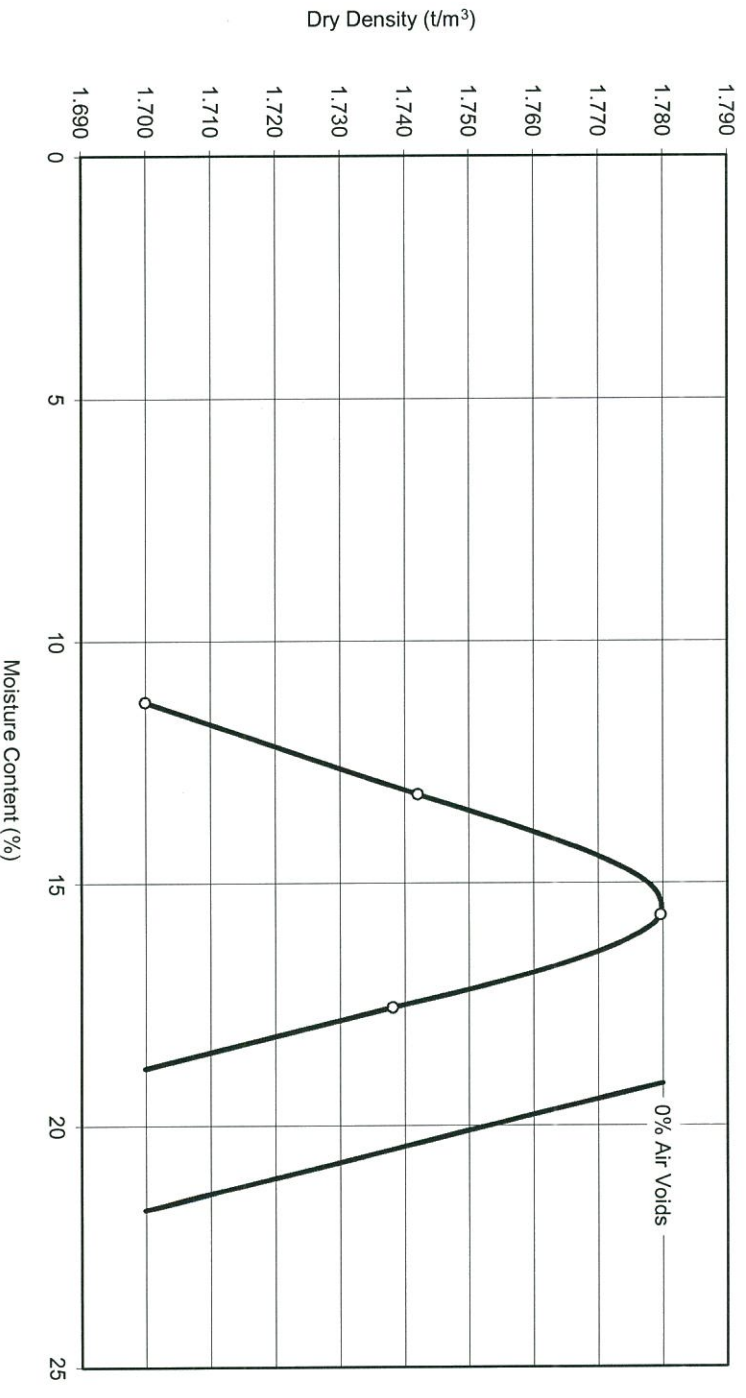




Results of Compaction Test

Client : Birla Mt. Gordon Pty Ltd
Project : B15035 - Mt Gordon
Location : Mt Gordon Mine, Mount Isa

Project No. : 63386
Report No. : T15-619
Report Date : 25/06/2015
Date of Test: 23/06/2015
Page: 1 of 1



Sample Details: Location: Pit B Tailings
Depth:

Particles > 19mm: 2%

Description: Slightly clayey gravelly silty sand

Maximum Dry Density: 1.78 t/m³
Optimum Moisture Content: 15.5 %

Remarks:

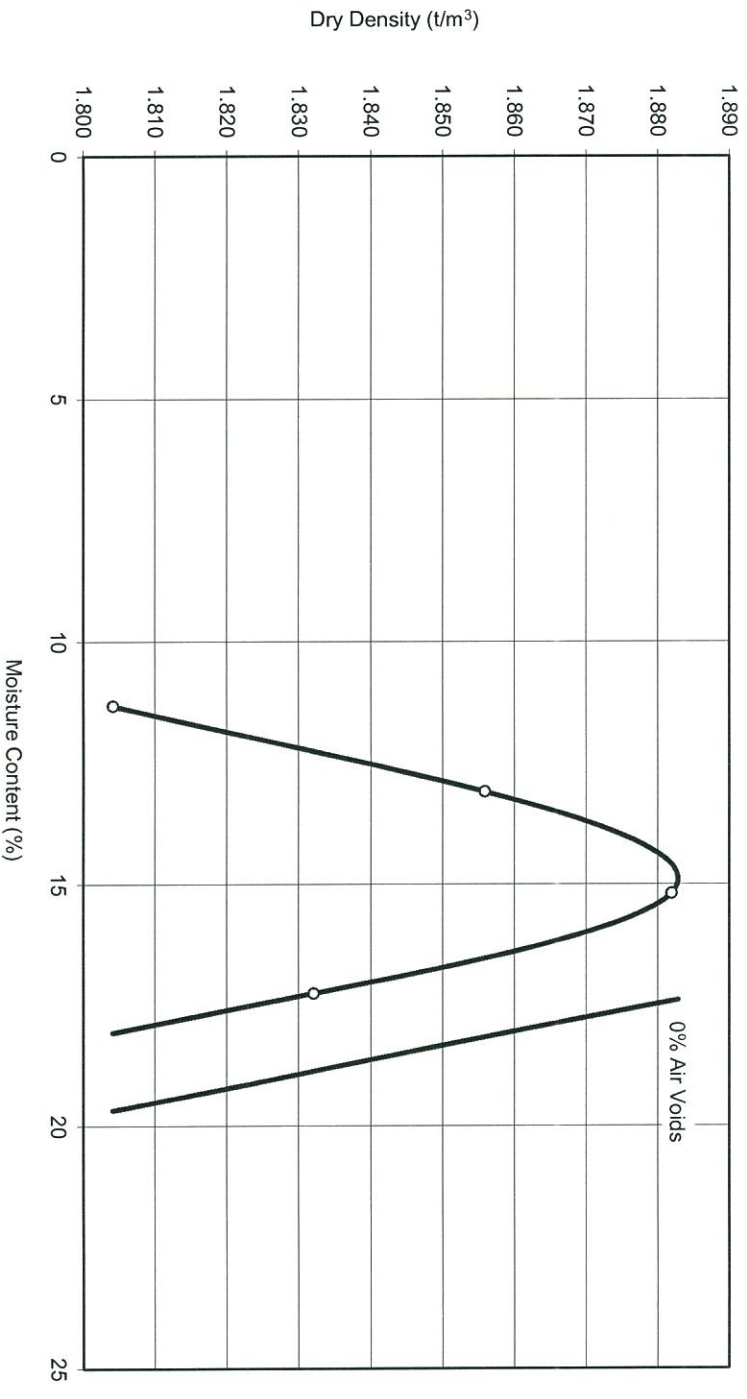
Test Methods: AS 1289.2.1.1, AS 1289.5.1.1

Sampling Methods: Sampled by Client



Results of Compaction Test

Client :	Birla Mt. Gordon Pty Ltd	Project No. :	63386
Project :	B15035 - Mt Gordon	Report No. :	T15-621
Location :	Mt Gordon Mine, Mount Isa	Report Date :	25/06/2015
		Date of Test:	23/06/2015
		Page:	1 of 1



Sample Details: Location: Mill Creek Soil 1
Depth:

Particles > 19mm: 3%

Description: Sandy silty gravel, some clay

Maximum Dry Density: 1.88 t/m³
Optimum Moisture Content: 15.0 %

Remarks:

Test Methods: AS 1289.2.1.1, AS 1289.5.1.1

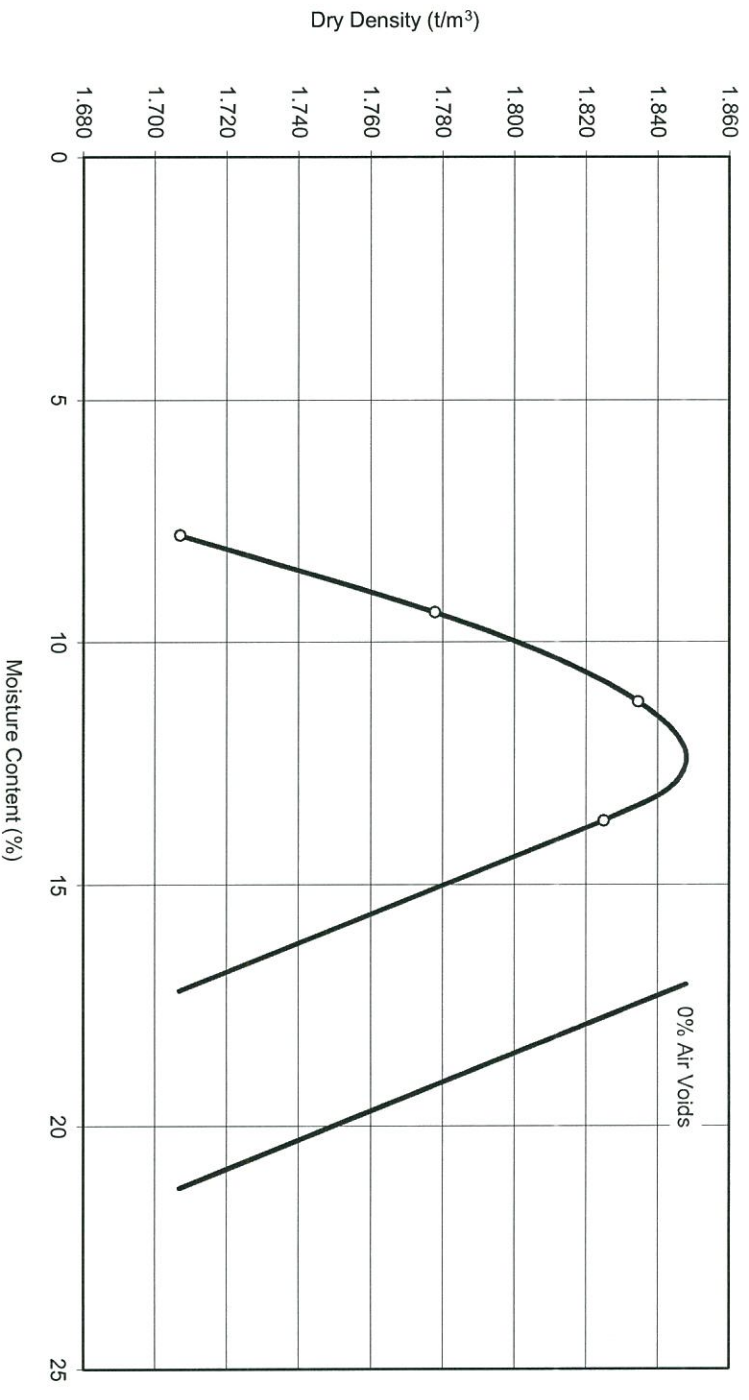
Sampling Methods: Sampled by Client



Results of Compaction Test

Client : Birla Mt. Gordon Pty Ltd
Project : B15035 - Mt Gordon
Location : Mt Gordon Mine, Mount Isa

Project No. : 633386
Report No. : T15-617
Report Date : 25/06/2015
Date of Test: 23/06/2015
Page: 1 of 1



Sample Details: Location: North Rock Soil 1
Depth:

Particles > 19mm: 11%

Description: Sandy gravel, some silt, some clay

Maximum Dry Density: 1.85 t/m³
Optimum Moisture Content: 12.5 %

Remarks:

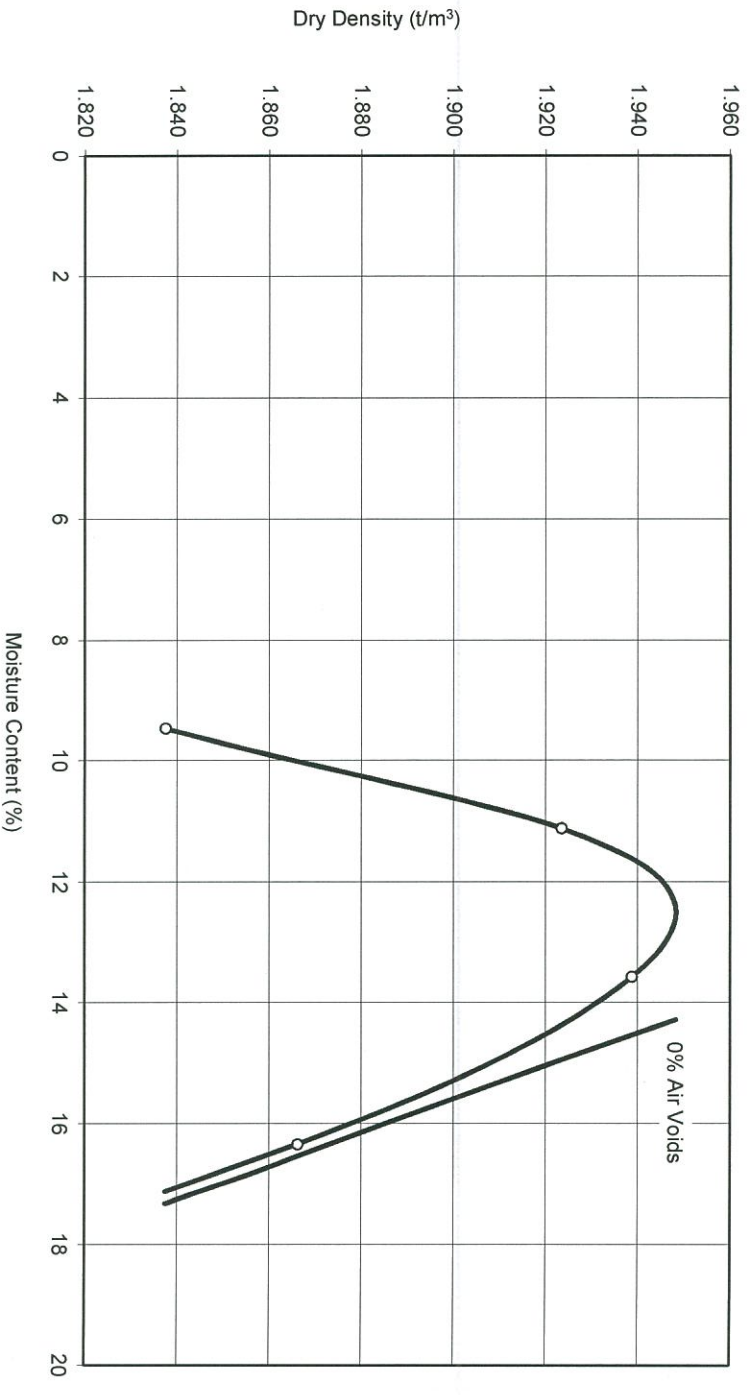
Test Methods: AS 1289.2.1.1, AS 1289.5.1.1

Sampling Methods: Sampled by Client



Results of Compaction Test

Client :	Birla Mt. Gordon Pty Ltd	Project No. :	63386
Project :	B15035 - Mt Gordon	Report No. :	M15102023
Location :	Mt Gordon Mine, Mount Isa, QLD	Report Date :	06/08/2015
		Date of Test:	31/07/2015
		Page:	1 of 1



Sample Details: Location: Div Dam3+Mill Creek1+Mag Creek1

Particles > 19mm: 0%

Depth: -

Description: Slightly silty, gravelly SAND some clay

Maximum Dry Density:	1.95 t/m^3
Optimum Moisture Content:	12.5 %

Remarks:

Test Methods: AS 1289.2.1.1, AS 1289. 5.1.1

Sampling Methods: Sampled by Client





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Determination of Emerson Class Number of Soil

Client:	Birla Mt. Gordon Pty Ltd			Project No:	63386
Project:	B15035 - Mt Gordon			Report No:	T15-636
				Report Date:	2/07/2015
Location:	Mt Gordon Mine, Mount Isa			Date of Test:	26/06/2015
				Page:	1 of 1
Sample No.	Depth (m)	Description	Water Type	Water Temp	Class No.
Magazine Creek Soil 1		Silty gravelly sand, some clay	Distilled	24°C	4
Diversion Dam Soil 3		Gravel and sand, some silt, some clay	Distilled	24°C	4
Borrow 2		Slightly clayey sand and gravel, some silt	Distilled	24°C	4
Pit A (20-1140)		Slightly silty sandy gravel, some clay	Distilled	24°C	5
Pit A (1140-1400)		Slightly gravelly clayey silty sand	Distilled	24°C	4

Test Methods:

AS 1289 3.8.1

Sampling Methods:

Sampled by Client

Remarks:



NATA Accredited Laboratory Number: 828

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Tested: AP
Checked: DP


Dean Pollock
Laboratory Manager



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Determination of Emerson Class Number of Soil

Client:	Birla Mt. Gordon Pty Ltd		Project No:	63386	
Project:	B15035 - Mt Gordon		Report No:	T15-637	
			Report Date:	2/07/2015	
Location:	Mt Gordon Mine, Mount Isa		Date of Test:	2/07/2015	
			Page:	1 of 1	
Sample No.	Depth (m)	Description	Water Type	Water Temp	Class No.
Pit B Tailings		Slightly clayey gravelly silty sand	Distilled	24°C	4
North Rock Soil 1		Sandy gravel, some silt, some clay	Distilled	24°C	4
Mill Creek Soil 1		Sandy silty gravel, some clay	Distilled	24°C	4

Test Methods: AS 1289 3.8.1

Sampling Methods: Sampled by Client

Remarks:



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Checked: DP


Dean Pollock
Laboratory Manager

Client: **Birla Mt Gordon Pty Ltd**
Project: **B15035 - Mt Gordon**
Location: **Mt Gordon Mine, Mount Isa**
Project No: **63386.00**
Page: **1 of 2**

Sample **Diversion Dam Soil 3**

Specific Gravity (S) **2.64**

Moisture content (w)	Dry Density (t/m ³)	Void ratio (e)	Porosity (n)
7.2%	1.848	0.4014	29%
9.1%	1.903	0.3609	27%
11.2%	1.934	0.3391	25%
13.4%	1.843	0.4052	29%

Sample **Borrow 2**

Specific Gravity (S) **2.71**

Moisture content (w)	Dry Density (t/m ³)	Void ratio (e)	Porosity (n)
7.6%	1.893	0.4044	29%
9.9%	1.933	0.3753	27%
12.1%	1.962	0.3550	26%
14.0%	1.919	0.3854	28%

Sample **Pit A (20-1140)**

Specific Gravity (S) **2.76**

Moisture content (w)	Dry Density (t/m ³)	Void ratio (e)	Porosity (n)
7.6%	1.941	0.3949	28%
9.8%	1.984	0.3647	27%
11.9%	2.02	0.3404	25%
14.3%	1.964	0.3786	27%

Sample **Pit A (1140-1400)**

Specific Gravity (S) **2.86**

Moisture content (w)	Dry Density (t/m ³)	Void ratio (e)	Porosity (n)
11.8%	1.723	0.6284	39%
14.4%	1.775	0.5807	37%
16.3%	1.832	0.5315	35%
18.5%	1.788	0.5692	36%

Sample **Magazine Creek Soil 1**

Specific Gravity (S) **2.63**

Moisture content (w)	Dry Density (t/m ³)	Void ratio (e)	Porosity (n)
4.9%	1.925	0.3403	25%
6.9%	1.966	0.3123	24%
9.1%	2.003	0.2881	22%
10.9%	1.963	0.3143	24%

Client: **Birla Mt Gordon Pty Ltd**
Project: **B15035 - Mt Gordon**
Location: **Mt Gordon Mine, Mount Isa**
Project No: **63386.00**
Page: **2 of 2**

Sample **Pit B Tailings**

Specific Gravity (S) **2.68**

Moisture content (w)	Dry Density (t/m ³)	Void ratio (e)	Porosity (n)
11.3%	1.7	0.5465	35%
13.2%	1.742	0.5092	34%
15.7%	1.78	0.4770	32%
17.6%	1.738	0.5127	34%

Sample **Mill Creek Soil 1**

Specific Gravity (S) **2.74**

Moisture content (w)	Dry Density (t/m ³)	Void ratio (e)	Porosity (n)
11.3%	1.804	0.4900	33%
13.1%	1.856	0.4482	31%
15.2%	1.882	0.4282	30%
17.3%	1.832	0.4672	32%

Sample **North Rock Soil 1**

Specific Gravity (S) **2.67**

Moisture content (w)	Dry Density (t/m ³)	Void ratio (e)	Porosity (n)
7.8%	1.707	0.5344	35%
9.4%	1.778	0.4732	32%
11.2%	1.835	0.4274	30%
13.7%	1.825	0.4352	30%

Client: **Birla Mt Gordon Pty Ltd**
Project: **B15035 - Mt Gordon**
Location: **Mt Gordon Mine, Mount Isa**
Project No: **63386.00**
Page: **1 of 1**

Sample **PitA(20-1140)+PartB Tailings**
Specific Gravity (S) **2.709**

Moisture content (w)	Dry Density (t/m ³)	Void ratio (e)	Porosity (n)
12.4%	1.779	0.4938	33%
14.5%	1.829	0.4530	31%
18.4%	1.8	0.4764	32%
20.3%	1.731	0.5353	35%

Client: **Birla Mt Gordon Pty Ltd**
Project: **B15035 - Mt Gordon**
Location: **Mt Gordon Mine, Mount Isa**
Project No: **63386.00**
Page: **1 of 1**

Sample **North Rock + Magazine Creek Soil 1**

Specific Gravity (S) **2.7**

Moisture content (w)	Dry Density (t/m ³)	Void ratio (e)	Porosity (n)
9.5%	1.838	0.4411	31%
11.1%	1.923	0.3774	27%
13.6%	1.939	0.3660	27%
16.4%	1.866	0.4195	30%

Appendix C

Soil and rock chemical characterisation

CERTIFICATE OF ANALYSIS

Work Order	: EB1520839	Page	: 1 of 47
Client	: BIRLA MT GORDON PTY LTD	Laboratory	: Environmental Division Brisbane
Contact	: MR TIM ROHDE	Contact	: Joy Morgan
Address	: PO BOX 2543	Address	: 2 Byth Street Stafford QLD Australia 4053
	MT ISA QLD 4825		
E-mail	: trohde@emgamm.com	E-mail	: joy.morgan@alsglobal.com
Telephone	: ----	Telephone	: + 61 7 4796 0605
Facsimile	: ----	Facsimile	: +61-7-3243 7218
Project	: Mt Gordon (cover design)	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 12-Jun-2015 13:10
C-O-C number	: ----	Date Analysis Commenced	: 16-Jun-2015
Sampler	: TIM ROHDE	Issue Date	: 26-Jun-2015 08:25
Site	: ----		
Quote number	: ----	No. of samples received	: 72
		No. of samples analysed	: 72

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

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.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Andrew Epps	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics
Dianne Blane	Laboratory Coordinator (2IC)	Newcastle - Inorganics
Satishkumar Trivedi	Acid Sulfate Soils Supervisor	Brisbane Acid Sulphate Soils



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

Ø = ALS is not NATA accredited for these tests.

- EG005T (Total Metals) Samples EB1520839-026 & 046 show poor matrix spike recovery due to sample heterogeneity. Confirmed by re-extraction and re-analysis.
- EK059G (Nitrite and Nitrate as N): Samples were diluted due to matrix interference. LOR adjusted accordingly.
- EA150H: Soil particle density results for sample #013 fell outside the scope of AS1289.3.6.3. Results should be scrutinised accordingly.
- EG005T/ED093T (Total Metals/Total Cations) Sample EB1520839-068 shows poor duplicate results due to sample heterogeneity. Confirmed by visual inspection.
- EG005T (Total Metals) Samples EB1520839-056 & 068 show poor duplicate results due to sample heterogeneity. Confirmed by visual inspection.
- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.
- EA058 Emerson: V. = Very, D. = Dark, L. = Light, VD. = Very Dark
- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl (Method 15G1) is a more suitable method for the determination of exchange acidity ($H^+ + Al^{3+}$).

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Pit A (0)	Pit A (0-10)	Pit A (20-40)	Pit A (70-100)	Pit A (300-350)
Client sampling date / time				[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	
Compound	CAS Number	LOR	Unit	EB1520839-001	EB1520839-002	EB1520839-003	EB1520839-004	EB1520839-005	
				Result	Result	Result	Result	Result	
EA009: Nett Acid Production Potential									
^ Net Acid Production Potential	----	0.5	kg H2SO4/t	12.7	7.7	0.7	0.00	0.00	
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	4.4	10.0	1.4	1.8	1.6	
^ ANC as CaCO3	----	0.1	% CaCO3	0.4	1.0	0.1	0.2	0.2	
Fizz Rating	----	0	Fizz Unit	0	1	0	0	0	
EA055: Moisture Content									
^ Moisture Content (dried @ 103°C)	----	1	%	<1.0	<1.0	1.4	3.2	5.4	
EA058: Emerson Aggregate Test									
Color (Munsell)	----	-	-	----	----	----	----	----	
Texture	----	-	-	----	----	----	----	----	
Emerson Class Number	EC/TC	-	-	----	----	----	----	----	
EA150: Particle Sizing									
+75µm	----	1	%	----	----	----	----	----	
+150µm	----	1	%	----	----	----	----	----	
+300µm	----	1	%	----	----	----	----	----	
+425µm	----	1	%	----	----	----	----	----	
+600µm	----	1	%	----	----	----	----	----	
+1180µm	----	1	%	----	----	----	----	----	
+2.36mm	----	1	%	----	----	----	----	----	
+4.75mm	----	1	%	----	----	----	----	----	
+9.5mm	----	1	%	----	----	----	----	----	
+19.0mm	----	1	%	----	----	----	----	----	
+37.5mm	----	1	%	----	----	----	----	----	
+75.0mm	----	1	%	----	----	----	----	----	
EA150: Soil Classification based on Particle Size									
Clay (<2 µm)	----	1	%	----	----	----	----	----	
Silt (2-60 µm)	----	1	%	----	----	----	----	----	
Sand (0.06-2.00 mm)	----	1	%	----	----	----	----	----	
Gravel (>2mm)	----	1	%	----	----	----	----	----	
Cobbles (>6cm)	----	1	%	----	----	----	----	----	
EA152: Soil Particle Density									
ø^Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	----	----	----	----	----	
ED008: Exchangeable Cations									

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Pit A (0)	Pit A (0-10)	Pit A (20-40)	Pit A (70-100)	Pit A (300-350)
Client sampling date / time				[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	
Compound	CAS Number	LOR	Unit	EB1520839-001	EB1520839-002	EB1520839-003	EB1520839-004	EB1520839-005	
				Result	Result	Result	Result	Result	
ED008: Exchangeable Cations - Continued									
^ Exchangeable Calcium	----	0.1	meq/100g	5.6	2.0	2.4	1.5	1.1	
Exchangeable Magnesium	----	0.1	meq/100g	0.4	----	----	----	----	
^ Exchangeable Magnesium	----	0.1	meq/100g	----	0.5	0.6	0.5	0.4	
Exchangeable Potassium	----	0.1	meq/100g	0.1	----	----	----	----	
^ Exchangeable Potassium	----	0.1	meq/100g	----	<0.1	0.1	0.1	0.1	
Exchangeable Sodium	----	0.1	meq/100g	<0.1	----	----	----	----	
^ Exchangeable Sodium	----	0.1	meq/100g	----	<0.1	<0.1	<0.1	<0.1	
^ Cation Exchange Capacity	----	0.1	meq/100g	6.3	2.8	3.4	2.3	1.7	
Exchangeable Sodium Percent	----	0.1	%	<0.1	----	----	----	----	
^ Exchangeable Sodium Percent	----	0.1	%	----	<0.1	<0.1	<0.1	<0.1	
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg	3930	2810	3640	2050	520	
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%	0.56	0.58	0.07	0.05	0.04	
ED093T: Total Major Cations									
Calcium	7440-70-2	50	mg/kg	2000	1230	3220	1530	420	
Magnesium	7439-95-4	50	mg/kg	920	1300	1020	900	370	
Sodium	7440-23-5	50	mg/kg	<50	<50	<50	<50	<50	
Potassium	7440-09-7	50	mg/kg	1140	1250	1430	1440	1360	
EG005S : Soluble Metals by ICPAES									
Aluminium	7429-90-5	1	mg/kg	2	<1	<1	<1	1	
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Arsenic	7440-38-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Boron	7440-42-8	1	mg/kg	<1	<1	<1	<1	<1	
Cadmium	7440-43-9	0.1	mg/kg	0.2	1.1	0.7	0.5	<0.1	
Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Cobalt	7440-48-4	0.1	mg/kg	3.3	5.9	10.3	2.4	1.0	
Copper	7440-50-8	0.1	mg/kg	133	317	165	41.2	20.1	
Iron	7439-89-6	1	mg/kg	<1	<1	<1	<1	<1	
Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Manganese	7439-96-5	0.1	mg/kg	22.2	29.8	44.1	14.2	4.3	
Nickel	7440-02-0	0.1	mg/kg	1.0	1.4	2.4	0.6	0.3	
Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Zinc	7440-66-6	0.1	mg/kg	2.7	3.2	4.0	1.0	0.4	
EG005T: Total Metals by ICP-AES									



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Pit A (0)	Pit A (0-10)	Pit A (20-40)	Pit A (70-100)	Pit A (300-350)
Client sampling date / time					[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]
Compound	CAS Number	LOR	Unit		EB1520839-001	EB1520839-002	EB1520839-003	EB1520839-004	EB1520839-005
					Result	Result	Result	Result	Result
EG005T: Total Metals by ICP-AES - Continued									
Aluminium	7429-90-5	50	mg/kg		5570	4280	5240	5380	5070
Antimony	7440-36-0	5	mg/kg		<5	<5	<5	<5	<5
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cobalt	7440-48-4	2	mg/kg		19	32	31	30	12
Iron	7439-89-6	50	mg/kg		51200	36900	34800	30900	23200
Manganese	7439-96-5	5	mg/kg		174	226	163	158	70
Vanadium	7440-62-2	5	mg/kg		28	23	30	25	21
Arsenic	7440-38-2	5	mg/kg		129	209	84	60	39
Cadmium	7440-43-9	1	mg/kg		<1	4	2	1	<1
Chromium	7440-47-3	2	mg/kg		11	10	10	10	8
Copper	7440-50-8	5	mg/kg		1250	3130	1870	506	284
Lead	7439-92-1	5	mg/kg		20	32	14	11	8
Nickel	7440-02-0	2	mg/kg		17	17	16	11	7
Zinc	7440-66-6	5	mg/kg		27	42	17	10	<5
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		<2.0	<0.5	<3.5	<0.1	<0.1
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		220	220	190	170	160
EK062: Total Nitrogen as N (TKN + NOx)									
^ Total Nitrogen as N	----	20	mg/kg		220	220	190	170	160
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		427	354	372	277	332
EK080: Bicarbonate Extractable Phosphorus (Colwell)									
Bicarbonate Ext. P (Colwell)	----	5	mg/kg		<5	<5	<5	<5	19

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Pit A (600-650)	Pit A (800-850)	Pit A (1100-1140)	Pit A (1140-1200)	Pit A (1350-1400)
Client sampling date / time				[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	
Compound	CAS Number	LOR	Unit	EB1520839-006	EB1520839-007	EB1520839-008	EB1520839-009	EB1520839-010	
				Result	Result	Result	Result	Result	
EA009: Nett Acid Production Potential									
^ Net Acid Production Potential	----	0.5	kg H2SO4/t	0.00	-25.0	-20.0	-14.1	-13.6	
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	1.6	29.3	22.2	14.7	14.5	
^ ANC as CaCO3	----	0.1	% CaCO3	0.2	3.0	2.3	1.5	1.5	
Fizz Rating	----	0	Fizz Unit	0	1	1	1	1	
EA055: Moisture Content									
^ Moisture Content (dried @ 103°C)	----	1	%	6.8	4.6	3.8	13.2	13.5	
EA058: Emerson Aggregate Test									
Color (Munsell)	----	-	-	----	----	----	----	----	
Texture		-	-	----	----	----	----	----	
Emerson Class Number	EC/TC	-	-	----	----	----	----	----	
EA150: Particle Sizing									
+75µm	----	1	%	----	----	----	----	----	
+150µm	----	1	%	----	----	----	----	----	
+300µm	----	1	%	----	----	----	----	----	
+425µm	----	1	%	----	----	----	----	----	
+600µm	----	1	%	----	----	----	----	----	
+1180µm	----	1	%	----	----	----	----	----	
+2.36mm	----	1	%	----	----	----	----	----	
+4.75mm	----	1	%	----	----	----	----	----	
+9.5mm	----	1	%	----	----	----	----	----	
+19.0mm	----	1	%	----	----	----	----	----	
+37.5mm	----	1	%	----	----	----	----	----	
+75.0mm	----	1	%	----	----	----	----	----	
EA150: Soil Classification based on Particle Size									
Clay (<2 µm)	----	1	%	----	----	----	----	----	
Silt (2-60 µm)	----	1	%	----	----	----	----	----	
Sand (0.06-2.00 mm)	----	1	%	----	----	----	----	----	
Gravel (>2mm)	----	1	%	----	----	----	----	----	
Cobbles (>6cm)	----	1	%	----	----	----	----	----	
EA152: Soil Particle Density									
ø^Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	----	----	----	----	----	
ED008: Exchangeable Cations									

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Pit A (600-650)	Pit A (800-850)	Pit A (1100-1140)	Pit A (1140-1200)	Pit A (1350-1400)
Client sampling date / time				[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	
Compound	CAS Number	LOR	Unit	EB1520839-006	EB1520839-007	EB1520839-008	EB1520839-009	EB1520839-010	
				Result	Result	Result	Result	Result	
ED008: Exchangeable Cations - Continued									
^ Exchangeable Calcium	----	0.1	meq/100g	0.9	2.6	2.3	----	----	
Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	----	----	
^ Exchangeable Magnesium	----	0.1	meq/100g	0.4	0.5	0.9	----	----	
Exchangeable Potassium	----	0.1	meq/100g	----	----	----	----	----	
^ Exchangeable Potassium	----	0.1	meq/100g	0.1	0.1	0.1	----	----	
Exchangeable Sodium	----	0.1	meq/100g	----	----	----	----	----	
^ Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	----	----	
^ Cation Exchange Capacity	----	0.1	meq/100g	1.6	3.4	3.4	----	----	
Exchangeable Sodium Percent	----	0.1	%	----	----	----	----	----	
^ Exchangeable Sodium Percent	----	0.1	%	<0.1	<0.1	<0.1	----	----	
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg	510	2790	360	430	470	
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%	0.04	0.14	0.07	0.02	0.03	
ED093T: Total Major Cations									
Calcium	7440-70-2	50	mg/kg	440	5340	5910	----	----	
Magnesium	7439-95-4	50	mg/kg	400	10600	9850	----	----	
Sodium	7440-23-5	50	mg/kg	<50	<50	<50	----	----	
Potassium	7440-09-7	50	mg/kg	1380	1160	1040	----	----	
EG005S : Soluble Metals by ICPAES									
Aluminium	7429-90-5	1	mg/kg	<1	<1	<1	<1	<1	
Antimony	7440-36-0	0.1	mg/kg	0.1	<0.1	<0.1	0.1	<0.1	
Arsenic	7440-38-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Boron	7440-42-8	1	mg/kg	<1	<1	<1	<1	<1	
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Cobalt	7440-48-4	0.1	mg/kg	0.9	0.2	<0.1	<0.1	<0.1	
Copper	7440-50-8	0.1	mg/kg	65.1	4.3	0.1	<0.1	<0.1	
Iron	7439-89-6	1	mg/kg	<1	<1	<1	<1	<1	
Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Manganese	7439-96-5	0.1	mg/kg	4.2	1.7	<0.1	<0.1	<0.1	
Nickel	7440-02-0	0.1	mg/kg	0.3	0.2	<0.1	<0.1	<0.1	
Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Zinc	7440-66-6	0.1	mg/kg	0.5	0.2	<0.1	<0.1	<0.1	
EG005T: Total Metals by ICP-AES									



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Client sample ID

				Pit A (600-650)	Pit A (800-850)	Pit A (1100-1140)	Pit A (1140-1200)	Pit A (1350-1400)
Client sampling date / time				[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]
Compound	CAS Number	LOR	Unit	EB1520839-006	EB1520839-007	EB1520839-008	EB1520839-009	EB1520839-010
				Result	Result	Result	Result	Result
EG005T: Total Metals by ICP-AES - Continued								
Aluminium	7429-90-5	50	mg/kg	6180	11900	9920	26700	29500
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cobalt	7440-48-4	2	mg/kg	9	114	178	51	65
Iron	7439-89-6	50	mg/kg	32500	37400	32300	115000	122000
Manganese	7439-96-5	5	mg/kg	92	542	1330	1580	1930
Vanadium	7440-62-2	5	mg/kg	25	35	36	244	509
Arsenic	7440-38-2	5	mg/kg	39	219	210	11	10
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	10	12	11	25	32
Copper	7440-50-8	5	mg/kg	589	2890	5880	394	313
Lead	7439-92-1	5	mg/kg	6	21	23	143	96
Nickel	7440-02-0	2	mg/kg	10	67	74	44	50
Zinc	7440-66-6	5	mg/kg	6	52	75	484	599
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	<0.5	0.8	1.7	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	160	100	120	----	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	160	100	120	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	396	800	712	----	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	5	<5	----	----

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID		Pit A (0)	Pit A (20-1140)	Pit A (1140-1400)	Pit B (0)	Pit B (0-10)	
Client sampling date / time				[03-Jun-2015]		[03-Jun-2015]		[03-Jun-2015]		[03-Jun-2015]	
Compound	CAS Number	LOR	Unit	EB1520839-011	EB1520839-012	EB1520839-013	EB1520839-014	EB1520839-015			
				Result	Result	Result	Result	Result			
EA009: Nett Acid Production Potential											
^ Net Acid Production Potential				----	0.5	kg H2SO4/t	----	----	----	-2.2	0.9
EA013: Acid Neutralising Capacity											
ANC as H2SO4				----	0.5	kg H2SO4 equiv./t	----	----	----	8.3	8.9
^ ANC as CaCO3				----	0.1	% CaCO3	----	----	----	0.8	0.9
Fizz Rating				----	0	Fizz Unit	----	----	----	0	1
EA055: Moisture Content											
^ Moisture Content (dried @ 103°C)				----	1	%	----	----	----	1.4	2.0
EA058: Emerson Aggregate Test											
Color (Munsell)				----	-	-	Reddish Brown	Reddish Brown	Dark Reddish Brown	----	----
Texture				----	-	-	Rocks	Rocks	Silty Clay	----	----
Emerson Class Number				EC/TC	-	-	8	8	4	----	----
EA150: Particle Sizing											
+75µm				----	1	%	61	68	65	----	----
+150µm				----	1	%	56	65	59	----	----
+300µm				----	1	%	53	64	53	----	----
+425µm				----	1	%	50	62	50	----	----
+600µm				----	1	%	46	61	46	----	----
+1180µm				----	1	%	42	58	36	----	----
+2.36mm				----	1	%	36	54	28	----	----
+4.75mm				----	1	%	28	48	22	----	----
+9.5mm				----	1	%	13	40	18	----	----
+19.0mm				----	1	%	5	12	6	----	----
+37.5mm				----	1	%	<1	<1	<1	----	----
+75.0mm				----	1	%	<1	<1	<1	----	----
EA150: Soil Classification based on Particle Size											
Clay (<2 µm)				----	1	%	13	12	19	----	----
Silt (2-60 µm)				----	1	%	26	21	17	----	----
Sand (0.06-2.00 mm)				----	1	%	20	10	28	----	----
Gravel (>2mm)				----	1	%	41	57	36	----	----
Cobbles (>6cm)				----	1	%	<1	<1	<1	----	----
EA152: Soil Particle Density											
ø^Soil Particle Density (Clay/Silt/Sand)				----	0.01	g/cm3	2.80	2.78	2.96	----	----
ED008: Exchangeable Cations											

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID		Pit A (0)	Pit A (20-1140)	Pit A (1140-1400)	Pit B (0)	Pit B (0-10)	
Client sampling date / time				[03-Jun-2015]		[03-Jun-2015]		[03-Jun-2015]		[03-Jun-2015]	
Compound	CAS Number	LOR	Unit	EB1520839-011	EB1520839-012	EB1520839-013	EB1520839-014	EB1520839-015			
				Result	Result	Result	Result	Result			
ED008: Exchangeable Cations - Continued											
^ Exchangeable Calcium	----	0.1	meq/100g	----	----	----	4.2	4.5			
Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	3.5	----			
^ Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	----	3.3			
Exchangeable Potassium	----	0.1	meq/100g	----	----	----	0.2	----			
^ Exchangeable Potassium	----	0.1	meq/100g	----	----	----	----	0.2			
Exchangeable Sodium	----	0.1	meq/100g	----	----	----	<0.1	----			
^ Exchangeable Sodium	----	0.1	meq/100g	----	----	----	----	<0.1			
^ Cation Exchange Capacity	----	0.1	meq/100g	----	----	----	7.9	8.2			
Exchangeable Sodium Percent	----	0.1	%	----	----	----	0.2	----			
^ Exchangeable Sodium Percent	----	0.1	%	----	----	----	----	0.3			
ED040S : Soluble Sulfate by ICPAES											
Sulfate as SO4 2-	14808-79-8	10	mg/kg	----	----	----	6020	8740			
ED042T: Total Sulfur by LECO											
Sulfur - Total as S (LECO)	----	0.01	%	----	----	----	0.20	0.32			
ED093T: Total Major Cations											
Calcium	7440-70-2	50	mg/kg	----	----	----	2560	4650			
Magnesium	7439-95-4	50	mg/kg	----	----	----	7740	8080			
Sodium	7440-23-5	50	mg/kg	----	----	----	110	170			
Potassium	7440-09-7	50	mg/kg	----	----	----	1800	2100			
EG005S : Soluble Metals by ICPAES											
Aluminium	7429-90-5	1	mg/kg	----	----	----	<1	<1			
Antimony	7440-36-0	0.1	mg/kg	----	----	----	<0.1	<0.1			
Arsenic	7440-38-2	0.1	mg/kg	----	----	----	<0.1	<0.1			
Boron	7440-42-8	1	mg/kg	----	----	----	<1	<1			
Cadmium	7440-43-9	0.1	mg/kg	----	----	----	<0.1	<0.1			
Chromium	7440-47-3	0.1	mg/kg	----	----	----	<0.1	<0.1			
Cobalt	7440-48-4	0.1	mg/kg	----	----	----	3.4	9.4			
Copper	7440-50-8	0.1	mg/kg	----	----	----	1.9	19.2			
Iron	7439-89-6	1	mg/kg	----	----	----	<1	<1			
Lead	7439-92-1	0.1	mg/kg	----	----	----	<0.1	<0.1			
Manganese	7439-96-5	0.1	mg/kg	----	----	----	100	219			
Nickel	7440-02-0	0.1	mg/kg	----	----	----	0.5	1.7			
Vanadium	7440-62-2	0.1	mg/kg	----	----	----	<0.1	<0.1			
Zinc	7440-66-6	0.1	mg/kg	----	----	----	0.6	1.7			
EG005T: Total Metals by ICP-AES											



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Client sample ID

				Pit A (0)	Pit A (20-1140)	Pit A (1140-1400)	Pit B (0)	Pit B (0-10)
Client sampling date / time				[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]
Compound	CAS Number	LOR	Unit	EB1520839-011	EB1520839-012	EB1520839-013	EB1520839-014	EB1520839-015
				Result	Result	Result	Result	Result
EG005T: Total Metals by ICP-AES - Continued								
Aluminium	7429-90-5	50	mg/kg	----	----	----	15500	15700
Antimony	7440-36-0	5	mg/kg	----	----	----	<5	<5
Boron	7440-42-8	50	mg/kg	----	----	----	<50	<50
Cobalt	7440-48-4	2	mg/kg	----	----	----	87	111
Iron	7439-89-6	50	mg/kg	----	----	----	77900	70700
Manganese	7439-96-5	5	mg/kg	----	----	----	1090	1580
Vanadium	7440-62-2	5	mg/kg	----	----	----	101	92
Arsenic	7440-38-2	5	mg/kg	----	----	----	100	137
Cadmium	7440-43-9	1	mg/kg	----	----	----	<1	<1
Chromium	7440-47-3	2	mg/kg	----	----	----	28	22
Copper	7440-50-8	5	mg/kg	----	----	----	1240	1610
Lead	7439-92-1	5	mg/kg	----	----	----	37	44
Nickel	7440-02-0	2	mg/kg	----	----	----	58	52
Zinc	7440-66-6	5	mg/kg	----	----	----	132	139
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	----	----	46.1	3.5
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	----	----	190	220
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	----	----	----	240	220
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	----	----	----	704	488
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	----	----	----	<5	<5

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Pit B (20-40)	Pit B (70-100)	Pit B (300-350)	Pit B (600-650)	Pit B (800-850)
Client sampling date / time				[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	
Compound	CAS Number	LOR	Unit	EB1520839-016	EB1520839-017	EB1520839-018	EB1520839-019	EB1520839-020	
				Result	Result	Result	Result	Result	
EA009: Nett Acid Production Potential									
^ Net Acid Production Potential	----	0.5	kg H2SO4/t	-0.6	1.0	4.6	46.2	53.2	
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	8.6	8.2	7.9	<0.5	<0.5	
^ ANC as CaCO3	----	0.1	% CaCO3	0.9	0.8	0.8	<0.1	<0.1	
Fizz Rating	----	0	Fizz Unit	1	1	1	0	0	
EA055: Moisture Content									
^ Moisture Content (dried @ 103°C)	----	1	%	3.1	5.2	7.3	7.9	13.1	
EA058: Emerson Aggregate Test									
Color (Munsell)	----	-	-	----	----	----	----	----	
Texture	----	-	-	----	----	----	----	----	
Emerson Class Number	EC/TC	-	-	----	----	----	----	----	
EA150: Particle Sizing									
+75µm	----	1	%	----	----	----	----	----	
+150µm	----	1	%	----	----	----	----	----	
+300µm	----	1	%	----	----	----	----	----	
+425µm	----	1	%	----	----	----	----	----	
+600µm	----	1	%	----	----	----	----	----	
+1180µm	----	1	%	----	----	----	----	----	
+2.36mm	----	1	%	----	----	----	----	----	
+4.75mm	----	1	%	----	----	----	----	----	
+9.5mm	----	1	%	----	----	----	----	----	
+19.0mm	----	1	%	----	----	----	----	----	
+37.5mm	----	1	%	----	----	----	----	----	
+75.0mm	----	1	%	----	----	----	----	----	
EA150: Soil Classification based on Particle Size									
Clay (<2 µm)	----	1	%	----	----	----	----	----	
Silt (2-60 µm)	----	1	%	----	----	----	----	----	
Sand (0.06-2.00 mm)	----	1	%	----	----	----	----	----	
Gravel (>2mm)	----	1	%	----	----	----	----	----	
Cobbles (>6cm)	----	1	%	----	----	----	----	----	
EA152: Soil Particle Density									
ø^Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	----	----	----	----	----	
ED008: Exchangeable Cations									

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Pit B (20-40)	Pit B (70-100)	Pit B (300-350)	Pit B (600-650)	Pit B (800-850)
Client sampling date / time				[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	
Compound	CAS Number	LOR	Unit	EB1520839-016	EB1520839-017	EB1520839-018	EB1520839-019	EB1520839-020	
				Result	Result	Result	Result	Result	
ED008: Exchangeable Cations - Continued									
^ Exchangeable Calcium	----	0.1	meq/100g	5.0	4.8	5.1	4.1	----	
Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	----	----	
^ Exchangeable Magnesium	----	0.1	meq/100g	3.3	2.9	3.5	5.7	----	
Exchangeable Potassium	----	0.1	meq/100g	----	----	----	----	----	
^ Exchangeable Potassium	----	0.1	meq/100g	0.2	0.2	0.2	0.2	----	
Exchangeable Sodium	----	0.1	meq/100g	----	----	----	----	----	
^ Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	----	
^ Cation Exchange Capacity	----	0.1	meq/100g	8.6	8.1	8.8	10.0	----	
Exchangeable Sodium Percent	----	0.1	%	----	----	----	----	----	
^ Exchangeable Sodium Percent	----	0.1	%	0.3	0.2	<0.1	<0.1	----	
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg	9700	7200	7190	8840	14700	
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%	0.26	0.30	0.41	1.51	1.74	
ED093T: Total Major Cations									
Calcium	7440-70-2	50	mg/kg	5790	3430	5880	4480	----	
Magnesium	7439-95-4	50	mg/kg	9300	7270	7910	9330	----	
Sodium	7440-23-5	50	mg/kg	150	120	70	110	----	
Potassium	7440-09-7	50	mg/kg	1720	1810	2220	2500	----	
EG005S : Soluble Metals by ICPAES									
Aluminium	7429-90-5	1	mg/kg	<1	<1	<1	<1	238	
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Arsenic	7440-38-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Boron	7440-42-8	1	mg/kg	<1	<1	<1	<1	<1	
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Cobalt	7440-48-4	0.1	mg/kg	10.8	7.5	1.6	3.2	32.3	
Copper	7440-50-8	0.1	mg/kg	16.0	42.9	16.5	9.3	879	
Iron	7439-89-6	1	mg/kg	<1	<1	<1	<1	<1	
Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Manganese	7439-96-5	0.1	mg/kg	219	129	23.0	26.3	95.9	
Nickel	7440-02-0	0.1	mg/kg	2.2	1.9	0.6	0.6	17.1	
Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Zinc	7440-66-6	0.1	mg/kg	1.7	1.6	0.8	0.4	3.2	
EG005T: Total Metals by ICP-AES									



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Pit B (20-40)	Pit B (70-100)	Pit B (300-350)	Pit B (600-650)	Pit B (800-850)
Client sampling date / time					[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]
Compound	CAS Number	LOR	Unit		EB1520839-016	EB1520839-017	EB1520839-018	EB1520839-019	EB1520839-020
					Result	Result	Result	Result	Result
EG005T: Total Metals by ICP-AES - Continued									
Aluminium	7429-90-5	50	mg/kg		15900	14000	12800	16800	16900
Antimony	7440-36-0	5	mg/kg		<5	<5	<5	<5	<5
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cobalt	7440-48-4	2	mg/kg		104	68	56	74	125
Iron	7439-89-6	50	mg/kg		60200	70200	44000	62300	56100
Manganese	7439-96-5	5	mg/kg		1170	1460	410	378	657
Vanadium	7440-62-2	5	mg/kg		79	116	28	27	44
Arsenic	7440-38-2	5	mg/kg		117	108	181	276	459
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		18	24	11	12	26
Copper	7440-50-8	5	mg/kg		1250	1090	721	1310	2840
Lead	7439-92-1	5	mg/kg		32	21	36	41	40
Nickel	7440-02-0	2	mg/kg		54	42	34	42	76
Zinc	7440-66-6	5	mg/kg		114	95	115	173	84
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		4.2	0.2	<0.1	0.3	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		220	240	130	150	----
EK062: Total Nitrogen as N (TKN + NOx)									
^ Total Nitrogen as N	----	20	mg/kg		220	240	130	150	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		396	397	399	460	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)									
Bicarbonate Ext. P (Colwell)	----	5	mg/kg		<5	<5	18	16	----

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Pit B (900-1000)	Pit B (1200-1300)	Pit B (1400-1500)	Pit B (900-1500)	Pit C (0)
Client sampling date / time				[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	
Compound	CAS Number	LOR	Unit	EB1520839-021	EB1520839-022	EB1520839-023	EB1520839-024	EB1520839-025	
				Result	Result	Result	Result	Result	
EA009: Nett Acid Production Potential									
^ Net Acid Production Potential	----	0.5	kg H2SO4/t	24.5	16.0	11.4	----	-28.2	
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	<0.5	1.1	2.4	----	33.4	
^ ANC as CaCO3	----	0.1	% CaCO3	<0.1	0.1	0.2	----	3.4	
Fizz Rating	----	0	Fizz Unit	0	0	0	----	1	
EA055: Moisture Content									
^ Moisture Content (dried @ 103°C)	----	1	%	13.0	5.9	4.4	----	1.1	
EA058: Emerson Aggregate Test									
Color (Munsell)	----	-	-	----	----	----	Dark Reddish Brown	----	
Texture	----	-	-	----	----	----	Sandy Loam	----	
Emerson Class Number	EC/TC	-	-	----	----	----	4	----	
EA150: Particle Sizing									
+75µm	----	1	%	----	----	----	64	----	
+150µm	----	1	%	----	----	----	34	----	
+300µm	----	1	%	----	----	----	7	----	
+425µm	----	1	%	----	----	----	4	----	
+600µm	----	1	%	----	----	----	4	----	
+1180µm	----	1	%	----	----	----	3	----	
+2.36mm	----	1	%	----	----	----	2	----	
+4.75mm	----	1	%	----	----	----	<1	----	
+9.5mm	----	1	%	----	----	----	<1	----	
+19.0mm	----	1	%	----	----	----	<1	----	
+37.5mm	----	1	%	----	----	----	<1	----	
+75.0mm	----	1	%	----	----	----	<1	----	
EA150: Soil Classification based on Particle Size									
Clay (<2 µm)	----	1	%	----	----	----	13	----	
Silt (2-60 µm)	----	1	%	----	----	----	19	----	
Sand (0.06-2.00 mm)	----	1	%	----	----	----	65	----	
Gravel (>2mm)	----	1	%	----	----	----	3	----	
Cobbles (>6cm)	----	1	%	----	----	----	<1	----	
EA152: Soil Particle Density									
ø^Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	----	----	----	2.73	----	
ED008: Exchangeable Cations									

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Pit B (900-1000)	Pit B (1200-1500)	Pit B (1400-1500)	Pit B (900-1500)	Pit C (0)
Client sampling date / time				[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	
Compound	CAS Number	LOR	Unit	EB1520839-021	EB1520839-022	EB1520839-023	EB1520839-024	EB1520839-025	
				Result	Result	Result	Result	Result	
ED008: Exchangeable Cations - Continued									
^ Exchangeable Calcium	----	0.1	meq/100g	----	----	----	----	7.0	
Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	----	----	
^ Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	----	1.7	
Exchangeable Potassium	----	0.1	meq/100g	----	----	----	----	----	
^ Exchangeable Potassium	----	0.1	meq/100g	----	----	----	----	0.1	
Exchangeable Sodium	----	0.1	meq/100g	----	----	----	----	----	
^ Exchangeable Sodium	----	0.1	meq/100g	----	----	----	----	<0.1	
^ Cation Exchange Capacity	----	0.1	meq/100g	----	----	----	----	9.3	
Exchangeable Sodium Percent	----	0.1	%	----	----	----	----	----	
^ Exchangeable Sodium Percent	----	0.1	%	----	----	----	----	<0.1	
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg	11300	6740	7000	----	1840	
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%	0.80	0.56	0.45	----	0.17	
ED093T: Total Major Cations									
Calcium	7440-70-2	50	mg/kg	----	----	----	----	8860	
Magnesium	7439-95-4	50	mg/kg	----	----	----	----	8130	
Sodium	7440-23-5	50	mg/kg	----	----	----	----	80	
Potassium	7440-09-7	50	mg/kg	----	----	----	----	1370	
EG005S : Soluble Metals by ICPAES									
Aluminium	7429-90-5	1	mg/kg	432	237	198	----	<1	
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	----	<0.1	
Arsenic	7440-38-2	0.1	mg/kg	0.1	<0.1	<0.1	----	<0.1	
Boron	7440-42-8	1	mg/kg	<1	<1	<1	----	<1	
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	----	<0.1	
Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	<0.1	----	<0.1	
Cobalt	7440-48-4	0.1	mg/kg	33.1	22.1	17.9	----	<0.1	
Copper	7440-50-8	0.1	mg/kg	1240	805	696	----	0.1	
Iron	7439-89-6	1	mg/kg	2	1	<1	----	<1	
Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	<0.1	----	<0.1	
Manganese	7439-96-5	0.1	mg/kg	57.6	37.2	26.5	----	1.8	
Nickel	7440-02-0	0.1	mg/kg	20.4	13.6	11.4	----	<0.1	
Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	<0.1	----	<0.1	
Zinc	7440-66-6	0.1	mg/kg	2.5	1.8	1.2	----	<0.1	
EG005T: Total Metals by ICP-AES									



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Client sample ID

				Pit B (900-1000)	Pit B (1200-1300)	Pit B (1400-1500)	Pit B (900-1500)	Pit C (0)
Client sampling date / time				[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]
Compound	CAS Number	LOR	Unit	EB1520839-021	EB1520839-022	EB1520839-023	EB1520839-024	EB1520839-025
				Result	Result	Result	Result	Result
EG005T: Total Metals by ICP-AES - Continued								
Aluminium	7429-90-5	50	mg/kg	12000	9460	20400	----	8330
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	----	<5
Boron	7440-42-8	50	mg/kg	<50	<50	<50	----	<50
Cobalt	7440-48-4	2	mg/kg	139	73	189	----	69
Iron	7439-89-6	50	mg/kg	41300	28000	35800	----	43100
Manganese	7439-96-5	5	mg/kg	257	234	577	----	615
Vanadium	7440-62-2	5	mg/kg	23	19	23	----	27
Arsenic	7440-38-2	5	mg/kg	848	335	311	----	280
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	----	<1
Chromium	7440-47-3	2	mg/kg	22	14	20	----	13
Copper	7440-50-8	5	mg/kg	1930	1270	1340	----	2290
Lead	7439-92-1	5	mg/kg	40	22	16	----	64
Nickel	7440-02-0	2	mg/kg	88	48	122	----	36
Zinc	7440-66-6	5	mg/kg	21	16	32	----	42
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	----	----	----	4.5
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	----	----	----	280
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	----	----	----	----	280
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	----	----	----	----	510
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	----	----	----	----	15

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Pit C (0-10)	Pit C (20-40)	Pit C (70-100)	Pit C (300-350)	Pit C (400-450)
Client sampling date / time				[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	
Compound	CAS Number	LOR	Unit	EB1520839-026	EB1520839-027	EB1520839-028	EB1520839-029	EB1520839-030	
				Result	Result	Result	Result	Result	
EA009: Nett Acid Production Potential									
^ Net Acid Production Potential	----	0.5	kg H2SO4/t	-30.2	-39.5	-26.8	-34.0	-15.7	
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	33.6	42.9	28.3	36.2	17.5	
^ ANC as CaCO3	----	0.1	% CaCO3	3.4	4.4	2.9	3.7	1.8	
Fizz Rating	----	0	Fizz Unit	1	2	1	1	1	
EA055: Moisture Content									
^ Moisture Content (dried @ 103°C)	----	1	%	1.5	1.5	2.1	4.5	12.6	
EA058: Emerson Aggregate Test									
Color (Munsell)	----	-	-	----	----	----	----	----	
Texture	----	-	-	----	----	----	----	----	
Emerson Class Number	EC/TC	-	-	----	----	----	----	----	
EA150: Particle Sizing									
+75µm	----	1	%	----	----	----	----	----	
+150µm	----	1	%	----	----	----	----	----	
+300µm	----	1	%	----	----	----	----	----	
+425µm	----	1	%	----	----	----	----	----	
+600µm	----	1	%	----	----	----	----	----	
+1180µm	----	1	%	----	----	----	----	----	
+2.36mm	----	1	%	----	----	----	----	----	
+4.75mm	----	1	%	----	----	----	----	----	
+9.5mm	----	1	%	----	----	----	----	----	
+19.0mm	----	1	%	----	----	----	----	----	
+37.5mm	----	1	%	----	----	----	----	----	
+75.0mm	----	1	%	----	----	----	----	----	
EA150: Soil Classification based on Particle Size									
Clay (<2 µm)	----	1	%	----	----	----	----	----	
Silt (2-60 µm)	----	1	%	----	----	----	----	----	
Sand (0.06-2.00 mm)	----	1	%	----	----	----	----	----	
Gravel (>2mm)	----	1	%	----	----	----	----	----	
Cobbles (>6cm)	----	1	%	----	----	----	----	----	
EA152: Soil Particle Density									
ø^Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	----	----	----	----	----	
ED008: Exchangeable Cations									

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Pit C (0-10)	Pit C (20-40)	Pit C (70-100)	Pit C (300-350)	Pit C (400-450)
Client sampling date / time				[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	
Compound	CAS Number	LOR	Unit	EB1520839-026	EB1520839-027	EB1520839-028	EB1520839-029	EB1520839-030	
				Result	Result	Result	Result	Result	
ED008: Exchangeable Cations - Continued									
^ Exchangeable Calcium	----	0.1	meq/100g	2.7	9.6	2.7	5.5	----	
Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	----	----	
^ Exchangeable Magnesium	----	0.1	meq/100g	1.3	1.7	1.2	4.9	----	
Exchangeable Potassium	----	0.1	meq/100g	----	----	----	----	----	
^ Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	<0.1	0.2	----	
Exchangeable Sodium	----	0.1	meq/100g	----	----	----	----	----	
^ Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	----	
^ Cation Exchange Capacity	----	0.1	meq/100g	4.2	11.5	4.1	10.7	----	
Exchangeable Sodium Percent	----	0.1	%	----	----	----	----	----	
^ Exchangeable Sodium Percent	----	0.1	%	<0.1	<0.1	<0.1	<0.1	----	
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg	1020	940	1730	600	520	
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%	0.11	0.11	0.05	0.07	0.06	
ED093T: Total Major Cations									
Calcium	7440-70-2	50	mg/kg	4860	5560	6820	4910	----	
Magnesium	7439-95-4	50	mg/kg	9500	12400	12400	11100	----	
Sodium	7440-23-5	50	mg/kg	<50	50	<50	<50	----	
Potassium	7440-09-7	50	mg/kg	710	660	790	1120	----	
EG005S : Soluble Metals by ICPAES									
Aluminium	7429-90-5	1	mg/kg	<1	<1	<1	<1	<1	
Antimony	7440-36-0	0.1	mg/kg	<0.1	0.1	<0.1	<0.1	<0.1	
Arsenic	7440-38-2	0.1	mg/kg	0.4	0.1	<0.1	<0.1	<0.1	
Boron	7440-42-8	1	mg/kg	<1	<1	<1	<1	<1	
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Copper	7440-50-8	0.1	mg/kg	<0.1	<0.1	0.1	<0.1	<0.1	
Iron	7439-89-6	1	mg/kg	<1	<1	<1	<1	<1	
Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Manganese	7439-96-5	0.1	mg/kg	0.2	<0.1	1.3	<0.1	<0.1	
Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	0.1	<0.1	<0.1	
Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
EG005T: Total Metals by ICP-AES									



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Pit C (0-10)	Pit C (20-40)	Pit C (70-100)	Pit C (300-350)	Pit C (400-450)
Client sampling date / time					[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]
Compound	CAS Number	LOR	Unit		EB1520839-026	EB1520839-027	EB1520839-028	EB1520839-029	EB1520839-030
					Result	Result	Result	Result	Result
EG005T: Total Metals by ICP-AES - Continued									
Aluminium	7429-90-5	50	mg/kg		12900	11900	11800	13800	24500
Antimony	7440-36-0	5	mg/kg		<5	8	7	<5	<5
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cobalt	7440-48-4	2	mg/kg		92	110	106	122	30
Iron	7439-89-6	50	mg/kg		34900	33400	32800	35900	99300
Manganese	7439-96-5	5	mg/kg		471	570	679	803	819
Vanadium	7440-62-2	5	mg/kg		20	22	23	21	44
Arsenic	7440-38-2	5	mg/kg		703	428	294	155	84
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		9	13	12	9	9
Copper	7440-50-8	5	mg/kg		3290	4160	7380	5460	491
Lead	7439-92-1	5	mg/kg		61	41	51	46	132
Nickel	7440-02-0	2	mg/kg		46	56	61	55	11
Zinc	7440-66-6	5	mg/kg		36	44	42	92	296
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		0.9	1.9	2.5	0.3	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		120	120	180	80	----
EK062: Total Nitrogen as N (TKN + NOx)									
^ Total Nitrogen as N	----	20	mg/kg		120	120	180	80	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		851	856	1080	922	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)									
Bicarbonate Ext. P (Colwell)	----	5	mg/kg		18	9	<5	5	----

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Pit C (600-650)	Pit C (800-850)	Pit C (1200-1300)	Pit C (1600-1700)	Pit D (0)
Client sampling date / time				[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	
Compound	CAS Number	LOR	Unit	EB1520839-031	EB1520839-032	EB1520839-033	EB1520839-034	EB1520839-035	
				Result	Result	Result	Result	Result	
EA009: Nett Acid Production Potential									
^ Net Acid Production Potential	----	0.5	kg H2SO4/t	4.5	33.0	43.4	49.9	-8.3	
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	1.6	<0.5	<0.5	<0.5	15.0	
^ ANC as CaCO3	----	0.1	% CaCO3	0.2	<0.1	<0.1	<0.1	1.5	
Fizz Rating	----	0	Fizz Unit	0	0	0	0	1	
EA055: Moisture Content									
^ Moisture Content (dried @ 103°C)	----	1	%	13.1	10.3	24.0	27.7	<1.0	
EA058: Emerson Aggregate Test									
Color (Munsell)	----	-	-	----	----	----	----	----	
Texture	----	-	-	----	----	----	----	----	
Emerson Class Number	EC/TC	-	-	----	----	----	----	----	
EA150: Particle Sizing									
+75µm	----	1	%	----	----	----	----	----	
+150µm	----	1	%	----	----	----	----	----	
+300µm	----	1	%	----	----	----	----	----	
+425µm	----	1	%	----	----	----	----	----	
+600µm	----	1	%	----	----	----	----	----	
+1180µm	----	1	%	----	----	----	----	----	
+2.36mm	----	1	%	----	----	----	----	----	
+4.75mm	----	1	%	----	----	----	----	----	
+9.5mm	----	1	%	----	----	----	----	----	
+19.0mm	----	1	%	----	----	----	----	----	
+37.5mm	----	1	%	----	----	----	----	----	
+75.0mm	----	1	%	----	----	----	----	----	
EA150: Soil Classification based on Particle Size									
Clay (<2 µm)	----	1	%	----	----	----	----	----	
Silt (2-60 µm)	----	1	%	----	----	----	----	----	
Sand (0.06-2.00 mm)	----	1	%	----	----	----	----	----	
Gravel (>2mm)	----	1	%	----	----	----	----	----	
Cobbles (>6cm)	----	1	%	----	----	----	----	----	
EA152: Soil Particle Density									
ø^Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	----	----	----	----	----	
ED008: Exchangeable Cations									

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Pit C (600-650)	Pit C (800-850)	Pit C (1200-1300)	Pit C (1600-1700)	Pit D (0)
Client sampling date / time				[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	
Compound	CAS Number	LOR	Unit	EB1520839-031	EB1520839-032	EB1520839-033	EB1520839-034	EB1520839-035	
				Result	Result	Result	Result	Result	
ED008: Exchangeable Cations - Continued									
^ Exchangeable Calcium	----	0.1	meq/100g	----	----	----	----	12.6	
Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	----	----	
^ Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	----	1.2	
Exchangeable Potassium	----	0.1	meq/100g	----	----	----	----	----	
^ Exchangeable Potassium	----	0.1	meq/100g	----	----	----	----	0.2	
Exchangeable Sodium	----	0.1	meq/100g	----	----	----	----	----	
^ Exchangeable Sodium	----	0.1	meq/100g	----	----	----	----	<0.1	
^ Cation Exchange Capacity	----	0.1	meq/100g	----	----	----	----	14.1	
Exchangeable Sodium Percent	----	0.1	%	----	----	----	----	----	
^ Exchangeable Sodium Percent	----	0.1	%	----	----	----	----	<0.1	
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg	6310	8200	11400	11400	380	
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%	0.20	1.08	1.42	1.63	0.22	
ED093T: Total Major Cations									
Calcium	7440-70-2	50	mg/kg	----	----	----	----	6720	
Magnesium	7439-95-4	50	mg/kg	----	----	----	----	8180	
Sodium	7440-23-5	50	mg/kg	----	----	----	----	<50	
Potassium	7440-09-7	50	mg/kg	----	----	----	----	2150	
EG005S : Soluble Metals by ICPAES									
Aluminium	7429-90-5	1	mg/kg	25	94	170	222	<1	
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Arsenic	7440-38-2	0.1	mg/kg	<0.1	0.2	0.2	0.2	0.1	
Boron	7440-42-8	1	mg/kg	<1	<1	<1	<1	<1	
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Cobalt	7440-48-4	0.1	mg/kg	6.0	12.1	33.0	42.7	<0.1	
Copper	7440-50-8	0.1	mg/kg	88.2	139	317	462	0.4	
Iron	7439-89-6	1	mg/kg	<1	39	530	538	<1	
Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Manganese	7439-96-5	0.1	mg/kg	23.2	27.5	60.4	71.6	0.1	
Nickel	7440-02-0	0.1	mg/kg	3.5	6.4	16.3	20.6	<0.1	
Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Zinc	7440-66-6	0.1	mg/kg	0.9	1.0	2.2	2.7	<0.1	
EG005T: Total Metals by ICP-AES									



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Client sample ID

				Pit C (600-650)	Pit C (800-850)	Pit C (1200-1300)	Pit C (1600-1700)	Pit D (0)
Client sampling date / time				[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]
Compound	CAS Number	LOR	Unit	EB1520839-031	EB1520839-032	EB1520839-033	EB1520839-034	EB1520839-035
				Result	Result	Result	Result	Result
EG005T: Total Metals by ICP-AES - Continued								
Aluminium	7429-90-5	50	mg/kg	25600	7560	15400	10300	12200
Antimony	7440-36-0	5	mg/kg	<5	7	6	6	6
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cobalt	7440-48-4	2	mg/kg	26	48	146	101	96
Iron	7439-89-6	50	mg/kg	102000	37800	45500	49600	58400
Manganese	7439-96-5	5	mg/kg	293	88	362	204	618
Vanadium	7440-62-2	5	mg/kg	46	12	31	16	30
Arsenic	7440-38-2	5	mg/kg	21	779	682	1020	301
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	9	17	31	20	11
Copper	7440-50-8	5	mg/kg	926	501	924	1170	2020
Lead	7439-92-1	5	mg/kg	63	35	31	66	47
Nickel	7440-02-0	2	mg/kg	13	34	99	73	54
Zinc	7440-66-6	5	mg/kg	203	8	24	12	82
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	----	----	----	17.8
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	----	----	----	720
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	----	----	----	----	740
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	----	----	----	----	961
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	----	----	----	----	36

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Pit D (0-10)	Pit D (20-40)	Pit D (70-100)	Pit D (300-350)	Pit D (400-450)
Client sampling date / time				[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	
Compound	CAS Number	LOR	Unit	EB1520839-036	EB1520839-037	EB1520839-038	EB1520839-039	EB1520839-040	
				Result	Result	Result	Result	Result	
EA009: Nett Acid Production Potential									
^ Net Acid Production Potential	----	0.5	kg H2SO4/t	-4.4	-6.9	-6.1	-6.6	-11.6	
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	6.6	7.8	7.0	8.4	13.1	
^ ANC as CaCO3	----	0.1	% CaCO3	0.7	0.8	0.7	0.8	1.3	
Fizz Rating	----	0	Fizz Unit	0	0	0	0	1	
EA055: Moisture Content									
^ Moisture Content (dried @ 103°C)	----	1	%	2.2	2.1	2.0	4.9	13.1	
EA058: Emerson Aggregate Test									
Color (Munsell)	----	-	-	----	----	----	----	----	
Texture	----	-	-	----	----	----	----	----	
Emerson Class Number	EC/TC	-	-	----	----	----	----	----	
EA150: Particle Sizing									
+75µm	----	1	%	----	----	----	----	----	
+150µm	----	1	%	----	----	----	----	----	
+300µm	----	1	%	----	----	----	----	----	
+425µm	----	1	%	----	----	----	----	----	
+600µm	----	1	%	----	----	----	----	----	
+1180µm	----	1	%	----	----	----	----	----	
+2.36mm	----	1	%	----	----	----	----	----	
+4.75mm	----	1	%	----	----	----	----	----	
+9.5mm	----	1	%	----	----	----	----	----	
+19.0mm	----	1	%	----	----	----	----	----	
+37.5mm	----	1	%	----	----	----	----	----	
+75.0mm	----	1	%	----	----	----	----	----	
EA150: Soil Classification based on Particle Size									
Clay (<2 µm)	----	1	%	----	----	----	----	----	
Silt (2-60 µm)	----	1	%	----	----	----	----	----	
Sand (0.06-2.00 mm)	----	1	%	----	----	----	----	----	
Gravel (>2mm)	----	1	%	----	----	----	----	----	
Cobbles (>6cm)	----	1	%	----	----	----	----	----	
EA152: Soil Particle Density									
ø^Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	----	----	----	----	----	
ED008: Exchangeable Cations									

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Pit D (0-10)	Pit D (20-40)	Pit D (70-100)	Pit D (300-350)	Pit D (400-450)
Client sampling date / time				[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	
Compound	CAS Number	LOR	Unit	EB1520839-036	EB1520839-037	EB1520839-038	EB1520839-039	EB1520839-040	
				Result	Result	Result	Result	Result	
ED008: Exchangeable Cations - Continued									
^ Exchangeable Calcium	----	0.1	meq/100g	2.2	1.7	1.7	2.2	----	
Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	----	----	
^ Exchangeable Magnesium	----	0.1	meq/100g	0.7	0.5	0.5	1.3	----	
Exchangeable Potassium	----	0.1	meq/100g	----	----	----	----	----	
^ Exchangeable Potassium	----	0.1	meq/100g	0.1	<0.1	<0.1	<0.1	----	
Exchangeable Sodium	----	0.1	meq/100g	----	----	----	----	----	
^ Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	----	
^ Cation Exchange Capacity	----	0.1	meq/100g	3.1	2.3	2.4	3.6	----	
Exchangeable Sodium Percent	----	0.1	%	----	----	----	----	----	
^ Exchangeable Sodium Percent	----	0.1	%	<0.1	<0.1	<0.1	<0.1	----	
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg	100	80	60	160	820	
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%	0.07	0.03	0.03	0.06	0.05	
ED093T: Total Major Cations									
Calcium	7440-70-2	50	mg/kg	3900	4030	3850	4930	----	
Magnesium	7439-95-4	50	mg/kg	7720	10700	8630	7100	----	
Sodium	7440-23-5	50	mg/kg	<50	<50	<50	<50	----	
Potassium	7440-09-7	50	mg/kg	1100	570	770	690	----	
EG005S : Soluble Metals by ICPAES									
Aluminium	7429-90-5	1	mg/kg	2	2	3	<1	<1	
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	0.1	
Arsenic	7440-38-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	0.1	
Boron	7440-42-8	1	mg/kg	<1	<1	<1	<1	<1	
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Copper	7440-50-8	0.1	mg/kg	0.1	0.1	0.1	<0.1	<0.1	
Iron	7439-89-6	1	mg/kg	1	<1	1	<1	<1	
Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Manganese	7439-96-5	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
EG005T: Total Metals by ICP-AES									



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Client sample ID

				Pit D (0-10)	Pit D (20-40)	Pit D (70-100)	Pit D (300-350)	Pit D (400-450)
Client sampling date / time				[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]
Compound	CAS Number	LOR	Unit	EB1520839-036	EB1520839-037	EB1520839-038	EB1520839-039	EB1520839-040
				Result	Result	Result	Result	Result
EG005T: Total Metals by ICP-AES - Continued								
Aluminium	7429-90-5	50	mg/kg	9730	11200	9840	8280	25100
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cobalt	7440-48-4	2	mg/kg	100	89	79	70	29
Iron	7439-89-6	50	mg/kg	29900	28200	25100	30800	112000
Manganese	7439-96-5	5	mg/kg	633	366	634	513	1300
Vanadium	7440-62-2	5	mg/kg	20	20	18	19	48
Arsenic	7440-38-2	5	mg/kg	173	143	134	107	16
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	9	8	9	8	6
Copper	7440-50-8	5	mg/kg	1030	1180	1080	1910	159
Lead	7439-92-1	5	mg/kg	11	10	10	26	156
Nickel	7440-02-0	2	mg/kg	57	46	41	33	9
Zinc	7440-66-6	5	mg/kg	28	28	28	46	322
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	1.8	1.1	1.2	0.9	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	140	100	90	110	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	140	100	90	110	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	1230	1340	1530	1020	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	22	35	34	27	----

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Pit D (600-650)	Pit D (800-850)	Pit D (1200-1300)	Pit D (1600-1700)	Magazine Creek Soil 1 (0)
Client sampling date / time				[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[04-Jun-2015]	
Compound	CAS Number	LOR	Unit	EB1520839-041	EB1520839-042	EB1520839-043	EB1520839-044	EB1520839-045	
				Result	Result	Result	Result	Result	
EA009: Nett Acid Production Potential									
^ Net Acid Production Potential	----	0.5	kg H2SO4/t	-1.7	12.2	31.8	68.5	<0.5	
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	6.0	0.9	<0.5	<0.5	2.5	
^ ANC as CaCO3	----	0.1	% CaCO3	0.6	<0.1	<0.1	<0.1	0.2	
Fizz Rating	----	0	Fizz Unit	1	0	0	0	0	
EA055: Moisture Content									
^ Moisture Content (dried @ 103°C)	----	1	%	11.2	8.8	26.0	15.8	<1.0	
EA058: Emerson Aggregate Test									
Color (Munsell)	----	-	-	----	----	----	----	----	
Texture	----	-	-	----	----	----	----	----	
Emerson Class Number	EC/TC	-	-	----	----	----	----	----	
EA150: Particle Sizing									
+75µm	----	1	%	----	----	----	----	----	
+150µm	----	1	%	----	----	----	----	----	
+300µm	----	1	%	----	----	----	----	----	
+425µm	----	1	%	----	----	----	----	----	
+600µm	----	1	%	----	----	----	----	----	
+1180µm	----	1	%	----	----	----	----	----	
+2.36mm	----	1	%	----	----	----	----	----	
+4.75mm	----	1	%	----	----	----	----	----	
+9.5mm	----	1	%	----	----	----	----	----	
+19.0mm	----	1	%	----	----	----	----	----	
+37.5mm	----	1	%	----	----	----	----	----	
+75.0mm	----	1	%	----	----	----	----	----	
EA150: Soil Classification based on Particle Size									
Clay (<2 µm)	----	1	%	----	----	----	----	----	
Silt (2-60 µm)	----	1	%	----	----	----	----	----	
Sand (0.06-2.00 mm)	----	1	%	----	----	----	----	----	
Gravel (>2mm)	----	1	%	----	----	----	----	----	
Cobbles (>6cm)	----	1	%	----	----	----	----	----	
EA152: Soil Particle Density									
ø^ Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	----	----	----	----	----	
ED008: Exchangeable Cations									



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Client sample ID

				Pit D (600-650)	Pit D (800-850)	Pit D (1200-1300)	Pit D (1600-1700)	Magazine Creek Soil 1 (0)
Client sampling date / time				[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[04-Jun-2015]
Compound	CAS Number	LOR	Unit	EB1520839-041	EB1520839-042	EB1520839-043	EB1520839-044	EB1520839-045
				Result	Result	Result	Result	Result
ED008: Exchangeable Cations - Continued								
^ Exchangeable Calcium	----	0.1	meq/100g	----	----	----	----	4.1
Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	----	----
^ Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	----	1.4
Exchangeable Potassium	----	0.1	meq/100g	----	----	----	----	----
^ Exchangeable Potassium	----	0.1	meq/100g	----	----	----	----	0.3
Exchangeable Sodium	----	0.1	meq/100g	----	----	----	----	----
^ Exchangeable Sodium	----	0.1	meq/100g	----	----	----	----	<0.1
^ Cation Exchange Capacity	----	0.1	meq/100g	----	----	----	----	5.9
Exchangeable Sodium Percent	----	0.1	%	----	----	----	----	----
^ Exchangeable Sodium Percent	----	0.1	%	----	----	----	----	<0.1
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	3040	550	6570	12400	20
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.14	0.43	1.04	2.24	0.09
ED093T: Total Major Cations								
Calcium	7440-70-2	50	mg/kg	----	----	----	----	1420
Magnesium	7439-95-4	50	mg/kg	----	----	----	----	530
Sodium	7440-23-5	50	mg/kg	----	----	----	----	<50
Potassium	7440-09-7	50	mg/kg	----	----	----	----	820
EG005S : Soluble Metals by ICPAES								
Aluminium	7429-90-5	1	mg/kg	7	1	188	432	7
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	7440-38-2	0.1	mg/kg	<0.1	<0.1	<0.1	0.8	<0.1
Boron	7440-42-8	1	mg/kg	<1	<1	<1	<1	<1
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/kg	4.1	0.8	10.7	31.1	<0.1
Copper	7440-50-8	0.1	mg/kg	146	28.8	215	597	0.3
Iron	7439-89-6	1	mg/kg	<1	<1	1	16	5
Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Manganese	7439-96-5	0.1	mg/kg	24.0	4.1	18.8	26.5	1.0
Nickel	7440-02-0	0.1	mg/kg	2.5	0.6	6.6	17.3	<0.1
Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	0.1	mg/kg	1.3	0.2	1.2	1.4	<0.1



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Client sample ID

				Pit D (600-650)	Pit D (800-850)	Pit D (1200-1300)	Pit D (1600-1700)	Magazine Creek Soil 1 (0)
Client sampling date / time				[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[03-Jun-2015]	[04-Jun-2015]
Compound	CAS Number	LOR	Unit	EB1520839-041	EB1520839-042	EB1520839-043	EB1520839-044	EB1520839-045
				Result	Result	Result	Result	Result
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	26400	6560	16100	11300	3320
Antimony	7440-36-0	5	mg/kg	<5	<5	5	6	<5
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cobalt	7440-48-4	2	mg/kg	74	32	114	163	10
Iron	7439-89-6	50	mg/kg	109000	24900	45800	29500	14400
Manganese	7439-96-5	5	mg/kg	1290	105	267	115	218
Vanadium	7440-62-2	5	mg/kg	85	13	29	16	28
Arsenic	7440-38-2	5	mg/kg	37	372	773	615	13
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	8	8	30	15	7
Copper	7440-50-8	5	mg/kg	1930	426	787	914	169
Lead	7439-92-1	5	mg/kg	136	24	33	36	7
Nickel	7440-02-0	2	mg/kg	24	24	90	103	6
Zinc	7440-66-6	5	mg/kg	328	11	22	13	6
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	----	----	----	3.3
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	----	----	----	1050
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	----	----	----	----	1050
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	----	----	----	----	173
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	----	----	----	----	<5

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Magazine Creek Soil 1 (200-300)	Magazine Creek Soil 1 (500-600)	Magazine Creek Soil 1 (700-800)	Magazine Creek Soil 1 (1000-1100)	Magazine Creek Soil 1 (0-1900)
Client sampling date / time				[04-Jun-2015]	[04-Jun-2015]	[04-Jun-2015]	[04-Jun-2015]	[04-Jun-2015]	
Compound	CAS Number	LOR	Unit	EB1520839-046	EB1520839-047	EB1520839-048	EB1520839-049	EB1520839-050	
				Result	Result	Result	Result	Result	
EA009: Nett Acid Production Potential									
^ Net Acid Production Potential	----	0.5	kg H2SO4/t	0.00	-2.5	-1.9	-1.5	----	
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	1.6	2.5	1.9	1.5	----	
^ ANC as CaCO3	----	0.1	% CaCO3	0.2	0.2	0.2	0.2	----	
Fizz Rating	----	0	Fizz Unit	0	0	0	0	----	
EA055: Moisture Content									
^ Moisture Content (dried @ 103°C)	----	1	%	2.0	2.7	2.4	3.9	----	
EA058: Emerson Aggregate Test									
Color (Munsell)	----	-	-	----	----	----	----	Reddish Brown	
Texture	----	-	-	----	----	----	----	Silty Clay Loam	
Emerson Class Number	EC/TC	-	-	----	----	----	----	3	
EA150: Particle Sizing									
+75µm	----	1	%	----	----	----	----	62	
+150µm	----	1	%	----	----	----	----	53	
+300µm	----	1	%	----	----	----	----	44	
+425µm	----	1	%	----	----	----	----	40	
+600µm	----	1	%	----	----	----	----	38	
+1180µm	----	1	%	----	----	----	----	36	
+2.36mm	----	1	%	----	----	----	----	34	
+4.75mm	----	1	%	----	----	----	----	30	
+9.5mm	----	1	%	----	----	----	----	27	
+19.0mm	----	1	%	----	----	----	----	15	
+37.5mm	----	1	%	----	----	----	----	<1	
+75.0mm	----	1	%	----	----	----	----	<1	
EA150: Soil Classification based on Particle Size									
Clay (<2 µm)	----	1	%	----	----	----	----	15	
Silt (2-60 µm)	----	1	%	----	----	----	----	19	
Sand (0.06-2.00 mm)	----	1	%	----	----	----	----	30	
Gravel (>2mm)	----	1	%	----	----	----	----	36	
Cobbles (>6cm)	----	1	%	----	----	----	----	<1	
EA152: Soil Particle Density									
ø^ Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	----	----	----	----	2.67	
ED008: Exchangeable Cations									



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Client sample ID

				Magazine Creek Soil 1 (200-300)	Magazine Creek Soil 1 (500-600)	Magazine Creek Soil 1 (700-800)	Magazine Creek Soil 1 (1000-1100)	Magazine Creek Soil 1 (0-1900)
Client sampling date / time				[04-Jun-2015]	[04-Jun-2015]	[04-Jun-2015]	[04-Jun-2015]	[04-Jun-2015]
Compound	CAS Number	LOR	Unit	EB1520839-046	EB1520839-047	EB1520839-048	EB1520839-049	EB1520839-050
				Result	Result	Result	Result	Result
ED008: Exchangeable Cations - Continued								
^ Exchangeable Calcium	----	0.1	meq/100g	1.4	1.2	0.7	0.4	----
Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	----	----
^ Exchangeable Magnesium	----	0.1	meq/100g	0.7	0.7	0.8	0.8	----
Exchangeable Potassium	----	0.1	meq/100g	----	----	----	----	----
^ Exchangeable Potassium	----	0.1	meq/100g	0.2	0.2	0.1	<0.1	----
Exchangeable Sodium	----	0.1	meq/100g	----	----	----	----	----
^ Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	----
^ Cation Exchange Capacity	----	0.1	meq/100g	2.5	2.2	1.7	1.4	----
Exchangeable Sodium Percent	----	0.1	%	----	----	----	----	----
^ Exchangeable Sodium Percent	----	0.1	%	<0.1	<0.1	<0.1	<0.1	----
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	10	40	40	<10	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.04	<0.01	<0.01	<0.01	----
ED093T: Total Major Cations								
Calcium	7440-70-2	50	mg/kg	400	350	180	110	----
Magnesium	7439-95-4	50	mg/kg	240	240	250	250	----
Sodium	7440-23-5	50	mg/kg	<50	<50	<50	<50	----
Potassium	7440-09-7	50	mg/kg	560	540	550	540	----
EG005S : Soluble Metals by ICPAES								
Aluminium	7429-90-5	1	mg/kg	14	13	10	8	----
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----
Arsenic	7440-38-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----
Boron	7440-42-8	1	mg/kg	<1	<1	<1	<1	----
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----
Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----
Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----
Copper	7440-50-8	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----
Iron	7439-89-6	1	mg/kg	9	9	7	5	----
Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----
Manganese	7439-96-5	0.1	mg/kg	<0.1	<0.1	0.1	<0.1	----
Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----
Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----
Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Client sample ID

				Magazine Creek Soil 1 (200-300)	Magazine Creek Soil 1 (500-600)	Magazine Creek Soil 1 (700-800)	Magazine Creek Soil 1 (1000-1100)	Magazine Creek Soil 1 (0-1900)
Client sampling date / time				[04-Jun-2015]	[04-Jun-2015]	[04-Jun-2015]	[04-Jun-2015]	[04-Jun-2015]
Compound	CAS Number	LOR	Unit	EB1520839-046	EB1520839-047	EB1520839-048	EB1520839-049	EB1520839-050
				Result	Result	Result	Result	Result
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	2740	2540	3150	3510	----
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	----
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	----
Cobalt	7440-48-4	2	mg/kg	8	7	2	3	----
Iron	7439-89-6	50	mg/kg	15700	13800	12400	11600	----
Manganese	7439-96-5	5	mg/kg	189	79	64	284	----
Vanadium	7440-62-2	5	mg/kg	30	27	26	25	----
Arsenic	7440-38-2	5	mg/kg	12	10	9	7	----
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	----
Chromium	7440-47-3	2	mg/kg	9	7	8	7	----
Copper	7440-50-8	5	mg/kg	91	100	100	101	----
Lead	7439-92-1	5	mg/kg	7	<5	<5	7	----
Nickel	7440-02-0	2	mg/kg	4	4	3	2	----
Zinc	7440-66-6	5	mg/kg	<5	<5	<5	<5	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	0.5	0.5	0.2	0.1	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	340	230	150	130	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	340	230	150	130	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	160	157	148	134	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	<5	<5	<5	----

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	North Rock Soil 1 (0)	North Rock Soil 1 (50-100)	North Rock Soil 1 (500-600)	North Rock Soil 1 (700-800)	North Rock Soil (1200-1300)
Client sampling date / time					[04-Jun-2015]	[04-Jun-2015]	[04-Jun-2015]	[04-Jun-2015]	[04-Jun-2015]
Compound	CAS Number	LOR	Unit	EB1520839-051	EB1520839-052	EB1520839-053	EB1520839-054	EB1520839-055	
				Result	Result	Result	Result	Result	
EA009: Nett Acid Production Potential									
^ Net Acid Production Potential	----	0.5	kg H2SO4/t	-1.7	-0.9	-1.8	-2.0	-3.6	
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	2.3	1.5	1.8	2.0	4.2	
^ ANC as CaCO3	----	0.1	% CaCO3	0.2	0.1	0.2	0.2	0.4	
Fizz Rating	----	0	Fizz Unit	0	0	0	0	0	
EA055: Moisture Content									
^ Moisture Content (dried @ 103°C)	----	1	%	<1.0	<1.0	3.6	3.4	10.3	
EA058: Emerson Aggregate Test									
Color (Munsell)	----	-	-	----	----	----	----	----	
Texture		-	-	----	----	----	----	----	
Emerson Class Number	EC/TC	-	-	----	----	----	----	----	
EA150: Particle Sizing									
+75µm	----	1	%	----	----	----	----	----	
+150µm	----	1	%	----	----	----	----	----	
+300µm	----	1	%	----	----	----	----	----	
+425µm	----	1	%	----	----	----	----	----	
+600µm	----	1	%	----	----	----	----	----	
+1180µm	----	1	%	----	----	----	----	----	
+2.36mm	----	1	%	----	----	----	----	----	
+4.75mm	----	1	%	----	----	----	----	----	
+9.5mm	----	1	%	----	----	----	----	----	
+19.0mm	----	1	%	----	----	----	----	----	
+37.5mm	----	1	%	----	----	----	----	----	
+75.0mm	----	1	%	----	----	----	----	----	
EA150: Soil Classification based on Particle Size									
Clay (<2 µm)	----	1	%	----	----	----	----	----	
Silt (2-60 µm)	----	1	%	----	----	----	----	----	
Sand (0.06-2.00 mm)	----	1	%	----	----	----	----	----	
Gravel (>2mm)	----	1	%	----	----	----	----	----	
Cobbles (>6cm)	----	1	%	----	----	----	----	----	
EA152: Soil Particle Density									
ø^Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	----	----	----	----	----	
ED008: Exchangeable Cations									



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Client sample ID

				North Rock Soil 1 (0)	North Rock Soil 1 (50-100)	North Rock Soil 1 (500-600)	North Rock Soil 1 (700-800)	North Rock Soil (1200-1300)
Client sampling date / time				[04-Jun-2015]	[04-Jun-2015]	[04-Jun-2015]	[04-Jun-2015]	[04-Jun-2015]
Compound	CAS Number	LOR	Unit	EB1520839-051	EB1520839-052	EB1520839-053	EB1520839-054	EB1520839-055
				Result	Result	Result	Result	Result
ED008: Exchangeable Cations - Continued								
^ Exchangeable Calcium	----	0.1	meq/100g	2.5	2.2	4.9	5.3	9.2
Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	----	----
^ Exchangeable Magnesium	----	0.1	meq/100g	0.9	0.8	2.1	3.0	11.8
Exchangeable Potassium	----	0.1	meq/100g	----	----	----	----	----
^ Exchangeable Potassium	----	0.1	meq/100g	0.2	0.1	0.2	0.4	0.4
Exchangeable Sodium	----	0.1	meq/100g	----	----	----	----	----
^ Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
^ Cation Exchange Capacity	----	0.1	meq/100g	3.7	3.2	7.3	8.8	21.6
Exchangeable Sodium Percent	----	0.1	%	----	----	----	----	----
^ Exchangeable Sodium Percent	----	0.1	%	<0.1	<0.1	<0.1	<0.1	0.2
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	30	20	210	20	180
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.02	<0.01	<0.01	0.02
ED093T: Total Major Cations								
Calcium	7440-70-2	50	mg/kg	940	770	1570	1320	2390
Magnesium	7439-95-4	50	mg/kg	1020	840	1830	2000	6240
Sodium	7440-23-5	50	mg/kg	<50	<50	<50	<50	110
Potassium	7440-09-7	50	mg/kg	900	870	1580	1870	2280
EG005S : Soluble Metals by ICPAES								
Aluminium	7429-90-5	1	mg/kg	7	6	<1	20	3
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	7440-38-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Boron	7440-42-8	1	mg/kg	<1	<1	<1	<1	<1
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Copper	7440-50-8	0.1	mg/kg	0.8	<0.1	<0.1	<0.1	<0.1
Iron	7439-89-6	1	mg/kg	5	4	<1	17	10
Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Manganese	7439-96-5	0.1	mg/kg	0.5	0.2	<0.1	<0.1	<0.1
Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Client sample ID

				North Rock Soil 1 (0)	North Rock Soil 1 (50-100)	North Rock Soil 1 (500-600)	North Rock Soil 1 (700-800)	North Rock Soil (1200-1300)
Client sampling date / time				[04-Jun-2015]	[04-Jun-2015]	[04-Jun-2015]	[04-Jun-2015]	[04-Jun-2015]
Compound	CAS Number	LOR	Unit	EB1520839-051	EB1520839-052	EB1520839-053	EB1520839-054	EB1520839-055
				Result	Result	Result	Result	Result
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	4610	5260	11000	13500	16600
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cobalt	7440-48-4	2	mg/kg	14	11	21	15	32
Iron	7439-89-6	50	mg/kg	13800	13900	25100	29800	49200
Manganese	7439-96-5	5	mg/kg	266	234	246	155	396
Vanadium	7440-62-2	5	mg/kg	29	30	68	86	89
Arsenic	7440-38-2	5	mg/kg	16	5	10	13	26
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	9	10	16	18	21
Copper	7440-50-8	5	mg/kg	245	49	75	58	88
Lead	7439-92-1	5	mg/kg	12	6	8	9	11
Nickel	7440-02-0	2	mg/kg	8	7	13	14	21
Zinc	7440-66-6	5	mg/kg	16	9	15	17	35
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	3.1	4.6	0.5	0.3	0.2
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	630	400	390	430	290
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	630	400	390	430	290
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	276	190	270	326	333
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	<5	64	25	8

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	North Rock Soil (1700-1800)	Mill Creek Hill Soil (200-300)	Mill Creek Hill Soil 1 (0-1900)	North Rock Soil 1 (0-1800)	Diversion Dam Soil 1 (0)
Client sampling date / time				[04-Jun-2015]	[04-Jun-2015]	[04-Jun-2015]	[04-Jun-2015]	[05-Jun-2015]	
Compound	CAS Number	LOR	Unit	EB1520839-056	EB1520839-057	EB1520839-058	EB1520839-059	EB1520839-060	
				Result	Result	Result	Result	Result	
EA009: Nett Acid Production Potential									
^ Net Acid Production Potential	----	0.5	kg H2SO4/t	-137	-2.7	----	----	-4.2	
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	138	3.6	----	----	4.8	
^ ANC as CaCO3	----	0.1	% CaCO3	14.1	0.4	----	----	0.5	
Fizz Rating	----	0	Fizz Unit	3	0	----	----	0	
EA055: Moisture Content									
^ Moisture Content (dried @ 103°C)	----	1	%	10.4	4.3	----	----	1.1	
EA058: Emerson Aggregate Test									
Color (Munsell)	----	-	-	----	----	Dark Reddish Brown	Reddish Brown	----	
Texture	----	-	-	----	----	Rocks	Silty Clay	----	
Emerson Class Number	EC/TC	-	-	----	----	8	4	----	
EA150: Particle Sizing									
+75µm	----	1	%	----	----	63	64	----	
+150µm	----	1	%	----	----	62	60	----	
+300µm	----	1	%	----	----	61	57	----	
+425µm	----	1	%	----	----	60	56	----	
+600µm	----	1	%	----	----	60	55	----	
+1180µm	----	1	%	----	----	58	54	----	
+2.36mm	----	1	%	----	----	54	51	----	
+4.75mm	----	1	%	----	----	48	44	----	
+9.5mm	----	1	%	----	----	34	19	----	
+19.0mm	----	1	%	----	----	7	3	----	
+37.5mm	----	1	%	----	----	<1	<1	----	
+75.0mm	----	1	%	----	----	<1	<1	----	
EA150: Soil Classification based on Particle Size									
Clay (<2 µm)	----	1	%	----	----	16	18	----	
Silt (2-60 µm)	----	1	%	----	----	23	19	----	
Sand (0.06-2.00 mm)	----	1	%	----	----	4	10	----	
Gravel (>2mm)	----	1	%	----	----	57	53	----	
Cobbles (>6cm)	----	1	%	----	----	<1	<1	----	
EA152: Soil Particle Density									
ø^Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	----	----	2.77	2.71	----	
ED008: Exchangeable Cations									



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Client sample ID

				North Rock Soil (1700-1800)	Mill Creek Hill Soil (200-300)	Mill Creek Hill Soil 1 (0-1900)	North Rock Soil 1 (0-1800)	Diversion Dam Soil 1 (0)
Client sampling date / time				[04-Jun-2015]	[04-Jun-2015]	[04-Jun-2015]	[04-Jun-2015]	[05-Jun-2015]
Compound	CAS Number	LOR	Unit	EB1520839-056	EB1520839-057	EB1520839-058	EB1520839-059	EB1520839-060
				Result	Result	Result	Result	Result
ED008: Exchangeable Cations - Continued								
^ Exchangeable Calcium	----	0.1	meq/100g	24.3	6.7	----	----	1.8
Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	----	----
^ Exchangeable Magnesium	----	0.1	meq/100g	13.3	2.2	----	----	0.5
Exchangeable Potassium	----	0.1	meq/100g	----	----	----	----	----
^ Exchangeable Potassium	----	0.1	meq/100g	0.4	0.4	----	----	0.1
Exchangeable Sodium	----	0.1	meq/100g	----	----	----	----	----
^ Exchangeable Sodium	----	0.1	meq/100g	0.1	<0.1	----	----	<0.1
^ Cation Exchange Capacity	----	0.1	meq/100g	38.2	9.3	----	----	2.4
Exchangeable Sodium Percent	----	0.1	%	----	----	----	----	----
^ Exchangeable Sodium Percent	----	0.1	%	0.3	<0.1	----	----	<0.1
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	90	80	----	----	<10
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.03	----	----	0.02
ED093T: Total Major Cations								
Calcium	7440-70-2	50	mg/kg	39900	2280	----	----	550
Magnesium	7439-95-4	50	mg/kg	24600	2310	----	----	260
Sodium	7440-23-5	50	mg/kg	180	<50	----	----	<50
Potassium	7440-09-7	50	mg/kg	1990	1730	----	----	360
EG005S : Soluble Metals by ICPAES								
Aluminium	7429-90-5	1	mg/kg	1	9	----	----	26
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	----	----	<0.1
Arsenic	7440-38-2	0.1	mg/kg	<0.1	<0.1	----	----	<0.1
Boron	7440-42-8	1	mg/kg	<1	<1	----	----	<1
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	----	----	<0.1
Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	----	----	<0.1
Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	----	----	<0.1
Copper	7440-50-8	0.1	mg/kg	<0.1	0.2	----	----	<0.1
Iron	7439-89-6	1	mg/kg	2	8	----	----	12
Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	----	----	<0.1
Manganese	7439-96-5	0.1	mg/kg	<0.1	0.4	----	----	0.1
Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	----	----	<0.1
Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	----	----	<0.1
Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	----	----	<0.1



Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

Client sample ID

				North Rock Soil (1700-1800)	Mill Creek Hill Soil (200-300)	Mill Creek Hill Soil 1 (0-1900)	North Rock Soil 1 (0-1800)	Diversion Dam Soil 1 (0)
Client sampling date / time				[04-Jun-2015]	[04-Jun-2015]	[04-Jun-2015]	[04-Jun-2015]	[05-Jun-2015]
Compound	CAS Number	LOR	Unit	EB1520839-056	EB1520839-057	EB1520839-058	EB1520839-059	EB1520839-060
				Result	Result	Result	Result	Result
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	14800	12100	----	----	4950
Antimony	7440-36-0	5	mg/kg	<5	6	----	----	<5
Boron	7440-42-8	50	mg/kg	<50	<50	----	----	<50
Cobalt	7440-48-4	2	mg/kg	22	178	----	----	4
Iron	7439-89-6	50	mg/kg	23100	82200	----	----	10800
Manganese	7439-96-5	5	mg/kg	1040	3590	----	----	137
Vanadium	7440-62-2	5	mg/kg	41	34	----	----	29
Arsenic	7440-38-2	5	mg/kg	6	174	----	----	5
Cadmium	7440-43-9	1	mg/kg	<1	<1	----	----	<1
Chromium	7440-47-3	2	mg/kg	14	13	----	----	9
Copper	7440-50-8	5	mg/kg	58	1440	----	----	13
Lead	7439-92-1	5	mg/kg	7	25	----	----	<5
Nickel	7440-02-0	2	mg/kg	14	46	----	----	<2
Zinc	7440-66-6	5	mg/kg	18	28	----	----	<5
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	0.3	0.8	----	----	0.7
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	200	1480	----	----	560
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	200	1480	----	----	560
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	157	409	----	----	129
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	<5	----	----	<5

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Diversion Dam Soil 1 (50-80)	Diversion Dam Soil 1 (200-250)	Diversion Dam Soil 1 (500-550)	Diversion Dam Soil 1 (800-850)	Diversion Dam Soil 1 (1100-1200)
Client sampling date / time				[05-Jun-2015]	[05-Jun-2015]	[05-Jun-2015]	[05-Jun-2015]	[05-Jun-2015]	[05-Jun-2015]
Compound	CAS Number	LOR	Unit	EB1520839-061	EB1520839-062	EB1520839-063	EB1520839-064	EB1520839-065	
				Result	Result	Result	Result	Result	Result
EA009: Nett Acid Production Potential									
^ Net Acid Production Potential	----	0.5	kg H2SO4/t	-0.8	0.00	-1.0	<0.5	-1.1	
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	1.4	1.1	1.0	<0.5	1.1	
^ ANC as CaCO3	----	0.1	% CaCO3	0.1	0.1	0.1	<0.1	0.1	
Fizz Rating	----	0	Fizz Unit	0	0	0	0	0	
EA055: Moisture Content									
^ Moisture Content (dried @ 103°C)	----	1	%	<1.0	1.3	3.5	2.4	<1.0	
EA058: Emerson Aggregate Test									
Color (Munsell)	----	-	-	----	----	----	----	----	
Texture	----	-	-	----	----	----	----	----	
Emerson Class Number	EC/TC	-	-	----	----	----	----	----	
EA150: Particle Sizing									
+75µm	----	1	%	----	----	----	----	----	
+150µm	----	1	%	----	----	----	----	----	
+300µm	----	1	%	----	----	----	----	----	
+425µm	----	1	%	----	----	----	----	----	
+600µm	----	1	%	----	----	----	----	----	
+1180µm	----	1	%	----	----	----	----	----	
+2.36mm	----	1	%	----	----	----	----	----	
+4.75mm	----	1	%	----	----	----	----	----	
+9.5mm	----	1	%	----	----	----	----	----	
+19.0mm	----	1	%	----	----	----	----	----	
+37.5mm	----	1	%	----	----	----	----	----	
+75.0mm	----	1	%	----	----	----	----	----	
EA150: Soil Classification based on Particle Size									
Clay (<2 µm)	----	1	%	----	----	----	----	----	
Silt (2-60 µm)	----	1	%	----	----	----	----	----	
Sand (0.06-2.00 mm)	----	1	%	----	----	----	----	----	
Gravel (>2mm)	----	1	%	----	----	----	----	----	
Cobbles (>6cm)	----	1	%	----	----	----	----	----	
EA152: Soil Particle Density									
ø^Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	----	----	----	----	----	
ED008: Exchangeable Cations									



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Client sample ID

				Diversion Dam Soil 1 (50-80)	Diversion Dam Soil 1 (200-250)	Diversion Dam Soil 1 (500-550)	Diversion Dam Soil 1 (800-850)	Diversion Dam Soil 1 (1100-1200)
Client sampling date / time				[05-Jun-2015]	[05-Jun-2015]	[05-Jun-2015]	[05-Jun-2015]	[05-Jun-2015]
Compound	CAS Number	LOR	Unit	EB1520839-061	EB1520839-062	EB1520839-063	EB1520839-064	EB1520839-065
				Result	Result	Result	Result	Result
ED008: Exchangeable Cations - Continued								
^ Exchangeable Calcium	----	0.1	meq/100g	1.6	0.8	0.2	0.2	<0.1
Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	----	----
^ Exchangeable Magnesium	----	0.1	meq/100g	0.5	0.4	0.3	0.4	<0.1
Exchangeable Potassium	----	0.1	meq/100g	----	----	----	----	----
^ Exchangeable Potassium	----	0.1	meq/100g	0.1	<0.1	<0.1	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	----	----	----	----	----
^ Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
^ Cation Exchange Capacity	----	0.1	meq/100g	2.3	1.2	0.6	0.7	0.2
Exchangeable Sodium Percent	----	0.1	%	----	----	----	----	----
^ Exchangeable Sodium Percent	----	0.1	%	<0.1	<0.1	<0.1	<0.1	<0.1
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	10	10	20	<10
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.02	<0.01	<0.01	<0.01
ED093T: Total Major Cations								
Calcium	7440-70-2	50	mg/kg	500	200	90	60	<50
Magnesium	7439-95-4	50	mg/kg	270	190	170	130	<50
Sodium	7440-23-5	50	mg/kg	<50	<50	<50	<50	<50
Potassium	7440-09-7	50	mg/kg	370	270	280	180	90
EG005S : Soluble Metals by ICPAES								
Aluminium	7429-90-5	1	mg/kg	19	28	22	12	1
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	7440-38-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Boron	7440-42-8	1	mg/kg	<1	<1	<1	<1	<1
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Copper	7440-50-8	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Iron	7439-89-6	1	mg/kg	9	13	12	8	1
Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Manganese	7439-96-5	0.1	mg/kg	0.2	<0.1	<0.1	<0.1	<0.1
Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Client sample ID

				Diversion Dam Soil 1 (50-80)	Diversion Dam Soil 1 (200-250)	Diversion Dam Soil 1 (500-550)	Diversion Dam Soil 1 (800-850)	Diversion Dam Soil 1 (1100-1200)
Client sampling date / time				[05-Jun-2015]	[05-Jun-2015]	[05-Jun-2015]	[05-Jun-2015]	[05-Jun-2015]
Compound	CAS Number	LOR	Unit	EB1520839-061	EB1520839-062	EB1520839-063	EB1520839-064	EB1520839-065
				Result	Result	Result	Result	Result
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	5080	5080	6550	5660	1200
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cobalt	7440-48-4	2	mg/kg	4	<2	<2	<2	<2
Iron	7439-89-6	50	mg/kg	9590	9800	14600	11700	1270
Manganese	7439-96-5	5	mg/kg	112	27	15	10	<5
Vanadium	7440-62-2	5	mg/kg	28	30	46	36	6
Arsenic	7440-38-2	5	mg/kg	<5	<5	<5	<5	<5
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	9	10	14	12	<2
Copper	7440-50-8	5	mg/kg	16	6	8	9	<5
Lead	7439-92-1	5	mg/kg	<5	<5	<5	<5	<5
Nickel	7440-02-0	2	mg/kg	2	2	3	<2	<2
Zinc	7440-66-6	5	mg/kg	<5	<5	<5	<5	<5
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	0.6	0.4	<0.1	<0.1	<0.1
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	640	320	260	110	30
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	640	320	260	110	30
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	125	96	92	138	88
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	<5	<5	<5	<5

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Diversion Dam Soil 2 (600-700)	Borrow 1 (0-1400)	Borrow 2 (0-1700)	Borrow 1 (0-1400)	Diversion Dam Soil 1 (0-1900)
Client sampling date / time				[05-Jun-2015]	[06-Jun-2015]	[06-Jun-2015]	[06-Jun-2015]	[05-Jun-2015]	
Compound	CAS Number	LOR	Unit	EB1520839-066	EB1520839-067	EB1520839-068	EB1520839-069	EB1520839-070	
				Result	Result	Result	Result	Result	
EA009: Nett Acid Production Potential									
^ Net Acid Production Potential	----	0.5	kg H2SO4/t	-1.3	-2.1	2.8	----	----	
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	1.3	2.1	1.8	----	----	
^ ANC as CaCO3	----	0.1	% CaCO3	0.1	0.2	0.2	----	----	
Fizz Rating	----	0	Fizz Unit	0	0	0	----	----	
EA055: Moisture Content									
^ Moisture Content (dried @ 103°C)	----	1	%	2.1	1.9	4.1	----	----	
EA058: Emerson Aggregate Test									
Color (Munsell)	----	-	-	----	----	----	Reddish Brown	Dark Reddish Brown	
Texture	----	-	-	----	----	----	Silty Caly	Silty Clay	
Emerson Class Number	EC/TC	-	-	----	----	----	4	4	
EA150: Particle Sizing									
+75µm	----	1	%	----	----	----	75	68	
+150µm	----	1	%	----	----	----	71	54	
+300µm	----	1	%	----	----	----	68	48	
+425µm	----	1	%	----	----	----	67	46	
+600µm	----	1	%	----	----	----	66	46	
+1180µm	----	1	%	----	----	----	64	45	
+2.36mm	----	1	%	----	----	----	61	42	
+4.75mm	----	1	%	----	----	----	55	37	
+9.5mm	----	1	%	----	----	----	42	26	
+19.0mm	----	1	%	----	----	----	28	21	
+37.5mm	----	1	%	----	----	----	11	5	
+75.0mm	----	1	%	----	----	----	<1	<1	
EA150: Soil Classification based on Particle Size									
Clay (<2 µm)	----	1	%	----	----	----	14	15	
Silt (2-60 µm)	----	1	%	----	----	----	11	14	
Sand (0.06-2.00 mm)	----	1	%	----	----	----	12	27	
Gravel (>2mm)	----	1	%	----	----	----	54	40	
Cobbles (>6cm)	----	1	%	----	----	----	9	4	
EA152: Soil Particle Density									
ø^ Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	----	----	----	2.74	2.68	
ED008: Exchangeable Cations									



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Client sample ID

				Diversion Dam Soil 2 (600-700)	Borrow 1 (0-1400)	Borrow 2 (0-1700)	Borrow 1 (0-1400)	Diversion Dam Soil 1 (0-1900)
Client sampling date / time				[05-Jun-2015]	[06-Jun-2015]	[06-Jun-2015]	[06-Jun-2015]	[05-Jun-2015]
Compound	CAS Number	LOR	Unit	EB1520839-066	EB1520839-067	EB1520839-068	EB1520839-069	EB1520839-070
				Result	Result	Result	Result	Result
ED008: Exchangeable Cations - Continued								
^ Exchangeable Calcium	----	0.1	meq/100g	0.9	0.8	5.5	----	----
Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	----	----
^ Exchangeable Magnesium	----	0.1	meq/100g	0.6	1.7	0.4	----	----
Exchangeable Potassium	----	0.1	meq/100g	----	----	----	----	----
^ Exchangeable Potassium	----	0.1	meq/100g	0.1	0.3	0.1	----	----
Exchangeable Sodium	----	0.1	meq/100g	----	----	----	----	----
^ Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	----	----
^ Cation Exchange Capacity	----	0.1	meq/100g	1.7	2.9	6.2	----	----
Exchangeable Sodium Percent	----	0.1	%	----	----	----	----	----
^ Exchangeable Sodium Percent	----	0.1	%	<0.1	<0.1	<0.1	----	----
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	20	<10	3110	----	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	<0.01	0.15	----	----
ED093T: Total Major Cations								
Calcium	7440-70-2	50	mg/kg	260	260	2510	----	----
Magnesium	7439-95-4	50	mg/kg	220	910	500	----	----
Sodium	7440-23-5	50	mg/kg	<50	<50	<50	----	----
Potassium	7440-09-7	50	mg/kg	410	1280	920	----	----
EG005S : Soluble Metals by ICPAES								
Aluminium	7429-90-5	1	mg/kg	21	3	<1	----	----
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	----	----
Arsenic	7440-38-2	0.1	mg/kg	<0.1	<0.1	<0.1	----	----
Boron	7440-42-8	1	mg/kg	<1	<1	<1	----	----
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	----	----
Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	<0.1	----	----
Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	0.2	----	----
Copper	7440-50-8	0.1	mg/kg	<0.1	<0.1	<0.1	----	----
Iron	7439-89-6	1	mg/kg	10	2	<1	----	----
Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	<0.1	----	----
Manganese	7439-96-5	0.1	mg/kg	0.1	<0.1	0.7	----	----
Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	<0.1	----	----
Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	<0.1	----	----
Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	<0.1	----	----



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Client sample ID

				Diversion Dam Soil 2 (600-700)	Borrow 1 (0-1400)	Borrow 2 (0-1700)	Borrow 1 (0-1400)	Diversion Dam Soil 1 (0-1900)
Client sampling date / time				[05-Jun-2015]	[06-Jun-2015]	[06-Jun-2015]	[06-Jun-2015]	[05-Jun-2015]
Compound	CAS Number	LOR	Unit	EB1520839-066	EB1520839-067	EB1520839-068	EB1520839-069	EB1520839-070
				Result	Result	Result	Result	Result
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	6840	5480	4600	----	----
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	----	----
Boron	7440-42-8	50	mg/kg	<50	<50	<50	----	----
Cobalt	7440-48-4	2	mg/kg	<2	4	22	----	----
Iron	7439-89-6	50	mg/kg	11600	22000	15900	----	----
Manganese	7439-96-5	5	mg/kg	26	35	95	----	----
Vanadium	7440-62-2	5	mg/kg	32	39	35	----	----
Arsenic	7440-38-2	5	mg/kg	<5	<5	<5	----	----
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	----	----
Chromium	7440-47-3	2	mg/kg	9	19	14	----	----
Copper	7440-50-8	5	mg/kg	10	48	38	----	----
Lead	7439-92-1	5	mg/kg	<5	6	<5	----	----
Nickel	7440-02-0	2	mg/kg	2	8	12	----	----
Zinc	7440-66-6	5	mg/kg	<5	6	6	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	0.1	0.2	0.7	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	230	130	200	----	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	230	130	200	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	82	71	113	----	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	<5	9	----	----

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	Diversion Dam Soil 2 (0-1300)	Borrow 2 (0-1700)	----	----	----
Client sampling date / time				[05-Jun-2015]	[06-Jun-2015]	----	----	----
Compound	CAS Number	LOR	Unit	EB1520839-071	EB1520839-072	-----	-----	-----
				Result	Result	Result	Result	Result
EA009: Nett Acid Production Potential								
^ Net Acid Production Potential		----	0.5	kg H2SO4/t	----	----	----	----
EA013: Acid Neutralising Capacity								
ANC as H2SO4		----	0.5	kg H2SO4 equiv./t	----	----	----	----
^ ANC as CaCO3		----	0.1	% CaCO3	----	----	----	----
Fizz Rating		----	0	Fizz Unit	----	----	----	----
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)		----	1	%	----	----	----	----
EA058: Emerson Aggregate Test								
Color (Munsell)		----	-	-	Red	Dark Reddish Brown	----	----
Texture		----	-	-	Sandy Loam	Rocks	----	----
Emerson Class Number		EC/TC	-	-	4	8	----	----
EA150: Particle Sizing								
+75µm		----	1	%	78	88	----	----
+150µm		----	1	%	44	69	----	----
+300µm		----	1	%	24	59	----	----
+425µm		----	1	%	21	57	----	----
+600µm		----	1	%	20	57	----	----
+1180µm		----	1	%	20	57	----	----
+2.36mm		----	1	%	17	57	----	----
+4.75mm		----	1	%	12	56	----	----
+9.5mm		----	1	%	6	54	----	----
+19.0mm		----	1	%	3	38	----	----
+37.5mm		----	1	%	<1	17	----	----
+75.0mm		----	1	%	<1	<1	----	----
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)		----	1	%	11	7	----	----
Silt (2-60 µm)		----	1	%	10	5	----	----
Sand (0.06-2.00 mm)		----	1	%	60	32	----	----
Gravel (>2mm)		----	1	%	19	43	----	----
Cobbles (>6cm)		----	1	%	<1	13	----	----
EA152: Soil Particle Density								
ø^ Soil Particle Density (Clay/Silt/Sand)		----	0.01	g/cm3	2.64	2.62	----	----
ED008: Exchangeable Cations								



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Client sample ID

				Diversion Dam Soil 2 (0-1300)	Borrow 2 (0-1700)	----	----	----
Client sampling date / time				[05-Jun-2015]	[06-Jun-2015]	----	----	----
Compound	CAS Number	LOR	Unit	EB1520839-071	EB1520839-072	-----	-----	-----
				Result	Result	Result	Result	Result
ED008: Exchangeable Cations - Continued								
^ Exchangeable Calcium	----	0.1	meq/100g	----	----	----	----	----
Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	----	----
^ Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	----	----
Exchangeable Potassium	----	0.1	meq/100g	----	----	----	----	----
^ Exchangeable Potassium	----	0.1	meq/100g	----	----	----	----	----
Exchangeable Sodium	----	0.1	meq/100g	----	----	----	----	----
^ Exchangeable Sodium	----	0.1	meq/100g	----	----	----	----	----
^ Cation Exchange Capacity	----	0.1	meq/100g	----	----	----	----	----
Exchangeable Sodium Percent	----	0.1	%	----	----	----	----	----
^ Exchangeable Sodium Percent	----	0.1	%	----	----	----	----	----
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	----	----	----	----	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	----	----	----	----	----
ED093T: Total Major Cations								
Calcium	7440-70-2	50	mg/kg	----	----	----	----	----
Magnesium	7439-95-4	50	mg/kg	----	----	----	----	----
Sodium	7440-23-5	50	mg/kg	----	----	----	----	----
Potassium	7440-09-7	50	mg/kg	----	----	----	----	----
EG005S : Soluble Metals by ICPAES								
Aluminium	7429-90-5	1	mg/kg	----	----	----	----	----
Antimony	7440-36-0	0.1	mg/kg	----	----	----	----	----
Arsenic	7440-38-2	0.1	mg/kg	----	----	----	----	----
Boron	7440-42-8	1	mg/kg	----	----	----	----	----
Cadmium	7440-43-9	0.1	mg/kg	----	----	----	----	----
Chromium	7440-47-3	0.1	mg/kg	----	----	----	----	----
Cobalt	7440-48-4	0.1	mg/kg	----	----	----	----	----
Copper	7440-50-8	0.1	mg/kg	----	----	----	----	----
Iron	7439-89-6	1	mg/kg	----	----	----	----	----
Lead	7439-92-1	0.1	mg/kg	----	----	----	----	----
Manganese	7439-96-5	0.1	mg/kg	----	----	----	----	----
Nickel	7440-02-0	0.1	mg/kg	----	----	----	----	----
Vanadium	7440-62-2	0.1	mg/kg	----	----	----	----	----
Zinc	7440-66-6	0.1	mg/kg	----	----	----	----	----



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Diversion Dam Soil 2 (0-1300)	Borrow 2 (0-1700)	----	----	----
Client sampling date / time					[05-Jun-2015]	[06-Jun-2015]	----	----	----
Compound	CAS Number	LOR	Unit		EB1520839-071	EB1520839-072	-----	-----	-----
				Result	Result	Result	Result	Result	Result
EG005T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg	----	----	----	----	----	----
Antimony	7440-36-0	5	mg/kg	----	----	----	----	----	----
Boron	7440-42-8	50	mg/kg	----	----	----	----	----	----
Cobalt	7440-48-4	2	mg/kg	----	----	----	----	----	----
Iron	7439-89-6	50	mg/kg	----	----	----	----	----	----
Manganese	7439-96-5	5	mg/kg	----	----	----	----	----	----
Vanadium	7440-62-2	5	mg/kg	----	----	----	----	----	----
Arsenic	7440-38-2	5	mg/kg	----	----	----	----	----	----
Cadmium	7440-43-9	1	mg/kg	----	----	----	----	----	----
Chromium	7440-47-3	2	mg/kg	----	----	----	----	----	----
Copper	7440-50-8	5	mg/kg	----	----	----	----	----	----
Lead	7439-92-1	5	mg/kg	----	----	----	----	----	----
Nickel	7440-02-0	2	mg/kg	----	----	----	----	----	----
Zinc	7440-66-6	5	mg/kg	----	----	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	----	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	----	----	----	----	----
EK062: Total Nitrogen as N (TKN + NOx)									
^ Total Nitrogen as N	----	20	mg/kg	----	----	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg	----	----	----	----	----	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)									
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	----	----	----	----	----	----

QA/QC Compliance Assessment for DQO Reporting

Work Order	: EB1520839	Page	: 1 of 20
Client	: BIRLA MT GORDON PTY LTD	Laboratory	: Environmental Division Brisbane
Contact	: MR TIM ROHDE	Telephone	: + 61 7 4796 0605
Project	: Mt Gordon (cover design)	Date Samples Received	: 12-Jun-2015
Site	: ----	Issue Date	: 26-Jun-2015
Sampler	: TIM ROHDE	No. of samples received	: 72
Order number	: ----	No. of samples analysed	: 72

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO** Method Blank value outliers occur.
- **NO** Laboratory Control outliers occur.
- Duplicate outliers exist - please see following pages for full details.
- Matrix Spike outliers exist - please see following pages for full details.
- For all regular sample matrices, **NO** surrogate recovery outliers occur.

Outliers : Analysis Holding Time Compliance

- Analysis Holding Time Outliers exist - please see following pages for full details.

Outliers : Frequency of Quality Control Samples

- Quality Control Sample Frequency Outliers exist - please see following pages for full details.

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Duplicate (DUP) RPDs							
ED093T: Total Major Cations	EB1520839--068	Borrow 2 (0-1700)	Calcium	7440-70-2	42.2 %	0% - 20%	RPD exceeds LOR based limits
EG005T: Total Metals by ICP-AES	EB1520839--068	Borrow 2 (0-1700)	Iron	7439-89-6	33.1 %	0% - 20%	RPD exceeds LOR based limits
EG005T: Total Metals by ICP-AES	EB1520839--068	Borrow 2 (0-1700)	Manganese	7439-96-5	72.9 %	0% - 20%	RPD exceeds LOR based limits
EG005T: Total Metals by ICP-AES	EB1520839--056	North Rock Soil (1700-1800)	Manganese	7439-96-5	56.1 %	0% - 20%	RPD exceeds LOR based limits
EK067G: Total Phosphorus as P by Discrete Analyser	EB1521125--003	Anonymous	Total Phosphorus as P	----	57.0 %	0% - 20%	RPD exceeds LOR based limits
Matrix Spike (MS) Recoveries							
EG005T: Total Metals by ICP-AES	EB1520839--002	Pit A (0-10)	Arsenic	7440-38-2	Not Determined	----	MS recovery not determined, background level greater than or equal to 4x spike level.
EG005T: Total Metals by ICP-AES	EB1520839--026	Pit C (0-10)	Arsenic	7440-38-2	Not Determined	----	MS recovery not determined, background level greater than or equal to 4x spike level.
EG005T: Total Metals by ICP-AES	EB1520839--026	Pit C (0-10)	Cobalt	7440-48-4	140 %	70-130%	Recovery greater than upper data quality objective
EG005T: Total Metals by ICP-AES	EB1520839--002	Pit A (0-10)	Copper	7440-50-8	Not Determined	----	MS recovery not determined, background level greater than or equal to 4x spike level.
EG005T: Total Metals by ICP-AES	EB1520839--026	Pit C (0-10)	Copper	7440-50-8	Not Determined	----	MS recovery not determined, background level greater than or equal to 4x spike level.
EG005T: Total Metals by ICP-AES	EB1520839--026	Pit C (0-10)	Lead	7439-92-1	250 %	70-130%	Recovery greater than upper data quality objective
EG005T: Total Metals by ICP-AES	EB1520839--002	Pit A (0-10)	Manganese	7439-96-5	Not Determined	----	MS recovery not determined, background level greater than or equal to 4x spike level.
EG005T: Total Metals by ICP-AES	EB1520839--026	Pit C (0-10)	Manganese	7439-96-5	Not Determined	----	MS recovery not determined, background level greater than or equal to 4x spike level.
EG005T: Total Metals by ICP-AES	EB1520839--026	Pit C (0-10)	Zinc	7440-66-6	135 %	70-130%	Recovery greater than upper data quality objective
EK067G: Total Phosphorus as P by Discrete Analyser	EB1520839--037	Pit D (20-40)	Total Phosphorus as P	----	Not Determined	----	MS recovery not determined, background level greater than or equal to 4x spike level.

Matrix: SOIL

Method	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA055: Moisture Content						

Method		Extraction / Preparation			Analysis		
Container / Client Sample ID(s)		Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA055: Moisture Content - Analysis Holding Time Compliance							
Soil Glass Jar - Unpreserved							
Pit A (0),	Pit A (0-10),	----	----	----	18-Jun-2015	17-Jun-2015	1
Pit A (20-40),	Pit A (70-100),						
Pit A (300-350),	Pit A (600-650),						
Pit A (800-850),	Pit A (1100-1140),						
Pit A (1140-1200),	Pit A (1350-1400),						
Pit B (0),	Pit B (0-10),						
Pit B (20-40),	Pit B (70-100),						
Pit B (300-350),	Pit C (0), Pit B (600-650),						
Pit B (800-850),	Pit B (900-1000),						
Pit B (1200-1300),	Pit B (1400-1500),						
Pit C (0-10),							
Pit C (20-40),	Pit C (70-100),						
Pit C (300-350),	Pit C (400-450),						
Pit C (600-650),	Pit C (800-850),						
Pit C (1200-1300),	Pit C (1600-1700),						
Pit D (0),	Pit D (0-10),						
Pit D (20-40),	Pit D (70-100),						
Pit D (300-350),	Pit D (400-450),						
Pit D (600-650),	Pit D (800-850),						
Pit D (1200-1300),	Pit D (1600-1700),						

Quality Control Sample Type	Count		Rate (%)		Quality Control Specification
Method	QC	Regular	Actual	Expected	
Matrix Spikes (MS)					
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	0	1	0.00	5.00	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-AES	0	1	0.00	5.00	NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Method	Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation



Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis			
Container / Client Sample ID(s)		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
EA013: Acid Neutralising Capacity								
Pulp Bag (EA013) Pit A (0), Pit A (20-40), Pit A (300-350), Pit A (800-850), Pit A (1140-1200), Pit B (0), Pit B (20-40), Pit B (300-350), Pit B (800-850), Pit B (1200-1300), Pit C (0-10), Pit C (20-40), Pit C (300-350), Pit C (600-650), Pit C (1200-1300), Pit D (0), Pit D (20-40), Pit D (300-350), Pit D (600-650), Pit D (1200-1300),	Pit A (0-10), Pit A (70-100), Pit A (600-650), Pit A (1100-1140), Pit A (1350-1400), Pit B (0-10), Pit B (70-100), Pit C (0), Pit B (600-650), Pit B (900-1000), Pit B (1400-1500), Pit C (70-100), Pit C (400-450), Pit C (800-850), Pit C (1600-1700), Pit D (0-10), Pit D (70-100), Pit D (400-450), Pit D (800-850), Pit D (1600-1700)	03-Jun-2015	23-Jun-2015	02-Jun-2016	✓	23-Jun-2015	20-Dec-2015	✓
Pulp Bag (EA013) Magazine Creek Soil 1 (0), Magazine Creek Soil 1 (500-600), Magazine Creek Soil 1 (1000-1100), North Rock Soil 1 (50-100), North Rock Soil 1 (700-800), North Rock Soil (1700-1800),	Magazine Creek Soil 1 (200-300), Magazine Creek Soil 1 (700-800), North Rock Soil 1 (0), North Rock Soil 1 (500-600), North Rock Soil (1200-1300), Mill Creek Hill Soil (200-300)	04-Jun-2015	23-Jun-2015	03-Jun-2016	✓	23-Jun-2015	20-Dec-2015	✓
Pulp Bag (EA013) Diversion Dam Soil 1 (0), Diversion Dam Soil 1 (200-250), Diversion Dam Soil 1 (800-850), Diversion Dam Soil 2 (600-700)	Diversion Dam Soil 1 (50-80), Diversion Dam Soil 1 (500-550), Diversion Dam Soil 1 (1100-1200),	05-Jun-2015	23-Jun-2015	04-Jun-2016	✓	23-Jun-2015	20-Dec-2015	✓
Pulp Bag (EA013) Borrow 1 (0-1400),	Borrow 2 (0-1700)	06-Jun-2015	23-Jun-2015	05-Jun-2016	✓	23-Jun-2015	20-Dec-2015	✓



Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA055: Moisture Content								
Soil Glass Jar - Unpreserved (EA055-103) Pit A (0), Pit A (20-40), Pit A (300-350), Pit A (800-850), Pit A (1140-1200), Pit B (0), Pit B (20-40), Pit B (300-350), Pit B (800-850), Pit B (1200-1300), Pit C (0-10), Pit C (20-40), Pit C (300-350), Pit C (600-650), Pit C (1200-1300), Pit D (0), Pit D (20-40), Pit D (300-350), Pit D (600-650), Pit D (1200-1300),	Pit A (0-10), Pit A (70-100), Pit A (600-650), Pit A (1100-1140), Pit A (1350-1400), Pit B (0-10), Pit B (70-100), Pit C (0), Pit B (600-650), Pit B (900-1000), Pit B (1400-1500), Pit C (70-100), Pit C (400-450), Pit C (800-850), Pit C (1600-1700), Pit D (0-10), Pit D (70-100), Pit D (400-450), Pit D (800-850), Pit D (1600-1700)	03-Jun-2015	----	----	----	18-Jun-2015	17-Jun-2015	✖
Soil Glass Jar - Unpreserved (EA055-103) Magazine Creek Soil 1 (0), Magazine Creek Soil 1 (500-600), Magazine Creek Soil 1 (1000-1100), North Rock Soil 1 (50-100), North Rock Soil 1 (700-800), North Rock Soil (1700-1800),	Magazine Creek Soil 1 (200-300), Magazine Creek Soil 1 (700-800), North Rock Soil 1 (0), North Rock Soil 1 (500-600), North Rock Soil (1200-1300), Mill Creek Hill Soil (200-300)	04-Jun-2015	----	----	----	18-Jun-2015	18-Jun-2015	✔
Soil Glass Jar - Unpreserved (EA055-103) Diversion Dam Soil 1 (0), Diversion Dam Soil 1 (200-250), Diversion Dam Soil 1 (800-850), Diversion Dam Soil 2 (600-700)	Diversion Dam Soil 1 (50-80), Diversion Dam Soil 1 (500-550), Diversion Dam Soil 1 (1100-1200),	05-Jun-2015	----	----	----	18-Jun-2015	19-Jun-2015	✔
Soil Glass Jar - Unpreserved (EA055-103) Borrow 1 (0-1400),	Borrow 2 (0-1700)	06-Jun-2015	----	----	----	18-Jun-2015	20-Jun-2015	✔



Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA058: Emerson Aggregate Test								
Snap Lock Bag (EA058) Pit A (0), Pit A (1140-1400),	Pit A (20-1140), Pit B (900-1500)	03-Jun-2015	----	----	----	18-Jun-2015	30-Nov-2015	✔
Snap Lock Bag (EA058) Magazine Creek Soil 1 (0-1900), North Rock Soil 1 (0-1800)	Mill Creek Hill Soil 1 (0-1900),	04-Jun-2015	----	----	----	18-Jun-2015	01-Dec-2015	✔
Snap Lock Bag (EA058) Diversion Dam Soil 1 (0-1900),	Diversion Dam Soil 2 (0-1300)	05-Jun-2015	----	----	----	18-Jun-2015	02-Dec-2015	✔
Snap Lock Bag (EA058) Borrow 1 (0-1400),	Borrow 2 (0-1700)	06-Jun-2015	----	----	----	18-Jun-2015	03-Dec-2015	✔
EA150: Soil Classification based on Particle Size								
Snap Lock Bag (EA150H) Pit A (0), Pit A (1140-1400),	Pit A (20-1140), Pit B (900-1500)	03-Jun-2015	----	----	----	23-Jun-2015	30-Nov-2015	✔
Snap Lock Bag (EA150H) Magazine Creek Soil 1 (0-1900), North Rock Soil 1 (0-1800)	Mill Creek Hill Soil 1 (0-1900),	04-Jun-2015	----	----	----	23-Jun-2015	01-Dec-2015	✔
Snap Lock Bag (EA150H) Diversion Dam Soil 1 (0-1900),	Diversion Dam Soil 2 (0-1300)	05-Jun-2015	----	----	----	23-Jun-2015	02-Dec-2015	✔
Snap Lock Bag (EA150H) Borrow 1 (0-1400),	Borrow 2 (0-1700)	06-Jun-2015	----	----	----	23-Jun-2015	03-Dec-2015	✔
EA152: Soil Particle Density								
Snap Lock Bag (EA152) Pit A (0), Pit A (1140-1400),	Pit A (20-1140), Pit B (900-1500)	03-Jun-2015	----	----	----	23-Jun-2015	30-Nov-2015	✔
Snap Lock Bag (EA152) Magazine Creek Soil 1 (0-1900), North Rock Soil 1 (0-1800)	Mill Creek Hill Soil 1 (0-1900),	04-Jun-2015	----	----	----	23-Jun-2015	01-Dec-2015	✔
Snap Lock Bag (EA152) Diversion Dam Soil 1 (0-1900),	Diversion Dam Soil 2 (0-1300)	05-Jun-2015	----	----	----	23-Jun-2015	02-Dec-2015	✔
Snap Lock Bag (EA152) Borrow 1 (0-1400),	Borrow 2 (0-1700)	06-Jun-2015	----	----	----	23-Jun-2015	03-Dec-2015	✔



Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis			
Container / Client Sample ID(s)		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
ED008: Exchangeable Cations								
Soil Glass Jar - Unpreserved (ED008) Pit A (0), Pit A (20-40), Pit A (300-350), Pit A (800-850), Pit B (0), Pit B (20-40), Pit B (300-350), Pit C (0), Pit D (0), Pit C (20-40), Pit C (300-350), Pit D (70-100),	Pit A (0-10), Pit A (70-100), Pit A (600-650), Pit A (1100-1140), Pit B (0-10), Pit B (70-100), Pit B (600-650), Pit C (0-10), Pit C (70-100), Pit D (0-10), Pit D (20-40), Pit D (300-350)	03-Jun-2015	22-Jun-2015	01-Jul-2015	✔	22-Jun-2015	01-Jul-2015	✔
Soil Glass Jar - Unpreserved (ED008) Magazine Creek Soil 1 (0), Magazine Creek Soil 1 (500-600), Magazine Creek Soil 1 (1000-1100), North Rock Soil 1 (50-100), North Rock Soil 1 (700-800), North Rock Soil (1700-1800),	Magazine Creek Soil 1 (200-300), Magazine Creek Soil 1 (700-800), North Rock Soil 1 (0), North Rock Soil 1 (500-600), North Rock Soil (1200-1300), Mill Creek Hill Soil (200-300)	04-Jun-2015	22-Jun-2015	02-Jul-2015	✔	22-Jun-2015	02-Jul-2015	✔
Soil Glass Jar - Unpreserved (ED008) Diversion Dam Soil 1 (0), Diversion Dam Soil 1 (200-250), Diversion Dam Soil 1 (800-850), Diversion Dam Soil 2 (600-700)	Diversion Dam Soil 1 (50-80), Diversion Dam Soil 1 (500-550), Diversion Dam Soil 1 (1100-1200),	05-Jun-2015	22-Jun-2015	03-Jul-2015	✔	22-Jun-2015	03-Jul-2015	✔
Soil Glass Jar - Unpreserved (ED008) Borrow 1 (0-1400),	Borrow 2 (0-1700)	06-Jun-2015	22-Jun-2015	04-Jul-2015	✔	22-Jun-2015	04-Jul-2015	✔



Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Sample Date	Extraction / Preparation			Analysis			
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
ED040S : Soluble Sulfate by ICPAES									
Soil Glass Jar - Unpreserved (ED040S)	Pit A (0), Pit A (20-40), Pit A (300-350), Pit A (800-850), Pit A (1140-1200), Pit B (0), Pit B (20-40), Pit B (300-350), Pit B (800-850), Pit B (1200-1300), Pit C (0-10), Pit C (20-40), Pit C (300-350), Pit C (600-650), Pit C (1200-1300), Pit D (0), Pit D (20-40), Pit D (300-350), Pit D (600-650), Pit D (1200-1300),	Pit A (0-10), Pit A (70-100), Pit A (600-650), Pit A (1100-1140), Pit A (1350-1400), Pit B (0-10), Pit B (70-100), Pit C (0), Pit B (600-650), Pit B (900-1000), Pit B (1400-1500), Pit C (70-100), Pit C (400-450), Pit C (800-850), Pit C (1600-1700), Pit D (0-10), Pit D (70-100), Pit D (400-450), Pit D (800-850), Pit D (1600-1700)	03-Jun-2015	22-Jun-2015	01-Jul-2015	✓	22-Jun-2015	20-Jul-2015	✓
Soil Glass Jar - Unpreserved (ED040S)	Magazine Creek Soil 1 (0), Magazine Creek Soil 1 (500-600), Magazine Creek Soil 1 (1000-1100), North Rock Soil 1 (50-100), North Rock Soil 1 (700-800), North Rock Soil (1700-1800),	Magazine Creek Soil 1 (200-300), Magazine Creek Soil 1 (700-800), North Rock Soil 1 (0), North Rock Soil 1 (500-600), North Rock Soil (1200-1300), Mill Creek Hill Soil (200-300)	04-Jun-2015	22-Jun-2015	02-Jul-2015	✓	22-Jun-2015	20-Jul-2015	✓
Soil Glass Jar - Unpreserved (ED040S)	Diversion Dam Soil 1 (0), Diversion Dam Soil 1 (200-250), Diversion Dam Soil 1 (800-850), Diversion Dam Soil 2 (600-700)	Diversion Dam Soil 1 (50-80), Diversion Dam Soil 1 (500-550), Diversion Dam Soil 1 (1100-1200),	05-Jun-2015	22-Jun-2015	03-Jul-2015	✓	22-Jun-2015	20-Jul-2015	✓
Soil Glass Jar - Unpreserved (ED040S)	Borrow 1 (0-1400),	Borrow 2 (0-1700)	06-Jun-2015	22-Jun-2015	04-Jul-2015	✓	22-Jun-2015	20-Jul-2015	✓



Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis			
Container / Client Sample ID(s)		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
ED042T: Total Sulfur by LECO								
Pulp Bag (ED042T) Pit A (0), Pit A (20-40), Pit A (300-350), Pit A (800-850), Pit A (1140-1200), Pit B (0), Pit B (20-40), Pit B (300-350), Pit B (800-850), Pit B (1200-1300), Pit C (0-10), Pit C (20-40), Pit C (300-350), Pit C (600-650), Pit C (1200-1300), Pit D (0), Pit D (20-40), Pit D (300-350), Pit D (600-650), Pit D (1200-1300),	Pit A (0-10), Pit A (70-100), Pit A (600-650), Pit A (1100-1140), Pit A (1350-1400), Pit B (0-10), Pit B (70-100), Pit C (0), Pit B (600-650), Pit B (900-1000), Pit B (1400-1500), Pit C (70-100), Pit C (400-450), Pit C (800-850), Pit C (1600-1700), Pit D (0-10), Pit D (70-100), Pit D (400-450), Pit D (800-850), Pit D (1600-1700)	03-Jun-2015	16-Jun-2015	01-Jul-2015	✓	16-Jun-2015	01-Jul-2015	✓
Pulp Bag (ED042T) Magazine Creek Soil 1 (0), Magazine Creek Soil 1 (500-600), Magazine Creek Soil 1 (1000-1100), North Rock Soil 1 (50-100), North Rock Soil 1 (700-800), North Rock Soil (1700-1800),	Magazine Creek Soil 1 (200-300), Magazine Creek Soil 1 (700-800), North Rock Soil 1 (0), North Rock Soil 1 (500-600), North Rock Soil (1200-1300), Mill Creek Hill Soil (200-300)	04-Jun-2015	16-Jun-2015	02-Jul-2015	✓	16-Jun-2015	02-Jul-2015	✓
Pulp Bag (ED042T) Diversion Dam Soil 1 (0), Diversion Dam Soil 1 (200-250), Diversion Dam Soil 1 (800-850), Diversion Dam Soil 2 (600-700)	Diversion Dam Soil 1 (50-80), Diversion Dam Soil 1 (500-550), Diversion Dam Soil 1 (1100-1200),	05-Jun-2015	16-Jun-2015	03-Jul-2015	✓	16-Jun-2015	03-Jul-2015	✓
Pulp Bag (ED042T) Borrow 1 (0-1400),	Borrow 2 (0-1700)	06-Jun-2015	16-Jun-2015	04-Jul-2015	✓	16-Jun-2015	04-Jul-2015	✓



Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis			
Container / Client Sample ID(s)		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
ED093T: Total Major Cations								
Soil Glass Jar - Unpreserved (ED093T) Pit A (0), Pit A (20-40), Pit A (300-350), Pit A (800-850), Pit B (0), Pit B (20-40), Pit B (300-350), Pit C (0), Pit D (0), Pit C (20-40), Pit C (300-350), Pit D (70-100), Pit A (0-10), Pit A (70-100), Pit A (600-650), Pit A (1100-1140), Pit B (0-10), Pit B (70-100), Pit B (600-650), Pit C (0-10), Pit C (70-100), Pit D (0-10), Pit D (20-40), Pit D (300-350)	03-Jun-2015	19-Jun-2015	30-Nov-2015	✔	19-Jun-2015	30-Nov-2015	✔	
Soil Glass Jar - Unpreserved (ED093T) Magazine Creek Soil 1 (0), Magazine Creek Soil 1 (500-600), Magazine Creek Soil 1 (1000-1100), North Rock Soil 1 (50-100), North Rock Soil 1 (700-800), North Rock Soil (1700-1800), Magazine Creek Soil 1 (200-300), Magazine Creek Soil 1 (700-800), North Rock Soil 1 (0), North Rock Soil 1 (500-600), North Rock Soil (1200-1300), Mill Creek Hill Soil (200-300)	04-Jun-2015	19-Jun-2015	01-Dec-2015	✔	19-Jun-2015	01-Dec-2015	✔	
Soil Glass Jar - Unpreserved (ED093T) Diversion Dam Soil 1 (0), Diversion Dam Soil 1 (200-250), Diversion Dam Soil 1 (800-850), Diversion Dam Soil 2 (600-700), Diversion Dam Soil 1 (50-80), Diversion Dam Soil 1 (500-550), Diversion Dam Soil 1 (1100-1200),	05-Jun-2015	19-Jun-2015	02-Dec-2015	✔	19-Jun-2015	02-Dec-2015	✔	
Soil Glass Jar - Unpreserved (ED093T) Borrow 1 (0-1400), Borrow 2 (0-1700)	06-Jun-2015	19-Jun-2015	03-Dec-2015	✔	19-Jun-2015	03-Dec-2015	✔	



Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG005S : Soluble Metals by ICPAES								
Soil Glass Jar - Unpreserved (EG005S) Pit A (0), Pit A (20-40), Pit A (300-350), Pit A (800-850), Pit A (1140-1200), Pit B (0), Pit B (20-40), Pit B (300-350), Pit B (800-850), Pit B (1200-1300), Pit C (0-10), Pit C (20-40), Pit C (300-350), Pit C (600-650), Pit C (1200-1300), Pit D (0), Pit D (20-40), Pit D (300-350), Pit D (600-650), Pit D (1200-1300),	Pit A (0-10), Pit A (70-100), Pit A (600-650), Pit A (1100-1140), Pit A (1350-1400), Pit B (0-10), Pit B (70-100), Pit C (0), Pit B (600-650), Pit B (900-1000), Pit B (1400-1500), Pit C (70-100), Pit C (400-450), Pit C (800-850), Pit C (1600-1700), Pit D (0-10), Pit D (70-100), Pit D (400-450), Pit D (800-850), Pit D (1600-1700)	03-Jun-2015	22-Jun-2015	30-Nov-2015	✓	22-Jun-2015	30-Nov-2015	✓
Soil Glass Jar - Unpreserved (EG005S) Magazine Creek Soil 1 (0), Magazine Creek Soil 1 (500-600), Magazine Creek Soil 1 (1000-1100), North Rock Soil 1 (50-100), North Rock Soil 1 (700-800), North Rock Soil (1700-1800),	Magazine Creek Soil 1 (200-300), Magazine Creek Soil 1 (700-800), North Rock Soil 1 (0), North Rock Soil 1 (500-600), North Rock Soil (1200-1300), Mill Creek Hill Soil (200-300)	04-Jun-2015	22-Jun-2015	01-Dec-2015	✓	22-Jun-2015	01-Dec-2015	✓
Soil Glass Jar - Unpreserved (EG005S) Diversion Dam Soil 1 (0), Diversion Dam Soil 1 (200-250), Diversion Dam Soil 1 (800-850), Diversion Dam Soil 2 (600-700)	Diversion Dam Soil 1 (50-80), Diversion Dam Soil 1 (500-550), Diversion Dam Soil 1 (1100-1200),	05-Jun-2015	22-Jun-2015	02-Dec-2015	✓	22-Jun-2015	02-Dec-2015	✓
Soil Glass Jar - Unpreserved (EG005S) Borrow 1 (0-1400),	Borrow 2 (0-1700)	06-Jun-2015	22-Jun-2015	03-Dec-2015	✓	22-Jun-2015	03-Dec-2015	✓



Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG005T: Total Metals by ICP-AES								
Soil Glass Jar - Unpreserved (EG005T) Pit A (0), Pit A (20-40), Pit A (300-350), Pit A (800-850), Pit A (1140-1200), Pit B (0), Pit B (20-40), Pit B (300-350), Pit B (800-850), Pit B (1200-1300), Pit C (0-10), Pit C (20-40), Pit C (300-350), Pit C (600-650), Pit C (1200-1300), Pit D (0), Pit D (20-40), Pit D (300-350), Pit D (600-650), Pit D (1200-1300),	Pit A (0-10), Pit A (70-100), Pit A (600-650), Pit A (1100-1140), Pit A (1350-1400), Pit B (0-10), Pit B (70-100), Pit C (0), Pit B (600-650), Pit B (900-1000), Pit B (1400-1500), Pit C (70-100), Pit C (400-450), Pit C (800-850), Pit C (1600-1700), Pit D (0-10), Pit D (70-100), Pit D (400-450), Pit D (800-850), Pit D (1600-1700)	03-Jun-2015	19-Jun-2015	30-Nov-2015	✔	19-Jun-2015	30-Nov-2015	✔
Soil Glass Jar - Unpreserved (EG005T) Magazine Creek Soil 1 (0), Magazine Creek Soil 1 (500-600), Magazine Creek Soil 1 (1000-1100), North Rock Soil 1 (50-100), North Rock Soil 1 (700-800), North Rock Soil (1700-1800),	Magazine Creek Soil 1 (200-300), Magazine Creek Soil 1 (700-800), North Rock Soil 1 (0), North Rock Soil 1 (500-600), North Rock Soil (1200-1300), Mill Creek Hill Soil (200-300)	04-Jun-2015	19-Jun-2015	01-Dec-2015	✔	19-Jun-2015	01-Dec-2015	✔
Soil Glass Jar - Unpreserved (EG005T) Diversion Dam Soil 1 (0), Diversion Dam Soil 1 (200-250), Diversion Dam Soil 1 (800-850), Diversion Dam Soil 2 (600-700)	Diversion Dam Soil 1 (50-80), Diversion Dam Soil 1 (500-550), Diversion Dam Soil 1 (1100-1200),	05-Jun-2015	19-Jun-2015	02-Dec-2015	✔	19-Jun-2015	02-Dec-2015	✔
Soil Glass Jar - Unpreserved (EG005T) Borrow 1 (0-1400),	Borrow 2 (0-1700)	06-Jun-2015	19-Jun-2015	03-Dec-2015	✔	19-Jun-2015	03-Dec-2015	✔



Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis			
Container / Client Sample ID(s)		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Soil Glass Jar - Unpreserved (EK059G) Pit A (0), Pit A (20-40), Pit A (300-350), Pit A (800-850), Pit B (0), Pit B (20-40), Pit B (300-350), Pit C (0), Pit D (0), Pit C (20-40), Pit C (300-350), Pit D (70-100), Pit A (0-10), Pit A (70-100), Pit A (600-650), Pit A (1100-1140), Pit B (0-10), Pit B (70-100), Pit B (600-650), Pit C (0-10), Pit C (70-100), Pit D (0-10), Pit D (20-40), Pit D (300-350)	03-Jun-2015	22-Jun-2015	30-Nov-2015	✔	22-Jun-2015	30-Nov-2015	✔	
Soil Glass Jar - Unpreserved (EK059G) Magazine Creek Soil 1 (0), Magazine Creek Soil 1 (500-600), Magazine Creek Soil 1 (1000-1100), North Rock Soil 1 (50-100), North Rock Soil 1 (700-800), North Rock Soil (1700-1800), Magazine Creek Soil 1 (200-300), Magazine Creek Soil 1 (700-800), North Rock Soil 1 (0), North Rock Soil 1 (500-600), North Rock Soil (1200-1300), Mill Creek Hill Soil (200-300)	04-Jun-2015	22-Jun-2015	01-Dec-2015	✔	22-Jun-2015	01-Dec-2015	✔	
Soil Glass Jar - Unpreserved (EK059G) Diversion Dam Soil 1 (0), Diversion Dam Soil 1 (200-250), Diversion Dam Soil 1 (800-850), Diversion Dam Soil 2 (600-700), Diversion Dam Soil 1 (50-80), Diversion Dam Soil 1 (500-550), Diversion Dam Soil 1 (1100-1200),	05-Jun-2015	22-Jun-2015	02-Dec-2015	✔	22-Jun-2015	02-Dec-2015	✔	
Soil Glass Jar - Unpreserved (EK059G) Borrow 1 (0-1400), Borrow 2 (0-1700)	06-Jun-2015	22-Jun-2015	03-Dec-2015	✔	22-Jun-2015	03-Dec-2015	✔	



Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis			
Container / Client Sample ID(s)		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Soil Glass Jar - Unpreserved (EK061G) Pit A (0), Pit A (20-40), Pit A (300-350), Pit A (800-850), Pit B (0), Pit B (20-40), Pit B (300-350), Pit C (0), Pit D (0), Pit C (20-40), Pit C (300-350), Pit D (70-100),	Pit A (0-10), Pit A (70-100), Pit A (600-650), Pit A (1100-1140), Pit B (0-10), Pit B (70-100), Pit B (600-650), Pit C (0-10), Pit C (70-100), Pit D (0-10), Pit D (20-40), Pit D (300-350)	03-Jun-2015	19-Jun-2015	30-Nov-2015	✔	22-Jun-2015	30-Nov-2015	✔
Soil Glass Jar - Unpreserved (EK061G) Magazine Creek Soil 1 (0), Magazine Creek Soil 1 (500-600), Magazine Creek Soil 1 (1000-1100), North Rock Soil 1 (50-100), North Rock Soil 1 (700-800), North Rock Soil (1700-1800),	Magazine Creek Soil 1 (200-300), Magazine Creek Soil 1 (700-800), North Rock Soil 1 (0), North Rock Soil 1 (500-600), North Rock Soil (1200-1300), Mill Creek Hill Soil (200-300)	04-Jun-2015	19-Jun-2015	01-Dec-2015	✔	22-Jun-2015	01-Dec-2015	✔
Soil Glass Jar - Unpreserved (EK061G) Diversion Dam Soil 1 (800-850), Diversion Dam Soil 2 (600-700)	Diversion Dam Soil 1 (1100-1200),	05-Jun-2015	19-Jun-2015	02-Dec-2015	✔	19-Jun-2015	02-Dec-2015	✔
Soil Glass Jar - Unpreserved (EK061G) Diversion Dam Soil 1 (0), Diversion Dam Soil 1 (200-250),	Diversion Dam Soil 1 (50-80), Diversion Dam Soil 1 (500-550)	05-Jun-2015	19-Jun-2015	02-Dec-2015	✔	22-Jun-2015	02-Dec-2015	✔
Soil Glass Jar - Unpreserved (EK061G) Borrow 1 (0-1400),	Borrow 2 (0-1700)	06-Jun-2015	19-Jun-2015	03-Dec-2015	✔	19-Jun-2015	03-Dec-2015	✔



Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis			
Container / Client Sample ID(s)		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
EK067G: Total Phosphorus as P by Discrete Analyser								
Soil Glass Jar - Unpreserved (EK067G) Pit A (0), Pit A (20-40), Pit A (300-350), Pit A (800-850), Pit B (0), Pit B (20-40), Pit B (300-350), Pit C (0), Pit D (0), Pit C (20-40), Pit C (300-350), Pit D (70-100), Pit A (0-10), Pit A (70-100), Pit A (600-650), Pit A (1100-1140), Pit B (0-10), Pit B (70-100), Pit B (600-650), Pit C (0-10), Pit C (70-100), Pit D (0-10), Pit D (20-40), Pit D (300-350)	03-Jun-2015	19-Jun-2015	30-Nov-2015	✔	22-Jun-2015	30-Nov-2015	✔	
Soil Glass Jar - Unpreserved (EK067G) Magazine Creek Soil 1 (0), Magazine Creek Soil 1 (500-600), Magazine Creek Soil 1 (1000-1100), North Rock Soil 1 (50-100), North Rock Soil 1 (700-800), North Rock Soil (1700-1800), Magazine Creek Soil 1 (200-300), Magazine Creek Soil 1 (700-800), North Rock Soil 1 (0), North Rock Soil 1 (500-600), North Rock Soil (1200-1300), Mill Creek Hill Soil (200-300)	04-Jun-2015	19-Jun-2015	01-Dec-2015	✔	22-Jun-2015	01-Dec-2015	✔	
Soil Glass Jar - Unpreserved (EK067G) Diversion Dam Soil 1 (800-850), Diversion Dam Soil 2 (600-700)	05-Jun-2015	19-Jun-2015	02-Dec-2015	✔	19-Jun-2015	02-Dec-2015	✔	
Soil Glass Jar - Unpreserved (EK067G) Diversion Dam Soil 1 (0), Diversion Dam Soil 1 (200-250), Diversion Dam Soil 1 (50-80), Diversion Dam Soil 1 (500-550)	05-Jun-2015	19-Jun-2015	02-Dec-2015	✔	22-Jun-2015	02-Dec-2015	✔	
Soil Glass Jar - Unpreserved (EK067G) Borrow 1 (0-1400), Borrow 2 (0-1700)	06-Jun-2015	19-Jun-2015	03-Dec-2015	✔	19-Jun-2015	03-Dec-2015	✔	



Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis			
Container / Client Sample ID(s)		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Soil Glass Jar - Unpreserved (EK080) Pit A (0), Pit A (20-40), Pit A (300-350), Pit A (800-850), Pit B (0), Pit B (20-40), Pit B (300-350), Pit C (0), Pit D (0), Pit C (20-40), Pit C (300-350), Pit D (70-100), Pit A (0-10), Pit A (70-100), Pit A (600-650), Pit A (1100-1140), Pit B (0-10), Pit B (70-100), Pit B (600-650), Pit C (0-10), Pit C (70-100), Pit D (0-10), Pit D (20-40), Pit D (300-350)	03-Jun-2015	----	----	----	17-Jun-2015	30-Nov-2015	✓	
Soil Glass Jar - Unpreserved (EK080) Magazine Creek Soil 1 (0), Magazine Creek Soil 1 (500-600), Magazine Creek Soil 1 (1000-1100), North Rock Soil 1 (50-100), North Rock Soil 1 (700-800), North Rock Soil (1700-1800), Magazine Creek Soil 1 (200-300), Magazine Creek Soil 1 (700-800), North Rock Soil 1 (0), North Rock Soil 1 (500-600), North Rock Soil (1200-1300), Mill Creek Hill Soil (200-300)	04-Jun-2015	----	----	----	17-Jun-2015	01-Dec-2015	✓	
Soil Glass Jar - Unpreserved (EK080) Diversion Dam Soil 1 (0), Diversion Dam Soil 1 (200-250), Diversion Dam Soil 1 (800-850), Diversion Dam Soil 2 (600-700), Diversion Dam Soil 1 (50-80), Diversion Dam Soil 1 (500-550), Diversion Dam Soil 1 (1100-1200),	05-Jun-2015	----	----	----	17-Jun-2015	02-Dec-2015	✓	
Soil Glass Jar - Unpreserved (EK080) Borrow 1 (0-1400), Borrow 2 (0-1700)	06-Jun-2015	----	----	----	17-Jun-2015	03-Dec-2015	✓	



Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: ✖ = Quality Control frequency not within specification ; ✔ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	Method	QC	Regular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
Acid Neutralising Capacity (ANC)	EA013	2	20	10.00	10.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Bicarbonate Extractable P (Colwell)	EK080	2	20	10.00	10.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Exchangeable Cations with pre-treatment	ED008	2	20	10.00	10.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Major Anions - Soluble	ED040S	2	20	10.00	10.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Major Cations by ICPAES - Total	ED093T	2	20	10.00	10.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Moisture Content	EA055-103	2	20	10.00	10.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	2	14	14.29	10.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Soluble Metals by ICPAES	EG005S	3	20	15.00	10.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Sulfur - Total as S (LECO)	ED042T	2	20	10.00	10.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TKN as N By Discrete Analyser	EK061G	2	20	10.00	10.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	4	20	20.00	10.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus By Discrete Analyser	EK067G	2	20	10.00	10.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Laboratory Control Samples (LCS)							
Acid Neutralising Capacity (ANC)	EA013	1	20	5.00	5.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Bicarbonate Extractable P (Colwell)	EK080	1	20	5.00	5.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Exchangeable Cations with pre-treatment	ED008	1	20	5.00	5.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Major Anions - Soluble	ED040S	1	20	5.00	5.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	1	14	7.14	5.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Soluble Metals by ICPAES	EG005S	1	20	5.00	5.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Sulfur - Total as S (LECO)	ED042T	1	20	5.00	5.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TKN as N By Discrete Analyser	EK061G	1	20	5.00	5.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	1	20	5.00	5.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus By Discrete Analyser	EK067G	1	20	5.00	5.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Bicarbonate Extractable P (Colwell)	EK080	1	20	5.00	5.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Exchangeable Cations with pre-treatment	ED008	1	20	5.00	5.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Major Anions - Soluble	ED040S	1	20	5.00	5.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Major Cations by ICPAES - Total	ED093T	1	20	5.00	5.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	1	14	7.14	5.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Soluble Metals by ICPAES	EG005S	1	20	5.00	5.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Sulfur - Total as S (LECO)	ED042T	1	20	5.00	5.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TKN as N By Discrete Analyser	EK061G	1	20	5.00	5.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	1	20	5.00	5.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement



Matrix: **SOIL**

Evaluation: ✖ = Quality Control frequency not within specification ; ✔ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	Method	QC	Regular	Actual	Expected	Evaluation	
Method Blanks (MB) - Continued							
Total Phosphorus By Discrete Analyser	EK067G	1	20	5.00	5.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Matrix Spikes (MS)							
Bicarbonate Extractable P (Colwell)	EK080	1	20	5.00	5.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	1	14	7.14	5.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TKN as N By Discrete Analyser	EK061G	1	20	5.00	5.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	1	20	5.00	5.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus By Discrete Analyser	EK067G	1	20	5.00	5.00	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement



Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Net Acid Production Potential	EA009	SOIL	In house: Referenced to Coastech Research (Canada)(Mod.). NAPP = Acid Production Potential (APP or MAP- Maximum Acid Potential) minus Neutralising Capacity (ANC). NAPP may be +ve, zero or -ve.
Acid Neutralising Capacity (ANC)	EA013	SOIL	In house: Referenced to USEPA 600/2-78-054, I. Miller (2000). A fizz test is done to semiquantitatively estimate the likely reactivity. The soil is then reacted with an known excess quantity of an appropriate acid. Titration determines the acid remaining, and the ANC can be calculated from comparison with a blank titration.
Moisture Content	EA055-103	SOIL	In-house. A gravimetric procedure based on weight loss over a 12 hour drying period at 103-105 degrees C. This method is compliant with NEPM (2013) Schedule B(3) Section 7.1 and Table 1 (14 day holding time).
Emerson Aggregate Test	EA058	SOIL	In house: Referenced to AS1289.3.8.1. Testing is performed only on soils with suitable aggregates; sands and gravels are usually unsuitable for this test. The test classifies the behaviour of soil aggregates, when immersed, on their coherence in water.
Particle Size Analysis by Hydrometer	EA150H	SOIL	Particle Size Analysis by Hydrometer according to AS1289.3.6.3 - 2003
Soil Particle Density	* EA152	SOIL	Soil Particle Density by AS 1289.3.5.1-2006 : Methods of testing soils for engineering purposes - Soil classification tests - Determination of the soil particle density of a soil - Standard method
Exchangeable Cations with pre-treatment	ED008	SOIL	In house: Referenced to Rayment & Higginson (2011) Method 15A2. Soluble salts are removed from the sample prior to analysis. Cations are exchanged from the sample by contact with Ammonium Chloride. They are then quantitated in the final solution by ICPAES and reported as meq/100g of original soil. This method is compliant with NEPM (2013) Schedule B(3) (Method 301)
Major Anions - Soluble	ED040S	SOIL	In-house. Soluble Anions are determined off a 1:5 soil / water extract by ICPAES.
Sulfur - Total as S (LECO)	ED042T	SOIL	In-house. Dried and pulverised sample is combusted in a high temperature furnace in the presence of strong oxidants / catalysts. The evolved S (as SO ₂) is measured by infra-red detector
Major Cations by ICPAES - Total	ED093T	SOIL	In house: Referenced to APHA 3120; USEPA SW 846 - 6010 (ICPAES) Major cations are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM (2013) Schedule B(3)
Soluble Metals by ICPAES	EG005S	SOIL	In house: Referenced to APHA 3120; USEPA SW 846 - 6010. Soluble metals are determined following an appropriate soil / water extraction of the soil. The ICPAES technique ionises samples in a plasma, emitting characteristic spectrums based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards.
Total Metals by ICP-AES	EG005T	SOIL	In house: Referenced to APHA 3120; USEPA SW 846 - 6010. Metals are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NO _x)- Soluble by Discrete Analyser	EK059G	SOIL	In house: Referenced to APHA 4500 NO ₃ - F. Combined oxidised Nitrogen (NO ₂ +NO ₃) in a water extract is determined by Chemical Reduction, and direct colourimetry by Discrete Analyser.
TKN as N By Discrete Analyser	EK061G	SOIL	In house: Referenced to APHA 4500-Norg-D Soil samples are digested using Kjeldahl digestion followed by determination by Discrete Analyser.

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 Work Order : EB1520839
 Client : BIRLA MT GORDON PTY LTD
 Project : Mt Gordon (cover design)



Analytical Methods	Method	Matrix	Method Descriptions
Total Nitrogen as N (TKN + NOx) By Discrete Analyser	EK062G	SOIL	In house: Referenced to APHA 4500 Norg/NO3- Total Nitrogen is determined as the sum of TKN and Oxidised Nitrogen, each determined seperately as N.
Total Phosporus By Discrete Analyser	EK067G	SOIL	In house: Referenced to APHA 4500 P-B&F This procedure involves sulfuric acid digestion and quantification using Discrete Analyser.
Bicarbonate Extractable P (Colwell)	EK080	SOIL	In house: Referenced to Rayment & Higginson (1992) Method 9B1 Phosphorus is extracted from the soil using 0.5M NaHCO3 at a 1:100 soil:solution ratio and determined by FIA.

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	SOIL	APHA 4500 Norg- D; APHA 4500 P - H. Macro Kjeldahl digestion.
Drying at 85 degrees, bagging and labelling (ASS)	EN020PR	SOIL	In house
Dry and Pulverise (up to 100g)	GEO30	SOIL	#

QUALITY CONTROL REPORT

Work Order	: EB1520839	Page	: 1 of 20
Client	: BIRLA MT GORDON PTY LTD	Laboratory	: Environmental Division Brisbane
Contact	: MR TIM ROHDE	Contact	: Joy Morgan
Address	: PO BOX 2543 MT ISA QLD 4825	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: trohde@emgamm.com	E-mail	: joy.morgan@alsglobal.com
Telephone	: ----	Telephone	: + 61 7 4796 0605
Facsimile	: ----	Facsimile	: +61-7-3243 7218
Project	: Mt Gordon (cover design)	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 12-Jun-2015
C-O-C number	: ----	Date Analysis Commenced	: 16-Jun-2015
Sampler	: TIM ROHDE	Issue Date	: 26-Jun-2015
Site	: ----	No. of samples received	: 72
Quote number	: ----	No. of samples analysed	: 72

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits



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

Andrew Epps
Andrew Epps
Dianne Blane
Satishkumar Trivedi

Position

Senior Inorganic Chemist
Senior Inorganic Chemist
Laboratory Coordinator (2IC)
Acid Sulfate Soils Supervisor

Accreditation Category

Brisbane Acid Sulphate Soils
Brisbane Inorganics
Newcastle - Inorganics
Brisbane Acid Sulphate Soils



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

Key :
Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
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
RPD = Relative Percentage Difference
= Indicates failed QC



Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:0% - 20%.

Sub-Matrix: SOIL				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA013: Acid Neutralising Capacity (QC Lot: 131145)									
EB1520839-001	Pit A (0)	EA013: ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	4.4	4.2	3.49	No Limit
EB1520839-015	Pit B (0-10)	EA013: ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	8.9	9.3	4.97	0% - 50%
EA013: Acid Neutralising Capacity (QC Lot: 131146)									
EB1520839-025	Pit C (0)	EA013: ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	33.4	33.4	0.00	0% - 20%
EB1520839-036	Pit D (0-10)	EA013: ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	6.6	6.5	1.93	0% - 50%
EA013: Acid Neutralising Capacity (QC Lot: 131147)									
EB1520839-045	Magazine Creek Soil 1 (0)	EA013: ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	2.5	2.2	11.9	No Limit
EB1520839-057	Mill Creek Hill Soil (200-300)	EA013: ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	3.6	3.9	7.36	No Limit
EA013: Acid Neutralising Capacity (QC Lot: 131148)									
EB1520839-068	Borrow 2 (0-1700)	EA013: ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	1.8	2.1	15.6	No Limit
EA055: Moisture Content (QC Lot: 129856)									
EB1520839-004	Pit A (70-100)	EA055-103: Moisture Content (dried @ 103°C)	----	1	%	3.2	3.2	0.00	No Limit
EB1520839-014	Pit B (0)	EA055-103: Moisture Content (dried @ 103°C)	----	1	%	1.4	1.8	21.9	No Limit
EA055: Moisture Content (QC Lot: 129857)									
EB1520839-028	Pit C (70-100)	EA055-103: Moisture Content (dried @ 103°C)	----	1	%	2.1	1.9	8.87	No Limit
EB1520839-035	Pit D (0)	EA055-103: Moisture Content (dried @ 103°C)	----	1	%	<1.0	<1.0	0.00	No Limit
EA055: Moisture Content (QC Lot: 129858)									
EB1520839-048	Magazine Creek Soil 1 (700-800)	EA055-103: Moisture Content (dried @ 103°C)	----	1	%	2.4	2.4	0.00	No Limit
EB1520839-056	North Rock Soil (1700-1800)	EA055-103: Moisture Content (dried @ 103°C)	----	1	%	10.4	10.5	1.42	0% - 50%
EA055: Moisture Content (QC Lot: 129859)									
EB1520970-007	Anonymous	EA055-103: Moisture Content (dried @ 103°C)	----	1	%	<1.0	<1.0	0.00	No Limit
ED008: Exchangeable Cations (QC Lot: 127965)									
EB1520839-001	Pit A (0)	ED008: Exchangeable Calcium	----	0.1	meq/100g	5.6	5.2	8.47	0% - 20%
		ED008: Exchangeable Magnesium	----	0.1	meq/100g	0.4	0.4	0.00	No Limit
		ED008: Exchangeable Potassium	----	0.1	meq/100g	0.1	0.1	0.00	No Limit
		ED008: Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	0.00	No Limit



Sub-Matrix: SOIL				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
ED008: Exchangeable Cations (QC Lot: 127965) - continued									
EB1520839-014	Pit B (0)	ED008: Exchangeable Calcium	----	0.1	meq/100g	4.2	4.6	10.3	0% - 20%
		ED008: Exchangeable Magnesium	----	0.1	meq/100g	3.5	3.6	0.00	0% - 20%
		ED008: Exchangeable Potassium	----	0.1	meq/100g	0.2	0.2	0.00	No Limit
		ED008: Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	0.00	No Limit
ED008: Exchangeable Cations (QC Lot: 127966)									
EB1520839-036	Pit D (0-10)	ED008: Exchangeable Calcium	----	0.1	meq/100g	2.2	2.2	0.00	0% - 20%
		ED008: Exchangeable Magnesium	----	0.1	meq/100g	0.7	0.6	0.00	No Limit
		ED008: Exchangeable Potassium	----	0.1	meq/100g	0.1	<0.1	0.00	No Limit
		ED008: Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	0.00	No Limit
ED008: Exchangeable Cations (QC Lot: 127975)									
EB1520839-039	Pit D (300-350)	ED008: Exchangeable Calcium	----	0.1	meq/100g	2.2	2.1	5.11	0% - 20%
		ED008: Exchangeable Magnesium	----	0.1	meq/100g	1.3	1.3	0.00	0% - 50%
		ED008: Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	0.00	No Limit
		ED008: Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	0.00	No Limit
EB1520839-053	North Rock Soil 1 (500-600)	ED008: Exchangeable Calcium	----	0.1	meq/100g	4.9	4.4	11.5	0% - 20%
		ED008: Exchangeable Magnesium	----	0.1	meq/100g	2.1	2.0	6.67	0% - 20%
		ED008: Exchangeable Potassium	----	0.1	meq/100g	0.2	0.2	0.00	No Limit
		ED008: Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	0.00	No Limit
ED008: Exchangeable Cations (QC Lot: 127976)									
EB1520839-067	Borrow 1 (0-1400)	ED008: Exchangeable Calcium	----	0.1	meq/100g	0.8	0.9	0.00	No Limit
		ED008: Exchangeable Magnesium	----	0.1	meq/100g	1.7	1.9	6.94	0% - 50%
		ED008: Exchangeable Potassium	----	0.1	meq/100g	0.3	0.3	0.00	No Limit
		ED008: Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	0.00	No Limit
ED040S: Soluble Major Anions (QC Lot: 129785)									
EB1520839-001	Pit A (0)	ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	3930	3620	8.12	0% - 20%
EB1520839-016	Pit B (20-40)	ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	9700	9860	1.60	0% - 20%
ED040S: Soluble Major Anions (QC Lot: 129786)									
EB1520839-034	Pit C (1600-1700)	ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	11400	11300	1.49	0% - 20%
EB1520839-025	Pit C (0)	ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	1840	1700	8.22	0% - 20%
ED040S: Soluble Major Anions (QC Lot: 129789)									
EB1520839-045	Magazine Creek Soil 1 (0)	ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	20	20	0.00	No Limit
EB1520839-060	Diversion Dam Soil 1 (0)	ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	90	159	No Limit
ED040S: Soluble Major Anions (QC Lot: 129792)									
EB1520839-068	Borrow 2 (0-1700)	ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	3110	3220	3.49	0% - 20%
ED042T: Total Sulfur by LECO (QC Lot: 126979)									
EB1520839-001	Pit A (0)	ED042T: Sulfur - Total as S (LECO)	----	0.01	%	0.56	0.57	2.40	0% - 20%
EB1520839-010	Pit A (1350-1400)	ED042T: Sulfur - Total as S (LECO)	----	0.01	%	0.03	0.03	0.00	No Limit
ED042T: Total Sulfur by LECO (QC Lot: 126980)									
EB1520839-025	Pit C (0)	ED042T: Sulfur - Total as S (LECO)	----	0.01	%	0.17	0.20	11.4	0% - 50%



Sub-Matrix: SOIL				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
ED042T: Total Sulfur by LECO (QC Lot: 126980) - continued									
EB1520839-034	Pit C (1600-1700)	ED042T: Sulfur - Total as S (LECO)	----	0.01	%	1.63	1.68	2.84	0% - 20%
ED042T: Total Sulfur by LECO (QC Lot: 126981)									
EB1520839-045	Magazine Creek Soil 1 (0)	ED042T: Sulfur - Total as S (LECO)	----	0.01	%	0.09	0.11	21.4	0% - 50%
EB1520839-055	North Rock Soil (1200-1300)	ED042T: Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.02	0.00	No Limit
ED042T: Total Sulfur by LECO (QC Lot: 126982)									
EB1520839-068	Borrow 2 (0-1700)	ED042T: Sulfur - Total as S (LECO)	----	0.01	%	0.15	0.16	6.79	0% - 50%
ED093T: Total Major Cations (QC Lot: 129797)									
EB1520839-001	Pit A (0)	ED093T: Calcium	7440-70-2	50	mg/kg	2000	2070	3.59	0% - 20%
		ED093T: Magnesium	7439-95-4	50	mg/kg	920	940	1.97	0% - 50%
		ED093T: Potassium	7440-09-7	50	mg/kg	1140	1150	1.14	0% - 20%
		ED093T: Sodium	7440-23-5	50	mg/kg	<50	<50	0.00	No Limit
EB1520839-014	Pit B (0)	ED093T: Calcium	7440-70-2	50	mg/kg	2560	2530	1.36	0% - 20%
		ED093T: Magnesium	7439-95-4	50	mg/kg	7740	7520	2.87	0% - 20%
		ED093T: Potassium	7440-09-7	50	mg/kg	1800	1800	0.00	0% - 20%
		ED093T: Sodium	7440-23-5	50	mg/kg	110	110	0.00	No Limit
ED093T: Total Major Cations (QC Lot: 129800)									
EB1520839-036	Pit D (0-10)	ED093T: Calcium	7440-70-2	50	mg/kg	3900	3680	5.77	0% - 20%
		ED093T: Magnesium	7439-95-4	50	mg/kg	7720	7760	0.584	0% - 20%
		ED093T: Potassium	7440-09-7	50	mg/kg	1100	1210	9.66	0% - 20%
		ED093T: Sodium	7440-23-5	50	mg/kg	<50	<50	0.00	No Limit
ED093T: Total Major Cations (QC Lot: 129802)									
EB1520839-054	North Rock Soil 1 (700-800)	ED093T: Calcium	7440-70-2	50	mg/kg	1320	1320	0.00	0% - 20%
		ED093T: Magnesium	7439-95-4	50	mg/kg	2000	2010	0.925	0% - 20%
		ED093T: Potassium	7440-09-7	50	mg/kg	1870	1910	1.99	0% - 20%
		ED093T: Sodium	7440-23-5	50	mg/kg	<50	<50	0.00	No Limit
EB1520839-045	Magazine Creek Soil 1 (0)	ED093T: Calcium	7440-70-2	50	mg/kg	1420	1190	17.7	0% - 20%
		ED093T: Magnesium	7439-95-4	50	mg/kg	530	470	12.8	0% - 50%
		ED093T: Potassium	7440-09-7	50	mg/kg	820	730	11.6	0% - 50%
		ED093T: Sodium	7440-23-5	50	mg/kg	<50	<50	0.00	No Limit
ED093T: Total Major Cations (QC Lot: 129804)									
EB1520839-068	Borrow 2 (0-1700)	ED093T: Calcium	7440-70-2	50	mg/kg	2510	# 3860	42.2	0% - 20%
		ED093T: Magnesium	7439-95-4	50	mg/kg	500	590	17.5	0% - 50%
		ED093T: Potassium	7440-09-7	50	mg/kg	920	1030	11.4	0% - 20%
		ED093T: Sodium	7440-23-5	50	mg/kg	<50	<50	0.00	No Limit
EG005S : Soluble Metals by ICPAES (QC Lot: 129783)									
EB1520839-001	Pit A (0)	EG005S: Cobalt	7440-48-4	0.1	mg/kg	3.3	3.0	12.0	0% - 20%
		EG005S: Copper	7440-50-8	0.1	mg/kg	133	110	18.8	0% - 20%
		EG005S: Zinc	7440-66-6	0.1	mg/kg	2.7	2.4	10.8	0% - 20%



Sub-Matrix: SOIL				Laboratory Duplicate (DUP) Report							
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)		
EG005S : Soluble Metals by ICPAES (QC Lot: 129783) - continued											
EB1520839-001	Pit A (0)	EG005S: Antimony	7440-36-0	0.1	mg/kg	<0.1	0.1	0.00	No Limit		
		EG005S: Arsenic	7440-38-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit		
		EG005S: Cadmium	7440-43-9	0.1	mg/kg	0.2	0.1	0.00	No Limit		
		EG005S: Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	0.00	No Limit		
		EG005S: Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	0.00	No Limit		
		EG005S: Manganese	7439-96-5	0.1	mg/kg	22.2	19.3	13.7	0% - 20%		
		EG005S: Nickel	7440-02-0	0.1	mg/kg	1.0	0.8	26.5	No Limit		
		EG005S: Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit		
		EG005S: Aluminium	7429-90-5	1	mg/kg	2	1	0.00	No Limit		
		EG005S: Boron	7440-42-8	1	mg/kg	<1	<1	0.00	No Limit		
EB1520839-016	Pit B (20-40)	EG005S: Iron	7439-89-6	1	mg/kg	<1	<1	0.00	No Limit		
		EG005S: Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit		
		EG005S: Arsenic	7440-38-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit		
		EG005S: Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	0.00	No Limit		
		EG005S: Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	0.00	No Limit		
		EG005S: Cobalt	7440-48-4	0.1	mg/kg	10.8	11.0	2.25	0% - 20%		
		EG005S: Copper	7440-50-8	0.1	mg/kg	16.0	16.4	2.45	0% - 20%		
		EG005S: Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	0.00	No Limit		
		EG005S: Manganese	7439-96-5	0.1	mg/kg	219	223	1.79	0% - 20%		
		EG005S: Nickel	7440-02-0	0.1	mg/kg	2.2	2.2	0.00	0% - 20%		
		EG005S: Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit		
		EG005S: Zinc	7440-66-6	0.1	mg/kg	1.7	1.7	0.00	0% - 50%		
		EG005S: Aluminium	7429-90-5	1	mg/kg	<1	<1	0.00	No Limit		
		EG005S: Boron	7440-42-8	1	mg/kg	<1	<1	0.00	No Limit		
		EG005S: Iron	7439-89-6	1	mg/kg	<1	<1	0.00	No Limit		
		EG005S : Soluble Metals by ICPAES (QC Lot: 129787)									
		EB1520839-034	Pit C (1600-1700)	EG005S: Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
				EG005S: Arsenic	7440-38-2	0.1	mg/kg	0.2	0.2	0.00	No Limit
				EG005S: Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
				EG005S: Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
EG005S: Cobalt	7440-48-4			0.1	mg/kg	42.7	40.1	6.26	0% - 20%		
EG005S: Copper	7440-50-8			0.1	mg/kg	462	435	5.96	0% - 20%		
EG005S: Lead	7439-92-1			0.1	mg/kg	<0.1	<0.1	0.00	No Limit		
EG005S: Manganese	7439-96-5			0.1	mg/kg	71.6	67.4	6.19	0% - 20%		
EG005S: Nickel	7440-02-0			0.1	mg/kg	20.6	19.4	5.67	0% - 20%		
EG005S: Vanadium	7440-62-2			0.1	mg/kg	<0.1	<0.1	0.00	No Limit		
EG005S: Zinc	7440-66-6			0.1	mg/kg	2.7	2.6	6.04	0% - 20%		
EG005S: Aluminium	7429-90-5			1	mg/kg	222	207	6.83	0% - 20%		
EG005S: Boron	7440-42-8			1	mg/kg	<1	<1	0.00	No Limit		
EG005S: Iron	7439-89-6			1	mg/kg	538	519	3.59	0% - 20%		



Sub-Matrix: SOIL				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG005S : Soluble Metals by ICPAES (QC Lot: 129787) - continued									
EB1520839-025	Pit C (0)	EG005S: Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Arsenic	7440-38-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Copper	7440-50-8	0.1	mg/kg	0.1	0.1	0.00	No Limit
		EG005S: Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Manganese	7439-96-5	0.1	mg/kg	1.8	1.7	0.00	0% - 50%
		EG005S: Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Aluminium	7429-90-5	1	mg/kg	<1	<1	0.00	No Limit
		EG005S: Boron	7440-42-8	1	mg/kg	<1	<1	0.00	No Limit
EG005S: Iron	7439-89-6	1	mg/kg	<1	<1	0.00	No Limit		
EG005S : Soluble Metals by ICPAES (QC Lot: 129790)									
EB1520839-045	Magazine Creek Soil 1 (0)	EG005S: Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Arsenic	7440-38-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Copper	7440-50-8	0.1	mg/kg	0.3	0.4	0.00	No Limit
		EG005S: Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Manganese	7439-96-5	0.1	mg/kg	1.0	1.1	9.40	0% - 50%
		EG005S: Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Aluminium	7429-90-5	1	mg/kg	7	8	0.00	No Limit
		EG005S: Boron	7440-42-8	1	mg/kg	<1	<1	0.00	No Limit
EG005S: Iron	7439-89-6	1	mg/kg	5	6	0.00	No Limit		
EB1520839-060	Diversion Dam Soil 1 (0)	EG005S: Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Arsenic	7440-38-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Copper	7440-50-8	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Manganese	7439-96-5	0.1	mg/kg	0.1	<0.1	0.00	No Limit
		EG005S: Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit



Sub-Matrix: SOIL				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG005S : Soluble Metals by ICPAES (QC Lot: 129790) - continued									
EB1520839-060	Diversion Dam Soil 1 (0)	EG005S: Aluminium	7429-90-5	1	mg/kg	26	26	0.00	0% - 20%
		EG005S: Boron	7440-42-8	1	mg/kg	<1	<1	0.00	No Limit
		EG005S: Iron	7439-89-6	1	mg/kg	12	12	0.00	0% - 50%
EG005S : Soluble Metals by ICPAES (QC Lot: 129793)									
EB1520839-068	Borrow 2 (0-1700)	EG005S: Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Arsenic	7440-38-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Cobalt	7440-48-4	0.1	mg/kg	0.2	0.2	0.00	No Limit
		EG005S: Copper	7440-50-8	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Manganese	7439-96-5	0.1	mg/kg	0.7	0.7	0.00	No Limit
		EG005S: Nickel	7440-02-0	0.1	mg/kg	<0.1	0.2	0.00	No Limit
		EG005S: Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG005S: Aluminium	7429-90-5	1	mg/kg	<1	<1	0.00	No Limit
		EG005S: Boron	7440-42-8	1	mg/kg	<1	<1	0.00	No Limit
		EG005S: Iron	7439-89-6	1	mg/kg	<1	<1	0.00	No Limit
EG005T: Total Metals by ICP-AES (QC Lot: 129798)									
EB1520839-001	Pit A (0)	EG005T: Cobalt	7440-48-4	2	mg/kg	19	18	0.00	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	129	126	2.43	0% - 20%
		EG005T: Copper	7440-50-8	5	mg/kg	1250	1240	0.762	0% - 20%
		EG005T: Lead	7439-92-1	5	mg/kg	20	20	0.00	No Limit
		EG005T: Manganese	7439-96-5	5	mg/kg	174	170	1.92	0% - 20%
EB1520839-014	Pit B (0)	EG005T: Cobalt	7440-48-4	2	mg/kg	87	88	0.00	0% - 20%
		EG005T: Arsenic	7440-38-2	5	mg/kg	100	102	2.44	0% - 20%
		EG005T: Copper	7440-50-8	5	mg/kg	1240	1250	1.08	0% - 20%
		EG005T: Lead	7439-92-1	5	mg/kg	37	38	0.00	No Limit
		EG005T: Manganese	7439-96-5	5	mg/kg	1090	1090	0.260	0% - 20%
EB1520839-001	Pit A (0)	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	11	12	9.17	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	17	19	10.3	No Limit
		EG005T: Antimony	7440-36-0	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Vanadium	7440-62-2	5	mg/kg	28	28	0.00	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	27	30	9.83	No Limit
		EG005T: Aluminium	7429-90-5	50	mg/kg	5570	6380	13.6	0% - 20%
		EG005T: Boron	7440-42-8	50	mg/kg	<50	<50	0.00	No Limit
		EG005T: Iron	7439-89-6	50	mg/kg	51200	50800	0.828	0% - 20%
EB1520839-014	Pit B (0)	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	28	24	14.2	0% - 50%



Sub-Matrix: SOIL				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG005T: Total Metals by ICP-AES (QC Lot: 129798) - continued									
EB1520839-014	Pit B (0)	EG005T: Nickel	7440-02-0	2	mg/kg	58	68	14.7	0% - 20%
		EG005T: Antimony	7440-36-0	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Vanadium	7440-62-2	5	mg/kg	101	88	14.0	0% - 20%
		EG005T: Zinc	7440-66-6	5	mg/kg	132	159	18.2	0% - 20%
		EG005T: Aluminium	7429-90-5	50	mg/kg	15500	17000	9.57	0% - 20%
		EG005T: Boron	7440-42-8	50	mg/kg	<50	<50	0.00	No Limit
		EG005T: Iron	7439-89-6	50	mg/kg	77900	73400	5.93	0% - 20%
EG005T: Total Metals by ICP-AES (QC Lot: 129799)									
EB1520839-025	Pit C (0)	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	13	14	0.00	No Limit
		EG005T: Cobalt	7440-48-4	2	mg/kg	69	75	8.38	0% - 20%
		EG005T: Nickel	7440-02-0	2	mg/kg	36	38	4.29	0% - 50%
		EG005T: Antimony	7440-36-0	5	mg/kg	<5	5	0.00	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	280	305	8.55	0% - 20%
		EG005T: Copper	7440-50-8	5	mg/kg	2290	2540	10.3	0% - 20%
		EG005T: Lead	7439-92-1	5	mg/kg	64	69	6.96	0% - 50%
		EG005T: Manganese	7439-96-5	5	mg/kg	615	652	5.75	0% - 20%
		EG005T: Vanadium	7440-62-2	5	mg/kg	27	28	3.78	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	42	41	3.66	No Limit
		EG005T: Aluminium	7429-90-5	50	mg/kg	8330	8510	2.10	0% - 20%
		EG005T: Boron	7440-42-8	50	mg/kg	<50	<50	0.00	No Limit
		EG005T: Iron	7439-89-6	50	mg/kg	43100	52300	19.2	0% - 20%
EB1520839-036	Pit D (0-10)	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	9	8	0.00	No Limit
		EG005T: Cobalt	7440-48-4	2	mg/kg	100	95	5.53	0% - 20%
		EG005T: Nickel	7440-02-0	2	mg/kg	57	55	2.52	0% - 20%
		EG005T: Antimony	7440-36-0	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	173	171	1.10	0% - 20%
		EG005T: Copper	7440-50-8	5	mg/kg	1030	987	4.08	0% - 20%
		EG005T: Lead	7439-92-1	5	mg/kg	11	11	0.00	No Limit
		EG005T: Manganese	7439-96-5	5	mg/kg	633	626	1.15	0% - 20%
		EG005T: Vanadium	7440-62-2	5	mg/kg	20	18	5.81	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	28	27	0.00	No Limit
		EG005T: Aluminium	7429-90-5	50	mg/kg	9730	9370	3.79	0% - 20%
		EG005T: Boron	7440-42-8	50	mg/kg	<50	<50	0.00	No Limit
		EG005T: Iron	7439-89-6	50	mg/kg	29900	28600	4.37	0% - 20%
EG005T: Total Metals by ICP-AES (QC Lot: 129801)									
EB1520839-056	North Rock Soil (1700-1800)	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	14	13	0.00	No Limit



Sub-Matrix: SOIL				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG005T: Total Metals by ICP-AES (QC Lot: 129801) - continued									
EB1520839-056	North Rock Soil (1700-1800)	EG005T: Cobalt	7440-48-4	2	mg/kg	22	29	26.5	0% - 50%
		EG005T: Nickel	7440-02-0	2	mg/kg	14	17	18.9	No Limit
		EG005T: Antimony	7440-36-0	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	6	7	17.2	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	58	57	2.10	0% - 50%
		EG005T: Lead	7439-92-1	5	mg/kg	7	6	0.00	No Limit
		EG005T: Manganese	7439-96-5	5	mg/kg	1040	# 1850	56.1	0% - 20%
		EG005T: Vanadium	7440-62-2	5	mg/kg	41	45	7.94	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	18	18	0.00	No Limit
		EG005T: Aluminium	7429-90-5	50	mg/kg	14800	13200	11.4	0% - 20%
		EG005T: Boron	7440-42-8	50	mg/kg	<50	<50	0.00	No Limit
		EG005T: Iron	7439-89-6	50	mg/kg	23100	22700	1.73	0% - 20%
EB1520839-045	Magazine Creek Soil 1 (0)	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	7	7	0.00	No Limit
		EG005T: Cobalt	7440-48-4	2	mg/kg	10	10	0.00	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	6	5	0.00	No Limit
		EG005T: Antimony	7440-36-0	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	13	12	9.14	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	169	166	1.58	0% - 20%
		EG005T: Lead	7439-92-1	5	mg/kg	7	6	20.1	No Limit
		EG005T: Manganese	7439-96-5	5	mg/kg	218	205	6.19	0% - 20%
		EG005T: Vanadium	7440-62-2	5	mg/kg	28	31	9.08	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	6	5	0.00	No Limit
		EG005T: Aluminium	7429-90-5	50	mg/kg	3320	2940	12.2	0% - 20%
		EG005T: Boron	7440-42-8	50	mg/kg	<50	<50	0.00	No Limit
		EG005T: Iron	7439-89-6	50	mg/kg	14400	14800	2.73	0% - 20%
EG005T: Total Metals by ICP-AES (QC Lot: 129803)									
EB1520839-068	Borrow 2 (0-1700)	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	14	20	36.9	No Limit
		EG005T: Cobalt	7440-48-4	2	mg/kg	22	24	8.78	0% - 50%
		EG005T: Nickel	7440-02-0	2	mg/kg	12	15	17.1	No Limit
		EG005T: Antimony	7440-36-0	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	<5	5	0.00	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	38	45	16.2	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Manganese	7439-96-5	5	mg/kg	95	# 204	72.9	0% - 20%
		EG005T: Vanadium	7440-62-2	5	mg/kg	35	48	32.5	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	6	8	23.4	No Limit
		EG005T: Aluminium	7429-90-5	50	mg/kg	4600	5290	14.0	0% - 20%

Sub-Matrix: SOIL				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG005T: Total Metals by ICP-AES (QC Lot: 129803) - continued									
EB1520839-068	Borrow 2 (0-1700)	EG005T: Boron	7440-42-8	50	mg/kg	<50	<50	0.00	No Limit
		EG005T: Iron	7439-89-6	50	mg/kg	15900	# 22200	33.1	0% - 20%
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 129784)									
EB1520839-001	Pit A (0)	EK059G: Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	<2.0	<2.5	22.2	No Limit
EB1520839-016	Pit B (20-40)	EK059G: Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	4.2	4.4	5.27	0% - 20%
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 129788)									
EB1520839-025	Pit C (0)	EK059G: Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	4.5	3.9	14.3	0% - 20%
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 129791)									
EB1520839-045	Magazine Creek Soil 1 (0)	EK059G: Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	3.3	3.3	0.00	0% - 20%
EB1520839-060	Diversion Dam Soil 1 (0)	EK059G: Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	0.7	0.3	85.0	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 129794)									
EB1520839-068	Borrow 2 (0-1700)	EK059G: Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	0.7	0.7	0.00	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 129812)									
EB1520839-001	Pit A (0)	EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	220	200	10.3	0% - 50%
EB1520839-016	Pit B (20-40)	EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	220	230	0.00	0% - 50%
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 129814)									
EB1520839-036	Pit D (0-10)	EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	140	140	0.00	No Limit
EB1520839-052	North Rock Soil 1 (50-100)	EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	400	410	3.86	0% - 20%
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 129818)									
EB1520839-064	Diversion Dam Soil 1 (800-850)	EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	110	100	9.45	No Limit
EB1521125-003	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	60	60	0.00	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 129811)									
EB1520839-001	Pit A (0)	EK067G: Total Phosphorus as P	----	2	mg/kg	427	371	14.0	0% - 20%
EB1520839-016	Pit B (20-40)	EK067G: Total Phosphorus as P	----	2	mg/kg	396	450	12.7	0% - 20%
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 129813)									
EB1520839-036	Pit D (0-10)	EK067G: Total Phosphorus as P	----	2	mg/kg	1230	1260	2.18	0% - 20%
EB1520839-052	North Rock Soil 1 (50-100)	EK067G: Total Phosphorus as P	----	2	mg/kg	190	210	10.1	0% - 20%
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 129817)									
EB1520839-064	Diversion Dam Soil 1 (800-850)	EK067G: Total Phosphorus as P	----	2	mg/kg	138	134	3.24	0% - 20%
EB1521125-003	Anonymous	EK067G: Total Phosphorus as P	----	2	mg/kg	116	# 209	57.0	0% - 20%
EK080: Bicarbonate Extractable Phosphorus (Colwell) (QC Lot: 127763)									
EB1520839-001	Pit A (0)	EK080: Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	<5	0.00	No Limit
EB1520839-016	Pit B (20-40)	EK080: Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	<5	0.00	No Limit
EK080: Bicarbonate Extractable Phosphorus (Colwell) (QC Lot: 127764)									
EB1520839-036	Pit D (0-10)	EK080: Bicarbonate Ext. P (Colwell)	----	5	mg/kg	22	18	21.3	No Limit
EK080: Bicarbonate Extractable Phosphorus (Colwell) (QC Lot: 127765)									



Sub-Matrix: SOIL				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EK080: Bicarbonate Extractable Phosphorus (Colwell) (QC Lot: 127765) - continued									
EB1520839-039	Pit D (300-350)	EK080: Bicarbonate Ext. P (Colwell)	----	5	mg/kg	27	26	0.00	No Limit
EB1520839-055	North Rock Soil (1200-1300)	EK080: Bicarbonate Ext. P (Colwell)	----	5	mg/kg	8	7	17.9	No Limit
EK080: Bicarbonate Extractable Phosphorus (Colwell) (QC Lot: 127766)									
EB1520839-067	Borrow 1 (0-1400)	EK080: Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	<5	0.00	No Limit



Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

Sub-Matrix: SOIL				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike Concentration	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result			LCS	Low
EA013: Acid Neutralising Capacity (QCLot: 131145)								
EA013: ANC as H2SO4	----	----	kg H2SO4 equiv./t	----	100 kg H2SO4 equiv./t	108	82	120
EA013: Acid Neutralising Capacity (QCLot: 131146)								
EA013: ANC as H2SO4	----	----	kg H2SO4 equiv./t	----	100 kg H2SO4 equiv./t	110	82	120
EA013: Acid Neutralising Capacity (QCLot: 131147)								
EA013: ANC as H2SO4	----	----	kg H2SO4 equiv./t	----	100 kg H2SO4 equiv./t	106	82	120
EA013: Acid Neutralising Capacity (QCLot: 131148)								
EA013: ANC as H2SO4	----	----	kg H2SO4 equiv./t	----	100 kg H2SO4 equiv./t	105	82	120
ED008: Exchangeable Cations (QCLot: 127965)								
ED008: Cation Exchange Capacity	----	0.1	meq/100g	<0.1	4.06 meq/100g	96.7	88	110
ED008: Exchangeable Calcium	----	0.1	meq/100g	<0.1	1 meq/100g	98.2	91	109
ED008: Exchangeable Magnesium	----	0.1	meq/100g	<0.1	1.67 meq/100g	99.4	89	111
ED008: Exchangeable Potassium	----	0.1	meq/100g	<0.1	0.52 meq/100g	104	79	116
ED008: Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.87 meq/100g	87.2	75	118
ED008: Exchangeable Cations (QCLot: 127966)								
ED008: Cation Exchange Capacity	----	0.1	meq/100g	<0.1	4.06 meq/100g	95.8	88	110
ED008: Exchangeable Calcium	----	0.1	meq/100g	<0.1	1 meq/100g	98.9	91	109
ED008: Exchangeable Magnesium	----	0.1	meq/100g	<0.1	1.67 meq/100g	98.9	89	111
ED008: Exchangeable Potassium	----	0.1	meq/100g	<0.1	0.52 meq/100g	98.6	79	116
ED008: Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.87 meq/100g	85.2	75	118
ED008: Exchangeable Cations (QCLot: 127975)								
ED008: Cation Exchange Capacity	----	0.1	meq/100g	<0.1	4.06 meq/100g	95.0	88	110
ED008: Exchangeable Calcium	----	0.1	meq/100g	<0.1	1 meq/100g	97.2	91	109
ED008: Exchangeable Magnesium	----	0.1	meq/100g	<0.1	1.67 meq/100g	97.7	89	111
ED008: Exchangeable Potassium	----	0.1	meq/100g	<0.1	0.52 meq/100g	102	79	116
ED008: Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.87 meq/100g	83.3	75	118
ED008: Exchangeable Cations (QCLot: 127976)								
ED008: Cation Exchange Capacity	----	0.1	meq/100g	<0.1	4.06 meq/100g	97.7	88	110
ED008: Exchangeable Calcium	----	0.1	meq/100g	<0.1	1 meq/100g	97.7	91	109
ED008: Exchangeable Magnesium	----	0.1	meq/100g	<0.1	1.67 meq/100g	99.7	89	111
ED008: Exchangeable Potassium	----	0.1	meq/100g	<0.1	0.52 meq/100g	108	79	116
ED008: Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.87 meq/100g	87.5	75	118
ED040S: Soluble Major Anions (QCLot: 129785)								
ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	500 mg/kg	99.4	90	114



Sub-Matrix: SOIL				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
Method: Compound	CAS Number	LOR	Unit		Spike Concentration	Spike Recovery (%)	Recovery Limits (%)	
						LCS	Low	High
ED040S: Soluble Major Anions (QCLot: 129786)								
ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	500 mg/kg	96.6	90	114
ED040S: Soluble Major Anions (QCLot: 129789)								
ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	500 mg/kg	98.4	90	114
ED040S: Soluble Major Anions (QCLot: 129792)								
ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	500 mg/kg	106	90	114
ED042T: Total Sulfur by LECO (QCLot: 126979)								
ED042T: Sulfur - Total as S (LECO)	----	0.01	%	<0.01	0.15 %	90.2	70	130
ED042T: Total Sulfur by LECO (QCLot: 126980)								
ED042T: Sulfur - Total as S (LECO)	----	0.01	%	<0.01	0.15 %	95.6	70	130
ED042T: Total Sulfur by LECO (QCLot: 126981)								
ED042T: Sulfur - Total as S (LECO)	----	0.01	%	<0.01	0.15 %	91.9	70	130
ED042T: Total Sulfur by LECO (QCLot: 126982)								
ED042T: Sulfur - Total as S (LECO)	----	0.01	%	<0.01	0.15 %	91.9	70	130
ED093T: Total Major Cations (QCLot: 129797)								
ED093T: Calcium	7440-70-2	50	mg/kg	<50	----	----	----	----
ED093T: Magnesium	7439-95-4	50	mg/kg	<50	----	----	----	----
ED093T: Potassium	7440-09-7	50	mg/kg	<50	----	----	----	----
ED093T: Sodium	7440-23-5	50	mg/kg	<50	----	----	----	----
ED093T: Total Major Cations (QCLot: 129800)								
ED093T: Calcium	7440-70-2	50	mg/kg	<50	----	----	----	----
ED093T: Magnesium	7439-95-4	50	mg/kg	<50	----	----	----	----
ED093T: Potassium	7440-09-7	50	mg/kg	<50	----	----	----	----
ED093T: Sodium	7440-23-5	50	mg/kg	<50	----	----	----	----
ED093T: Total Major Cations (QCLot: 129802)								
ED093T: Calcium	7440-70-2	50	mg/kg	<50	----	----	----	----
ED093T: Magnesium	7439-95-4	50	mg/kg	<50	----	----	----	----
ED093T: Potassium	7440-09-7	50	mg/kg	<50	----	----	----	----
ED093T: Sodium	7440-23-5	50	mg/kg	<50	----	----	----	----
ED093T: Total Major Cations (QCLot: 129804)								
ED093T: Calcium	7440-70-2	50	mg/kg	<50	----	----	----	----
ED093T: Magnesium	7439-95-4	50	mg/kg	<50	----	----	----	----
ED093T: Potassium	7440-09-7	50	mg/kg	<50	----	----	----	----
ED093T: Sodium	7440-23-5	50	mg/kg	<50	----	----	----	----
EG005S : Soluble Metals by ICPAES (QCLot: 129783)								
EG005S: Aluminium	7429-90-5	1	mg/kg	<1	5 mg/kg	103	78	112
EG005S: Antimony	7440-36-0	0.1	mg/kg	<0.1	----	----	----	----
EG005S: Arsenic	7440-38-2	0.1	mg/kg	<0.1	5 mg/kg	102	83	111



Sub-Matrix: SOIL				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%) Low High	
Method: Compound	CAS Number	LOR	Unit	Result				
EG005S : Soluble Metals by ICPAES (QCLot: 129783) - continued								
EG005S: Boron	7440-42-8	1	mg/kg	<1	----	----	----	----
EG005S: Cadmium	7440-43-9	0.1	mg/kg	<0.1	5 mg/kg	106	87	112
EG005S: Chromium	7440-47-3	0.1	mg/kg	<0.1	5 mg/kg	103	91	110
EG005S: Cobalt	7440-48-4	0.1	mg/kg	<0.1	----	----	----	----
EG005S: Copper	7440-50-8	0.1	mg/kg	<0.1	5 mg/kg	101	84	111
EG005S: Iron	7439-89-6	1	mg/kg	<1	----	----	----	----
EG005S: Lead	7439-92-1	0.1	mg/kg	<0.1	5 mg/kg	104	90	112
EG005S: Manganese	7439-96-5	0.1	mg/kg	<0.1	----	----	----	----
EG005S: Nickel	7440-02-0	0.1	mg/kg	<0.1	5 mg/kg	104	82	112
EG005S: Vanadium	7440-62-2	0.1	mg/kg	<0.1	----	----	----	----
EG005S: Zinc	7440-66-6	0.1	mg/kg	<0.1	5 mg/kg	104	94	110
EG005S : Soluble Metals by ICPAES (QCLot: 129787)								
EG005S: Aluminium	7429-90-5	1	mg/kg	<1	5 mg/kg	102	78	112
EG005S: Antimony	7440-36-0	0.1	mg/kg	<0.1	----	----	----	----
EG005S: Arsenic	7440-38-2	0.1	mg/kg	<0.1	5 mg/kg	102	83	111
EG005S: Boron	7440-42-8	1	mg/kg	<1	----	----	----	----
EG005S: Cadmium	7440-43-9	0.1	mg/kg	<0.1	5 mg/kg	105	87	112
EG005S: Chromium	7440-47-3	0.1	mg/kg	<0.1	5 mg/kg	102	91	110
EG005S: Cobalt	7440-48-4	0.1	mg/kg	<0.1	----	----	----	----
EG005S: Copper	7440-50-8	0.1	mg/kg	<0.1	5 mg/kg	100	84	111
EG005S: Iron	7439-89-6	1	mg/kg	<1	----	----	----	----
EG005S: Lead	7439-92-1	0.1	mg/kg	<0.1	5 mg/kg	102	90	112
EG005S: Manganese	7439-96-5	0.1	mg/kg	<0.1	----	----	----	----
EG005S: Nickel	7440-02-0	0.1	mg/kg	<0.1	5 mg/kg	102	82	112
EG005S: Vanadium	7440-62-2	0.1	mg/kg	<0.1	----	----	----	----
EG005S: Zinc	7440-66-6	0.1	mg/kg	<0.1	5 mg/kg	103	94	110
EG005S : Soluble Metals by ICPAES (QCLot: 129790)								
EG005S: Aluminium	7429-90-5	1	mg/kg	<1	5 mg/kg	102	78	112
EG005S: Antimony	7440-36-0	0.1	mg/kg	<0.1	----	----	----	----
EG005S: Arsenic	7440-38-2	0.1	mg/kg	<0.1	5 mg/kg	97.6	83	111
EG005S: Boron	7440-42-8	1	mg/kg	<1	----	----	----	----
EG005S: Cadmium	7440-43-9	0.1	mg/kg	<0.1	5 mg/kg	105	87	112
EG005S: Chromium	7440-47-3	0.1	mg/kg	<0.1	5 mg/kg	101	91	110
EG005S: Cobalt	7440-48-4	0.1	mg/kg	<0.1	----	----	----	----
EG005S: Copper	7440-50-8	0.1	mg/kg	<0.1	5 mg/kg	100	84	111
EG005S: Iron	7439-89-6	1	mg/kg	<1	----	----	----	----
EG005S: Lead	7439-92-1	0.1	mg/kg	<0.1	5 mg/kg	102	90	112
EG005S: Manganese	7439-96-5	0.1	mg/kg	<0.1	----	----	----	----
EG005S: Nickel	7440-02-0	0.1	mg/kg	<0.1	5 mg/kg	101	82	112



Sub-Matrix: SOIL				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%) Low High	
Method: Compound	CAS Number	LOR	Unit	Result				
EG005S : Soluble Metals by ICPAES (QCLot: 129790) - continued								
EG005S: Vanadium	7440-62-2	0.1	mg/kg	<0.1	----	----	----	----
EG005S: Zinc	7440-66-6	0.1	mg/kg	<0.1	5 mg/kg	102	94	110
EG005S : Soluble Metals by ICPAES (QCLot: 129793)								
EG005S: Aluminium	7429-90-5	1	mg/kg	<1	5 mg/kg	102	78	112
EG005S: Antimony	7440-36-0	0.1	mg/kg	<0.1	----	----	----	----
EG005S: Arsenic	7440-38-2	0.1	mg/kg	<0.1	5 mg/kg	98.9	83	111
EG005S: Boron	7440-42-8	1	mg/kg	<1	----	----	----	----
EG005S: Cadmium	7440-43-9	0.1	mg/kg	<0.1	5 mg/kg	105	87	112
EG005S: Chromium	7440-47-3	0.1	mg/kg	<0.1	5 mg/kg	101	91	110
EG005S: Cobalt	7440-48-4	0.1	mg/kg	<0.1	----	----	----	----
EG005S: Copper	7440-50-8	0.1	mg/kg	<0.1	5 mg/kg	101	84	111
EG005S: Iron	7439-89-6	1	mg/kg	<1	----	----	----	----
EG005S: Lead	7439-92-1	0.1	mg/kg	<0.1	5 mg/kg	103	90	112
EG005S: Manganese	7439-96-5	0.1	mg/kg	<0.1	----	----	----	----
EG005S: Nickel	7440-02-0	0.1	mg/kg	<0.1	5 mg/kg	102	82	112
EG005S: Vanadium	7440-62-2	0.1	mg/kg	<0.1	----	----	----	----
EG005S: Zinc	7440-66-6	0.1	mg/kg	<0.1	5 mg/kg	102	94	110
EG005T: Total Metals by ICP-AES (QCLot: 129798)								
EG005T: Aluminium	7429-90-5	50	mg/kg	<50	----	----	----	----
EG005T: Antimony	7440-36-0	5	mg/kg	<5	----	----	----	----
EG005T: Arsenic	7440-38-2	5	mg/kg	<5	21.7 mg/kg	100	84	123
EG005T: Boron	7440-42-8	50	mg/kg	<50	----	----	----	----
EG005T: Cadmium	7440-43-9	1	mg/kg	<1	4.64 mg/kg	104	88	117
EG005T: Chromium	7440-47-3	2	mg/kg	<2	43.9 mg/kg	117	83	125
EG005T: Cobalt	7440-48-4	2	mg/kg	<2	16 mg/kg	109	89	125
EG005T: Copper	7440-50-8	5	mg/kg	<5	32 mg/kg	113	86	122
EG005T: Iron	7439-89-6	50	mg/kg	<50	8400 mg/kg	117	70	120
EG005T: Lead	7439-92-1	5	mg/kg	<5	40 mg/kg	106	84	119
EG005T: Manganese	7439-96-5	5	mg/kg	<5	130 mg/kg	97.7	84	113
EG005T: Nickel	7440-02-0	2	mg/kg	<2	55 mg/kg	107	89	126
EG005T: Vanadium	7440-62-2	5	mg/kg	<5	29.6 mg/kg	116	91	127
EG005T: Zinc	7440-66-6	5	mg/kg	<5	60.8 mg/kg	114	87	127
EG005T: Total Metals by ICP-AES (QCLot: 129799)								
EG005T: Aluminium	7429-90-5	50	mg/kg	<50	----	----	----	----
EG005T: Antimony	7440-36-0	5	mg/kg	<5	----	----	----	----
EG005T: Arsenic	7440-38-2	5	mg/kg	<5	21.7 mg/kg	111	84	123
EG005T: Boron	7440-42-8	50	mg/kg	<50	----	----	----	----
EG005T: Cadmium	7440-43-9	1	mg/kg	<1	4.64 mg/kg	102	88	117
EG005T: Chromium	7440-47-3	2	mg/kg	<2	43.9 mg/kg	112	83	125

EK059G: Nitrite plus Nitrate as N (NO_x) by Discrete Analyser (QCLot: 129784)

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Sub-Matrix: SOIL				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%) Low High	
Method: <i>Compound</i>	CAS Number	LOR	Unit	Result				
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 129784) - continued								
EK059G: Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	<0.1	2.5 mg/kg	92.1	86	115
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 129788)								
EK059G: Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	<0.1	2.5 mg/kg	94.8	86	115
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 129791)								
EK059G: Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	<0.1	2.5 mg/kg	97.0	86	115
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 129794)								
EK059G: Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	<0.1	2.5 mg/kg	98.1	86	115
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 129812)								
EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	<20	1000 mg/kg	91.1	70	118
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 129814)								
EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	<20	1000 mg/kg	92.4	70	118
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 129818)								
EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	<20	1000 mg/kg	92.2	70	118
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 129811)								
EK067G: Total Phosphorus as P	----	2	mg/kg	<2	442 mg/kg	100	77	111
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 129813)								
EK067G: Total Phosphorus as P	----	2	mg/kg	<2	442 mg/kg	100.0	77	111
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 129817)								
EK067G: Total Phosphorus as P	----	2	mg/kg	<2	442 mg/kg	98.9	77	111
EK080: Bicarbonate Extractable Phosphorus (Colwell) (QCLot: 127763)								
EK080: Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	200 mg/kg	94.2	70	130
EK080: Bicarbonate Extractable Phosphorus (Colwell) (QCLot: 127764)								
EK080: Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	200 mg/kg	94.2	70	130
EK080: Bicarbonate Extractable Phosphorus (Colwell) (QCLot: 127765)								
EK080: Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	200 mg/kg	94.2	70	130
EK080: Bicarbonate Extractable Phosphorus (Colwell) (QCLot: 127766)								
EK080: Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	200 mg/kg	94.2	70	130

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: SOIL				Matrix Spike (MS) Report			
				Spike Concentration	SpikeRecovery(%) MS	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number			Low	High
EG005T: Total Metals by ICP-AES (QCLot: 129798)							
EB1520839-002	Pit A (0-10)						



Sub-Matrix: **SOIL**

Sub-Matrix: SOIL				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG005T: Total Metals by ICP-AES (QCLot: 129798) - continued							
EB1520839-002	Pit A (0-10)	EG005T: Arsenic	7440-38-2	50 mg/kg	# Not Determined	70	130
		EG005T: Cadmium	7440-43-9	25 mg/kg	98.9	70	130
		EG005T: Chromium	7440-47-3	50 mg/kg	109	70	130
		EG005T: Cobalt	7440-48-4	50 mg/kg	104	70	130
		EG005T: Copper	7440-50-8	50 mg/kg	# Not Determined	70	130
		EG005T: Lead	7439-92-1	50 mg/kg	121	70	130
		EG005T: Manganese	7439-96-5	50 mg/kg	# Not Determined	70	130
		EG005T: Nickel	7440-02-0	50 mg/kg	100	70	130
		EG005T: Vanadium	7440-62-2	50 mg/kg	99.0	70	130
		EG005T: Zinc	7440-66-6	50 mg/kg	81.3	70	130
EG005T: Total Metals by ICP-AES (QCLot: 129799)							
EB1520839-026	Pit C (0-10)	EG005T: Arsenic	7440-38-2	50 mg/kg	# Not Determined	70	130
		EG005T: Cadmium	7440-43-9	25 mg/kg	109	70	130
		EG005T: Chromium	7440-47-3	50 mg/kg	121	70	130
		EG005T: Cobalt	7440-48-4	50 mg/kg	# 140	70	130
		EG005T: Copper	7440-50-8	50 mg/kg	# Not Determined	70	130
		EG005T: Lead	7439-92-1	50 mg/kg	# 250	70	130
		EG005T: Manganese	7439-96-5	50 mg/kg	# Not Determined	70	130
		EG005T: Nickel	7440-02-0	50 mg/kg	121	70	130
		EG005T: Vanadium	7440-62-2	50 mg/kg	110	70	130
		EG005T: Zinc	7440-66-6	50 mg/kg	# 135	70	130
EG005T: Total Metals by ICP-AES (QCLot: 129801)							
EB1520839-046	Magazine Creek Soil 1 (200-300)	EG005T: Arsenic	7440-38-2	50 mg/kg	103	70	130
		EG005T: Cadmium	7440-43-9	25 mg/kg	108	70	130
		EG005T: Chromium	7440-47-3	50 mg/kg	94.9	70	130
		EG005T: Cobalt	7440-48-4	50 mg/kg	105	70	130
		EG005T: Copper	7440-50-8	50 mg/kg	104	70	130
		EG005T: Lead	7439-92-1	50 mg/kg	104	70	130
		EG005T: Manganese	7439-96-5	50 mg/kg	# Not Determined	70	130
		EG005T: Nickel	7440-02-0	50 mg/kg	97.4	70	130
		EG005T: Vanadium	7440-62-2	50 mg/kg	99.1	70	130
		EG005T: Zinc	7440-66-6	50 mg/kg	107	70	130

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 Client : BIRLA MT GORDON PTY LTD
 Project : Mt Gordon (cover design)



Sub-Matrix: SOIL				Matrix Spike (MS) Report			
				Spike Concentration	SpikeRecovery(%) MS	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number			Low	High
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 129784)							
EB1520839-002	Pit A (0-10)	EK059G: Nitrite + Nitrate as N (Sol.)	----	2 mg/kg	110	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 129788)							
EB1520839-026	Pit C (0-10)	EK059G: Nitrite + Nitrate as N (Sol.)	----	2 mg/kg	102	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 129791)							
EB1520839-046	Magazine Creek Soil 1 (200-300)	EK059G: Nitrite + Nitrate as N (Sol.)	----	2 mg/kg	95.3	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 129812)							
EB1520839-002	Pit A (0-10)	EK061G: Total Kjeldahl Nitrogen as N	----	500 mg/kg	102	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 129814)							
EB1520839-037	Pit D (20-40)	EK061G: Total Kjeldahl Nitrogen as N	----	500 mg/kg	98.9	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 129818)							
EB1520839-065	Diversion Dam Soil 1 (1100-1200)	EK061G: Total Kjeldahl Nitrogen as N	----	500 mg/kg	94.8	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 129811)							
EB1520839-002	Pit A (0-10)	EK067G: Total Phosphorus as P	----	100 mg/kg	95.7	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 129813)							
EB1520839-037	Pit D (20-40)	EK067G: Total Phosphorus as P	----	100 mg/kg	# Not Determined	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 129817)							
EB1520839-065	Diversion Dam Soil 1 (1100-1200)	EK067G: Total Phosphorus as P	----	100 mg/kg	83.7	70	130
EK080: Bicarbonate Extractable Phosphorus (Colwell) (QCLot: 127763)							
EB1520839-002	Pit A (0-10)	EK080: Bicarbonate Ext. P (Colwell)	----	48.8 mg/kg	96.5	70	130
EK080: Bicarbonate Extractable Phosphorus (Colwell) (QCLot: 127764)							
EB1520839-037	Pit D (20-40)	EK080: Bicarbonate Ext. P (Colwell)	----	48.8 mg/kg	97.1	70	130
EK080: Bicarbonate Extractable Phosphorus (Colwell) (QCLot: 127765)							
EB1520839-045	Magazine Creek Soil 1 (0)	EK080: Bicarbonate Ext. P (Colwell)	----	48.8 mg/kg	114	70	130
EK080: Bicarbonate Extractable Phosphorus (Colwell) (QCLot: 127766)							
EB1520839-068	Borrow 2 (0-1700)	EK080: Bicarbonate Ext. P (Colwell)	----	48.8 mg/kg	94.5	70	130

Appendix D

Survey logs

Project:	Mt Gordon	Date:	3 June 2015	Location:	Pit A	Observation Type:		Coordinates:	Easting	Zone	-	
Job Number	B15035					P - Soil Pit			Northing	Elevation		
Natural Vegetation:	None - on laydown area built on top of the old tailings storage facility			Land Use:	Tailings storage and laydown area (refer to photos)			Surface Soil Condition				
									Hard Packed	Hard		
Topography	Not recorded			Surface Rock % (> 60mm dia):	>50% (refer to photo)			Erosion:	None			
Drainage:	Final surface is graded towards a surface drain system											
Remarks:	Australian soil classification fields (ASC) do not apply and have not been completed. The RL of Pit A is approximately 1 m higher than the rest of the TSF			ASC Mapped:				ASC Ground Truth:				
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Pedality	Structure	Consistence	Drainage	Boundaries	Horizons	Sample
0-20	Loamy Sand - LS	40-50%	5YR/7/2 (pinkish gray)	>70% gravel (2-60 mm)		Weakly Pedal		2 - Weak	Well Drained			(0) and (0-10)
20-1140	Loamy Sand - LS	60-70%	5YR/7/2 (pinkish gray)	>70% gravel (2-60 mm)		Weakly Pedal		2 - Weak	Well Drained	Clear		(20-40), (70-100), (300-350), (600-650), (800-850) and (1100-1140)*
1140-1700	Silty Clay Loam - SiCL	Nil	2.5YR/4/4 (reddish brown)	Nil		Apedal	Massive	3 - Firm	Poorly Drained	Clear		(1140-1200) and (1350-1400)* ²
1700+	Clayey Sand - CLS	Nil	5YR/5/4 (reddish brown)	Nil		Apedal	Massive	1 - Very Weak	Poorly Drained	Not Recorded		Nil

* Layer sampled for particle size distribution

2 Bulk sample (20 kg) taken to determine its potential as substitute for an RPL

Project:	Mt Gordon	Date:	3 June 2015	Location:	Pit B	Observation Type:		Coordinates:	Easting	Zone	-	
Job Number	B15035					P - Soil Pit			Northing	Elevation		
Natural Vegetation:	None - on laydown area built on top of the old tailings storage facility			Land Use:	Tailings storage and laydown area (refer to photos)			Surface Soil Condition				
										Hard Packed	Hard	
Topography	Not recorded		Surface Rock % (> 60mm dia):	>50% (refer to photo)		Erosion:	None		Drainage:	Final surface is graded towards a surface drain system		
Remarks:	Australian soil classification fields (ASC) do not apply and have not been completed			ASC Mapped:				ASC Ground Truth:				
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Pedality	Structure	Consistence	Drainage	Boundaries	Horizons	Sample
0-20	Loamy Sand - LS	40-50%	5YR/7/2 (pinkish gray)	>70% gravel (2-60 mm)		Weakly Pedal		2 - Weak	Well Drained			(0) and (0-10)
20-650	Loamy Sand - LS	60-70%	5YR/7/2 (pinkish gray)	>70% gravel (2-60 mm)		Weakly Pedal		2 - Weak	Well Drained	Clear		(20-40), (70-100), (300-350) and (600-650)
650-800		≥90%	5Y/4/1 (dark gray)	>90% gravel (2-60 mm). Boulders present (<60 mm)			Blocky	6 - Very Strong	Not Recorded	Clear		Rock
800-1500	Clayey Sand - CLS	Nil	5YR/5/4 (reddish brown)	Nil		Apedal	Massive	1 - Very Weak	Poorly Drained	Not Recorded		(800-850), (900-1000), (1200-1300) and (1400-1500)* ²

* Layer sampled for particle size distribution

2 Bulk sample (20 kg) taken to determine its potential as substitute for an RPL

Project:	Mt Gordon	Date:	5 June 2015	Location:	Pit B1	Observation Type:						
Job Number	B15035					P - Soil Pit	Coordinates:	Easting	Zone	-		
							Northing	Elevation				
Natural Vegetation:	None - on laydown area built on top of the old tailings storage facility				Land Use:	Tailings storage (refer to photos)				Surface Soil Condition		
										Hard Packed	Hard	
Topography	Not recorded		Surface Rock % (> 60mm dia):	70% (refer to photo)		Erosion:	None		Drainage:	In drainage line		
Remarks:	Australian soil classification fields (ASC) do not apply and have not been completed				ASC Mapped:					ASC Ground Truth:		
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Pedality	Structure	Consistence	Drainage	Boundaries	Horizons	Sample
0-300	Loamy Sand - LS	60-70%	5YR/7/2 (pinkish gray)	>70% gravel (2-60 mm)		Weakly Pedal		2 - Weak	Well Drained	Clear		(0), (0-10), (20-40), (70-100) and 300-350)
300-900	Silty Clay Loam - SiCL	60-70%	2.5YR/4/4 (reddish brown)	Nil		Apedal	Massive	3 - Firm	Poorly Drained	Clear		(400-450) and (600-650)
900-1300	Clayey Sand - CLS	Nil	5YR/5/4 (reddish brown)	Nil		Apedal	Massive	1 - Very Weak	Poorly Drained	Not Recorded		(800-850), (1200-1300) and (1600-1700)

Project:	Mt Gordon	Date:	5 June 2015	Location:	Pit B2	Observation Type:			Coordinates:	Easting	Zone	-
Job Number	B15035					P - Soil Pit			Northing	Elevation		
Natural Vegetation:	None - on laydown area built on top of the old tailings storage facility				Land Use:	Tailings storage (refer to photos)				Surface Soil Condition		
	    								Hard Packed	Hard		
Topography	Not recorded		Surface Rock % (> 60mm dia):	70% (refer to photo)		Erosion:	None		Drainage:	In drainage line		
Remarks:	Australian soil classification fields (ASC) do not apply and have not been completed				ASC Mapped:					ASC Ground Truth:		
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Pedality	Structure	Consistence	Drainage	Boundaries	Horizons	Sample
0-600	Loamy Sand - LS	60-70%	5YR/7/2 (pinkish gray)	>70% gravel (2-60 mm)		Weakly Pedal		2 - Weak	Well Drained	Clear		No samples taken. Same principal profile as Pit A, Pit C and Pit D
600-1000	Silty Clay Loam - SiCL	60-70%	2.5YR/4/4 (reddish brown)	Nil		Apedal	Massive	3 - Firm	Poorly Drained	Clear		
1000-1200	Clayey Sand - CLS	Nil	5YR/5/4 (reddish brown)	Nil		Apedal	Massive	1 - Very Weak	Poorly Drained	Not Recorded		

Project:	Mt Gordon	Date:	5 June 2015	Location:	Pit B3	Observation Type:							
Job Number	B15035					P - Soil Pit	Coordinates:	Easting	Zone	-			
							Northing	Elevation					
Natural Vegetation:	None - on laydown area built on top of the old tailings storage facility					Land Use:	Tailings storage and laydown area (refer to photos)				Surface Soil Condition		
	   									Hard Packed	Hard		
Topography	Not recorded		Surface Rock % >50% (refer to photo (> 60mm dia):		Erosion:		None		Drainage: Final surface is graded towards a surface drain system				
Remarks:	Australian soil classification fields (ASC) do not apply and have not been completed					ASC Mapped:		ASC Ground Truth:					
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Pedality	Structure	Consistence	Drainage	Boundaries	Horizons	Sample	
0-700	Loamy Sand - LS	40-50%	5YR/7/2 (pinkish gray)	>70% gravel (2-60 mm)		Weakly Pedal		2 - Weak	Well Drained			No samples taken. Same principal profile as Pit B	
700-900		≥90%	5Y/4/1 (dark gray)	>90% gravel (2-60 mm). Boulders present (<60 mm)			Blocky	6 - Very Strong	Not Recorded	Clear			
900-1400	Clayey Sand - CLS	Nil	5YR/5/4 (reddish brown) and 2.5Y/7/1 (light gray)	Nil		Apedal	Massive	1 - Very Weak	Poorly Drained	Not Recorded			

Project:	Mt Gordon	Date:	5 June 2015	Location:	Pit B4	Observation Type:		Coordinates:	Easting	Zone	-	
Job Number	B15035					P - Soil Pit			Northing	Elevation		
Natural Vegetation:	None - on laydown area built on top of the old tailings storage facility				Land Use:	Tailings storage and laydown area (refer to photos)			Surface Soil Condition			
	    							Hard Packed	Hard			
Topography	Not recorded		Surface Rock % (> 60mm dia):	>50% (refer to photo)		Erosion:	None		Drainage:	Final surface is graded towards a surface drain system		
Remarks:	Australian soil classification fields (ASC) do not apply and have not been completed				ASC Mapped:				ASC Ground Truth:			
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Pedality	Structure	Consistence	Drainage	Boundaries	Horizons	Sample
0-500	Loamy Sand - LS	40-50%	5YR/7/2 (pinkish gray)	>70% gravel (2-60 mm)		Weakly Pedal		2 - Weak	Well Drained			No samples taken. Same principal profile as Pit B
500-900		≥90%	5Y/4/1 (dark gray)	>90% gravel (2-60 mm). Boulders present (<60 mm)			Blocky	6 - Very Strong	Not Recorded	Clear		
900-1400	Clayey Sand - CLS	Nil	5YR/5/4 (reddish brown)	Nil		Apedal	Massive	1 - Very Weak	Poorly Drained	Not Recorded		

Project:	Mt Gordon	Date:	5 June 2015	Location:	Pit B5	Observation Type:			Coordinates:	Easting	Zone	-	
Job Number	B15035					P - Soil Pit			Northing	Elevation			
Natural Vegetation:	None - did have regrowth but it was cleared six months ago				Land Use:	Tailings storage (refer to photos)				Surface Soil Condition			
	    					Hard Packed	Hard						
Topography	Not recorded		Surface Rock % (> 60mm dia):	70% (refer to photo)		Erosion:	None		Drainage:	In drainage line			
Remarks:	Australian soil classification fields (ASC) do not apply and have not been completed				ASC Mapped:					ASC Ground Truth:			
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Pedality	Structure	Consistence	Drainage	Boundaries	Horizons	Sample	
0-200	Loamy Sand - LS	60-70%	5YR/7/2 (pinkish gray)	>70% gravel (2-60 mm)		Weakly Pedal		2 - Weak	Well Drained	Clear		No samples taken. Same principal profile as Pit A, Pit C and Pit D	
200-550	Silty Clay Loam - SiCL	60-70%	2.5YR/4/4 (reddish brown)	Nil		Apedal	Massive	3 - Firm	Poorly Drained	Clear			
550-1500	Clayey Sand - CLS	Nil	5YR/5/4 (reddish brown) and 5Y/4/1 (dark gray)	Nil		Apedal	Massive	1 - Very Weak	Poorly Drained	Not Recorded			

Project:	Mt Gordon	Date:	5 June 2015	Location:	Pit B6	Observation Type:						
Job Number	B15035					P - Soil Pit	Coordinates:	Easting	Zone	-		
							Northing	Elevation				
Natural Vegetation:	None - on laydown area built on top of the old tailings storage facility				Land Use:	Tailings storage and laydown area (refer to photos)				Surface Soil Condition		
	    							Hard Packed	Hard			
Topography	Not recorded		Surface Rock % (> 60mm dia):	>50% (refer to photo)		Erosion:	None		Drainage:	Final surface is graded towards a surface drain system		
Remarks:	Australian soil classification fields (ASC) do not apply and have not been completed				ASC Mapped:			ASC Ground Truth:				
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Pedality	Structure	Consistence	Drainage	Boundaries	Horizons	Sample
0-700	Loamy Sand - LS	40-50%	5YR/7/2 (pinkish gray)	>70% gravel (2-60 mm)		Weakly Pedal		2 - Weak	Well Drained			No samples taken. Same principal profile as Pit B
700-1100		≥90%	5Y/4/1 (dark gray)	>90% gravel (2-60 mm). Boulders present (<60 mm)			Blocky	6 - Very Strong	Not Recorded	Clear		
1100-1300	Clayey Sand - CLS	Nil	5YR/5/4 (reddish brown)	Nil		Apedal	Massive	1 - Very Weak	Poorly Drained	Not Recorded		

Project:	Mt Gordon	Date:	3 June 2015	Location:	Pit C	Observation Type:		Coordinates:	Easting	Zone	-	
Job Number	B15035					P - Soil Pit		Northing		Elevation		
Natural Vegetation:	None - did have regrowth but it was cleared six months ago				Land Use:	Tailings storage (refer to photos)			Surface Soil Condition			
	    							Hard Packed	Hard			
Topography	Not recorded		Surface Rock % (> 60mm dia):	70% (refer to photo)		Erosion:	None		Drainage:	In drainage line		
Remarks:	Australian soil classification fields (ASC) do not apply and have not been completed				ASC Mapped:				ASC Ground Truth:			
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Pedality	Structure	Consistence	Drainage	Boundaries	Horizons	Sample
0-400	Loamy Sand - LS	60-70%	5YR/7/2 (pinkish gray)	>70% gravel (2-60 mm)		Weakly Pedal		2 - Weak	Well Drained	Clear		(0), (0-10), (20-40), (70-100) and 300-350)
400-700	Silty Clay Loam - SiCL	60-70%	2.5YR/4/4 (reddish brown)	Nil		Apedal	Massive	3 - Firm	Poorly Drained	Clear		(400-450) and (600-650)
700-1700	Clayey Sand - CLS	Nil	5YR/5/4 (reddish brown)	Nil		Apedal	Massive	1 - Very Weak	Poorly Drained	Not Recorded		(800-850), (1200-1300) and (1600-1700)

Project:	Mt Gordon	Date:	3 June 2015	Location:	Pit D	Observation Type:						
Job Number	B15035					P - Soil Pit	Coordinates:	Easting	Zone	-		
							Northing	Elevation				
Natural Vegetation:	None - did have regrowth but it was cleared six months ago				Land Use:	Tailings storage (refer to photos)				Surface Soil Condition		
										Hard Packed	Hard	
Topography	Not recorded		Surface Rock % (> 60mm dia):	70% (refer to photo)		Erosion:	None		Drainage:	In drainage line		
Remarks:	Australian soil classification fields (ASC) do not apply and have not been completed				ASC Mapped:				ASC Ground Truth:			
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Pedality	Structure	Consistence	Drainage	Boundaries	Horizons	Sample
0-400	Loamy Sand - LS	60-70%	5YR/7/2 (pinkish gray)	>70% gravel (2-60 mm)		Weakly Pedal		2 - Weak	Well Drained	Clear		(0), (0-10), (20-40), (70-100) and 300-350)
400-700	Silty Clay Loam - SiCL	60-70%	2.5YR/4/4 (reddish brown)	Nil		Apedal	Massive	3 - Firm	Poorly Drained	Clear		(400-450) and (600-650)
700-1700	Clayey Sand - CLS	Nil	5YR/5/4 (reddish brown)	Nil		Apedal	Massive	1 - Very Weak	Poorly Drained	Not Recorded		(800-850), (1200-1300) and (1600-1700)

Project:	Mt Gordon	Date:	4 June 2015	Location:	Magazine Creek Soil 1	Observation Type:			Coordinates:	Easting	Zone	-
Job Number	B15035					P - Soil Pit			Northing	Elevation		
Natural Vegetation:	Undisturbed	Land Use:				Magazine Creek dams and undisturbed (refer to photos)			Surface Soil Condition			
											Soft	
Topography	Not recorded	Surface Rock % (> 60mm dia):	100% (refer to photo)	Erosion:	None			Drainage:	Toe of slope. Free draining			
Remarks:	Nil			ASC Mapped:				ASC Ground Truth:	Rudosols			
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Pedality	Structure	Consistence	Drainage	Boundaries	Horizons	Sample
0-700	Loamy Sand - LS	50-60%	5YR/3/3 (dark reddish brown)	>50% gravel (2-60 mm)		Apedal	Massive	0 - Loose	Well Drained	Gradual	B2	(0), (200-300) and (500-600) ¹
700-1100		70-80%		>70% gravel (2-60 mm)		Apedal	Massive	2 - Weak	Well Drained	Clear	B2C	(700-800) and (1000-1100) ¹
1100-1900								5 - Strong		Not Recorded		Weathered rock ¹

¹ Composite sample taken for 0-1900 mm for particle size distribution analysis

Project: Mt Gordon		Date: 6 June 2015		Location: Magazine Creek Soil Borrow ¹		Observation Type:		Coordinates: Easting Zone -				
Job Number B15035						P - Soil Pit		Northing Elevation				
Natural Vegetation: Undisturbed				Land Use: Magazine Creek dams and undisturbed (refer to photos)				Surface Soil Condition				
 				  				Soft				
Topography Toe of slope		Surface Rock % 100% (refer to photo (> 60mm dia):		Erosion: None		Drainage: Toe of slope. Free draining						
Remarks: Nil				ASC Mapped:		ASC Ground Truth: Rudosols						
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Pedality	Structure	Consistence	Drainage	Boundaries	Horizons	Sample
0-1200	Loamy Sand - LS	50-60%	5YR/3/3 (dark reddish brown)	>50% gravel (2-60 mm)		Apedal	Massive	0 - Loose	Well Drained	Gradual	B2	¹
1200-1400		70-80%	5YR/3/3 (dark reddish brown)	>70% gravel (2-60 mm)		Apedal	Massive	2 - Weak	Well Drained	Clear	B2C	(0-1400) ¹
1400+								5 - Strong		Not Recorded		Weathered rock

¹ Composite sample taken for 0-1400 mm for particle size distribution analysis

² Bulk sample (20 kg) taken to determine its potential as borrow material for soil mulch

Project: Mt Gordon		Date: 6 June 2015		Location: Magazine Creek Soil Borrow 2		Observation Type:		Coordinates: Easting		Zone -			
Job Number B15035						P - Soil Pit		Northing		Elevation			
Natural Vegetation: Undisturbed				Land Use: Magazine Creek dams and undisturbed (refer to photos)				Surface Soil Condition					
				  								Soft	
Topography Not recorded		Surface Rock % 0% (refer to photo)		Erosion: None				Drainage: Dam floor					
		(> 60mm dia):											
Remarks: Nil				ASC Mapped:				ASC Ground Truth: Rudosols					
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Pedality	Structure	Consistence	Drainage	Boundaries	Horizons	Sample	
0-60	Loam, fine sand - Lfsy	0-5%	5YR/3/4 (dark reddish brown)	<5% gravel (2-60 mm)		Apedal	Massive	0 - Loose	Well Drained	Clear		¹	
60-1700		70-80%	5YR/3/3 (dark reddish brown)	>70% gravel (2-60 mm). Boulders present (<60 mm)		Apedal	Massive	2 - Weak	Well Drained	Clear	B2	(0-1700) ¹	

¹ Composite sample taken for 0-1700 mm for particle size distribution analysis

[illegible]

[illegible]

Project: Mt Gordon		Date: 6 June 2015		Location: Magazine Creek Soil Borrow 5		Observation Type:		Coordinates: Easting Zone -				
Job Number B15035						P - Soil Pit		Northing Elevation				
Natural Vegetation: Undisturbed				Land Use: Undisturbed and Diversion Dam (refer to photos)				Surface Soil Condition				
   								Soft				
Topography Midslope		Surface Rock % (> 60mm dia): 100% (refer to photo)		Erosion: Nil		Drainage: Free draining midslope						
Remarks:				ASC Mapped:		ASC Ground Truth: Rudosols						
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Pedality	Structure	Consistence	Drainage	Boundaries	Horizons	Sample
0-100	Loamy Sand - LS	40-50%	5YR/3/4 (dark reddish brown)	>40% gravel (2-60 mm)		Apedal		0 - Loose	Well Drained	Clear	A1	No sample. Principal profile is the same as Borrow 2
100-1000	Loamy Sand - LS	60-70%	2.5YR/4/4 (reddish brown)	>40% gravel (2-60 mm). Boulders present (<60 mm)		Apedal		2 - Weak	Well Drained	Diffuse	B2	
1000-1700			2.5YR/4/8 (red)			Apedal		4 - Very Firm	Well Drained	Not Recorded	B2C	

Project:	Mt Gordon	Date:	4 June 2015	Location:	Mill Creek Soil 1 ²	Observation Type:			Coordinates:	Easting	Zone	-
Job Number	B15035					P - Soil Pit			Northing	Elevation		
Natural Vegetation:	Undisturbed	Land Use:				Mill Creek dam and undisturbed (refer to photo)			Surface Soil Condition			Soft
												
Topography	Not recorded	Surface Rock % (> 60mm dia):	100% (refer to photo)	Erosion:	None			Drainage:	Toe of slope. Free draining			
Remarks:	Nil			ASC Mapped:				ASC Ground Truth:	Rudosols			
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Pedality	Structure	Consistence	Drainage	Boundaries	Horizons	Sample
0-300	Loamy Sand - LS	30-40%	5YR/3/3 (dark reddish brown)	>30% gravel (2-60 mm)		Apedal	Massive	1 - Very Weak	Well Drained	Diffuse	B2C	(200-300) ¹
300-1900								5 - Strong		Not Recorded	C	Weathered rock ¹

¹ Composite sample taken for 0-1800 mm for particle size distribution analysis

² Bulk sample (20 kg) taken to determine its potential as borrow material for soil mulch

Project:	Mt Gordon	Date:	4 June 2015	Location:	North Rock Soil 1 ²	Observation Type:						
Job Number	B15035					P - Soil Pit	Easting		Zone		-	
							Northing		Elevation			
Natural Vegetation:	Undisturbed midslope. Slope toe disturbed (old borrow pit)				Land Use:	Borrow pit (refer to photos)				Surface Soil Condition		
									Soft			
Topography	Not recorded	Surface Rock % (> 60mm dia):	100% (refer to photo)	Erosion:	None				Drainage:	Toe of slope. Free draining		
Remarks:	Rudodol over a buried layer (possible red Dermosol)				ASC Mapped:					ASC Ground Truth:	Rudosols	
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Pedality	Structure	Consistence	Drainage	Boundaries	Horizons	Sample
0-600		70-80%	5YR/4/4 (reddish brown)	>70% gravel (2-60 mm)		Apedal		2 - Weak	Well Drained	Diffuse	B2	(0), (50-100) and (500-800) ¹
600-1000		40-50%	5YR/4/4 (reddish brown)	>40% gravel (2-60 mm)		Apedal		2 - Weak	Well Drained	Diffuse	B2	(700-800) ¹
1000-1500	Silty Clay - SiC	0-5%	5YR/4/6 (yellowish red)	Nil		Weakly Pedal	Massive	3 - Firm	Well Drained	Clear		(1200-1300) ¹
1500-1900								6 - Very Strong		Not Recorded	C	(1700-1800) ¹

¹ Composite sample taken for 0-1800 mm for particle size distribution analysis

² Bulk sample (20 kg) taken to determine its potential as borrow material for soil mulch

Project:	Mt Gordon	Date:	5 June 2015	Location:	Diversion Dam Soil 1	Observation Type:			Coordinates:	Easting	Zone	-
Job Number	B15035					P - Soil Pit			Northing	Elevation		
Natural Vegetation:	Undisturbed	Land Use:				Undisturbed and Diversion Dam (refer to photos)			Surface Soil Condition		Soft	
												
Topography	Crest of Hill	Surface Rock % (> 60mm dia):	100% (refer to photo)	Erosion:	Nil	Drainage: Free draining crest line						
Remarks: Gravel content increased with depth. Gravel size was uniform at 900 mm+. Testure of B2 relates to fine fraction only.				ASC Mapped:				ASC Ground Truth: Rudosols				
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Pedality	Structure	Consistence	Drainage	Boundaries	Horizons	Sample
0-100	Loamy Sand - LS	40-50%	5YR/3/4 (dark reddish brown)	>40% gravel (2-60 mm)		Apedal		0 - Loose	Well Drained	Clear	A1	(0) and (50-80) ¹
100-900	Loamy Sand - LS	60-70%	2.5YR/4/4 (reddish brown)	>40% gravel (2-60 mm)		Apedal		2 - Weak	Well Drained	Diffuse	B2	(200-250), (500-550) and (800-850) ¹
900-1400		70-80%	2.5YR/4/8 (red)	>40% gravel (Uniformly about 3 mm in diameter)		Apedal		4 - Very Firm	Well Drained	Not Recorded	B2C	(1100-1200) ¹

¹ Composite sample taken for 0-1400 mm for particle size distribution analysis

Project:	Mt Gordon	Date:	5 June 2015	Location:	Diversion Dam Soil 2 ²	Observation Type:			Coordinates:	Easting	Zone	-
Job Number	B15035					P - Soil Pit			Northing	Elevation		
Natural Vegetation:	Undisturbed	Land Use:				Undisturbed and Borrow pit (refer to photos)			Surface Soil Condition		Soft	
												
Topography	Crest of Hill	Surface Rock % (> 60mm dia):	100% (refer to photo)	Erosion:	Nil			Drainage:	Free draining crest line			
Remarks:	Increasing gravel size and content with depth.			ASC Mapped:				ASC Ground Truth:	Rudosols			
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Pedality	Structure	Consistence	Drainage	Boundaries	Horizons	Sample
0-20	Loamy Sand - LS	40-50%	5YR/3/4 (dark reddish brown)	>40% gravel (2-60 mm)		Apedal		0 - Loose	Well Drained	Clear	A1	¹
20-1300	Loamy Sand - LS	80-90%	2.5YR/4/4 (reddish brown)	>80% gravel (2-60 mm). Boulders present (<60 mm)		Apedal		2 - Weak	Well Drained	Not Recorded	B2	(600-700) ¹

¹ Composite sample taken for 0-1300 mm for particle size distribution analysis

² Bulk sample (20 kg) taken to determine its potential as borrow material for soil mulch

Project:	Mt Gordon	Date:	5 June 2015	Location:	Diversion Dam Soil 3 ²	Observation Type:			Coordinates:	Easting	Zone	-
Job Number	B15035					P - Soil Pit			Northing	Elevation		
Natural Vegetation:	Undisturbed	Land Use:				Undisturbed and Diversion Dam (refer to photos)			Surface Soil Condition			
										Soft		
Topography	Midslope	Surface Rock % (> 60mm dia):	100% (refer to photo)	Erosion:	Nil			Drainage:	Free draining midslope			
Remarks:	Gravel content increased with depth. Gravel size was uniform at 900 mm+. Testure of B2 relates to fine fraction only.				ASC Mapped:				ASC Ground Truth:	Rudosols		
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Pedality	Structure	Consistence	Drainage	Boundaries	Horizons	Sample
0-100	Loamy Sand - LS	40-50%	5YR/3/4 (dark reddish brown)	>40% gravel (2-60 mm)		Apedal		0 - Loose	Well Drained	Clear	A1	No sample. Principal profile is the same as Diversion Dam Soil 1 and Diversion Dam Soil 2
100-900	Loamy Sand - LS	60-70%	2.5YR/4/4 (reddish brown)	>40% gravel (2-60 mm). Boulders present (<60 mm)		Apedal		2 - Weak	Well Drained	Diffuse	B2	
900-1400		70-80%	2.5YR/4/8 (red)	>40% gravel (Uniformly about 3 mm in diameter)		Apedal		4 - Very Firm	Well Drained	Not Recorded	B2C	

2 Bulk sample (20 kg) taken to determine its potential as borrow material for soil mulch

Appendix E

Notes on interpretation of geochemistry

E.1 Acid base accounting

The acid base account involves static laboratory procedures that evaluate the balance between acid generating processes (oxidation of sulfide minerals) and acid neutralising processes (dissolution of alkaline carbonates, displacement of exchangeable bases, and weathering of silicates).

The values arising from the acid base account are referred to as the maximum potential acidity (MPA) and the acid neutralising potential (ANP). The difference between the MPA and the ANC is referred to as the net acid producing potential (NAPP).

Table E.1 summarises the main static tests used to calculate the acid base account and their reason for inclusion in the EGi (1998) study.

Table 6.2 Acid base account testing

Test	Reason for inclusion
Total sulfur	Used to calculate maximum potential acidity.
Acid neutralising potential	Potential neutralising agents such as carbonates that maybe available to reduce the total acid balance.
Net Acid Generation (NAG) to pH 4.5 and pH 7	An indication of the form of acidity. The acidity at pH4.5 includes acidity due to free acid as well as soluble iron and aluminium. The titration value at pH 7 also includes metallic ions that precipitate as hydroxides at pH between 4.5 and 7.
pH1:2 and EC1:2	Gives an indication of the inherent acidity and salinity of waste material when exposed in waste emplacement. A material categorised as non acid forming (NAF) may still have existing salinity and acidity risks that make it unsuitable for surface or uncontrolled placement.

The use of Total Sulfur as a measure of maximum potential acidity may not be a conservative measure as Total S comprises both unoxidised sulfide and oxidised sulfate salt.

E.2 Calculations

$$\%Sulfate\ Sulfur = \frac{Sulfate\ sulfur\ (mg/kg)}{10,000} \quad [1]$$

$$\%Sulfur = \frac{\%Sulfate\ sulfur}{3} \quad [2]$$

$$Sulfide\ sulfur = Total\ sulfur(\%) - Sulfate\ sulfur(\%) \quad [3]$$

$$MPA\ (tH_2SO_4) = Sulfide(\%) \times 30.59 \quad [4]$$

$$MPA\ (tCaCO_3) = Sulfide(\%) \times 31.25 \quad [5]$$

Appendix F

Soil water characteristic curve interpretation

The soil water characteristic curve is fundamental to understanding unsaturated soil mechanics. It is a plot of soil water (conventionally in terms of volumetric water content = volume of water/total volume; but it could also be in terms of degree of saturation = volume of water/volume of voids; or gravimetric moisture content = mass of water/mass of solids, expressed as a %).

The key elements of the soil water characteristic curve are the following (Figure F.1).

- The intercept on the vertical axis represents near-saturated conditions at the test density (the higher the density the lower the intercept, and increasing the density will induce drainage).
- The break in the curve at a high degree of saturation or high water content, referred to as the air-entry value (AEV) on drying, beyond which the material is unable to remain saturated, and air starts to replace any further moisture lost from the pores of the material. Up to the AEV, the material is essentially saturated (degree of saturation $S > 85\%$) and suction effects can be ignored. The capillary rise in metres at the AEV = $AEV/9.81$.
- The slope of the curve at matric suctions higher than the AEV. The flatter the curve, the more water the material is able to store, and the harder it is to dewater (that is, the higher the applied pressure required to effect dewatering). Over this portion of the curve, matric (or capillary) suction and liquid water flow dominate.
- The break in the curve at a low degree of saturation or low water content, referred to as the water-entry value (WEV) on re-wetting, beyond which osmotic suction and water vapour flow dominate. The WEV is the suction at which the material starts to rapidly wet up on re-wetting. As the material dries beyond the WEV, the salt concentration of the diminishing pore water increases and so too does the osmotic suction. Beyond the WEV, further dewatering is more difficult to achieve, as evidenced by the flatter curve. Evaporation continues unabated to about 3,000 kPa suction, thereafter decreasing at an increasing rate and ceasing at a suction of about 100,000 kPa.
- The oven-dry (zero moisture) state corresponds to a suction of 1,000,000 kPa, for all materials.
- There is a hysteresis between drying and re-wetting cycles. As a soil desaturates, moisture is first lost from the largest pores, with residual moisture retreating to ever-finer pores, requiring ever-higher matric suctions to remove it. As a soil re-wets, the largest pores saturate first, with the finer pores saturating last, but at much lower matric suctions than were required to drain them during the drying cycle.
- Over the suction range up to about 1,000 kPa, matric (or capillary) suctions dominate, while above about 1,000 kPa the increasing concentration of salts in the pore water mean that osmotic (or solute) suctions come to dominate. Most soil-like materials exist at a suction of $< 10,000$ kPa, and hence matric suction usually dominates. An exception is salt pan deposits and hypersaline tailings.

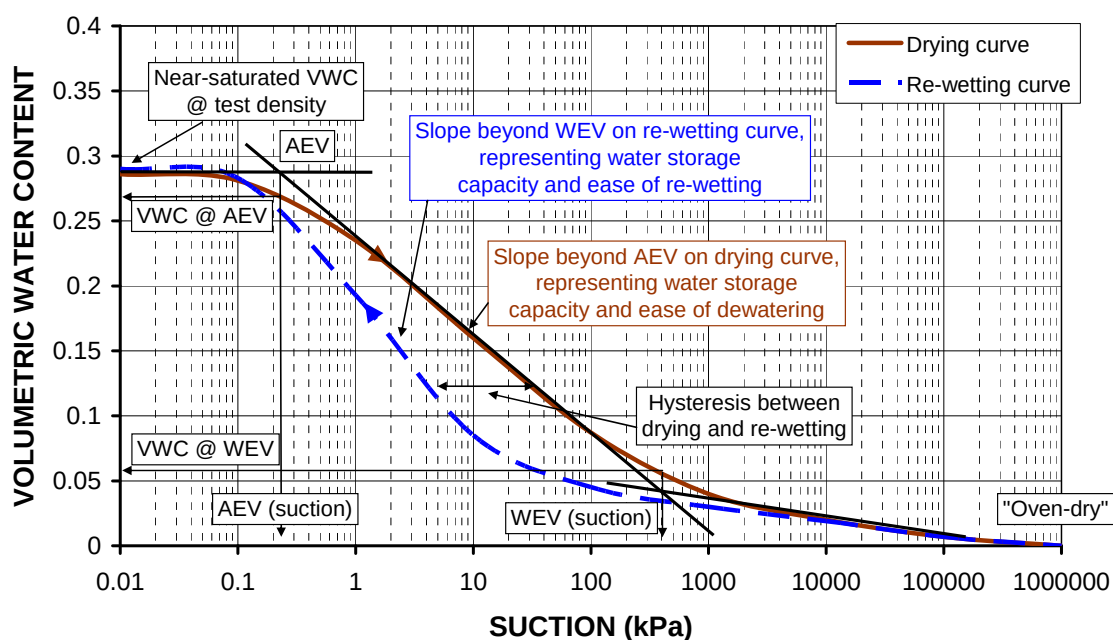


Figure F.1 Key elements of a soil water characteristic curve

Soil water characteristic curve data are conventionally measured in the laboratory using a Tempe cell and the curves are then fitted to the measured data using the method of Fredlund and Xing (1994)¹. Field soil water characteristic curve data may also be collected, and the curve fitted using the same method. The laboratory and field data may produce quite different soil water characteristic curves, the differences being greatest where there is significant structure or cementation in situ, which is destroyed on sampling and laboratory testing. The soil water characteristic curve for a material with significant structure or cementation is shifted to the right, having a much higher AEV and steeper post-AEV slope. An estimate of the laboratory soil water characteristic curve may also be obtained from the particle size distribution, density and specific gravity of the material using the Fredlund et al (1997)² and the library of data contained within the program *Soilvision*.

In addition, the saturated hydraulic conductivity of the material at a representative density may be obtained by constant or falling head testing or calculated from consolidation testing.

From the soil water characteristic curve and measured saturated hydraulic conductivity, the unsaturated hydraulic conductivity function of the material may be calculated using the method of Fredlund et al (1994)³.

¹ Fredlund D and Xing A 1994. Equations for the soil-water characteristic curve. Canadian Geotechnical Journal, 31, 521-532

² Fredlund M, Fredlund D and Wilson G 1997. Prediction of the soil water characteristic curve from grain size distribution and volume mass properties. Proceedings of 3rd Brazilian Symposium on Unsaturated Soils, Rio de Janeiro, Brazil, 22-25 April 1997, 12 pp

³ Fredlund D, Xing A and Huang A 1994. Predicting the permeability function for unsaturated soils using the soil water characteristic curve. Canadian Geotechnical Journal, 31, 533-546



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