FINAL

Codrilla Coal Mine Project

Soil, Overburden and Land Use Survey

September 2010

MEM06-002

GSS ENVIRONMENTAL

Environmental, Land and Project Management Consultants

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1.0 INTRODUCTION

1.1 Project Background

GSS Environmental (GSSE) was commissioned by McCollum Environmental Management Services (MEMS) on behalf of Bowen Basin Coal Joint Venture (BB Coal JV) to undertake a soil survey and land resource assessment for the Codrilla Project, located in Central Queensland. The Codrilla Project is a proposed open cut coal mining and processing operation located approximately 57 km to the east south east of Moranbah and 45 km to the south south west of Nebo. For the remainder of this report, the area of the Codrilla Project studied during this survey will be referred to as the “project site”. The project site covers an area of approximately 5,010 ha.

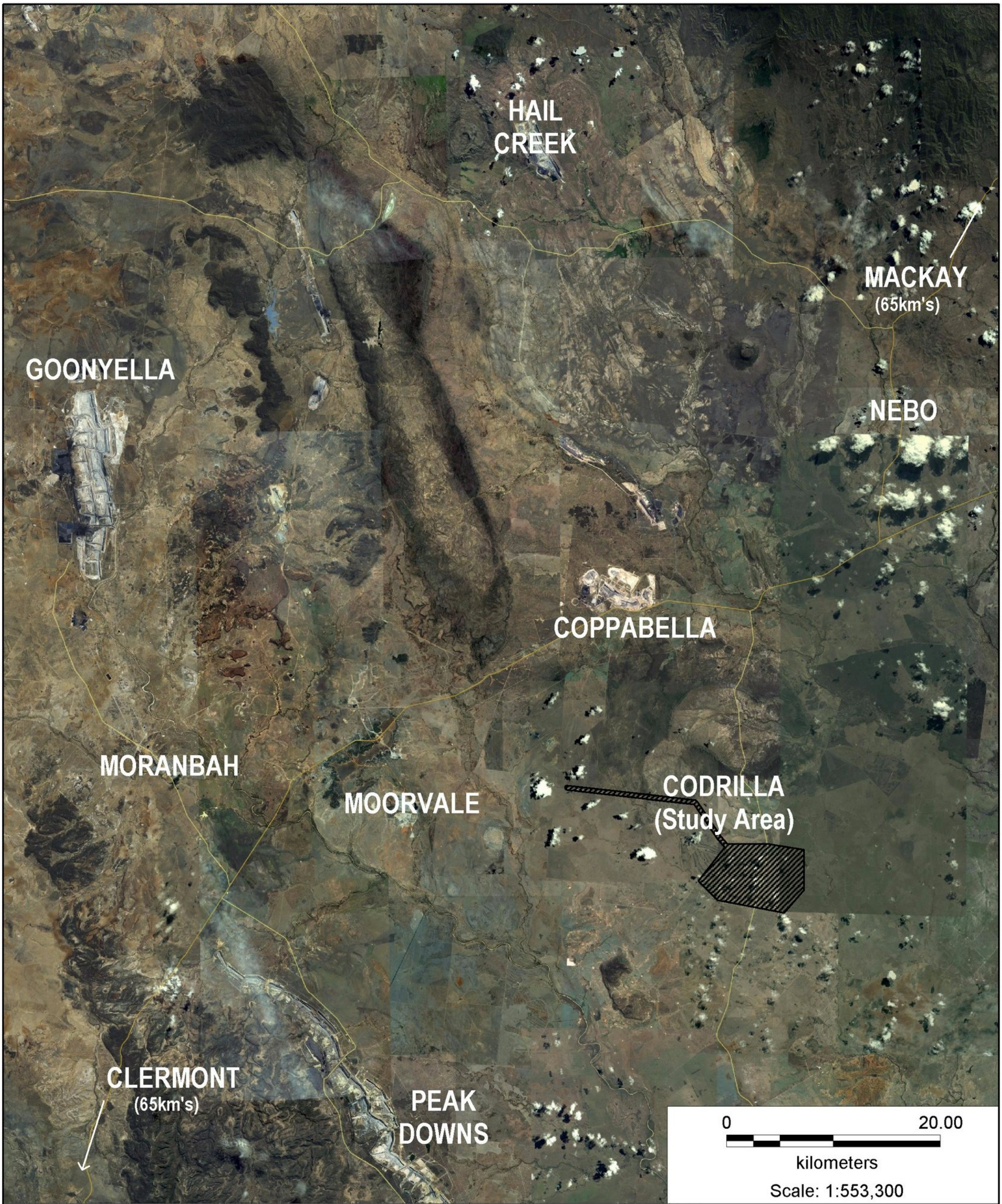
As the Codrilla Mine will be developed within the project site, soil resources will be impacted by mining operations. Excavation of the open cut pit and construction of out-of-pit overburden stockpiles, haul roads, other service roads, dams, drains and administration area will result in ground disturbance. To ensure sufficient topsoil resources are available for post-mining rehabilitation, it is important that all suitable natural topsoil reserves are identified and recovered ahead of this disturbance. If not adequately managed, impacts within the project sites may also cause impacts further downstream through the sedimentation of watercourses, especially with the potential for exposing saline and sodic soils. Disturbance to the ground surface and landscape character may also impact the agricultural suitability of land within the project site or downstream.

1.2 Location

The project is located in the Central Queensland Bowen Basin. The project lies 120 km south west of Mackay and 45 km to the south south west of Nebo. The project site is bisected by the Fitzroy Development Road approximately 25 km south of where this road intersects the Peak Downs Highway.

The region contains rich thermal and metallurgical coal resources at depth, and several open-cut and underground coal mines operating nearby supply both domestic and export markets. The Moorvale and Coppabella mines lie to the north and northwest approximately 25 km and 30 km respectively. The Peak Downs mine lies approximately 50 km to the west of the project site. Other regional industries include beef cattle grazing and limited cropping.

A locality map, showing the project site in a regional context, is provided in **Figure 1**. The specific study is shown in all subsequent Figures in this report.



LEGEND
Major Roads

FIGURE 1

Regional Location Plan

Version:	Date:	Author:	Checked:	Approved:
1	22/12/09	AR	KM	CR

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Project: Codrilla Soils Assessment

Client: McCollum Environmental Management Services

File: Fg1_MEM06-002_Location Plan_v1

Projection: MGA(94) Zone 55

2.0 EXISTING ENVIRONMENT SUMMARY

2.1 Geology

The geology of the project area consists of; Permian, sedimentary rock comprised of sandstone, siltstone and carbonaceous shale overlaid by unconsolidated Tertiary sediments. The geology varies along the northern haul road routes and in addition to the geology described above would pass through; Permian, sandstone, conglomerate, mudstone, carbonaceous shale, coal and cherty tuff geology with undefined cover material.

2.2 Topography

The topography of the project area is typically flat to gently undulating varying between 1 and 4% relief. The project area naturally drains via tributaries to Devlin Creek, which flows from west to east through the project area and on to the Isaac River. The project area is located 25km to the south east of the head of the Devlin Creek Catchment Area. The majority of the site, including the proposed pit locations tend to have aggraded gradational geomorphology, with an interrupted convergent tributary channel pattern.

2.3 Vegetation

The vast majority of the project area has been cleared of the original vegetation cover as a result of historical clearing and grazing activities. There is little remaining remnant vegetation within the project area. The Devlin Creek riparian zone, a small area in the north east of the project area, and the northern haul road routes, have not been cleared of the remnant vegetation. Declared weeds are known to occur throughout the general area including Parthenium (Parthenium hysterophorus) and Harisia Cactus (Eriocereus spp), however inspections of the site indicate weed infestation is not significant.

3.0 SOIL SURVEY ASSESSMENT & MANAGEMENT RECOMMENDATIONS

3.1 Introduction & Objectives

A soil survey was undertaken in October 2009 by GSSE to:

1. classify and determine the soil profile types of the study area;
2. assess the suitability of the current topsoil material for future rehabilitation;
3. assess the pre-mine landform in terms of agricultural land suitability and extent of GQAL likely to be affected by the mining operations, together with an assessment of the post-mine landform land use options and land capability; and
4. identify any potentially unfavourable soil material for rehabilitation within the Project Area.

The survey was conducted in accordance with the methodology outlined in this section. The soils and land resource assessment results are presented in **Section 3** of this report.

3.2 Soil Survey Methodology

3.2.1 Mapping

An initial soil map was developed using the following resources and techniques.

1) Aerial photographs and terrain maps - Aerial photo and terrain map interpretation was used as a remote sensing technique, allowing detailed analysis of the landscape and mapping of features related to the distribution of soils within the project site. Google Earth Pro (2010) was used to identify terrain units and landform features along with aerial image interpretation. The Broadsound Shire Planning Scheme Map 5 (2005) was also used to identify potential high value agricultural soils.

2) Stratified Observations - Following production of a base soils map, surface soil exposures, topography and vegetation throughout the potential disturbance areas were visually assessed to verify potential soil units, delineate soil unit boundaries and determine preferred locations for targeted subsurface investigations.

3.2.2 Soil Profiling

Twenty Eight (28) soil profiles were assessed at selected sites throughout the project area to enable soil profile descriptions to be made. Subsurface exposure was generally undertaken by backhoe excavation of test pits to 1.2 m deep. The test pit locations were chosen to provide representative profiles of the soil types encountered during the survey. The soil layers were generally distinguished on the basis of changes in texture, structure and colour. Soil colours were assessed according to the Munsell Soil Colour Charts (Macbeth, 1994). Photographs of soil profile exposures and associated landscape were also taken (refer to **Plates 1** to **10**). Soil profiles were also observed through the use of surface exposures located in existing track cuttings, gullies and creek banks. Soil profile site locations are shown in **Figure 2.**

3.2.3 Field Assessment

Soil profiles within the survey area were assessed generally in accordance with the Australian Soil and Land Survey Field Handbook soil classification procedures (McDonald et al, 1998). Soil layers at each profile site were also assessed according to a procedure devised by Elliot and Veness (1981) for the recognition of suitable topdressing material. This procedure assesses soils based on grading, texture, structure, consistence, mottling and root presence. The system remains the benchmark for land resource assessment in the Australian coal mining industry. A more detailed explanation of the Elliot and Veness procedure is presented in **Appendix 1** to this report. Detailed soil profile descriptions recorded information that covered a variety of parameters as specified in **Table 1**. Soil profile logging was undertaken by completing soil data sheets. GPS recordings were taken for all sites where detailed soil descriptions were made. Vegetation type and land use were also recorded. Soil exposures from excavated pits were photographed during field operations as colour photography of profile sites is a useful adjunct to description of land attributes.

Table 1 – Field Assessment Parameters

Descriptor	Application
Physical:	
Horizon Depth	Weathering characteristics, soil development
Field Colour	Permeability, susceptibility to dispersion /erosion
Field Texture Grade	Erodibility, hydraulic conductivity, moisture retention, root penetration
Boundary Distinctness and Shape	Erosional / dispositional status, textural grade
Consistence Force	Structural stability, dispersion, ped formation
Structure Pedality Grade	Soil structure, root penetration, permeability, aeration
Pore Number and Size	Soil structure, root penetration, permeability, aeration
Structure Ped & Size	Soil structure, root penetration, permeability, aeration
Stones – Amount & Size	Water holding capacity, weathering status, erosional / depositional character
Roots – Amount & Size	Effective rooting depth, vegetative sustainability
Ants, Termites, Worms etc	Biological mixing depth

3.2.4 Laboratory Testing

Soil samples were collected from the exposed soil profiles and subsequently sent to the NSW Land and Property Management Authority Soil Conservation Service Laboratory at Scone, NSW for analysis. Samples were analysed to establish the suitability of surface and near-surface soil horizons as potential growth media, and identify high value soils and, conversely, soils that may have properties that are deleterious to vegetation establishment. Samples were analysed from the following sites (as shown on **Figure 2**):

- Test Pit 1 – 1/1, 1/2, & 1/3
- Test Pit 2 – 2/1, 2/2 & 2/3
- Test Pit 3 – 3/1& 3/2
- Test Pit 4 – Not Analysed
- Test Pit 5 – 5/1 & 5/2
- Test Pit 6 – Not Analysed
- Test Pit 7 – 7/1& 7/2
- Test Pit 8 – 8/1 & 8/2
- Test Pit 9 – 9/1, 9/2 & 9/3
- Test Pit 10 – 10/1, 10/2 & 10/3
- Test Pit 12 – 12/1 & 12/2
- Test Pit 13 – 13/1 & 13/2
- Test Pit 14 – 14/1 & 14/2
- Test Pit 15 – 15/1 & 15/2
- Test Pit 16 – 16/1 & 16/2
- Test Pit 17 – 17/1 & 17/2
- Test Pit 18 – 18/1 & 18/2
- Test Pit 19 – 19/1 & 19/2

Parsons Brinckerhoff Samples – Haul Road Alignment

- Test Pit MC05 – 5/1, 5/2, & 5/3
- Test Pit MC06 – 6/1, 6/2, & 6/3
- Test Pit MC07– 7/1, 7/2, & 7/3
- Test Pit MC08 –8/1, 8/2, & 8/3
- Test Pit MC09 – Not analysed
- Test Pit MC10 – Not analysed
- Test Pit MC11 –11/1, 11/2, & 11/3
- Test Pit MC12 –12/1, 12/2, & 12/3
- Test Pit MC13 –13/1, 13/2, & 13/3
- Test Pit MC14 –14/1 & 14/2

Soil horizons are signified by /1 /2 in the sample ID with the surface horizon being /1 and subsoil horizons being /2 and /3. The samples were subsequently analysed for the following parameters.

- Colour;
- Particle Size Analysis;
- Emerson Aggregate Test;
- pH;
- Electrical Conductivity; and
- Cation Exchange Capacity and Exchangeable Cations

A description of the significance of each test and typical values for each soil characteristic is included in **Appendix 2**.

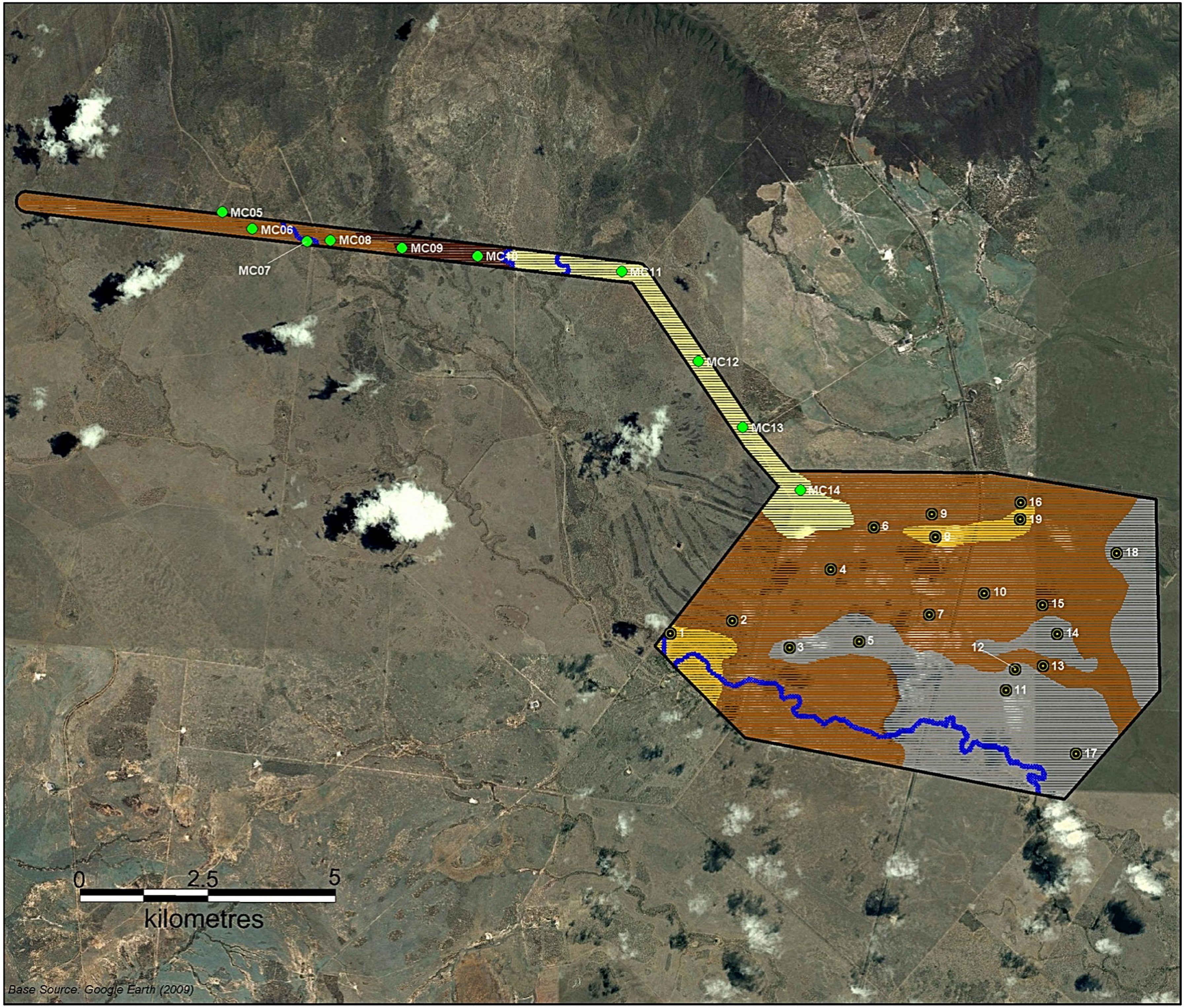
The laboratory test results were used in conjunction with the field assessment results to determine the depth of soil material that is suitable for recovery and use as a growth medium for rehabilitation of disturbed areas. Similarly, potentially unfavourable soil material was identified. The soil test results for the soil survey are provided in **Appendix 3**.

3.3 Soil Survey Results

A site inspection was undertaken in October 2009 to classify the soil profile types associated with Codrilla. The objective of the field assessment was to observe soil profiles (to a maximum depth of 1.5 m). The following soil units were identified within the study area:

- Brown Yellow Duplex (221.3 ha);
- Brown Grey Duplex (1434.7 ha);
- Brown Duplex (3,208.3ha);
- Yellow Duplex (432.3 ha); and
- Skeletal Soils (98.5 ha)

The distribution of these soils is illustrated in **Figure 2**. Exposed profiles of major soil units are shown in **Plates 1, 3**, **5, 7** & **9.** Landscape photos of areas where each soil unit was observed are shown in **Plates 2, 4, 6, 8** & **10**.



LEGEND

- Study Area
- Creek Lines
- Sample Locations (GSSE Oct09)
- Sample Locations (PB Jun09)

Soil Unit Classification

- Brown Duplex (3,207.3ha)
- Brown Grey Duplex (1,434.7ha)
- Yellow Duplex (432.3ha)
- Brown Yellow Duplex (221.3ha)
- Rocky/Skeletal Soil (98.5ha)

N

FIGURE 2

Soil Unit Classification & Sample Locations

Project: Codrilla Soils Assessment

Client: McCollum Environmental Management Services

File: Fg2_MEM06_Soil Units_v1

Projection: MGA(94) Zone 55

Version:	Date:	Author:	Checked:	Approved:
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3.3.1 Brown Yellow Duplex

Description: This soil unit is characterised by a gradual change between the light pale brown sandy loam surface soil and the yellow clay subsurface soil. These moderately structured soils range from neutral to slightly acidic to slightly alkaline at depth. The soils are non-saline and have low to moderate fertility. The topsoils are generally non-sodic whilst the subsoils exhibit non-sodic to moderately sodic characteristics.

Location: These soils cover 5% or 221.3 ha of the project area and are present on the lower slopes and flat areas near the south western boundary of the project area and in the central north of the project area. Profile sites 1, 8 and 19 occur within this unit.

Landuse: The land overlying these soils is dominated by open grazing farmland. Farm tracks and sparse low lying shrubs transect the area.

Management: The top 0.25 m of this soil is suitable for stripping and reuse as a topdressing medium in rehabilitation. The lower layers are generally unsuitable due to the limiting factors of massive structure (at increased depth) moderate potential for dispersion and slight alkalinity. Whilst this subsoil is unsuitable for use as a topdressing material, consideration may be given to selectively stripping and conserving this material for use as an intermediate layer between reshaped overburden and the final topdressing layer. This soil requires only the standard erosion and sediment control measures if disturbed.

Table 2 – Brown Yellow Duplex Profile

LAYER	DEPTH (m)	DESCRIPTION
1	0.00 to 0.25	Pale Brown (10YR 6/3), moderate consistence sandy loam. A moderate pedality (angular blocky 10-50mm) soil, neutral (pH 6.7 to 7.5), low dispersion (EAT 3(1) to 8/3(2)), non-saline (<0.01 – 0.02dS/m), roots common to many and nil stones. Approx sample depth 0.15m. Gradual even boundary to Layer 2.
2	0.25 to 0.55+	Yellow (10YR 7/6), moderate consistence sandy clay. A moderate pedality (angular blocky (5-50mm) soil with neutral to slight alkalinity (pH 7.3 to 7.6), low to moderate dispersion (EAT 3(2) & 3(3), non-saline (0.01dS/m), roots few to common and <5% stones (<5mm). Approx sample depth 0.40m.

Plate 1 –Brown Yellow Duplex Profile

Plate 2 –Brown Yellow Duplex Landscape

3.3.2 Brown Grey Duplex

Description: This soil unit is characterised by an abrupt change between the light pale to brownish grey sandy loam surface soil and the light yellowish to brown sandy clay loam and clayey subsurface soil. These weakly to moderately structured soils range from slightly acidic to moderately alkaline at depth. The topsoils are generally non-sodic whilst the subsoils exhibit moderate to high sodicity.

Location: These soils cover 26% or 1434.7 ha of the project area and are present on the eastern and central flat slopes of the project area. Profile sites 3, 5,12,14,17 and 18 occur within this unit.

Landuse: The land overlying these soils is dominated by open grazing farmland. Farm tracks transect the area with sparse low lying shrubs.

Management: The top 0.35 m of this soil is suitable for stripping and reuse as a topdressing medium in rehabilitation. The lower layers are generally unsuitable due to the limiting factors of massive structure, high to very high potential for dispersion and moderate alkalinity. This soil requires only the standard erosion and sediment control measures if disturbed, however given the sodicity at depth, if the topsoil is removed, it may lead to dispersion and erosion in wet conditions.

Table 3 – Brown Grey Duplex Profile

LAYER	DEPTH (m)	DESCRIPTION
1	0.00 to 0.35	Light Brownish Grey (10YR 6/2) moderate consistence sandy loam. A weak pedality (angular blocky 0-10mm) soil, slightly acidic to neutral (pH 6.0 to 7.7), low dispersion (EAT 3(1)), non-saline (<0.01 – 0.02dS/m), roots common to many and <5% stones (<5-10mm). Approx sample depth 0.25m). Clear and even boundary to Layer 2.
2	0.35 to 0.65+	Light Yellowish Brown (10YR 6/4) moderate consistence sandy clay loam. An apedal massive soil that is neutral to strongly alkaline (pH 7.5 to 9.0), high to very high dispersion (EAT 2(3) & 1), non-saline to moderately saline (0.01 to 0.56dS/m), roots none and stones 10-50% (<10mm). Approx sample depth 0.50m.

Plate 3 –Brown Grey Duplex Profile

Plate 4 –Brown Grey Duplex Landscape

3.3.3 Brown Duplex

Description: The Brown Duplex soil unit generally consists of light brown loam and clay loam surface soils which overlie a texture contrast to pale brown to light yellowish brown clay subsurface soils. These moderately structured soils range from neutral to strongly alkaline at depth. The soils are non-saline in the upper layers ranging to moderately saline at depth. . The topsoil varies in sodicity (low to moderate) and becoming increasingly dispersive at depth.

Location: These soils cover 59% or 3208.3 ha of the project area and are generally present throughout the western and central regions of the project area on low lying flat areas. In addition, these soils occur along the far western haul road option of the project area. Profile sites 2, 4, 6, 7, 9, 10, 13, 15, 16, MC 05, MC 06, MC 07 and MC 08 occur within this unit.

Landuse: The land overlying these soils is dominated by open grazing farmland. Farm tracks with sections of bush land along the haul road corridor.

Management: The top 0.20 m of this soil is suitable for stripping and reuse as topdressing medium in rehabilitation; however sites 10, 15 and 16 are unsuitable for stripping and reuse due to a moderate to high potential for dispersion in the topsoil layer. The lower layers are generally unsuitable due to the limiting factors of massive structure, moderate to high potential for dispersion and moderate to strong alkalinity. This soil requires only the standard erosion and sediment control measures if disturbed, however given the sodicity at depth, if the topsoil is removed, it may lead to dispersion and erosion in wet conditions.

Table 4 – Brown Duplex Profile

LAYER	DEPTH (m)	DESCRIPTION
1	0.00 to 0.20	Brown (10YR 5/3) moderate consistence loam. A moderate pedality (angular blocky 10-50mm) soil, slightly acidic to neutral (pH 6.4 to 7.4), low dispersion (EAT 3(1)), non-saline (<0.01 to 0.03dS/m), roots common to many and nil stones. Approx sample depth 0.15m. Boundary is clear and even to Layer 2.
2	0.20 to 0.60	Pale Brown (10YR 6/3) strong consistence clay. A weak pedality (angular blocky 10-20mm) soil, slightly to strongly alkaline (pH 7.8 to 9.2), moderate to high dispersion (EAT 2(2) – 2(3), non-saline to moderately saline (0.04 - 0.60dS/m), roots few and nil stones. Approx sample depth 0.40m. Boundary is clear and even to Layer 3.
3	0.60 to 1.00+	Light Yellowish Brown (10YR 6/4) strong consistence medium clay. An apedal massive soil that is generally slightly to strongly alkaline (pH 8.0 – 9.3), high dispersion (EAT 2(3), moderately saline (0.53 – 0.62dS/m), roots and stones nil. Approx sample depth 0.80m.

Plate 5 –Brown Duplex Profile

Plate 6 –Brown Duplex Landscape

3.3.4 Yellow Duplex

Description: The Yellow Duplex soil unit generally consists of light yellowish brown and greyish brown sandy loam surface soils which overlie a texture contrast to yellowish brown sandy clay and sandy clay loam subsurface soils. These soils range from moderately acidic in the upper layers to neutral at depth. The soils are non-saline. The surface soils are non-sodic ranging to moderate at depth.

Location: These soils cover 8% or 432.2 ha of the project area and are present on the proposed haul road option and in the north western boundary of the project area. Profile sites MC 11, MC 12, MC 13 and MC 14 occur within this unit.

Landuse: The land overlying these soils is dominated by remnant vegetation.

Management: Generally, the top 0.30 m of this soil is considered marginally suitable for stripping and reuse as topdressing medium in rehabilitation due to high sand content and massive structure with depth. However, if mixed with other material that has a finer texture; or used for areas to be direct seeded with trees this soil can be used in rehabilitation. This soil requires only the standard erosion and sediment control measures if disturbed, however given the sodicity at depth, if the topsoil is removed, it may lead to dispersion and erosion in wet conditions.

Table 5 – Yellow Duplex Profile

LAYER	DEPTH (m)	DESCRIPTION
1	0.00 to 0.05	Greyish brown (10YR 5/2) sandy loam. A weak pedality soil with neutral to moderate acidity (pH 7.0 to 5.9). Low to very low dispersion (EAT 3(1) – 8/3(1)), non-saline (0.01- 0.03dS/m), roots common and nil stones. Approx sample depth 0.02. Boundary is clear and even to layer 2.
2	0.05 to 0.45	Yellowish brown (10YR 5/4) loamy sand. A weak pedality soil with neutral to moderate acidity (pH 6.8 to 5.9). Low dispersion (EAT 3(1)), non-saline (<0.01dS/m), roots few and nil stones. Approx sample depth 0.30m. Boundary is clear and even to layer 3.
3	0.45 to 1.00+	Yellowish Brown (10YR 5/6) sandy clay. An apedal massive soil that is strongly acidic to neutral (pH 9.2 to 7.0) and low to moderately dispersive (EAT 3(1) to 2(1)). Non saline (0.03 – 0.36dS/m), roots and stones nil. Approx sample depth 0.80m.

Plate 7–Yellow Duplex Profile

Plate 8 –Yellow Duplex Landscape

3.3.5 Skeletal Soil

Description: This soil unit is characterised by shallow greyish brown stony sandy clay soils associated with the steeper eroded side slopes and ridgelines throughout the western area of the project site. These soils (sites MC 09 & MC 10) were sampled however not analysed due to high stone content.

Location: These soils cover 2% or 98.5 ha of the project area and are present on the steeper eroded slopes along the haul road option of the project area. Profile sites MC 09 and MC 10 occur within this unit.

Landuse: The land overlying these soils is dominated by remnant native vegetation, native grasses and shrubs. Farm tracks transect the area.

Management: This soil unit is generally unsuitable due to the limiting factors of high stone content, poor structure and shallow depth to bedrock.

Plate 9 – Skeletal Soil Profile

Plate 10 – Skeletal Soil Landscape

3.4 Erosion Potential

3.4.1 Erosion Potential of Soil Types

All soil samples were laboratory tested for dispersion, using the Emerson Aggregate Test (EAT) and sodicity, using the Exchangeable Sodium Percentage (ESP). These tests indicate the susceptibility of a soil to losing its structure and binding capacity when wet, and therefore the erosion potential of the soil. The results showed a similar pattern indicating that soils across the project area are generally sodic.

The middle and lower layers within the Brown Grey Duplex, Brown Duplex and Yellow Duplex soil units generally displayed a moderate to very high potential for erosion with Emerson Aggregate Test ratings of 3 to 1, which indicates a moderate to very high potential for dispersion and surface hardsettingness. Once this material is disturbed, the potential for erosion may be increased. If this disturbance occurs within the vicinity of a drainage line, this could impact on the health of downstream watercourses, through an increase in the sediment load. These soils should, therefore, be managed to ensure that the soils are not disturbed without suitable erosion and sediment controls being implemented. These measures include the construction of structural soil conservation works such as contour, graded and diversion banks and drop structures together with sediment control dams. The use of cover crops and/or organic ameliorants will reduce soil dispersion and surface crusting thereby reducing runoff and increasing infiltration, which will subsequently reduce erosion and sedimentation.

The appropriate erosion and sediment control measures should be in place prior to surface disturbance of these soils, as the risk of erosion is high once the subsoil is exposed. Appropriate measures are outlined in **Section 3.6.3** of this report, with further detailed measures to be developed in the erosion and sediment control plan which will be developed in conjunction with mine approvals.

3.4.2 Potential Erosion Rates

The Revised Universal Soil Loss Equation (RUSLE) has been used in this assessment to estimate the long time average soil loss rates that may result from sheet and rill flow during various levels of disturbance. It must be noted that wind and gully erosion is discussed separately in the section below.

The RUSLE calculates annual erosion rates based on the following equation:

$$A = R \cdot K \cdot LS \cdot C \cdot P$$

Where: A = annual soil loss due to erosion [t/ha/yr]
R = rainfall erosivity factor
K = soil erodibility factor
LS = topographic factor derived from slope length and slope gradient
C = cover and management factor
P = erosion control practice factor

The following table offers a comparison of disturbance levels which aims to highlight the higher risk activities in regard to erosion rates. It must be noted that assumptions have been made as to the specific values of soil and overburden characteristics, vegetation establishment success, climatic conditions, slope gradients and lengths and various management practices, and therefore the following values should only be used for comparison purposes. The calculations were made with the ‘worst case’ scenarios used consistently for all disturbance levels.

Table 6 – Estimated Erosion Rates using the RUSLE

Disturbance Level	Rainfall Erosivity Factor (R)	Raw Soil Erodibility Factor	Adjusted* Soil Erodibility Factor (K)	Topographic Factor (LS)	Cover and Management Factor (C)	Erosion Control Practice Factor (P)	Annual Soil Loss (A) (t/ha/yr)
Undisturbed Surface Pre Mining	1804	0.030	0.030	1.00	0.01	1.0	0.54
Surface cleared of vegetation and topsoil	1804	0.017	0.020	1.00	1.00	1.3	47.84
Unshaped Overburden Dumps	1804	0.025	0.030	8.22	1.00	0.8	355.89
Shaped Overburden Dumps with Graded Banks	1804	0.025	0.030	3.07	1.00	0.8	132.92
Newly Rehabilitated Shaped Overburden Dumps	1804	0.030	0.036	3.07	0.45	0.8	71.78
Established Rehabilitated Shaped Overburden Dumps	1804	0.030	0.036	3.07	0.03	0.8	4.79

* Adjusted for dispersive soil by +20%

Table 6 above shows the disturbance level during mining with the highest risk of severe erosion rates is the unshaped overburden scenario. The key factor to observe in this result is the topographic factor (LS) where the overburden is free dumped and left at the angle of repose albeit benched in some cases. This practice is unlikely to be modified due to cost effectiveness and practicalities of dumping activities. However it is recommended that these areas and times of highest risk should have adequate sedimentation controls in place downstream to capture any material eroded from these slopes. The shaped overburden dumps with graded banks (but without topsoil or vegetation) was the second highest predicted rate of erosion which indicates the need for the reshaping, grading, topdressing and seeding of overburden dumps to be undertaken in the quickest possible timframe in order to minimise the risk of severe rainfall events impacting on these exposed slopes over a long period of time.

Gully erosion is not considered within the RUSLE equation above, however given the succession of erosion severity from rill to gully erosion, it is predicted that the same disturbance levels will contain the same risk rankings for gully erosion rates as the RUSLE equation has displayed. Once overburden dumps have been shaped and graded banks established, any gully erosion should be repaired and rehabilitated as soon as possible to reduce further erosion and sedimentation downstream.

Wind erosion has the potential to cause loss of material from overburden dumps during the mining process, especially given the raised elevation of the dumps within the landscape. Management practices during mining may limit the extent of wind erosion, by reducing truck movements and earthworks on highly exposed dumps during periods of extreme wind conditions. Furthermore, mine planning considerations for minimising exposed surfaces and timely rehabilitation activities may protect surface soil from wind erosion of overburden dumps.

3.5 Acid Sulfate Soil Potential

The potential for acid generation from regolith material (topsoil and subsoil) within the project site is low. This does not include acid generation potential within the overburden material (consolidated bedrock below 2-3 m depth), which was addressed separate in **Section 5** of this report.

Acid Sulphate Soils (ASS), which are the main cause of acid generation within the soil mantle, are commonly found less than 5 m above sea level, particularly in low-lying coastal areas such as mangroves, salt marshes, floodplains, swamps, wetlands, estuaries, and brackish or tidal lakes. The project site is located within the Central Highlands region (which is located approximately 150 km from the coast at > 260 m AHD). There has been little history of acid generation from regolith material with this region.

3.6 Topsoil Selection & Management for Rehabilitation

The following management and mitigation strategies are recommended for implementation during mining, in order to reduce the potential for degradation within the project site and adjoining lands. These recommendations are based on the assessment of the existing site conditions and experience with the management of mining surface impacts at sites throughout New South Wales and Central Queensland.

3.6.1 Topsoil Stripping Criteria

The potential for major land disturbance is likely to result from excavation of the open cut pit, out-of-pit overburden dumps, haul road construction and infrastructure areas. It is recommended that topsoil be recovered in these areas of disturbance.

Soil analysis results were used in conjunction with the field assessment to determine the depth of soil materials suitable for recovery. Structural and textural properties of subsoils are the most significant limiting factors in determining depth of soil suitable for re-use. Salinity levels, pH and dispersion potential are also limiting factors in some soils in some project sites. Elliot and Veness (1981) described the basic procedure, adopted in this survey, for the recognition of suitable topdressing materials (refer **Table 7**). This procedure has been adapted to include sandy loams as suitable.

Table 7 – Topsoil Stripping Criteria

Descriptor	Reasoning	Desirable criteria
Structure Grade	Good permeability to water and adequate aeration are essential for the germination and establishment of plants. The ability of water to enter soil generally varies with structure grade (Charman, 1978) and depends on the proportion of coarse peds in the soil surface. Better structured soils have higher infiltration rates and better aeration characteristics. Structureless soils without pores are considered unsuitable as topdressing materials.	- 30% peds present - coherent when wet or dry - EAT: < 2 (2) - conductivity: < 1.5 dS/m - exchangeable Na% < 12% - pH: > 4.5 & < 8.4 - no mottle present - finer than sandy loam - sand & gravel content < 60%
Consistence – Shearing Test	The shearing test is used as a measure of the ability of soils to maintain structure grade. Brittle soils are not considered suitable for revegetation where structure grade is weak or moderate because peds are likely to be destroyed and structure is likely to become massive following mechanical work associated with the extraction, transportation and spreading of topdressing material. Consequently, surface sealing and reduced infiltration of water may occur which will restrict the establishment of plants.	
Consistence – Disruptive Test	The force to disrupt peds, when assessed on soil in a moderately moist state, is an indicator of solidity and the method of ped formation. Deflocculated soils are hard when dry and slake when wet, whereas flocculated soils produce crumbly peds in both the wet and dry state. The deflocculated soils are not suitable for revegetation and may be identified by a strong force required to break aggregates	
Mottling	The presence of mottling within the soil may indicate reducing conditions and poor soil aeration. These factors are common in soil with low permeability's; however, some soils are mottled due to other reasons, including proximity to high water-tables or inheritance of mottles from previous conditions. Reducing soils and poorly aerated soils are unsuitable for revegetation purposes.	

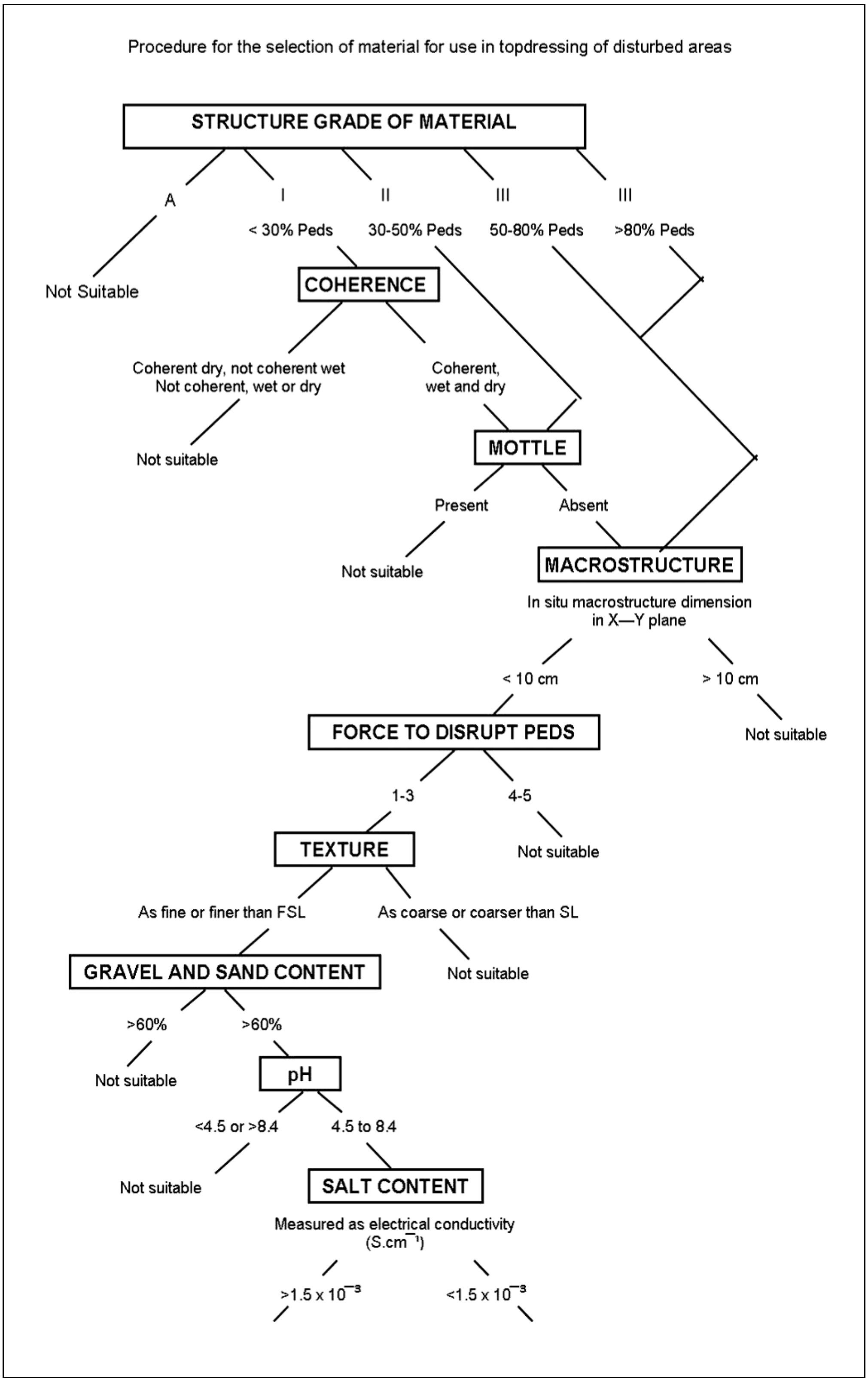

Figure 3: Selection process for topdressing material (Source: Elliot and Veness; 1981)

The recommended stripping depth for each soil unit, together with area of land and calculated volume are provided in **Table 8** below.

Table 8 – Recommended Stripping Depths

Soil Unit Type	Recommended Stripping Depth (m)	Area (ha)	Volume (m^3)	Disturbance Area (ha)	Disturbance Area Volume (m^3)
Brown Yellow Duplex	0.25	221.3	553,250	25.9	64,750
Brown Grey Duplex	0.35	1,434.7	5,021,450	346.2	1,211,700
Brown Duplex	0.20	3,208.3	6,416,600	1,019.6	2,039,200
Yellow Duplex	0.30	432.3	1,296,900	7.0	21,000
Skeletal Soil	Not recommended for stripping				
		Total Volume	**13,288,200**		**3,336,650**
		Total Volume (10% handling loss allowance)	**11,959,380**		**3,002,985**

Allowing for a 10% handling loss, approximately **3,002,985 m^3** of suitable topdressing is available within the disturbance area. The majority of topsoil disturbance will result from the excavation of the open cut pit, out of pit overburden dumps, dams and the infrastructure area.

3.6.2 Topsoil Stripping and Handling

Where topsoil stripping and transportation is required, the following topsoil handling techniques are recommended to prevent excessive soil deterioration.

- Strip material to the depths stated in **Table 8**, subject to further investigation as required.
- Topsoil should be maintained in a slightly moist condition during stripping. Material should not be stripped in either an excessively dry or wet condition.
- Place stripped material directly onto reshaped overburden and spread immediately (if mining sequences, equipment scheduling and weather conditions permit) to avoid the requirement for stockpiling.
- Grading or pushing soil into windrows with graders or dozers for later collection by elevating scrapers, or for loading into rear dump trucks by front-end loaders, are examples of less aggressive soil handling systems. This minimises compression effects of the heavy equipment that is often necessary for economical transport of soil material.
- Soil transported by dump trucks may be placed directly into storage. Soil transported by bottom dumping scrapers is best pushed to form stockpiles by other equipment (e.g. dozer) to avoid tracking over previously laid soil.
- The surface of soil stockpiles should be left in as coarsely textured a condition as possible in order to promote infiltration and minimise erosion until vegetation is established and to prevent anaerobic zones forming.
- As a general rule, maintain a maximum stockpile height of 3 m. Clayey soils should be stored in lower stockpiles for shorter periods of time (i.e. less than 12 months) compared to sandier soils, selected from the alluvial soils.
- If long-term stockpiling is planned (i.e. greater than 12 months), seed and fertilise stockpiles as soon as possible. An annual cover crop species that produce sterile florets or seeds should be sown. A rapid growing and healthy annual pasture sward provides sufficient competition to

minimise the emergence of undesirable weed species. The annual pasture species will not persist in the rehabilitation areas but will provide sufficient competition for emerging weed species and enhance the desirable micro-organism activity in the soil.

- An inventory of available suitable surface cover material should be maintained to ensure adequate topsoil materials are available for planned rehabilitation activities.

3.6.3 Landform Design and Erosion Control Measures

Rehabilitation strategies and concepts proposed below have been formulated according to results of industry-wide research and experience.

The main objective of regrading is to produce slope angles, lengths and shapes that are compatible with the proposed land use and not prone to an unacceptable rate of erosion. Integrated with this is a drainage pattern that is capable of conveying runoff from the newly created catchments whilst minimising the risk of erosion and sedimentation. Final slope gradient should not exceed 17%, or approximately 10^0.

The most significant means of controlling surface flow on disturbed areas is to construct contour furrows or contour banks at intervals down the slope. The effect of these is to divide a long slope into a series of short slopes with the catchment area commencing at each bank or furrow. This prevents runoff from reaching a depth of flow or velocity that would cause erosion. As the slope angle increases, the banks or furrows must be spaced closer together until a point is reached where they are no longer effective.

Contour ripping across the grade is by far the most common form of structural erosion control on mine sites as it simultaneously provides some measure of erosion protection and cultivates the surface in readiness for sowing.

Graded banks are essentially a much larger version of contour furrows, with a proportionately greater capacity to store runoff and/or drain it to some chosen discharge point. The banks are constructed away from the true contour, at a designed gradient (0.5% to 1%) so that they drain water from one part of a slope to another; for example, towards a watercourse or a sediment control dam.

Eventually, runoff that has been intercepted and diverted must be disposed of down slope. The use of engineered waterways using erosion blankets, ground-cover vegetation and/or rip rap is recommended to safely dispose of runoff downslope.

The construction of sediment control dams is recommended for the purpose of capturing sediment laden runoff prior to off-site release. Sediment control dams are responsible for improving water quality throughout the mine site and, through the provision of semi-permanent water storages, enhance the ecological diversity of the area.

The following points should be considered when selecting sites for sediment control dams.

- Each dam should be located so that runoff may easily be directed to it, without the need for extensive channel excavation or for excessive channel gradient. Channels must be able to discharge into the dam without risk of erosion. Similarly, spillways must be designed and located so as to safely convey the maximum anticipated discharge.
- The material from which the dam is constructed must be stable. Dispersive clays will require treatment with gypsum to prevent failure of the wall by tunnel erosion. Failure by tunnelling is most likely in dams which store a considerable depth of water above ground level, or whose water level fluctuates widely. Dams should always be well sealed, as leakage may lead to instability, as well as allowing less control over the storage and release of water.
- The number and capacity of dams should be related to the total area of catchment and the anticipated volume of runoff. The most damaging rains, in terms of erosion and sediment problems are localised, high intensity storms.

3.6.4 Topsoil Respreading & Seedbed Preparation

Sampling and analysis of topsoil resources, whether stockpiled or in-situ, is recommended prior to respreading. This will assist in identifying potential soil deficiencies and estimating required rates of fertiliser or ameliorant (i.e. gypsum or lime) application.

Where possible, suitable topsoil should be re-spread directly onto reshaped areas. Where topsoil resources allow, topsoil should be spread to a minimum depth of 10 cm on all regraded spoil. Topsoil should be spread, treated with fertilizer or ameliorants (if required) and seeded in one consecutive operation, to reduce the potential for topsoil loss to wind and water erosion.

Prior to re-spreading stockpiled topsoil onto reshaped overburden (particularly onto designated tree seeding areas), an assessment of weed infestation on stockpiles should be undertaken to determine if individual stockpiles require herbicide application and / or "scalping" of weed species prior to topsoil spreading.

Thorough seedbed preparation should be undertaken to ensure optimum establishment and growth of vegetation. All topsoiled areas should be contour ripped (after topsoil spreading) to create a "key" between the soil and the spoil. Ripping should be undertaken on the contour and the tynes lifted for approximately 2 m every 200 m to reduce the potential for channelised erosion. Best results will be obtained by ripping when soil is moist and when undertaken immediately prior to sowing. The respread topsoil surface should be scarified prior to, or during seeding, to reduce run-off and increase infiltration. This can be undertaken by contour tilling with a fine-tyned plough or disc harrow.

4.0 LAND RESOURCE ASSESSMENTS

4.1 Land Capability Assessment

The project site was assessed in accordance with Rosser et al (1974) for pre-mining land capability. The system includes eight (8) possible classifications and refers to the overall agricultural potential of the land. Land capability classifications provide a ranking of the capacity of each part of a land resource to sustain broad land use classed (with lower number classes suited to more intense uses, and higher number classes suited to low intensity rural use, conservation and the like). Land capability assessment is more appropriate to broad hectare areas where the land choices are farming, grazing and non agricultural. The various classes are provided in **Table 9**. The pre-mining rural land capability classification of the study area is provided in **Table 10**.

Table 9 – Land Capability Classes

Category	Class	Description
Suitable for Cultivation	**Class I**	No special practices required.
	Class II	Simple management practices required.
	Class III	Complex or intensive practices required to sustain cropping.
	Class IV	Occasional or limited cultivation but with severe management inputs required to prevent degradation.
Not Suitable for Cultivation	**Class V**	Suitable soil and topography for crops but economically not viable. High quality grazing land.
	Class VI	Moderately susceptible to degradation requiring proper management to sustain use.
	Class VII	Highly susceptible to degradation requiring severe restrictions on use; grazing may be conducted with rigorous management inputs required to prevent degradation.
Not Suitable for Grazing	**Class VIII**	Wildlife reserves, bushland, recreation or water supply catchments.

Table 10 – Pre Mining Rural Land Capability Classes

Land Capability Class	Pre Mining		Post Mining	
	ha	%	ha	%
Class V	4,774.6	88.5	3,336.0	61.8
Class VI	521.0	9.7	1,218.0	22.6
Class VII	0.0	0.0	568.0	10.5
Class VIII	98.5	1.8	272.1	5.0
Total	**5,394.1**	**100.0**	**5,394.1**	**100.0**

Figure 4 illustrates the existing rural land capability classification and **Table 10** quantifies the area of each class. The study area encompasses classes V, VI and VIII lands. The majority of the project site is Class V – Suitable soil and topography for crops but economically not viable, however it is high quality grazing land. The rocky hills and ridgelines, within the vicinity of the haul road option, are considered to be Class VIII – land that is highly susceptible to degradation requiring severe restrictions for use. Highly eroded Skeletal Soils occupy this area. Grazing may be conducted with rigorous management inputs required to prevent degradation.

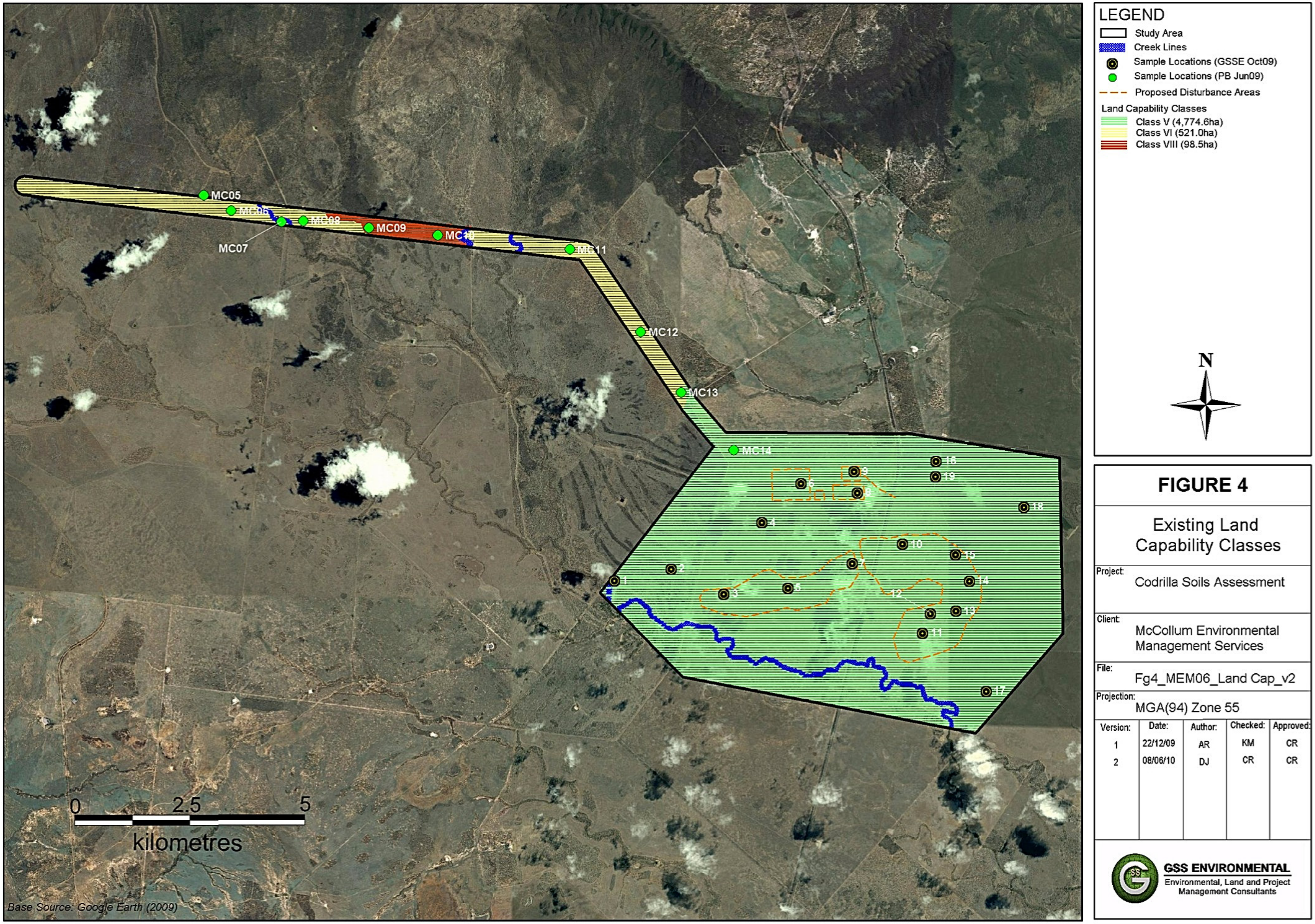

FIGURE 4

Existing Land Capability Classes

Project:	Codrilla Soils Assessment
Client:	McCollum Environmental Management Services
File:	Fg4_MEM06_Land Cap_v2
Projection:	MGA(94) Zone 55

Version:	Date:	Author:	Checked:	Approved:
1	22/12/09	AR	KM	CR
2	08/06/10	DJ	CR	CR

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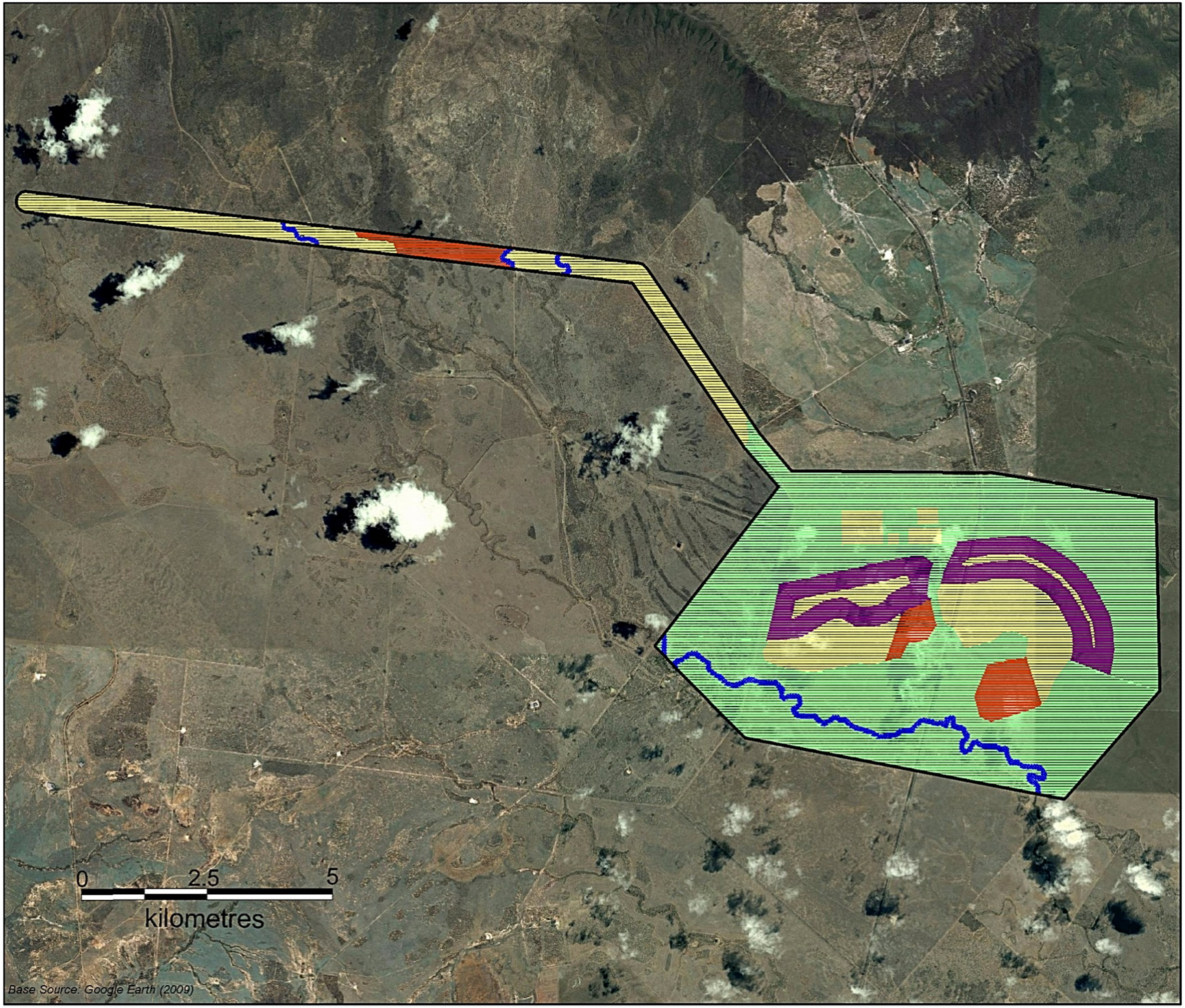

LEGEND

- Study Area
- Creek Lines
- Proposed Disturbance Areas

Land Capability Classes

- Class V (3,336ha)
- Class VI (1218ha)
- Class VII (568ha)
- Class VIII (272.1ha)

N

FIGURE 5

Post Mining Land Capability Classes

Project: Codrilla Soils Assessment

Client: McCollum Environmental Management Services

File: Fg5_MEM06-002

Projection: MGA(94) Zone 55

Version:	Date:	Author:	Checked:	Approved:
1	08/06/10	DJ	CR	CR

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Class V, VI & VII are all grazing land classes and are not suitable for cultivation. **Figure 5** illustrates the post mining rural land capability classification and **Table 10** quantifies the area of each class.

4.2 Land Suitability Assessment

4.2.1 Land Suitability Assessment Scheme

Agricultural land suitability of the project site has been assessed largely using criteria provided in the *Guidelines for agricultural land evaluation in Queensland* (Queensland Department of Primary Industries, Land Resources Branch, 1990).

The method of land suitability assessment takes into account a range of factors including climate, soils, geology, geomorphology, soil erosion, topography and the effects of past land uses. The classification does not necessarily reflect the existing land use. Rather, it indicates the potential of the land for such uses as crop production, pasture improvement and grazing.

The system allows for land to be allocated into five possible classes (with land suitability decreasing progressively from Class 1 to Class 5) on the basis of a specified land use that allows optimum production with minimal degradation to the land resource in the long term. Land is considered less suitable as the severity of limitations for a land use increase. Increasing limitations may reflect any combination of:

- reduced potential for production;
- increased inputs to achieve an acceptable level of production; and/or
- increased inputs required to prevent land degradation.

The agricultural land suitability classes are described in **Table 11**.

Table 11 – Scheme for Classifying Land Suitability

LS Class	Orders	LS Class Descriptor	Description
1	S Suitable	S1 None/Minor Limitations (Highly Suitable)	Land with negligible limitations, which is highly productive requiring only simple management practices to maintain economic production.
2		S2 Minor Limitations (Moderately Suitable)	Land with minor limitations which either reduce production or require more than the simple management practices of Class 1 land to maintain economic production.
3		S3 Moderate Limitations (Marginally suitable)	Land with moderate limitations which either further lower production or require more than those management practices of Class 2 land to maintain economic production.
4	N Not Suitable	N1 (or S4) Marginal Land (Presently Unsuitable)	Marginal lands with severe limitations which make it doubtful whether the inputs required achieving and maintaining production outweigh the benefits in the long term (presently considered unsuitable due to the uncertainty of the land to achieve sustained economic production)
5		N2 (or S5) Unsuitable	Unsuitable land with extreme limitations that preclude its use for the proposed purpose.

Reproduced from CSIRO, 2008.

A land suitability assessment provides an analysis on how 'fit' a given area of land is for a specific type of land utilisation (e.g. rainfed cropping or grazing). The analysis considers the area's land use characteristics (e.g. soil pH), land quality attributes (e.g. moisture availability) and how these match conditions that are necessary for 'successful and sustained' implementation of a specific land utilisation type (CSIRO, 2008; DME, 1995; Shields and Williams, 1991).

The expression of land suitability assessments is commonly reported using a rating system that uses five discrete classes (1 through to 5) with 1 being the most suitable and 5 being the least suitable (refer **Table 11**) (CSIRO, 2008; DME, 1995). Classes 1 to 3 (also known as S1 to S3) are generally considered suitable and classes 4 and 5 unsuitable (also known as N1 and N2) for the specific type of land utilisation (CSIRO, 2008).

GSSE's land suitability analysis provides a proportional land suitability assessment whereby each soil type's characteristics and attributes are cross-referenced against the DME (1995) 'criteria checklist' for 'rainfed broadacre cropping' and 'beef cattle grazing'. GSSE understands that Mr John Burgess is preparing an agricultural suitability framework for the Isaac–Connors and McKenzie River Catchments. The framework may be incorporated into new Technical Guidelines, which are *in prep*. In the meantime the moisture limitations attributes and subclasses can be used for land suitability assessments. The aforementioned document will be referred to hereafter as 'Burgess 2010 guidelines *in prep'*.

The overall land suitability ranking for each specific soil type is determined by the most severe limitation, or a combination of the varying limitations. For this reason the major limiting factors determining land suitability will be presented.

Table 12 – Comparison of Current and *in prep* Land Suitability Guidelines for Plant Available Water Capacity (PAWC)

Guideline Source	Land suitability ranking for rainfed cropping				
	1	**2**	**3**	**4**	**5**
DME (1995)	PAWC > 150 mm	PAWC 125-150mm	PAWC 100-125mm	PAWC 75-100mm	PAWC < 75mm
Burgess 2010 guidelines *in prep.*	PAWC > 150mm	PAWC 130-150mm	PAWC 115-130mm	PAWC 70-115mm	PAWC < 70mm
	Land suitability ranking for beef cattle grazing				
	1	**2**	**3**	**4**	**5**
DME (1995)	PAWC > 125mm	PAWC 100-125mm	PAWC 75-100mm	PAWC 50-75mm	PAWC < 50mm
Burgess 2010 guidelines *in prep.*	PAWC > 90mm	PAWC 70-90mm	PAWC 35-70mm	PAWC < 35mm	-

Source: Table Reproduced from *pers comm*. B. Forster 11.02.10.

4.2.2 Calculation of Plant Available Water Capacity and Effective Rooting Depth

The primary land suitability assessment attribute is 'moisture'. The indicator for moisture is Plant Available Water Capacity (PAWC). PAWC is an estimate of the amount of moisture stored in the soil profile that is available for plant extraction. It is generally defined as the difference between field capacity and permanent wilting point. PAWC is calculated for the soil profile by summing the available water capacity over the soil's effective rooting depth (ERD).

ERD is defined as the soil depth to which 90% of the plant roots will extract water (Burgess, 2005). ERD can be estimated through observed rooting depth, soil chemical parameters or a standardised depth can be used (*Soil Physical Measurement and Interpretation for Land Evaluation*, 2008). For the purposes of this project area assessment ERD has been determined from both observed rooting depth and the chemical parameters as defined in **Table 13**.

PAWC can be directly measured in the field, estimated from textural classes or interpolated using a QLD approved software program (PAWCER). GSSE calculated PAWC using the PAWCER software program for each soil unit. Each soil unit's PAWC is detailed in **Table 14.**

Table 13 – Effective Rooting Depth Criteria

Limitation #	Descriptor	ERD occurs where:
1	$EC_{1:5}$ for sorghum and wheat[1] (90% yield reduction threshold)	>0.8 dS/m
2	Cl 1:5	>1,000 ppm
3	ESP	>20% where clay content is >25%
4	pH	<5.5
5	Depth to C horizons	--
6	Unsuitable subsoil structure	moderate or strong columnar structure sandy free draining horizons significant rock content

Source: Burgess, 2003

Table 14 – Effective Rooting Depth (ERD) and Plant Available Water Capacity (PAWC)

Soil Unit	ERD		
	Limitations	Average Depth (m)	Average PAWC (mm)
Brown Yellow Duplex	6	0.53	58
Brown Grey Duplex	1,3,6	0.27	35
Brown Duplex	1,3,6	0.18	32
Yellow Duplex	1,3,6	0.36	33
Shallow Soil (Skeletal)	-	N/A	N/A

4.2.3 Land Suitability Rankings

The project area's soil units have been assessed against the criteria for 'rainfed cropping' and 'broadacre grazing' land utilisation types as per the guidelines. The first limitation for land utilisation is moisture and each soil unit's average PAWC is provided in **Table 14**. Where soil units have been classified as unsuitable for cropping, (Class 5; **Table 15**), these soil units have been subsequently assessed for their suitability for pastoral activities (refer **Table 16**). **Figure 6** illustrates their spatial distribution. All soil units have been assessed as not suitable for Rainfed Cropping. All soil units were assessed as marginally suitable for grazing. The Brown Yellow Duplex soil unit has been classed as Land Suitability 3 and is considered moderately suitable for grazing. This soil type has moderate moisture limitation and minor sanity limitation. In addition, the subsoils are generally non-sodic to moderately sodic. This soil unit should be able to support grazing using native pastures providing the soil is managed to limit ground disturbance.

The Brown Grey Duplex soil unit is moderately suitable for grazing and has been classified as Land Suitability 3. This soil type has a moderate PAWC limitation whilst the subsoils within this unit are generally sodic, moderately alkaline and saline, and high in clay content which may restrict plant rooting depth and growth. This soil unit should be able to support grazing using native pastures providing the soil is managed to limit ground disturbance.

The Brown Duplex soil unit has been classed as Land Suitability 4 and is considered marginally suitable for grazing. This soil unit has marginal topsoil structure texture as it is easily erodible and a marginal PAWC limitation. Subsoils within this unit are generally saline, alkaline, sodic and high in clay content which may restrict plant rooting depth and growth. This soil unit should be able to support intermittent low-quality grazing of native pastures with no pasture improvement.

The Yellow Duplex soil unit is considered marginally suitable for grazing and has been classified Land Suitability 4. The Yellow Duplex Sandy Loam is considered marginally suitable for grazing and has also been classified as Land Suitability 4. This soil unit has marginal topsoil texture as it is easily erodible, low fertility and a high PAWC limitation. Subsoils within this unit are moderately sodic and high in clay content which may restrict plant rooting depth and growth. This soil unit should be able to support intermittent low-quality grazing of native pastures with no pasture improvement.

The Skeletal soil unit is considered marginally suitable for grazing and has been classified Land Suitability 4. This soil unit covers 2% of the project site and is generally rocky and occurs with the steeper side slopes and ridgelines in the west. Where accessible for grazing animals, this land should be able to support intermittent low-quality grazing of native pastures with no pasture improvement.

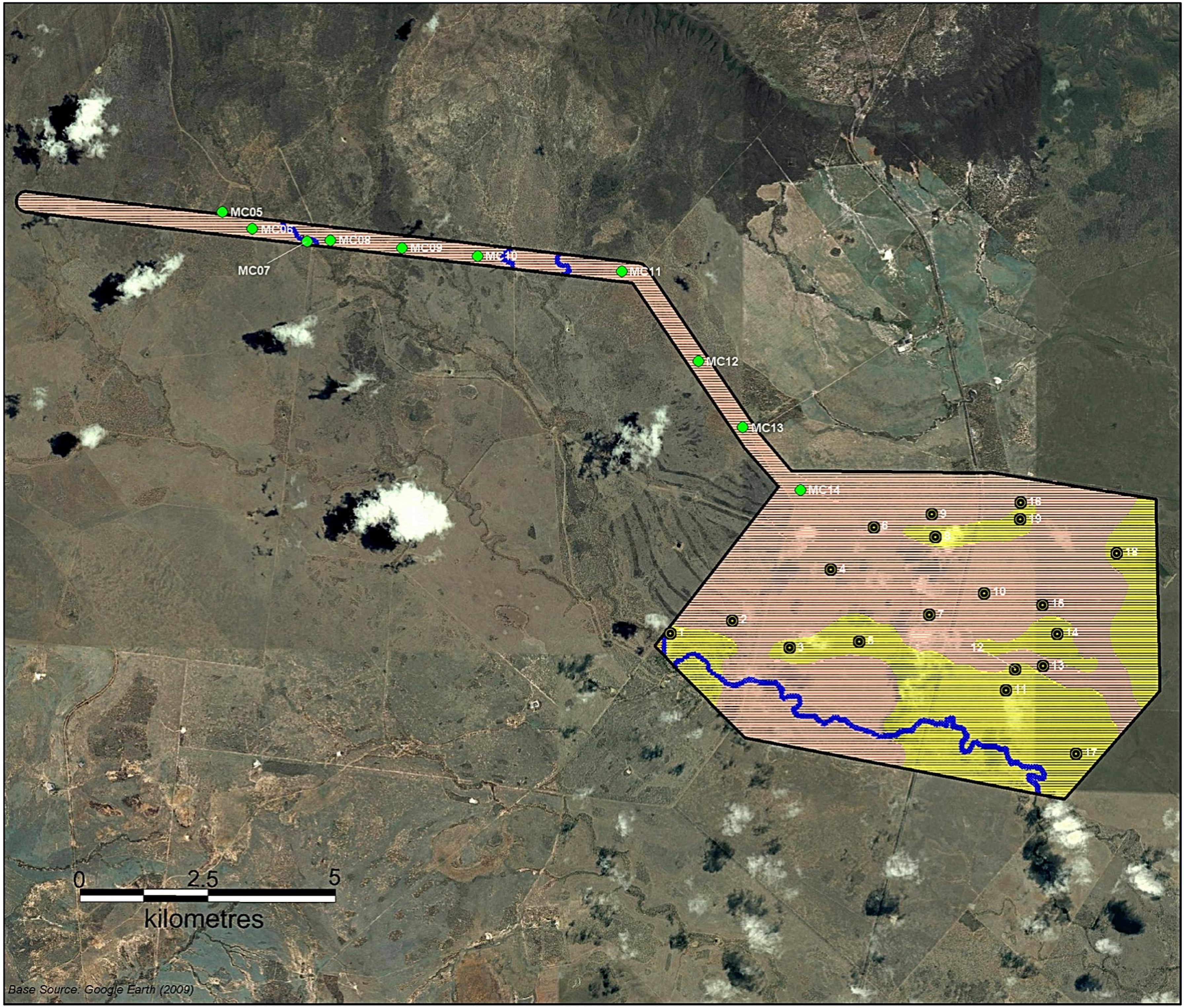
Table 15 – Land Suitability (LS) Ranking for Rainfed Broadacre Cropping

Soil Type	LS ranking	Overall LS Ranking	Suitable/ unsuitable
	Moisture		
Brown Yellow Duplex	5	**5**	Unsuitable
Brown Grey Duplex	5	**5**	Unsuitable
Brown Duplex	5	**5**	Unsuitable
Yellow Duplex	5	**5**	Unsuitable
Shallow Soil (Skeletal)	-	**-**	Unsuitable

Table 16 – Land Suitability (LS) Ranking for Beef Cattle Grazing

Soil Type	LS ranking				Overall LS Ranking	Suitable/ Unsuitable
	Moisture[1]	ESP %	Salinity	pH		
Brown Yellow Duplex	3	2	1	2	**3**	Suitable
Brown Grey Duplex	3	2	1	2	**3**	Suitable
Brown Duplex	4	2	1	2	**4**	Suitable
Yellow Duplex	4	1	1	2	**4**	Suitable
Shallow Soil (Skeletal)	-	-	-	-	**4**	Suitable

1 Criteria used from reference 'Burgess 2010 guidelines *in prep*'.



LEGEND

Study Area
Creek Lines
Sample Locations (GSSE Oct09)
Sample Locations (PB Jun09)

Land Suitability
Class 3 (1656ha)
Class 4 (3738.1ha)

N

FIGURE 6

Existing Land Suitability
(Beef Cattle Grazing)

Project: Codrilla Soils Assessment

Client: McCollum Environmental Management Services

File: Fg6_MEM06-002

Projection: MGA(94) Zone 55

Version:	Date:	Author:	Checked:	Approved:
1	08/06/10	DJ	CR	CR

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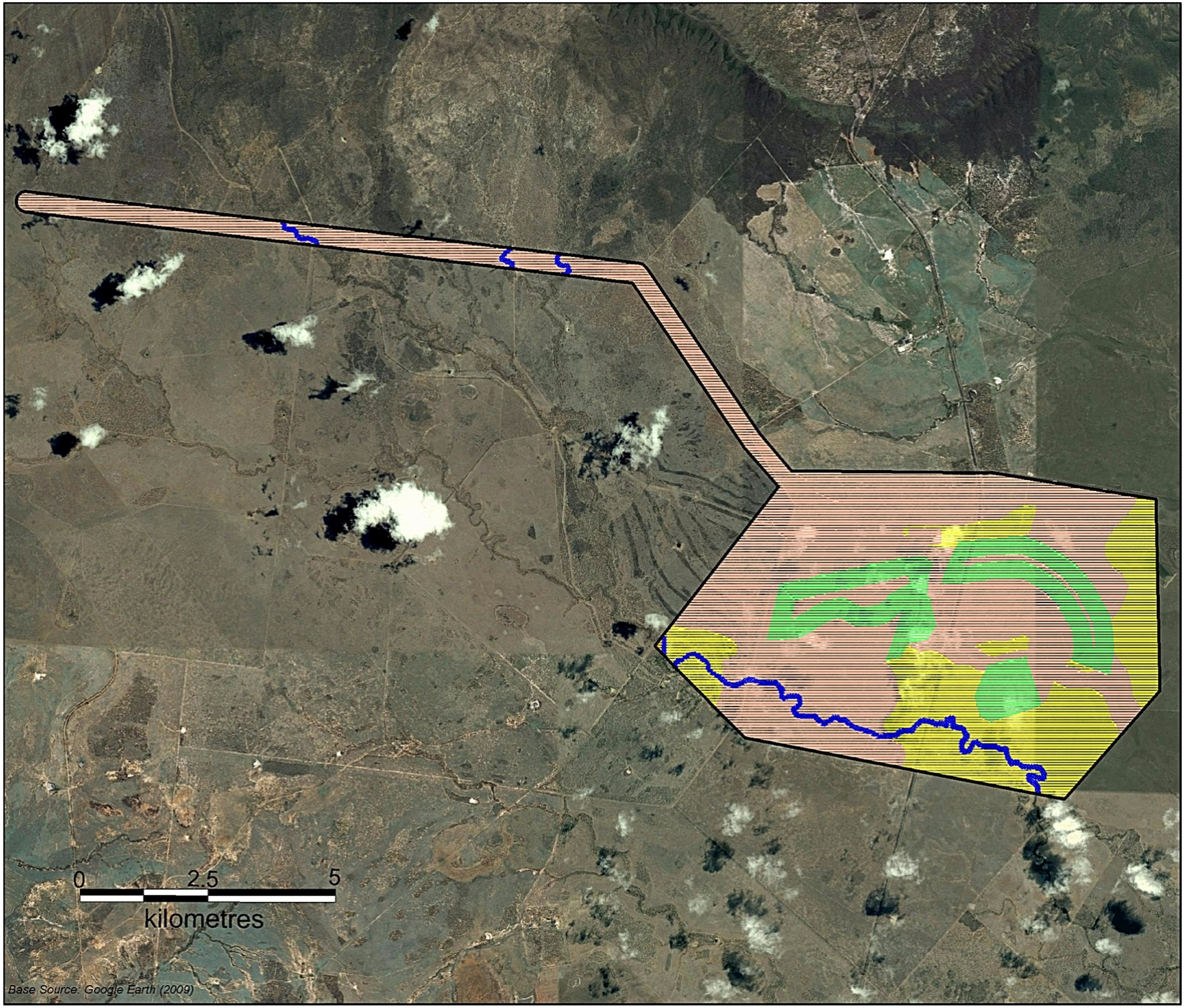

LEGEND

Study Area
Creek Lines

Land Suitability

Class 3 (1265.6ha)
Class 4 (3389ha)
Class 5 (739.5ha)

N

FIGURE 7

Post Mining Land Suitability (Beef Cattle Grazing)

Project:	Codrilla Soils Assessment			
Client:	McCollum Environmental Management Services			
File:	Fg7_MEM06-002			
Projection:	MGA(94) Zone 55			
Version:	Date:	Author:	Checked:	Approved:
1	08/06/10	DJ	CR	CR

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4.2.4 Post-mining Land Suitability

Although detailed closure options were not available during the production of this report, the proposed post-mining land use for the project sites is expected to be a mosaic of grassland and bushland. In terms of soil conservation and agricultural land suitability, the predicted changes in land suitability class for the project area are outlined in **Table 17** below.

Table 17 – Land Suitability (LS) Pre and Post Mining

Land Suitability Class	Existing Area	Post Mining Area
	ha	ha
3	1,656.0	1,265.6
4	3,738.1	3,389.0
5	0.0	739.5
Total Area	**5,394.1**	**5,394.1**

In order to sustain the desired land use without degradation, it is important that the post-mining land only be used in accordance with the limits of the agricultural suitability class. Soil conservation practices such as stocking rate control and establishment or re-establishment of permanent pasture are recommended for areas of mining impact. The overriding principle is to maintain the most beneficial future use of land that can be sustained in view of the range of limiting factors. The proposed post-mining land must provide and sustain a sufficient bulk of nutritious forage in addition to the following management considerations in the event of future low density grazing.

- The ability to access and manage livestock.
- Flood free and relatively dry ground conditions.
- Adequate stock drinking water and shelter.
- Stock routes throughout the land.

Provided that environmental controls such as structural soil conservation works (refer **Section 3.3**) and effective revegetation are in place and operating properly during mine construction and operation, there should be no adverse effects to the project site or the surrounding grazing land.

4.3 Agricultural Land Class Assessment & GQAL

The project site, and immediately surrounding land, was also assessed against the Agricultural Land Class (ALC) system, which is used to identify potential Good Quality Agricultural Land (GQAL) in accordance with the *Guidelines for the identification Good Quality Agricultural Land* (Qld DPI & DHLG&P, 1993) (referred to as the Good Quality Agricultural Land guidelines*)*. Agricultural land is defined as land used for crop or animal production, but excluding intensive animal uses (i.e. feedlots and piggeries). Good quality agricultural land is land which is capable of sustainable use for agriculture, with a reasonable level of inputs, and without causing degradation of land or other natural resources.

The DPI guidelines have been introduced to provide local authorities and development proponents with a system to identify areas of good quality agricultural land for planning and project approval purposes. Descriptions of the agricultural land classes are provided in **Table 18**.

The ALC classification system combines land suitability assessments for a number of specific land utilisation types into a single land classification. This ALC classification system has four categories: Arable (A), Limited arable (B), Pastoral (C) and Non-agricultural (D) (refer **Table 18**).

Table 18 – Scheme for Classifying Agricultural Land

Class	Name	Description
A	Arable land (Crop land)	Land that is suitable for current and potential crops with limitations to production which range from none to moderate levels.
B	Limited arable land (Limited crop land)	Land that is marginal for current and potential crops due to severe limitations; and suitable for pastures. Engineering and/or agronomic improvements may be required before the land is considered suitable for cropping.
C	Pastoral land	Land that is suitable only for improved or native pastures due to limitations which preclude continuous cultivation for crop production; but some areas may tolerate a short period of ground disturbance for pasture establishment.
D	Non-agricultural land	Land not suitable for agricultural uses due to extreme limitations. This may be undisturbed land with significant habitat, conservation and/or catchment values or land that may be unsuitable because of very steep slopes, shallow soils, rock outcrop or poor drainage.

Source: QDPI (1993).

The overall land suitability rating of 1-5 is translated into an ALC rating of A-D, additionally, for the Central West QLD region, ALC C is further divided into three sub-classes of C1, C2 and C3, according to potential grazing quality, as outlined in **Table 19** below.

Table 19 – Broadacre Cropping Land Suitability (LS) Ranking and Agricultural Land Class (ALC)

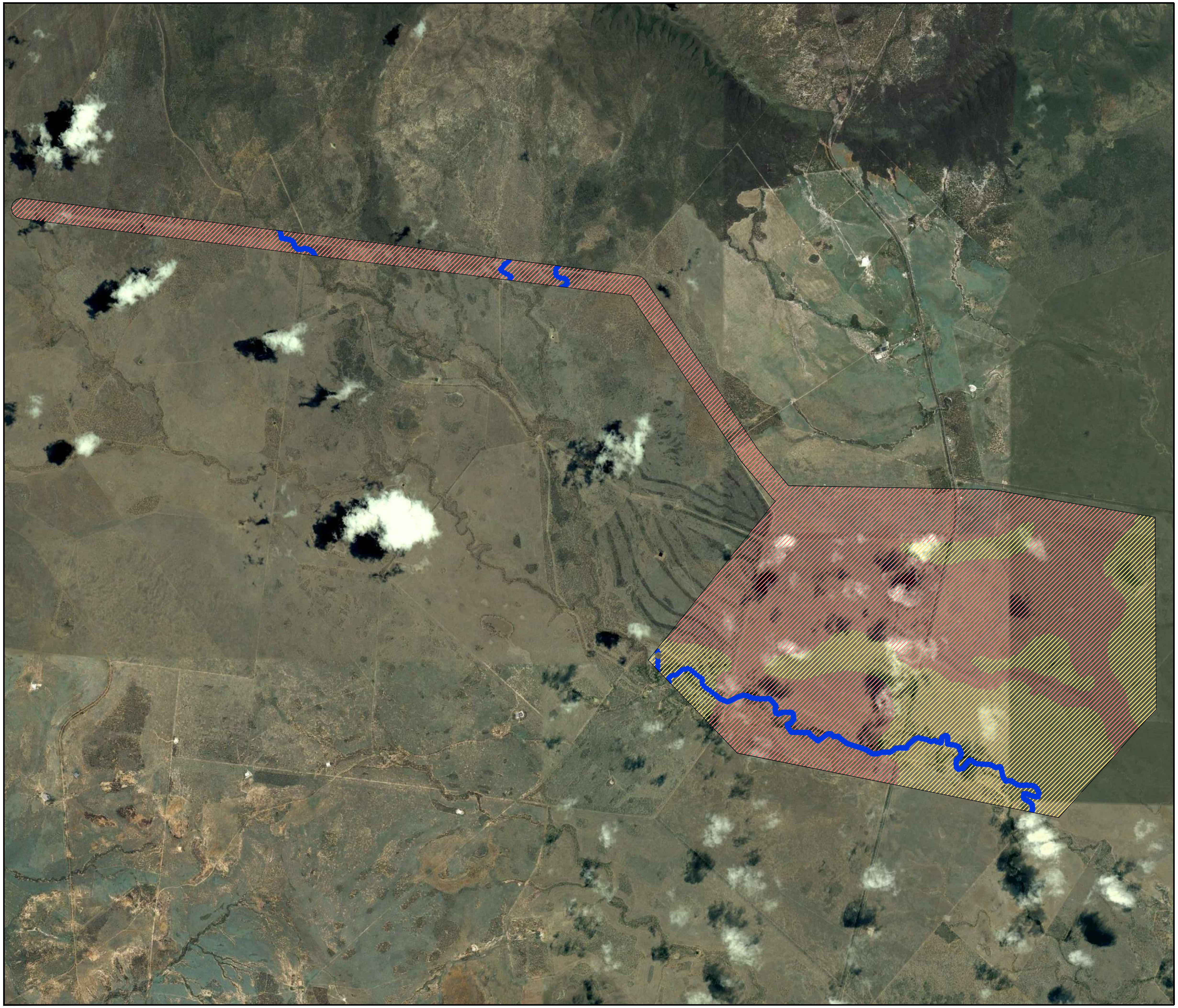
<table>
<tr><th>LS Rating</th><th>Land Suitability Description (DME, 1995)</th><th>ALC</th><th>Pastoral Management (ref)</th><th>B. Forster (per comm., 2010))</th></tr>
<tr><td>1</td><td>High quality land with few or minor limitations</td><td>C1</td><td rowspan="2">Good quality grazing and/or highly suitable for pasture improvement</td><td>Brigalow vegetation; appropriate for fattening beef cattle; good grazing on sown pastures and can withstand ground disturbance.</td></tr>
<tr><td>2</td><td>Land with minor limitations</td><td>C1</td><td>Brigalow vegetation and/or transitional vegetation to Poplar Box vegetation communities.</td></tr>
<tr><td>3</td><td>Moderate limitations to sustaining its use</td><td>C2</td><td>Moderate quality grazing and/or moderately suitable for pasture improvement.</td><td>Eucalypt woodland, Poplar Box, narrow-leaved Eucalyptus, gum-top woodlands; low-moderate PAWC and low-moderate fertility; good grazing on native pastures without ground disturbance; appropriate for beef cattle breeders.</td></tr>
<tr><td>4</td><td>Marginal land requiring major inputs to sustain the use</td><td>C3</td><td>Low quality grazing, grazing of native pastures with limited suitability for pasture improvement.</td><td>Tea-tree vegetation; usually characterised by steep country or mangrove flats.</td></tr>
<tr><td>5</td><td>Unsuitable due to extreme limitations.</td><td>D</td><td>Not suitable</td><td>Unsuitable due to extreme limitations.</td></tr>
</table>

The relationship(s) between soil type, land suitability rating and ALC for the Codrilla project area are outlined below in **Table 20** and shown in **Figure 8**.

Table 20 – Codrilla Soil Types and Agricultural Land Class (ALC)

Soil Type	Overall LS Rating	ALC
Brown Yellow Duplex	**3**	C2
Brown Grey Duplex	**3**	C2
Brown Duplex	**4**	C3
Yellow Duplex	**4**	C3
Shallow Soil (Skeletal)	**4**	C3

The results in **Table 20** above show the land is suitable for grazing between C2 and C3 Agricultural Land Class. According to the Isaac Regional Shire Council Planning Scheme Agricultural Land Class A, B & C1 is considered 'Good Quality Agricultural Land' (GQAL), therefore the assessment has found that the Codrilla project area contains no GQAL under the above definitions. The post mining conditions for assessing Land Suitability and Agricultural Land Class are predictive only, however given there was no GQAL found within the study site, there will be no loss of such land. Following mining there is expected to be a shift in Agricultural Land Classes from Class C2 to C3 or D, given the modifications to slopes and the establishment of a rudimentary soil profile.



LEGEND

Study Area

Creek Line

Agricultural Land Class

C2

C3

FIGURE 8

Pre-Mining
Agricultural Land Class

Project:
Codrilla Soils Assessment

Client:
McCollum Environmental
Management Services

File:
Fg8_MEM06-002_Ag Class_100608.dwg

Projection:
MGA(94) Zone 55

Version:	Date:	Author:	Checked:	Approved:
1	8/06/2010	TC	CR	CR

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Management Consultants

5.0 OVERBURDEN & REJECTS GEOCHEMICAL ASSESSMENTS

5.1 Geochemical Characterisation Testing Procedures

GSS Environmental and Henderson Geotech developed a geochemical sampling and testing program which focused on utilising representative samples of overburden and potential reject material from the roof, floor and coal seam. The geochemical properties of overburden material likely to report as spoil from open cut mining and of roof, coal and floor that will comprise CHPP waste were evaluated. Whilst there are no specific regulatory requirements in Queensland that dictate the density of sampling and testing of overburden and potential reject materials, adequate overburden samples have been tested to give a representative assessment of material on the proposed Codrilla site. A total of 26 overburden samples and 5 tailings component samples were tested. A key requirement of the sampling strategy was to ensure that drill samples were selected to represent the various overburden rock types likely to be associated with the mine development.

Overburden and potential reject samples were screened using a series of standard static physical geochemical tests including Particle Sizing, pH, Electrical Conductivity (EC), Moisture Content, Total Sulfur by LECO, Exchangeable Cations, Acid Neutralising Capacity (ANC), Net Acid Generation, Net Acid Producing Potential (NAPP), Total Metals by ICP-AES (including Arsenic, Boron, Cadmium, Chromium, Cobalt, Copper, Lead, Nickel, Selenium & Zinc) and Total recoverable Mercury. The Net Acid Generation (NAG) test was only used for overburden testing and not the coal rejects testing as recent research into the veracity of the NAG test indicates that the presence of organic matter in samples can cause erroneous results to be recorded (Stewart et al., 2003). The potential for a sample to generate acid was derived from the Total Oxidisable Sulfur (TOS) content and the calculated NAPP value.

All analytical tests were conducted by Australian Laboratory Services (ALS). The laboratory results received from ALS are provided in **Appendix 3**.

The details of the above tests are outlined in the sections below.

5.1.1 pH

The 14 overburden samples from 2009 were tested for pH using the saturated paste pH test. This was carried out by equilibrating crushed solid sample in deionised water for approximately 16 hrs at a solid to water ratio of 1:2. The pH is then measured and gives an indication of the inherent acidity of the waste material when initially exposed in a waste emplacement area.

The 12 overburden samples from 2008 were tested for pH using the soil pH value, KCl pH and OX pH values. For this assessment, the soil pH value was used for these 12 overburden samples.

5.1.2 Electrical Conductivity (EC)

The 14 overburden samples from 2009 were tested for EC using the saturated paste method. The 2008 samples were not assessed for EC. The 5 coal composite samples were assessed for EC using PC titrator @ 25^{o}C.

5.1.3 Exchangeable Cations & Exchangeable Sodium Percentage (ESP)

The cation exchange capacity (CEC) is a measure of the total capacity of a soil to hold exchangeable cations and therefore indicates the negative charge present per unit mass of soil, generally cmolc/kg or mequiv./100g. Much of the behaviour of soils is governed by the nature of the surfaces of soil particles, particularly the surface area and charge. The CEC provides a buffering effect to changes in pH, available nutrients, calcium levels and soil structural changes. Therefore CEC is a major controlling agent of soil structure, nutrient availability for plant growth, soil pH, and the soils reaction to fertilisers and other ameliorants. In general, a low CEC means the soil has low resistance to changes in soil chemistry.

Sodic soils are dispersible under wet conditions and therefore are susceptible to the following problems:

Very severe surface crusting;

Very low infiltration and hydraulic conductivity;

Severe gully erosion; and

Severe tunnelling.

The region of Central Queensland, where the Codrilla site is located, has a long history with attempting to manage the effects of sodic overburden material. The Exchangeable Sodium Percentage (ESP) is calculated by dividing the exchangeable sodium value by the total cation exchange capoacity and multiplying by 100. Soils with an ESP of 0-6% are considered non-sodic, 6-14% are considered marginally sodic to sodic, and greater than 14% are considered strongly sodic (Hazelton & Murphy 2007)

5.1.4 Acid Base Account

Acid rock drainage (ARD) is a result of the exposure of sulphide minerals such as pyrite to atmospheric oxygen and water. The ability to identify in advance any mine materials that could potentially produce ARD is essential for timely implementation of mine waste management strategies.

The procedure used for the Codrilla samples to help assess the acid forming characteristics of mine waste material is the Acid-Base Account (ABA). This method is referred to as a static procedure because it involves a single measurement in time.

The acid-base account involves static laboratory procedures that evaluate the balance between acid generation processes (oxidation of sulphide 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 capacity (ANC), respectively. The difference between the MPA and ANC value is referred to as the net acid producing potential (NAPP).

Total Sulfur

Total sulfur content was determined by the Leco high temperature combustion method. The total sulfate content is determined by the Inductively Coupled Plasma Atomic Emission Spectroscopy (!CP-AES) method. The total oxidisable sulfur (TOS) content is calculated as the total sulfur less the sulfate sulfur content. The TOS is then used to calculate the Maximum Potential Acidity (MPA), which is based on the assumption that only the TOS content is present as reactive pyrite.

Maximum Potential Acidity

The MPA that can be generated by a sample is determined from the sample sulphur content. The total sulphur content of a sample is determined by the Leco high temperature combustion method. The calculation assumes that all the sulphur measured in the sample occurs as pyrite (FeS_2) and that the pyrite reacts under oxidising conditions to generate acid according to the reaction:

$$FeS_2 + 15/4\ O_2 + 7/2H_2O \Rightarrow Fe(OH)_3 + 2H_2SO_4$$

According to this reaction, the MPA of a sample containing 1% S as pyrite would be 30.6 kilograms of H_2SO_4 per tonne of material (i.e. kg H_2SO_4/t). Hence the MPA of a sample is calculated from the total sulphur content using the following formula:

$$\text{MPA (kg } H_2SO_4\text{/t)} = \text{(Total \%S)} \times 30.6$$

The use of the total sulphur assay to estimate the MPA is a conservative approach because some sulphur may occur in forms other than pyrite. Sulphate-sulphur and native sulphur, for example, are non-acid generating sulphur forms. Also, some sulphur may occur as other metal sulphides (e.g. covellite, chalcocite, sphalerite, galena) which yield less acidity than pyrite when oxidised or, in some cases, may be non-acid generating.

Acid Neutralising Capacity

The acid formed from pyrite oxidation will to some extent react with acid neutralising minerals contained within the sample. This inherent acid buffering is quantified in terms of the ANC.

The ANC is commonly determined by the Modified Sobek method. This method involves the addition of a known amount of standardised hydrochloric acid (HCl) to an accurately weighed sample, allowing the sample time to react (with heating), then back-titrating the mixture with standardised sodium hydroxide (NaOH) to determine the amount of unreacted HCl. The amount of acid consumed by reaction with the sample is then calculated and expressed in the same units as the MPA, that is kg H_2SO_4/t.

Net Acid Producing Potential

This is a theoretical calculation commonly used to indicate if a material has potential to produce acidic drainage. It represents the balance between the capacity of a sample to generate acid (MPA) and its capacity to neutralise acid (ANC). The NAPP is also expressed in units of kg H_2SO_4/t and is calculated as follows:

$$NAPP = MPA - ANC$$

If the MPA is less than the ANC then the NAPP is negative, which indicates that the sample may have sufficient ANC to prevent acid generation. Conversely, if the MPA exceeds the ANC then the NAPP is positive, which indicates that the material may be acid generating.

Net Acid Generation (NAG) Test

The NAG test is used in association with the NAPP to classify the acid generating potential of a sample. The NAG test involves reaction of a sample with hydrogen peroxide to rapidly oxidise any sulphide minerals contained within a sample. During the NAG test both acid generation and acid neutralisation reactions can occur simultaneously. Therefore, the end result represents a direct measurement of the net amount of acid generated by the sample. This value is commonly referred to as the NAG capacity and is expressed in the same units as NAPP, that is kg H_2SO_4/t.

Single Addition NAG Test

The single addition NAG test involves the addition of 250 mL of 15% hydrogen peroxide to 2.5 gm of sample. The peroxide is allowed to react with the sample overnight and the following day the sample is gently heated to accelerate the oxidation of any remaining sulphides, then vigorously boiled for several minutes to decompose residual peroxide. When cool, the pH and acidity of the NAG liquor are measured.

The acidity of the liquor is then used to estimate the net amount of acidity produced per unit weight of sample. An indication of the form of the acidity is provided by initially titrating the NAG liquor to pH 4.5, then continuing the titration up to pH 7. The titration value at pH 4.5 includes acidity due to free acid (i.e. H_2SO_4) 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.

Sample Classification

Due to the limitations of the NAG test, as discussed above the Total Oxidisable Sulfur (TOS) and NAPP data have been used to classify the acid forming nature of overburden and reject materials at the Codrilla site according to **Table 21** below.

Table 21 – Sample Classification of Acid producing potential

Total Oxidisable Sulfur (TOS) (%)	NAPP (kg H_2SO_4 /t)	Sample Classification
< 0.1	-	Non-Acid Forming (NAF)
$0.1 \le TOS \le 0.2$	≤ -20	
$0.1 \le TOS \le 0.2$	$-20 < NAPP \le 0$	Uncertain - Non-Acid Forming (UC-NAF)
$0.1 \le TOS \le 0.2$	> 0	Uncertain (UC)
>0.20	≤ 0	
$0.2 < TOS \le 1.0$	$0 > NAPP \le 20$	Uncertain - Potentially Acid Forming (UC-PAF)
> 1.0	> 20	Potentially Acid Forming (PAF)

5.1.5 Metal Scans

In mineralised areas it is common to find a suite of enriched elements that have resulted from natural geological processes. Metal scans are carried out to identify any elements that are present in a material at concentrations that may be of environmental concern with respect to surface water quality and revegetation. In addition to the exchangeable cations assessed as discussed above the Codrilla samples were analysed for the following elements:

- Sulfur – S
- Arsenic – As
- Boron – B
- Cadmium – Cd
- Cobolt – Co
- Chromium – Cr
- Copper – Cu
- Mercury – Hg
- Nickel – Ni
- Lead – Pb
- Selenium – Se
- Zinc – Zn

Whilst there are no guidelines or regulatory criteria specifically related to total metal concentrations in overburden and coal reject materials, the metal scan results were assessed against QLD-EPA (1998) environmental investigation levels (contaminated soils) and NEPC (1999a) health-based investigation levels (HILs) for parks and recreation (open spaces). The QLD-EPA (1998) guidelines are primarily aimed at contaminated land investigations and, in this context, provide a suitable guideline for an industrial facility, such as a mine. The NEPC (1999a) guidelines for 'open spaces' are less stringent than the QLD-EPA guidelines, however their applicability stems from the likely final land use of the mine following closure (*i.e.* a return to livestock grazing).

Metals do not necessarily pose an environmental risk if identified as enriched, and furthermore, metals of low concentration may cause environmental concerns in varying circumstances. The important issue for the Codrilla mine is the potential for overburden and potential reject material to leach soluble metals at concentrations that may impact the environment or human health.

Water extracts were used to determine the immediate element solubilities under the existing pH conditions of the sample. Element concentrations are generally compared with those recommended in relevant surface water (ANZECC, 2000) and groundwater (NEPM, 1999a) guidelines in order to determine their environmental significance.

5.2 Geochemical Characterisation Results of Overburden Material

The full suite of test results for overburden samples is attached in **Appendix 3**. Overburden and interburden are considered and reported together for this report and are hereby referred to as Overburden.

5.2.1 pH

The test results for current pH of the 14 overburden samples from the 2009 testing range from 6.3 through to 8.5 and average 7.48. The pH test results from the 12 overburden samples from the 2008 testing range from 7.2 to 8.9 and average 8.2. Therefore the pH of leachate from overburden material at the Codrilla site is likely to range from very slightly acidic to moderately alkaline, however the majority of material is likely to be neutral.

5.2.2 EC

The test results for EC of the 14 overburden samples range from 1,090 to 3,930uS/cm and average 2,595 uS/cm the preferred standard for measurement is in dS/m and therefore the range is 1.09 to 3.93 dS/m and average of 2.59 dS/m.

5.2.3 Cation Exchange Capacity and Sodicity

The Cation Exchange Capacity of the overburden samples ranges from 12.5 to 35.4 meq/100g with an average value of 21.2 meq/100g. These values indicate the overburden material is within the Moderate to High ranges for CEC and should therefore provide a reasonable growth medium for vegetation roots.

Table 22: Ratings for Cation Exchange Capacity

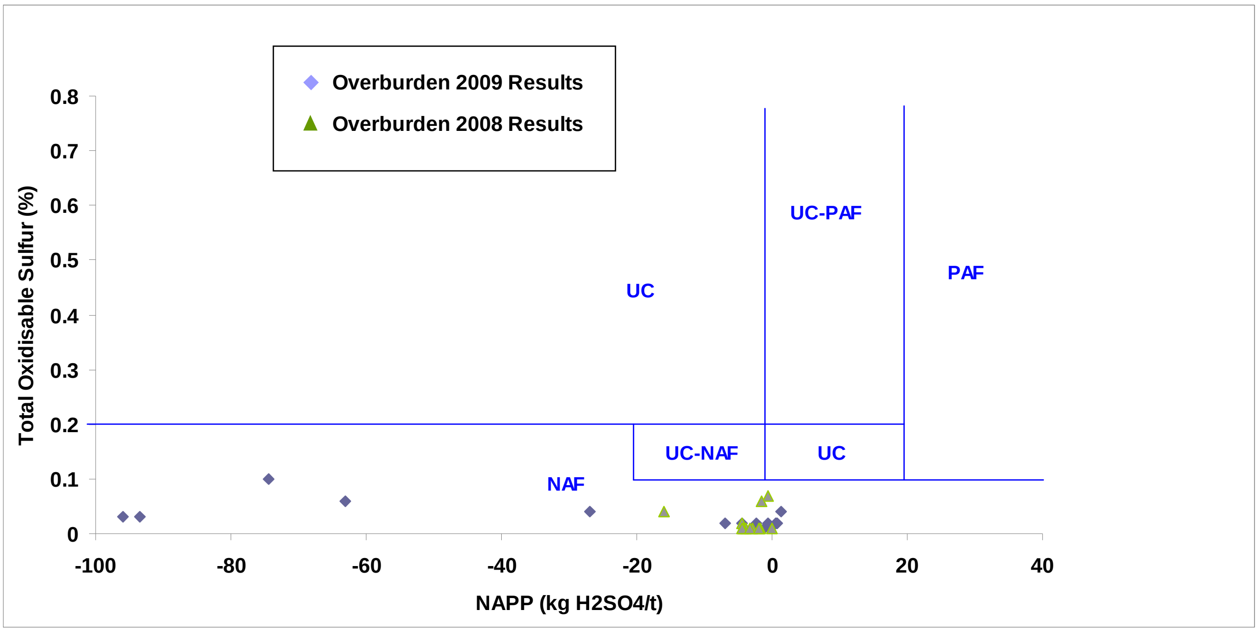
CEC Rating	CEC meq/100g
very low	<6
low	6-12
moderate	12-25
high	25-40
very high	>40

All of the tested overburden samples had very high ESP values ranging from 17.8% to 60.6% with the average being 47.5%. Given soils with ESP values of greater than 14% are considered strongly sodic, the overburden material at the Codrilla site may be considered extremely sodic. These materials are expected to be highly susceptible to severe erosion and tunnelling within the overburden dumps. The disturbance and exposure of this material to water may result in erosion and sedimentation of waterways and dams. The general practice with extremely sodic materials is to bury within the overburden dump where exposure to rain and runoff water is minimised, however given all the overburden samples tested were extremely sodic, the practice of minimising surface exposure to rainfall is the only practical solution.

5.2.4 Acid Base (NAPP) Results

The Acid Base test results for the 14 overburden (2009) samples, and 12 overburden (2008) samples are summarised in **Figure 9** below. On the basis of these results, all 26 overburden samples from 2008 and 2009 are classified as Non Acid Forming (NAF). The total sulfur content of all overburden samples was below 0.1% and considered inert for rehabilitation purposes.

Figure 9: Correlation between Overburden and interburden TOS and NAPP values



5.2.5 Metal Scans

The results of the overburden samples assessed for metals are provided in **Table 23** below and allows comparison of any enriched metal concentrations with those described in QLD-EPA (1998) environmental investigation guidelines for contaminated sites and NEPC (1999a) health-based guidelines for soils in 'open spaces'.

It is important to note that there are no specific regulatory criteria for metal concentrations in overburden and coal reject materials, nor in leachate derived from such materials on mine sites. It was determined that the most suitable tests to be undertaken for metal analysis was solids testing, as comparison to guidelines was clear and the overburden material was considered to be relatively dry within the emplacements due to a free draining landform. The metal concentrations in overburden from these materials, has been compared with the above guidelines to provide some context for the discussion of test results.

Table 23: Codrilla Overburden Metal Scan Results

Metal	No of samples analysed	Results range (mg/kg)	Average (mg/kg)	Health Investigation Levels (HIL's) (exposure setting E - NEPC 1999) (mg/kg)	Environmental Investigation Levels (EILs (EPA 1998) (mg/kg)
Arsenic	26	<5 to 14	*	200	20
Barium	12	<10 - 110	*	N/A	N/A
Beryllium	12	<1 - 3	*	40	N/A
Boron	26	<50 to <50	*	6,000	N/A
Cadmium	26	<1 to <1	*	40	3
Chromium	26	4 to 35	15	200	50
Cobalt	26	2 to 62	13	200	N/A
Copper	26	<5 to 95	*	2,000	60
Lead	26	<5 to 23	*	600	300
Manganese	12	<5 - 440	*	3,000	500
Mercury	26	<0.1 to <0.1	*	30	1
Molybdenum	12	<2 - <2	*	N/A	N/A
Nickel	26	2 to 126	29	600	60
Selenium	26	<5 to <5	*	N/A	N/A
Silver	12	<2 - <2	*	N/A	N/A
Strontium	12	20 - 256	73.2	N/A	N/A
Tin	12	<5 - <5	*	N/A	50
Zinc	26	5 to 148	50	14,000	200
Vanadium	12	13 - 75	30.7	N/A	N/A

* average not provided due to results less than laboratory limit of reporting

The results in **Table 23** indicate that several overburden materials tested have Copper and Nickel concentrations in solids greater than QLD-EPA (1998) environmental investigation levels (EIL), but well below NEPC (1999a) health-based investigation levels (HIL) for soils. Hence, multi-element results indicate that the concentration of metals in overburden solids and runoff/seepage is unlikely to present any environmental issues associated with revegetation and rehabilitation of any out-of-pit overburden storage facilities and on-site or downstream water quality.

5.3 Chemical Characterisation of Tailings & Reject Material

When coal is mined, some non-coal material from above and below the seams is usually extracted as well – this is termed “dilution”. A main objective of CHPP processes is to exclude from the product coal as much dilution, and as little coal, as possible. In simple terms, the ROM coal is first crushed to break it down to a nominated size and then screened to exclude the fragments larger than that size, on the principal that what did not break down was stronger than coal and was therefore dilution. This excluded material comprises the coarse reject. The crushed material is crushed further then added to a fluid medium then separated using various techniques that utilise differences in physical properties between coal and non-coal. The resultant waste is a mixture of water, process additives and ground and saturated rock particles, referred to as fine reject, or tailings.

Inevitably, neither coarse nor fine separation processes are completely effective, and a proportion of coal is captured in both waste streams. The actual amounts depend on the efficiency of both mining and coal preparation but coarse reject typically includes 20-30% coal; for tailings a representative range is 40-70% coal. Physically, coarse reject is predominantly gravel-sized fragments >20mm, while tailings depends heavily on strata close to the coal seam (roof and floor) but is a mixture of sand, silt and clay sized particles.

Because of the uncertain composition of actual reject, it was decided to analyse the component materials separately. Two samples of each roof and floor were composited from single boreholes and were sent with one coal sample for laboratory analyses. In addition to solids analyses, 1:2 leachates were prepared by mechanical agitation to represent potential runoff/leachate from coarse reject and supernatant from tailings. Analytes included normal soil water characteristics and parameters listed in Table 3 of the November 2009 Draft of the Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (DERM). The results are summarised in Table 23 and Table 24.

Table 24: Codrilla Reject Solids Chemistry

Metal	No of samples analysed	Roof, coal and floor results range (mg/kg)	Health Investigation Levels (HILs) (exposure setting E - NEPC 1999) (mg/kg)	Environmental Investigation Levels (EILs) (EPA 1998) (mg/kg)	Hazardous dam Solids - (EPA 2002) (mg/kg)
Arsenic	17	<5 – 39	200	20	500
Boron	17	<50 - <50	6,000	N/A	15,000
Cadmium	17	<1 - <1	40	3	100
Chromium	12	<2 – 14	200	50	-
Cobalt	17	<2 – 31	200	N/A	500
Copper	17	<5 – 11	2,000	60	5,000
Lead	17	<5 – 79	600	300	1,500
Nickel	17	<2 – 128	600	60	3,000
Selenium	17	<5 - <5	N/A	N/A	-
Zinc	17	<5 – 904	14,000	200	35,000
Mercury	17	<0.1 – 0.3	30	1	75

Note: no average provided due to all results having some parameters less than laboratory limit of reporting.

Table 25: Codrilla Reject Leachate Chemistry

Metal	No of samples analysed	Roof, coal and floor results range (mg/L)	RCTIL (DERM, 2010) (mg/L)	OWSCL (DERM, 2010) (mg/L)	Hazardous dam liquor (mg/L) - (EPA 2002)
Aluminium	17	<0.1 – 2.3	0.1	5	-
Arsenic	17	<0.01 - <0.1	0.013	0.5	1
Boron	17	<0.1 – 1.3	0.37	-	5
Cadmium	17	<0.005 - <0.05	0.0002	0,01	10
Chromium	17	<0.01 - <0.1	0.001	-	-
Cobalt	17	<0.01 – 0.8	0.09	-	1
Copper	17	<0.01 – 1	0.002	1	1
Iron	17	<0.05 - 8	0.3	-	-
Lead	17	<0.01 – <0.1	0.01	0.1	0.5
Nickel	17	<0.01 – 3.1	0.011	1	1
Selenium	17	<0.01 – 0.8	0.01	-	-
Zinc	17	0.02 – 12.6	0.008	20	20
Mercury	17	<0.0001 - <0.001	-	-	2

Note: no average provided due to all results having some parameters less than laboratory limit of reporting.

With regard to potential for acid production, based on the classification in Table 20 all samples tested were either Uncertain or Uncertain – Potentially Acid Forming. This was due to all samples having >0.2% sulphur, although two samples so had high Acid Neutralising Capacity.

None of the results exceeded the limits in the DERM draft dams manual, which indicates that dams containing tailings or reject-contacted water would not automatically be considered regulated dams based on contaminant concentrations. However, an aboveground tailings storage facility would normally be assessed as Significant Hazard Category, and therefore a regulated dam, based on the physical consequences of discharge.

The concentrations of most analytes exceeded model EA conditions release water investigation trigger levels in one or more samples. Hence it is likely that water that has been in contact with CHPP reject will not be of suitable quality for uncontrolled release to receiving waters, and will need to be captured within the mine water management system. This is the usual situation for coal mines in central Queensland.

5.4 Conclusions and Management of Overburden & Reject Material

5.4.1 Overburden

The results from the Acid Base testing indicates that the overburden material will initially generate neutral to slightly alkaline runoff and seepage due to the current pH of the material. All overburden samples had very low sulphur content of <0.1% and are considered inert. The ANC generally exceeded the MPA for overburden samples indicating that the material has sufficient buffering capacity to neutralise the small amount of acidity that may be generated from sulphide oxidation. All overburden samples were classified as NAF with majority of NAPP values being negative, whilst only 3 samples were slightly positive being 0.6, 0.7 and 1.3 kg H_2SO_4/t.

The salinity levels of the runoff and seepage water is expected to be moderate. This may cause some vegetation species to be slower growing once the roots penetrate the moderately saline overburden material. Over time it is expected that salinity levels near the surface layers of overburden will lower due to leaching further into the dump profile. Water management structures such as dams should be monitored for salinity levels and appropriate management and release actions should be followed.

The presence of extremely sodic material throughout the overburden profiles gives rise to the need for implementing appropriate erosion and sediment controls on site prior to and during the development of the overburden emplacements. This sodic material is prone to severe surface crusting, gully erosion and tunnelling. The sodic overburden material should be covered with an inert topdressing sourced from the sites topsoil. The addition of gypsum over the surface may provide an effective reduction of surface crusting and dispersion, however the availability in central Queensland can be low. The addition of organic matter as an ameliorant into the soil should also reduce the effects of sodicity. The best suited final landuse for the overburden emplacements at Codrilla include nature conservation and a mosaic of grassland and bushland as is proposed. The final slope of the overburden emplacement should not exceed 10 degrees, and graded banks should be constructed at 1.2 to 1.5 % grade to minimise the chances of ponding and resultant tunnelling. As a general recommendation, the construction of dams or ponds on the rehabilitated overburden dumps should be minimised, to reduced the chances of tunnelling, however any water storage structures located on the dumps should be clay lined, again to minimise the chances of tunnelling through the dispersive material.

The range of analyses included in the water quality monitoring program for runoff/seepage from any constructed overburden or reject storage facility should focus on pH, EC and Total Dissolved Solids (TDS). Periodic sampling and testing of the full suite of dissolved metals described in this report (say every two years) should be included in the water quality monitoring program developed for the project.

5.4.2 Reject Material

CHPP reject is to be stored in the main in a co-disposal facility, that is, the coarse and fine reject streams will be combined at the CHPP and pumped as slurry to the disposal area. The excess water that drains from the matrix of reject solids will be recovered and returned to the process water circuit. There may be localized low pH seepage but based on the NAPP results ranging from 6.4 to -78.2 kg H_2SO_4/t, the return water is not expected to be generally acidic. However, as noted in Section 5.3 water associated with the co-disposal facility, including runoff, will not be of suitable quality for uncontrolled release from site and will be captured in the mine water system.

In the context of rehabilitation, the CHPP reject appears to be not particularly saline but poor fertility and combustion risk (from the included coal) dictate that an inert cover will be necessary. The main characteristics required of this cover are low potential to draw moisture out of the co-disposed reject; favourable growth medium properties and erosion resistance appropriate to the landform design.

6.0 REFERENCES

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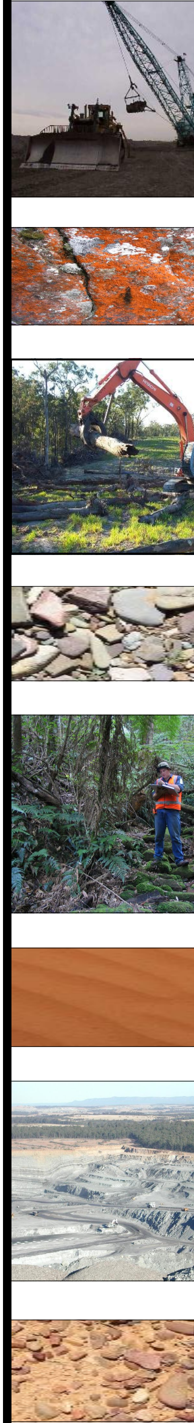


Field Assessment Procedure

APPENDIX 1

FIELD ASSESSMENT PROCEDURE

Elliott and Veness (1981) have described the basic procedure, adopted in this survey, for the recognition of suitable topdressing materials. In this procedure, the following soils factors are analysed. They are listed in decreasing order of importance.

Structure Grade

Good permeability to water and adequate aeration are essential for the germination and establishment of plants. The ability of water to enter soil generally varies with structure grade (Charman, 1978) and depends on the proportion of coarse peds in the soil surface.

Better structured soils have higher infiltration rates and better aeration characteristics. Structureless soils without pores are considered unsuitable as topdressing materials.

Consistence - Shearing Test

The shearing test is used as a measure of the ability of soils to maintain structure grade.

Brittle soils are not considered suitable for revegetation where structure grade is weak or moderate because peds are likely to be destroyed and structure is likely to become massive following mechanical work associated with the extraction, transportation and spreading of topdressing material.

Consequently, surface sealing and reduced infiltration of water may occur which will restrict the establishment of plants.

Consistence - Disruptive Test

The force to disrupt peds, when assessed on soil in a moderately moist state, is an indicator of solidity and the method of ped formation. Deflocculated soils are hard when dry and slake when wet, whereas flocculated soils produce crumbly peds in both the wet and dry state. The deflocculated soils are not suitable for revegetation and may be identified by a strong force required to break aggregates.

Mottling

The presence of mottling within the soil may indicate reducing conditions and poor soil aeration. These factors are common in soil with low permeabilities; however, some soils are mottled due to other reasons, including proximity to high water-tables or inheritance of mottles from previous conditions. Reducing soils and poorly aerated soils are unsuitable for revegetation purposes.

Macrostructure

Refers to the combination or arrangement of the larger aggregates or peds in the soil. Where these peds are larger than 10 cm (smaller dimension) in the subsoil, soils are likely to either slake or be hardsetting and prone to surface sealing. Such soils are undesirable as topdressing materials.

Texture

Sandy soils are poorly suited to plant growth because they are extremely erodible and have low water holding capacities. For these reasons soils with textures equal to or coarser than sandy loams are considered unsuitable as topdressing materials for climates of relatively unreliable rainfall, such as the Hunter Valley.

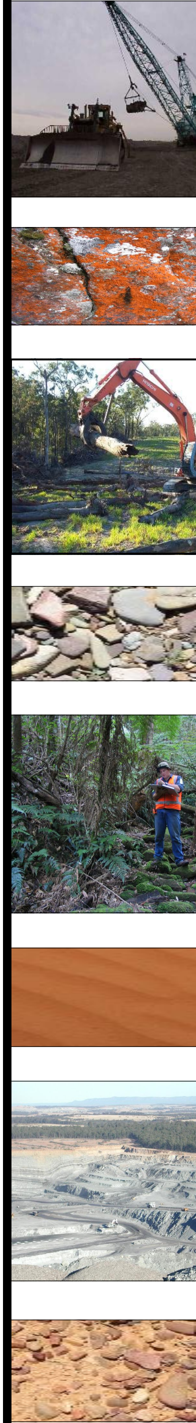
Root Density and Root Pattern

Root abundance and root branching is a reliable indicator of the capability for propagation and stockpiling.

Field Exposure Indicators

The extent of colonisation of vegetation on exposed materials as well as the surface behavior and condition after exposure is a reliable field indicator for suitability for topdressing purposes. These layers may alternate with other layers which are unsuitable. Unsuitable materials may be included in the topdressing mixture if they are less than 15cm thick and comprise less than 30 per cent of the total volume of soil material to be used for topdressing. Where unsuitable soil materials are more than 15 cm thick they should be selectively discarded.

Soil Information



APPENDIX 2

TEST SIGNIFICANCE AND TYPICAL VALUES

Particle Size Analysis

Particle size analysis measures the size of the soil particles in terms of grainsize fractions, and expresses the proportions of these fractions as a percentage of the sample. The grainsize fractions are:

clay	(<0.002 mm)
silt	(0.002 to 0.02 mm)
fine sand	(0.02 to 0.2 mm)
medium and coarse sand	(0.2 to 2 mm)

Particles greater than 2 mm, that is gravel and coarser material, are not included in the analysis.

Emerson Aggregate Test

Emerson aggregate test measures the susceptibility to dispersion of the soil in water. Dispersion describes the tendency for the clay fraction of a soil to go into colloidal suspension in water. The test indicates the credibility and structural stability of the soil and its susceptibility to surface sealing under irrigation and rainfall. Soils are divided into eight classes on the basis of the coherence of soil aggregates in water. The eight classes and their properties are:

Class 1	-	very dispersible soils with a high tunnel erosion susceptibility.
Class 2	-	moderately dispersible soils with some degree of tunnel erosion susceptibility.
Class 3	-	slightly or non-dispersible soils which are generally stable and suitable for soil conservation earthworks.
Class 4-6	-	more highly aggregated materials which are less likely to hold water. Special compactive efforts are required in the construction of earthworks.
Class 7-8	-	highly aggregated materials exhibiting low dispersion characteristics.

The following subdivisions within Emerson classes may be applied:

(1) slight milkiness, immediately adjacent to the aggregate
(2) obvious milkiness, less than 50% of the aggregate affected
(3) obvious milkiness, more than 50% of the aggregate affected
(4) total dispersion, leaving only sand grains.

Salinity

Salinity is measured as electrical conductivity on a 1:5 soil:water suspension to give EC (1:5). The effects of salinity levels expressed as EC at 25° (dS/cm), on plants are:

0 to 1	very low salinity, effects on plants mostly negligible.
1 to 2	low salinity, only yields of very sensitive crops are restricted.
greater than 2	saline soils, yields of many crops restricted.

pH

The pH is a measure of acidity and alkalinity. For 1:5 soil:water suspensions, soils having pH values less than 4.5 are regarded as strongly acid, 4.5 to 5.0 moderately acidic, and values greater than 7.0 are regarded as alkaline. Most plants grow best in slightly acidic soils.

LABORATORY TEST METHODS

Particle Size Analysis

Determination by sieving and hydrometer of percentage, by weight, of particle size classes: Gravel >2mm, Coarse Sand 0.2-2 mm, Fine Sand 0.02-0.2 mm, Silt 0.002-0.2 mm and Clay <0.002 mm SCS Standard method. Reference - Bond, R, Craze B, Rayment G, and Higginson (in press 1990) **Australia Soil and Land Survey Laboratory Handbook**, Inkata Press, Melbourne.

Emerson Aggregate Test

An eight class classification of soil aggregate coherence (slaking and dispersion) in water. SCS Standard Method closely related to Australian Standard AS1289. The degree of dispersion is included in brackets for class 2 and 3 aggregates. Reference - Bond R., Craze, B., Rayment, G., Higginson, F.R., (in press 1990). **Australian Soil and Land survey Laboratory Handbook**, Inkata Press, Melbourne.

EC

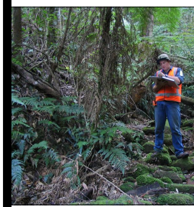
Electrical Conductivity determined on a 1:5 soil:water suspension. Prepared from the fine earth fraction of the sample. Reference - Bond R, Craze B, Rayment G, Higginson FR (in press 1990) **Australian Soil and Land Survey Handbook.** Inkata Press, Melbourne.

pH

Determined on a 1:5 soil:water suspension. Soil refers to the fine earth fraction of the sample. Reference - Bond, R., Craze, B., Rayment, G., Higginson, F.R. (in press 1990). **Australian Soil and Land Survey Handbook.** Inkata Press, Melbourne.








Soil Test Results

APPENDIX 3

CERTIFICATE OF ANALYSIS

Work Order	: **EB0918060**	Page	: 1 of 6
Client	: **GSS ENVIRONMENTAL**	Laboratory	: Environmental Division Brisbane
Contact	: MR CLAYTON RICHARDS	Contact	: Tim Kilmister
Address	: LEVEL 1, 241 DENISON ST BROADMEADOW NSW AUSTRALIA 2292	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: richards@gssenvironmental.com	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: 02 49203000	Telephone	: +61-7-3243 7222
Facsimile	: ----	Facsimile	: +61-7-3243 7218
Project	: CODRILLA COAL MINE	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 16-NOV-2009
Sampler	: P.T, AGE GW consult	Issue Date	: 30-NOV-2009
Site	: ----		
		No. of samples received	: 19
Quote number	: BN/495/09	No. of samples analysed	: 5

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA
WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Cass Sealby	Senior Chemist - Acid Sulphate Soils	Inorganics
Cass Sealby	Senior Chemist - Acid Sulphate Soils	Stafford Minerals - AY
Kim McCabe	Senior Inorganic Chemist	Inorganics
Stephen Hislop	Senior Inorganic Chemist	Inorganics

General Comments

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

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

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient 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 date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

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

- **ED045G (Chloride): LCS recovery falls outside Dynamic Control Limits. They are however within ALS Static Control Limits and hence deemed acceptable.**
- **EG005 (Total Metals): Sample EB0918060-015 (IC2 Roof) shows poor duplicate results due to sample heterogeneity. This was confirmed by visual inspection.**
- **EG005W (Water Leachable Metals): LCS recoveries for Cobalt fall outside Dynamic Control Limits. They are however within ALS Static Control Limits and hence deemed acceptable.**

Analytical Results

Sub-Matrix: **COAL**			Client sample ID	**3C8 COAL Composite**	----	----	----	----
			Client sampling date / time	16-NOV-2009 15:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB0918060-016**	**----**	**----**	**----**	**----**
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	**18.6**	----	----	----	----

Analytical Results

Sub-Matrix: COMPOSITE			Client sample ID	ICZ ROOF Composite	3C8 COAL Composite	9C10 FLOOR Composite	11C12 ROOF Composite	17C18 FLOOR Composite
			Client sampling date / time	16-NOV-2009 08:30	16-NOV-2009 08:30	16-NOV-2009 08:30	16-NOV-2009 08:30	16-NOV-2009 08:30
Compound	CAS Number	LOR	Unit	EB0918060-015	EB0918060-016	EB0918060-017	EB0918060-018	EB0918060-019
EA009: Nett Acid Production Potential								
^ Net Acid Production Potential	----	0.5	kg H2SO4/t	-9.4	6.4	1.7	-78.2	-54.8
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	6.9	3.6	5.7	8.7	8.7
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	3.7	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	0.2	20.2	2.3	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	16.5	8.5	5.4	99.2	70.1
^ ANC as CaCO3	----	0.1	% CaCO3	1.7	0.9	0.5	10.1	7.2
Fizz Rating	----	0	Fizz Unit	0	0	0	2	2
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.23	0.48	0.23	0.69	0.50
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	6	<5	<5	12	<5
Boron	7440-42-8	50	mg/kg	80	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Cobalt	7440-48-4	2	mg/kg	31	7	<2	2	4
Copper	7440-50-8	5	mg/kg	90	22	15	13	48
Lead	7439-92-1	5	mg/kg	17	<5	34	5	7
Nickel	7440-02-0	2	mg/kg	98	26	9	<2	<2
Selenium	7782-49-2	5	mg/kg	<5	<5	<5	<5	<5
Zinc	7440-66-6	5	mg/kg	104	27	10	19	50
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.2	<0.1	<0.1

Analytical Results

Sub-Matrix: **DI WATER LEACHATE**

Compound	CAS Number	LOR	Unit	ICZ ROOF Composite	3C8 COAL Composite	9C10 FLOOR Composite	11C12 ROOF Composite	17C18 FLOOR Composite
Client sampling date / time				19-NOV-2009 14:00	19-NOV-2009 14:00	19-NOV-2009 14:00	19-NOV-2009 14:00	19-NOV-2009 14:00
				EB0918060-015	EB0918060-016	EB0918060-017	EB0918060-018	EB0918060-019
EA005: pH								
pH Value	----	0.01	pH Unit	6.74	7.67	8.10	8.48	8.53
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	603	2650	1250	1890	1040
ED040W: Water Leachable Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	1	mg/L	34	82	44	84	70
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1	mg/L	301	657	288	573	200
ED093W: Water Leachable Major Cations								
Calcium	7440-70-2	1	mg/L	<1	8	2	8	4
Magnesium	7439-95-4	1	mg/L	<1	16	1	9	4
Sodium	7440-23-5	1	mg/L	63	532	240	378	233
Potassium	7440-09-7	1	mg/L	2	4	2	4	4
EG005W: Water Leachable Metals by ICPAES								
Aluminium	7429-90-5	0.10	mg/L	1.29	0.31	<0.10	0.41	0.27
Arsenic	7440-38-2	0.01	mg/L	<0.01	<0.01	0.03	<0.01	<0.01
Boron	7440-42-8	0.1	mg/L	0.2	0.3	0.4	0.3	0.3
Cadmium	7440-43-9	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium	7440-47-3	0.01	mg/L	<0.01	<0.01	0.01	<0.01	<0.01
Cobalt	7440-48-4	0.01	mg/L	<0.01	0.02	<0.01	<0.01	<0.01
Copper	7440-50-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Iron	7439-89-6	0.05	mg/L	0.10	0.50	<0.05	<0.05	<0.05
Lead	7439-92-1	0.01	mg/L	<0.01	<0.01	0.02	<0.01	<0.01
Nickel	7440-02-0	0.01	mg/L	<0.01	0.06	0.01	<0.01	<0.01
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.01	mg/L	0.07	0.08	0.02	0.02	0.02
EG035W: Water Leachable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	1.1	0.7	0.7	0.5	0.5

Analytical Results

Sub-Matrix: **SOIL**			Client sample ID	ICZ ROOF Composite	9C10 FLOOR Composite	11C12 ROOF Composite	17C18 FLOOR Composite	----
			Client sampling date / time	16-NOV-2009 15:00	16-NOV-2009 15:00	16-NOV-2009 15:00	16-NOV-2009 15:00	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB0918060-015**	**EB0918060-017**	**EB0918060-018**	**EB0918060-019**	**----**
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	**8.4**	**23.8**	**14.6**	**18.9**	----

CERTIFICATE OF ANALYSIS

Work Order	: **EB0914861**	Page	: 1 of 8
Client	: **GSS ENVIRONMENTAL**	Laboratory	: Environmental Division Brisbane
Contact	: MR CLAYTON RICHARDS	Contact	: Tim Kilmister
Address	: LEVEL 1, 241 DENISON ST BROADMEADOW NSW AUSTRALIA 2292	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: richards@gssenvironmental.com	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: 02 49203000	Telephone	: +61-7-3243 7222
Facsimile	: ----	Facsimile	: +61-7-3243 7218
Project	: CODRILLA COAL MINE	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: 568040	Date Samples Received	: 18-SEP-2009
Sampler	: PAUL TETT	Issue Date	: 01-OCT-2009
Site	: ----		
		No. of samples received	: 14
Quote number	: BN/495/09	No. of samples analysed	: 14

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Dianne Blane		Newcastle
Kim McCabe	Senior Inorganic Chemist	Inorganics
Stephen Hislop	Senior Inorganic Chemist	Inorganics
Stephen Hislop	Senior Inorganic Chemist	Stafford Minerals - AY

General Comments

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When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

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

- **ANC Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong.**

Analytical Results

Sub-Matrix: SOIL			Client sample ID	CX1902-349061	CX1902-349067	CX1902-349082	CX1914-67286	CX1914-67290
			Client sampling date / time	15-SEP-2009 15:00	15-SEP-2009 15:00	15-SEP-2009 15:00	15-SEP-2009 15:00	15-SEP-2009 15:00
Compound	CAS Number	LOR	Unit	EB0914861-001	EB0914861-002	EB0914861-003	EB0914861-004	EB0914861-005
EA150: Particle Sizing								
+75µm	----	1	%	27	36	50	15	6
+150µm	----	1	%	6	22	48	8	4
+300µm	----	1	%	1	5	45	5	3
+425µm	----	1	%	1	2	44	4	2
+600µm	----	1	%	1	1	42	4	2
+1180µm	----	1	%	<1	<1	35	3	1
+2.36mm	----	1	%	<1	<1	20	1	1
+4.75mm	----	1	%	<1	<1	2	<1	<1
+9.5mm	----	1	%	<1	<1	<1	<1	<1
+19.0mm	----	1	%	<1	<1	<1	<1	<1
+37.5mm	----	1	%	<1	<1	<1	<1	<1
+75.0mm	----	1	%	<1	<1	<1	<1	<1
EA009: Nett Acid Production Potential								
^ Net Acid Production Potential	----	0.5	kg H2SO4/t	<0.5	-2.3	-63.0	-6.9	-1.2
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	6.8	7.4	8.7	8.8	7.0
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	0.5	2.8	64.7	7.4	1.5
^ ANC as CaCO3	----	0.1	% CaCO3	<0.1	0.3	6.6	0.8	0.2
Fizz Rating	----	0	Fizz Unit	0	0	3	0	0
EA031: pH (saturated paste)								
pH (Saturated Paste)	----	0.1	pH Unit	6.3	6.8	8.1	7.6	7.4
EA032: Electrical Conductivity (saturated paste)								
Electrical Conductivity (Saturated Paste)	----	1	µS/cm	2420	2950	2360	2460	2980
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	13.3	16.8	21.2	11.8	13.9
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	37	33	27	44	44
Silt (2-60 µm)	----	1	%	33	28	21	39	48
Sand (0.06-2.00 mm)	----	1	%	30	39	32	15	8
Gravel (>2mm)	----	1	%	<1	<1	20	2	<1
Cobbles (>6cm)	----	1	%	<1	<1	<1	<1	<1
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	0.4	1.8	8.0	3.7	1.7

Analytical Results

Sub-Matrix: **SOIL**			Client sample ID	CX1902-349061	CX1902-349067	CX1902-349082	CX1914-67286	CX1914-67290
			Client sampling date / time	15-SEP-2009 15:00	15-SEP-2009 15:00	15-SEP-2009 15:00	15-SEP-2009 15:00	15-SEP-2009 15:00
Compound	CAS Number	LOR	Unit	EB0914861-001	EB0914861-002	EB0914861-003	EB0914861-004	EB0914861-005
ED007: Exchangeable Cations - Continued								
^ Exchangeable Magnesium	----	0.1	meq/100g	6.4	7.6	6.6	5.8	5.3
^ Exchangeable Potassium	----	0.1	meq/100g	0.8	0.7	0.6	0.5	0.9
^ Exchangeable Sodium	----	0.1	meq/100g	8.4	12.5	11.4	6.5	8.0
^ Cation Exchange Capacity	----	0.1	meq/100g	16.0	22.6	26.6	16.5	15.9
^ Exchangeable Sodium Percent	----	0.1	%	52.4	55.1	42.7	39.4	50.4
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.02	0.06	0.02	0.01
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	<5	8	6	6	<5
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	11	19	26	18	17
Cobalt	7440-48-4	2	mg/kg	27	62	31	<2	7
Copper	7440-50-8	5	mg/kg	19	67	94	8	42
Lead	7439-92-1	5	mg/kg	9	11	9	<5	11
Nickel	7440-02-0	2	mg/kg	18	80	126	6	30
Selenium	7782-49-2	5	mg/kg	<5	<5	<5	<5	<5
Zinc	7440-66-6	5	mg/kg	31	141	118	9	148
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: SOIL			Client sample ID	CX1914-67299	CX1914-350413	CX1924-353327	CX1924-353335	CX1924-353341
			Client sampling date / time	15-SEP-2009 15:00	15-SEP-2009 15:00	15-SEP-2009 15:00	15-SEP-2009 15:00	15-SEP-2009 15:00
Compound	CAS Number	LOR	Unit	EB0914861-006	EB0914861-007	EB0914861-008	EB0914861-009	EB0914861-010
EA150: Particle Sizing								
+75µm	----	1	%	46	53	18	6	5
+150µm	----	1	%	40	45	4	4	11
+300µm	----	1	%	35	38	1	3	8
+425µm	----	1	%	32	35	<1	3	6
+600µm	----	1	%	28	32	<1	2	5
+1180µm	----	1	%	22	26	<1	2	3
+2.36mm	----	1	%	12	16	<1	1	1
+4.75mm	----	1	%	<1	<1	<1	<1	<1
+9.5mm	----	1	%	<1	<1	<1	<1	<1
+19.0mm	----	1	%	<1	<1	<1	<1	<1
+37.5mm	----	1	%	<1	<1	<1	<1	<1
+75.0mm	----	1	%	<1	<1	<1	<1	<1
EA009: Nett Acid Production Potential								
^ Net Acid Production Potential	----	0.5	kg H2SO4/t	-93.5	-74.4	0.6	0.7	-96.0
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	10.5	8.9	6.9	6.9	8.8
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	94.6	77.5	<0.5	<0.5	97.0
^ ANC as CaCO3	----	0.1	% CaCO3	9.6	7.9	<0.1	<0.1	9.9
Fizz Rating	----	0	Fizz Unit	3	3	0	0	3
EA031: pH (saturated paste)								
pH (Saturated Paste)	----	0.1	pH Unit	8.5	8.4	6.9	6.8	8.0
EA032: Electrical Conductivity (saturated paste)								
Electrical Conductivity (Saturated Paste)	----	1	µS/cm	1590	1660	1090	3250	3360
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	12.9	14.6	14.7	30.9	24.0
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	24	19	40	57	35
Silt (2-60 µm)	----	1	%	29	27	37	36	49
Sand (0.06-2.00 mm)	----	1	%	35	38	23	6	14
Gravel (>2mm)	----	1	%	12	16	<1	1	2
Cobbles (>6cm)	----	1	%	<1	<1	<1	<1	<1
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	23.2	9.6	1.2	1.1	7.1

Analytical Results

Sub-Matrix: SOIL			Client sample ID	CX1914-67299	CX1914-350413	CX1924-353327	CX1924-353335	CX1924-353341
			Client sampling date / time	15-SEP-2009 15:00	15-SEP-2009 15:00	15-SEP-2009 15:00	15-SEP-2009 15:00	15-SEP-2009 15:00
Compound	CAS Number	LOR	Unit	EB0914861-006	EB0914861-007	EB0914861-008	EB0914861-009	EB0914861-010
ED007: Exchangeable Cations - Continued								
^ Exchangeable Magnesium	----	0.1	meq/100g	4.8	7.0	6.3	5.4	12.5
^ Exchangeable Potassium	----	0.1	meq/100g	1.2	1.0	0.5	0.3	0.8
^ Exchangeable Sodium	----	0.1	meq/100g	6.3	9.1	7.4	8.5	12.4
^ Cation Exchange Capacity	----	0.1	meq/100g	35.4	26.7	15.3	15.3	32.9
^ Exchangeable Sodium Percent	----	0.1	%	17.8	34.0	48.0	55.4	37.8
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.03	0.10	0.02	0.02	0.03
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	14	11	5	<5	6
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	16	23	14	10	22
Cobalt	7440-48-4	2	mg/kg	15	20	16	<2	29
Copper	7440-50-8	5	mg/kg	44	53	23	<5	95
Lead	7439-92-1	5	mg/kg	7	17	<5	<5	<5
Nickel	7440-02-0	2	mg/kg	29	60	23	2	95
Selenium	7782-49-2	5	mg/kg	<5	<5	<5	<5	<5
Zinc	7440-66-6	5	mg/kg	74	94	32	<5	87
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: SOIL			Client sample ID	CX1930-66306	CX1930-66310	CX1930-66314	CX1930-66323	----
			Client sampling date / time	15-SEP-2009 15:00	15-SEP-2009 15:00	15-SEP-2009 15:00	15-SEP-2009 15:00	----
Compound	CAS Number	LOR	Unit	EB0914861-011	EB0914861-012	EB0914861-013	EB0914861-014	----
EA150: Particle Sizing								
+75µm	----	1	%	15	39	23	31	----
+150µm	----	1	%	31	15	3	29	----
+300µm	----	1	%	16	4	2	28	----
+425µm	----	1	%	10	2	2	28	----
+600µm	----	1	%	8	1	2	27	----
+1180µm	----	1	%	6	<1	1	22	----
+2.36mm	----	1	%	4	<1	1	10	----
+4.75mm	----	1	%	<1	<1	<1	2	----
+9.5mm	----	1	%	<1	<1	<1	<1	----
+19.0mm	----	1	%	<1	<1	<1	<1	----
+37.5mm	----	1	%	<1	<1	<1	<1	----
+75.0mm	----	1	%	<1	<1	<1	<1	----
EA009: Nett Acid Production Potential								
^ Net Acid Production Potential	----	0.5	kg H2SO4/t	1.3	-0.5	-4.5	-27.0	----
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	6.3	7.2	8.0	8.7	----
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	----
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	----
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	<0.5	1.0	5.1	28.2	----
^ ANC as CaCO3	----	0.1	% CaCO3	<0.1	0.1	0.5	2.9	----
Fizz Rating	----	0	Fizz Unit	0	0	0	0	----
EA031: pH (saturated paste)								
pH (Saturated Paste)	----	0.1	pH Unit	7.0	7.5	7.5	7.9	----
EA032: Electrical Conductivity (saturated paste)								
Electrical Conductivity (Saturated Paste)	----	1	µS/cm	2610	3930	3540	2130	----
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	15.1	20.2	24.6	22.2	----
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	33	36	35	35	----
Silt (2-60 µm)	----	1	%	27	38	56	29	----
Sand (0.06-2.00 mm)	----	1	%	36	26	9	26	----
Gravel (>2mm)	----	1	%	4	<1	<1	10	----
Cobbles (>6cm)	----	1	%	<1	<1	<1	<1	----
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	1.0	2.6	3.3	8.3	----

Analytical Results

Sub-Matrix: SOIL			Client sample ID	CX1930-66306	CX1930-66310	CX1930-66314	CX1930-66323	----
			Client sampling date / time	15-SEP-2009 15:00	15-SEP-2009 15:00	15-SEP-2009 15:00	15-SEP-2009 15:00	----
Compound	CAS Number	LOR	Unit	EB0914861-011	EB0914861-012	EB0914861-013	EB0914861-014	----
ED007: Exchangeable Cations - Continued								
^ Exchangeable Magnesium	----	0.1	meq/100g	5.3	8.2	6.6	8.0	----
^ Exchangeable Potassium	----	0.1	meq/100g	0.6	1.0	1.2	1.2	----
^ Exchangeable Sodium	----	0.1	meq/100g	10.6	15.3	14.0	12.8	----
^ Cation Exchange Capacity	----	0.1	meq/100g	17.4	27.2	25.0	30.4	----
^ Exchangeable Sodium Percent	----	0.1	%	60.6	56.4	56.0	42.2	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.04	0.02	0.02	0.04	----
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	11	12	7	6	----
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	----
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	----
Chromium	7440-47-3	2	mg/kg	34	12	7	21	----
Cobalt	7440-48-4	2	mg/kg	<2	15	15	28	----
Copper	7440-50-8	5	mg/kg	9	63	32	91	----
Lead	7439-92-1	5	mg/kg	<5	9	8	10	----
Nickel	7440-02-0	2	mg/kg	6	42	34	71	----
Selenium	7782-49-2	5	mg/kg	<5	<5	<5	<5	----
Zinc	7440-66-6	5	mg/kg	16	96	89	90	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EB0815504**	Page	: 1 of 12
Amendment	: **1**		
Client	: **BOWEN BASIN JOINT VENTURE**	Laboratory	: Environmental Division Brisbane
Contact	: MR NGAIRE TRANTER	Contact	: Tim Kilmister
Address	: C/- McCOLLUM ENVIRONMENTAL MANAGEMENT SERVICES PTY LTD PO BOX 8120 MOUNT PLEASANT QLD, AUSTRALIA 4740	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: cash.sale@alsenviro.com	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 7 4953 2700	Telephone	: +61-7-3243 7222
Facsimile	: ----	Facsimile	: +61-7-3243 7218
Project	: CODRILLA	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 07-NOV-2008
Sampler	: ----	Issue Date	: 29-JAN-2009
Site	: ----		
		No. of samples received	: 12
Quote number	: ----	No. of samples analysed	: 12

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA

WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Cass Sealby	Senior Chemist - Acid Sulphate Soils	Inorganics
Kim McCabe	Senior Inorganic Chemist	Inorganics
Stephen Hislop	Senior Inorganic Chemist	Inorganics
Stephen Hislop	Senior Inorganic Chemist	Stafford Minerals - AY

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 insuffient 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 date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

Key : CAS Number = Chemistry Abstract Services number
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **ANC Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong.**
- **ED040S (Soluble Major Anions): Sample EB0815504-011 (CX0714FC ENV1/A) shows poor duplicate results due to sample heterogeneity. Confirmed by visual inspection.**
- **EG005T (Total metals) Sample EB0815504-001 (CX0417FC ENV1) shows poor duplicate results due to sample heterogeneity. Confirmed by visual inspection.**
- **EG005T (Total metals) Sample EB0815504-002 (CX0417FC ENV2) shows poor matrix spike recovery due to matrix interference. Confirmed by visual inspection.**
- **EG005T (Total metals) Sample EB0815504-011 (CX0714FC ENV1/A) shows poor duplicate results due to sample heterogeneity. Confirmed by visual inspection..**
- **Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime ($CaCO_3$) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from 'kg/t dry weight' to 'kg/m3 in-situ soil', multiply 'reported results' x 'wet bulk density of soil in t/m3'.**
- **Retained Acidity not required because pH KCl greater than or equal to 4.5**
- **This report has been amended and re-released to allow the change of client details.**

Analytical Results

Sub-Matrix: SOIL			Client sample ID	CX0417FC ENV1 9.24 To 9.38 wea obn	CX0417FC ENV2 21.08 To 21.24 wea obn	CX0417FC ENV3 68.55 To 68.75 obn	CX0701FC ENV2 21.56 To 21.6 wea obn	CX0701FC ENV1 2.85 To 3 wea obn
			Client sampling date / time	[06-NOV-2008]	[06-NOV-2008]	[06-NOV-2008]	[06-NOV-2008]	[06-NOV-2008]
Compound	CAS Number	LOR	Unit	EB0815504-001	EB0815504-002	EB0815504-003	EB0815504-004	EB0815504-005
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	7.2	8.5	8.9	7.4	8.2
EA009: Nett Acid Production Potential								
^ Net Acid Production Potential	----	0.5	kg H2SO4/t	-4.4	-3.8	-16.0	-1.7	-2.8
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	6.4	7.5	8.5	5.9	6.0
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	2.4	<0.1	<0.1	4.8	8.7
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equ	5.0	3.8	17.2	2.0	2.8
^ ANC as CaCO3	----	0.1	% CaCO3	0.5	0.4	1.8	0.2	0.3
Fizz Rating	----	0	Fizz Unit	0	0	0	0	0
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	6.0	7.3	8.2	5.0	6.4
pH OX (23B)	----	0.1	pH Unit	7.2	9.0	8.8	6.3	6.9
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	2	<2	<2	12	<2
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	<2	<2	2	7
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	<2	<2	<2	7
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	0.02	<0.02	<0.02	<0.02	<0.02
Peroxide Sulfur (23De)	----	0.02	% S	<0.02	<0.02	0.03	<0.02	<0.02
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	<0.02	<0.02	0.03	<0.02	<0.02
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	<10	18	<10	<10
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	<0.02	0.05	0.12	0.03	0.04
Peroxide Calcium (23Wh)	----	0.02	% Ca	<0.02	0.07	0.42	<0.02	<0.02
Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.02	<0.02	0.30	<0.02	<0.02
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	<10	152	<10	<10
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.02	<0.02	0.24	<0.02	<0.02

Analytical Results

Sub-Matrix: SOIL			Client sample ID	CX0417FC ENV1 9.24 To 9.38 wea obn	CX0417FC ENV2 21.08 To 21.24 wea obn	CX0417FC ENV3 68.55 To 68.75 obn	CX0701FC ENV2 21.56 To 21.6 wea obn	CX0701FC ENV1 2.85 To 3 wea obn
			Client sampling date / time	[06-NOV-2008]	[06-NOV-2008]	[06-NOV-2008]	[06-NOV-2008]	[06-NOV-2008]
Compound	CAS Number	LOR	Unit	EB0815504-001	EB0815504-002	EB0815504-003	EB0815504-004	EB0815504-005
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	0.10	0.11	0.10	0.12	0.14
Peroxide Magnesium (23Tm)	----	0.02	% Mg	0.10	0.11	0.17	0.10	0.12
Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.02	<0.02	0.07	<0.02	<0.02
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	<10	55	<10	<10
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.02	<0.02	0.09	<0.02	<0.02
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	<0.02	0.39	0.44	----	<0.02
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	<10	78	88	----	<10
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	<0.02	0.12	0.14	----	<0.02
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	12	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	11.2	11.0	8.0	10.4	10.9
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	0.3	1.5	4.0	1.1	1.4
^ Exchangeable Magnesium	----	0.1	meq/100g	6.9	7.0	6.8	8.0	9.9
^ Exchangeable Potassium	----	0.1	meq/100g	0.7	0.6	1.0	0.5	0.8
^ Exchangeable Sodium	----	0.1	meq/100g	8.6	8.0	8.1	7.7	10.3
^ Cation Exchange Capacity	----	0.1	meq/100g	16.5	17.1	19.9	17.3	22.4
^ Exchangeable Sodium Percent	----	0.1	%	52.0	46.6	40.5	44.4	46.1
ED040S: Soluble Major Anions								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	160	120	260	110	160
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	<0.01	0.04	0.01	<0.01
ED045: Chloride								
Chloride	16887-00-6	10	mg/kg	1130	1180	1020	880	890
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	5010	4700	7140	3630	5050
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5

Analytical Results

Sub-Matrix: SOIL			Client sample ID	CX0417FC ENV1 9.24 To 9.38 wea obn	CX0417FC ENV2 21.08 To 21.24 wea obn	CX0417FC ENV3 68.55 To 68.75 obn	CX0701FC ENV2 21.56 To 21.6 wea obn	CX0701FC ENV1 2.85 To 3 wea obn
			Client sampling date / time	[06-NOV-2008]	[06-NOV-2008]	[06-NOV-2008]	[06-NOV-2008]	[06-NOV-2008]
Compound	CAS Number	LOR	Unit	EB0815504-001	EB0815504-002	EB0815504-003	EB0815504-004	EB0815504-005
EG005T: Total Metals by ICP-AES - Continued								
Arsenic	7440-38-2	5	mg/kg	<5	<5	14	<5	<5
Barium	7440-39-3	10	mg/kg	20	60	<10	<10	<10
Beryllium	7440-41-7	1	mg/kg	3	<1	<1	<1	<1
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	15	8	15	12	6
Cobalt	7440-48-4	2	mg/kg	10	6	36	<2	<2
Copper	7440-50-8	5	mg/kg	16	18	65	12	9
Iron	7439-89-6	50	mg/kg	14000	16200	15000	13400	24500
Lead	7439-92-1	5	mg/kg	14	13	23	6	<5
Manganese	7439-96-5	5	mg/kg	238	393	351	6	7
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
Nickel	7440-02-0	2	mg/kg	23	9	38	6	6
Selenium	7782-49-2	5	mg/kg	<5	<5	<5	<5	<5
Silver	7440-22-4	2	mg/kg	<2	<2	<2	<2	<2
Strontium	7440-24-6	2	mg/kg	20	38	66	32	44
Tin	7440-31-5	5	mg/kg	<5	<5	<5	<5	<5
Vanadium	7440-62-2	5	mg/kg	38	46	20	58	17
Zinc	7440-66-6	5	mg/kg	22	19	101	8	13
Calcium	7440-70-2	50	mg/kg	60	450	5460	260	320
Magnesium	7439-95-4	50	mg/kg	1370	1360	5010	1380	2150
Sodium	7440-23-5	50	mg/kg	2300	2190	2240	2140	2600
Potassium	7440-09-7	50	mg/kg	610	500	610	270	260
^ Sulfur as S	----	50	mg/kg	80	<50	350	60	<50
Phosphorus	7723-14-0	50	mg/kg	80	110	800	<50	<50
Titanium	7440-32-6	10	mg/kg	10	10	20	<10	20
Thallium	7440-28-0	5	mg/kg	<5	<5	<5	<5	<5
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	----	0.100	mg/kg	<0.100	0.321	<0.100	<0.100	<0.100
EK058G: Nitrate as N by Discrete Analyser								
^ Nitrate as N (Sol.)	----	0.100	mg/kg	<0.100	<0.100	<0.100	<0.100	<0.100
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.100	mg/kg	<0.100	0.360	0.147	<0.100	0.146

Analytical Results

Sub-Matrix: SOIL			Client sample ID	CX0701FC ENV3 36.78 To 36.9 wea obn	CX0732FC ENV1/A 35 To 35.1 wea obn	CX0732FC ENV1/B 35.1 To 35.2 wea obn	CX0732FC ENV2/A 47.92 To 48.12 wea obn	CX0732FC ENV2/B 48.12 To 48.22 wea obn
			Client sampling date / time	[06-NOV-2008]	[06-NOV-2008]	[06-NOV-2008]	[06-NOV-2008]	[06-NOV-2008]
Compound	CAS Number	LOR	Unit	EB0815504-006	EB0815504-007	EB0815504-008	EB0815504-009	EB0815504-010
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	8.6	8.1	8.2	8.2	8.4
EA009: Nett Acid Production Potential								
^ Net Acid Production Potential	----	0.5	kg H2SO4/t	<0.5	-0.6	-4.2	-4.5	-3.2
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	6.2	6.1	6.5	6.0	6.0
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	4.9	6.8	2.8	7.5	6.2
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equ	<0.5	2.8	4.6	4.8	3.6
^ ANC as CaCO3	----	0.1	% CaCO3	<0.1	0.3	0.5	0.5	0.4
Fizz Rating	----	0	Fizz Unit	0	0	0	0	0
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	6.9	6.8	6.8	7.0	7.0
pH OX (23B)	----	0.1	pH Unit	7.0	6.9	7.1	4.2	4.2
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	11	<2	77	72
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	11	<2	77	72
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	0.12	0.12
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	0.12	0.12
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Peroxide Sulfur (23De)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	0.03	0.06	0.06	0.10	0.06
Peroxide Calcium (23Wh)	----	0.02	% Ca	<0.02	0.05	0.05	0.12	0.06
Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.02	<0.02	<0.02	0.02	<0.02
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	<10	<10	10	<10
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02

Analytical Results

Sub-Matrix: SOIL			Client sample ID	CX0701FC ENV3 36.78 To 36.9 wea obn	CX0732FC ENV1/A 35 To 35.1 wea obn	CX0732FC ENV1/B 35.1 To 35.2 wea obn	CX0732FC ENV2/A 47.92 To 48.12 wea obn	CX0732FC ENV2/B 48.12 To 48.22 wea obn
			Client sampling date / time	[06-NOV-2008]	[06-NOV-2008]	[06-NOV-2008]	[06-NOV-2008]	[06-NOV-2008]
Compound	CAS Number	LOR	Unit	EB0815504-006	EB0815504-007	EB0815504-008	EB0815504-009	EB0815504-010
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	**0.07**	**0.13**	**0.13**	**0.15**	**0.12**
Peroxide Magnesium (23Tm)	----	0.02	% Mg	**0.06**	**0.12**	**0.12**	**0.14**	**0.11**
Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.02	<0.02	<0.02	<0.02	<0.02
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	<10	<10	<10	<10
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	**0.06**	<0.02	**0.08**	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	**12**	<10	**16**	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	<0.02	<0.02	**0.03**	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	**0.08**	**0.08**
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	**51**	**48**
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	**4**	**4**
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	**12.4**	**17.9**	**13.4**	**15.4**	**15.4**
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	**1.0**	**2.2**	**2.3**	**3.6**	**2.6**
^ Exchangeable Magnesium	----	0.1	meq/100g	**4.6**	**8.8**	**8.5**	**9.9**	**8.3**
^ Exchangeable Potassium	----	0.1	meq/100g	**0.4**	**0.7**	**0.8**	**0.5**	**0.6**
^ Exchangeable Sodium	----	0.1	meq/100g	**6.5**	**12.0**	**11.4**	**11.9**	**10.9**
^ Cation Exchange Capacity	----	0.1	meq/100g	**12.5**	**23.8**	**22.9**	**26.0**	**22.4**
^ Exchangeable Sodium Percent	----	0.1	%	**51.8**	**50.4**	**49.6**	**46.0**	**48.5**
ED040S: Soluble Major Anions								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	**160**	**160**	**110**	**170**	**190**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	**0.07**	**0.01**	**0.01**	**0.01**
ED045: Chloride								
Chloride	16887-00-6	10	mg/kg	**1030**	**1880**	**1370**	**1910**	**1970**
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**2150**	**1900**	**2920**	**1690**	**1770**
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5

Analytical Results

Sub-Matrix: **SOIL**

Client sample ID				CX0701FC ENV3 36.78 To 36.9 wea obn	CX0732FC ENV1/A 35 To 35.1 wea obn	CX0732FC ENV1/B 35.1 To 35.2 wea obn	CX0732FC ENV2/A 47.92 To 48.12 wea obn	CX0732FC ENV2/B 48.12 To 48.22 wea obn
Client sampling date / time				[06-NOV-2008]	[06-NOV-2008]	[06-NOV-2008]	[06-NOV-2008]	[06-NOV-2008]
Compound	*CAS Number*	*LOR*	*Unit*	**EB0815504-006**	**EB0815504-007**	**EB0815504-008**	**EB0815504-009**	**EB0815504-010**
EG005T: Total Metals by ICP-AES - Continued								
Arsenic	7440-38-2	5	mg/kg	**10**	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg	<10	**40**	<10	**40**	**80**
Beryllium	7440-41-7	1	mg/kg	**1**	<1	**1**	**1**	<1
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	**4**	**7**	**35**	**7**	**7**
Cobalt	7440-48-4	2	mg/kg	**3**	<2	**2**	<2	<2
Copper	7440-50-8	5	mg/kg	**14**	**10**	**35**	**8**	**17**
Iron	7439-89-6	50	mg/kg	**17500**	**19200**	**85600**	**870**	**4770**
Lead	7439-92-1	5	mg/kg	<5	<5	<5	**12**	**6**
Manganese	7439-96-5	5	mg/kg	**43**	**7**	**44**	<5	**105**
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
Nickel	7440-02-0	2	mg/kg	**7**	**3**	**14**	**2**	**3**
Selenium	7782-49-2	5	mg/kg	<5	<5	<5	<5	<5
Silver	7440-22-4	2	mg/kg	<2	<2	<2	<2	<2
Strontium	7440-24-6	2	mg/kg	**28**	**256**	**98**	**123**	**130**
Tin	7440-31-5	5	mg/kg	<5	<5	<5	<5	<5
Vanadium	7440-62-2	5	mg/kg	**34**	**20**	**75**	**14**	**16**
Zinc	7440-66-6	5	mg/kg	**12**	<5	**16**	<5	**11**
Calcium	7440-70-2	50	mg/kg	**380**	**500**	**640**	**640**	**590**
Magnesium	7439-95-4	50	mg/kg	**930**	**1090**	**1310**	**1140**	**1060**
Sodium	7440-23-5	50	mg/kg	**1600**	**2480**	**2360**	**2390**	**2280**
Potassium	7440-09-7	50	mg/kg	**130**	**210**	**190**	**430**	**410**
^ Sulfur as S	----	50	mg/kg	<50	**50**	<50	<50	<50
Phosphorus	7723-14-0	50	mg/kg	**160**	**340**	**780**	**100**	**140**
Titanium	7440-32-6	10	mg/kg	**30**	<10	**40**	<10	<10
Thallium	7440-28-0	5	mg/kg	<5	<5	<5	<5	<5
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	----	0.100	mg/kg	<0.100	<0.100	<0.100	<0.100	<0.100
EK058G: Nitrate as N by Discrete Analyser								
^ Nitrate as N (Sol.)	----	0.100	mg/kg	<0.100	<0.100	<0.100	<0.100	<0.100
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.100	mg/kg	<0.100	<0.100	**0.133**	**0.124**	<0.100

Analytical Results

Sub-Matrix: SOIL			Client sample ID	CX0714FC ENV1/A 19.4 To 19.5 wea obn	CX0714FC ENV2/B 19.5 To 19.6 wea obn	----	----	----
			Client sampling date / time	[06-NOV-2008]	[06-NOV-2008]	----	----	----
Compound	CAS Number	LOR	Unit	EB0815504-011	EB0815504-012	----	----	----
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**8.2**	**8.0**	----	----	----
EA009: Nett Acid Production Potential								
^ Net Acid Production Potential	----	0.5	kg H2SO4/t	**-2.0**	**-1.5**	----	----	----
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**6.0**	**6.0**	----	----	----
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	----	----	----
NAG (pH 7.0)	----	0.1	kg H2SO4/t	**5.9**	**5.9**	----	----	----
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equ	**2.0**	**3.3**	----	----	----
^ ANC as CaCO3	----	0.1	% CaCO3	**0.2**	**0.3**	----	----	----
Fizz Rating	----	0	Fizz Unit	**0**	**0**	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	**6.0**	**6.4**	----	----	----
pH OX (23B)	----	0.1	pH Unit	**7.8**	**7.2**	----	----	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	----	----	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	**10**	----	----	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	**10**	----	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	----	----	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	<0.02	<0.02	----	----	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.02	<0.02	----	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	**0.02**	----	----	----
Peroxide Sulfur (23De)	----	0.02	% S	<0.02	**0.02**	----	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	<0.02	<0.02	----	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	<10	----	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	<0.02	<0.02	----	----	----
Peroxide Calcium (23Wh)	----	0.02	% Ca	<0.02	<0.02	----	----	----
Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.02	<0.02	----	----	----
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	<10	----	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.02	<0.02	----	----	----
EA029-E: Magnesium Values								

Analytical Results

Sub-Matrix: SOIL			Client sample ID	CX0714FC ENV1/A 19.4 To 19.5 wea obn	CX0714FC ENV2/B 19.5 To 19.6 wea obn	----	----	----
			Client sampling date / time	[06-NOV-2008]	[06-NOV-2008]	----	----	----
Compound	CAS Number	LOR	Unit	EB0815504-011	EB0815504-012	----	----	----
EA029-E: Magnesium Values - Continued								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	**0.08**	**0.08**	----	----	----
Peroxide Magnesium (23Tm)	----	0.02	% Mg	**0.07**	**0.06**	----	----	----
Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.02	<0.02	----	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	<10	----	----	----
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.02	<0.02	----	----	----
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	**0.08**	<0.02	----	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	**16**	<10	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	**0.03**	<0.02	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	----	----	----
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	----	----	----
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	----	----	----
Liming Rate	----	1	kg CaCO3/t	<1	<1	----	----	----
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	**16.0**	**12.4**	----	----	----
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	**0.6**	**0.6**	----	----	----
^ Exchangeable Magnesium	----	0.1	meq/100g	**5.2**	**5.2**	----	----	----
^ Exchangeable Potassium	----	0.1	meq/100g	**0.4**	**0.4**	----	----	----
^ Exchangeable Sodium	----	0.1	meq/100g	**7.7**	**7.8**	----	----	----
^ Cation Exchange Capacity	----	0.1	meq/100g	**13.9**	**14.0**	----	----	----
^ Exchangeable Sodium Percent	----	0.1	%	**55.2**	**55.7**	----	----	----
ED040S: Soluble Major Anions								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	**490**	**330**	----	----	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	**0.06**	----	----	----
ED045: Chloride								
Chloride	16887-00-6	10	mg/kg	**1380**	**1300**	----	----	----
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**3440**	**3160**	----	----	----
Antimony	7440-36-0	5	mg/kg	<5	<5	----	----	----
Arsenic	7440-38-2	5	mg/kg	<5	<5	----	----	----

Analytical Results

Sub-Matrix: **SOIL**			*Client sample ID*	**CX0714FC ENV1/A 19.4 To 19.5 wea obn**	**CX0714FC ENV2/B 19.5 To 19.6 wea obn**	----	----	----
			Client sampling date / time	[06-NOV-2008]	[06-NOV-2008]	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB0815504-011**	**EB0815504-012**	**----**	**----**	**----**
EG005T: Total Metals by ICP-AES - Continued								
Barium	7440-39-3	10	mg/kg	<10	**110**	----	----	----
Beryllium	7440-41-7	1	mg/kg	<1	<1	----	----	----
Boron	7440-42-8	50	mg/kg	<50	<50	----	----	----
Cadmium	7440-43-9	1	mg/kg	<1	<1	----	----	----
Chromium	7440-47-3	2	mg/kg	**8**	**7**	----	----	----
Cobalt	7440-48-4	2	mg/kg	<2	**5**	----	----	----
Copper	7440-50-8	5	mg/kg	**8**	**10**	----	----	----
Iron	7439-89-6	50	mg/kg	**7500**	**7870**	----	----	----
Lead	7439-92-1	5	mg/kg	<5	<5	----	----	----
Manganese	7439-96-5	5	mg/kg	**36**	**440**	----	----	----
Molybdenum	7439-98-7	2	mg/kg	<2	<2	----	----	----
Nickel	7440-02-0	2	mg/kg	**7**	**7**	----	----	----
Selenium	7782-49-2	5	mg/kg	<5	<5	----	----	----
Silver	7440-22-4	2	mg/kg	<2	<2	----	----	----
Strontium	7440-24-6	2	mg/kg	**21**	**22**	----	----	----
Tin	7440-31-5	5	mg/kg	<5	<5	----	----	----
Vanadium	7440-62-2	5	mg/kg	**13**	**17**	----	----	----
Zinc	7440-66-6	5	mg/kg	**35**	**16**	----	----	----
Calcium	7440-70-2	50	mg/kg	**140**	**130**	----	----	----
Magnesium	7439-95-4	50	mg/kg	**1220**	**1100**	----	----	----
Sodium	7440-23-5	50	mg/kg	**2210**	**2040**	----	----	----
Potassium	7440-09-7	50	mg/kg	**430**	**400**	----	----	----
^ Sulfur as S	----	50	mg/kg	**60**	**60**	----	----	----
Phosphorus	7723-14-0	50	mg/kg	<50	<50	----	----	----
Titanium	7440-32-6	10	mg/kg	**10**	**20**	----	----	----
Thallium	7440-28-0	5	mg/kg	<5	<5	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	----	0.100	mg/kg	<0.100	<0.100	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
^ Nitrate as N (Sol.)	----	0.100	mg/kg	<0.100	<0.100	----	----	----
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.100	mg/kg	<0.100	<0.100	----	----	----

Land and Property Management Authority

Soil Conservation Service

SOIL TEST REPORT

Scone Research Centre

REPORT NO:	SCO09/294R1
REPORT TO:	Clayton Richards GSS Environmental PO Box 907 Hamilton NSW 2303
REPORT ON:	Thirty seven soil samples Codrilla MEM06-002
PRELIMINARY RESULTS ISSUED:	Not issued
REPORT STATUS:	Final
DATE REPORTED:	13 November 2009
METHODS:	Information on test procedures can be obtained from Scone Research Centre

TESTING CARRIED OUT ON SAMPLE AS RECEIVED
THIS DOCUMENT MAY NOT BE REPRODUCED EXCEPT IN FULL

SR Young

SR Young
(Laboratory Manager)

SOIL AND WATER TESTING LABORATORY
Scone Research Service Centre

Report No: SCO09/294R1
Client Reference: Clayton Richards
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/1 Particle Size Analysis (%)					P9B/2	C1A/4	C2A/3	C5A/3 CEC & ex cation (me/100g)			P18B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	EC (dS/m)	pH	CEC	Na	ESP	MC 15 bar (%)	Dry	Moist
1	Codrilla 1/1	10	14	70	6	<1	3(1)	0.02	6.2	4.8	<0.1	<2	3.3	10YR6/3	10YR4/3
2	Codrilla 1/2	26	17	53	4	0	3(2)	0.01	6.7	10.3	0.4	4	8.4	7.5YR6/4	7.5YR4/4
3	Codrilla 1/3	33	12	52	3	0	2(1)	0.02	7.1	13.3	0.9	7	11.1	7.5YR6/6	7.5YR5/6
4	Codrilla 2/1	16	19	49	16	<1	3(2)	0.02	7.2	7.7	0.4	5	5.1	10YR6/2	10YR4/2
5	Codrilla 2/2	16	18	49	16	1	2(2)	0.03	7.8	7.7	0.7	9	4.9	10YR7/2	10YR4/2
6	Codrilla 2/3	48	12	29	10	1	2(3)	0.62	9.2	23.2	5.4	23	14.6	10YR6/4	10YR4/4
7	Codrilla 3/1	34	8	47	11	<1	3(2)	0.10	8.5	20.8	2.0	10	11.0	10YR6/2	10YR4/2
8	Codrilla 3/2	36	8	43	12	1	2(1)	0.24	9.2	23.1	2.9	13	11.6	10YR6/2	10YR5/3
9	Codrilla 5/1	10	10	55	25	<1	3(1)	0.02	7.0	4.7	0.3	6	2.9	10YR6/2	10YR4/2
10	Codrilla 5/2	34	6	36	18	6	1	0.21	7.6	13.2	3.9	30	12.2	10YR6/3	10YR5/4
11	Codrilla 6/1	25	14	49	12	<1	8/3(1)	0.03	6.6	11.8	0.4	3	7.9	10YR5/3	10YR3/2
12	Codrilla 6/2	44	6	39	11	<1	2(3)	0.60	8.7	21.8	5.6	26	13.5	10YR6/3	10YR5/2

SOIL AND WATER TESTING LABORATORY
Scone Research Service Centre

Report No: SCO09/294R1
Client Reference: Clayton Richards
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/1 Particle Size Analysis (%)					P9B/2	C1A/4	C2A/3	C5A/3 CEC & ex cation (me/100g)			P18B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	EC (dS/m)	pH	CEC	Na	ESP	MC 15 bar (%)	Dry	Moist
13	Codrilla 7/1	23	12	43	21	1	3(1)	0.01	6.8	8.2	0.4	5	6.2	10YR6/3	10YR4/4
14	Codrilla 7/2	50	10	29	11	<1	2(3)	0.14	8.0	20.1	3.3	16	15.4	10YR6/3	10YR5/4
15	Codrilla 8/1	14	2	59	25	<1	3(1)	<0.01	6.7	3.9	0.2	5	3.4	10YR6/3	10YR4/4
16	Codrilla 8/2	19	4	51	21	5	3(2)	0.01	7.3	3.6	0.8	22	4.6	10YR7/6	10YR5/6
17	Codrilla 9/1	23	13	49	15	<1	3(1)	0.02	6.4	11.1	0.6	5	7.1	10YR6/3	10YR4/3
18	Codrilla 9/2	50	11	29	9	1	2(1)	0.30	9.0	27.2	3.7	14	14.5	10YR6/3	10YR5/3
19	Codrilla 9/3	41	10	37	11	1	2(3)	0.95	9.3	23.8	6.8	29	13.5	10YR6/3	10YR5/4
20	Codrilla 10/1	38	15	34	13	<1	2(3)	0.12	8.4	16.1	2.9	18	11.2	10YR6/3	10YR4/3
21	Codrilla 10/2	35	15	36	12	2	2(3)	0.79	9.2	17.7	6.1	34	11.9	10YR6/3	10YR5/4
22	Codrilla 12/1	7	11	51	29	2	8/3(1)	<0.01	7.7	2.4	0.2	8	2.1	7.5YR7/2	7.5YR5/3
23	Codrilla 12/2	21	8	38	21	12	3(2)	0.01	7.5	4.8	0.5	10	6.3	10YR7/3	10YR5/4
24	Codrilla 13/1	30	11	31	26	2	3(3)	0.01	7.1	9.7	0.4	4	8.1	10YR6/4	10YR4/4
25	Codrilla 13/2	45	10	23	20	2	2(3)	0.04	7.6	15.5	1.8	12	13.0	10YR6/3	10YR5/4

SOIL AND WATER TESTING LABORATORY
Scone Research Service Centre

Report No: SCO09/294R1
Client Reference: Clayton Richards
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/1 Particle Size Analysis (%)					P9B/2	C1A/4	C2A/3	C5A/3 CEC & ex cation (me/100g)			P18B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	EC (dS/m)	pH	CEC	Na	ESP	MC 15 bar (%)	Dry	Moist
26	Codrilla 14/1	8	6	52	29	5	3(1)	<0.01	6.0	2.1	0.2	10	1.9	10YR7/2	10YR5/4
27	Codrilla 14/2	27	7	27	21	18	2(3)	0.08	8.6	12.8	2.9	23	11.4	10YR6/4	10YR5/4
28	Codrilla 15/1	17	23	46	14	<1	3(3)	0.02	6.6	5.8	0.5	9	4.8	10YR6/3	10YR4/3
29	Codrilla 15/2	33	14	36	16	1	2(3)	0.53	8.2	12.0	4.8	40	10.6	10YR6/4	10YR4/6
30	Codrilla 16/1	20	13	46	19	2	2(1)	0.03	7.4	6.4	1.2	19	6.1	10YR6/3	10YR4/4
31	Codrilla 16/2	37	11	36	15	1	2(3)	0.54	9.1	15.9	7.2	45	12.5	10YR6/6	10YR4/6
32	Codrilla 17/1	10	9	49	27	5	8/3(1)	0.01	7.5	4.7	0.6	13	3.2	10YR7/2	10YR5/4
33	Codrilla 17/2	27	11	42	20	<1	2(3)	0.56	9.0	15.4	5.4	35	10.4	10YR6/4	10YR4/6
34	Codrilla 18/1	13	16	39	26	6	8/3(2)	0.01	8.0	5.4	0.6	11	3.5	10YR6/3	10YR4/4
35	Codrilla 18/2	33	13	31	22	1	1	0.15	9.1	14.0	3.5	25	10.2	10YR6/4	10YR4/6
36	Codrilla 19/1	13	8	52	26	1	8/3(2)	<0.01	7.5	5.2	0.4	8	3.4	10YR6/3	10YR4/4
37	Codrilla 19/2	30	5	42	20	3	3(3)	0.01	7.6	7.4	0.5	7	7.6	10YR7/6	10YR5/6

END OF TEST REPORT

Land and Property Management Authority

Soil Conservation Service

SOIL TEST REPORT

Scone Research Centre

REPORT NO:	SCO09/293R1
REPORT TO:	Clayton Richards GSS Environmental PO Box 907 Hamilton NSW 2303
REPORT ON:	Twenty three soil samples Codrilla Haul Road MEM06-002
PRELIMINARY RESULTS ISSUED:	Not issued
REPORT STATUS:	Final
DATE REPORTED:	6 November 2009
METHODS:	Information on test procedures can be obtained from Scone Research Centre

TESTING CARRIED OUT ON SAMPLE AS RECEIVED
THIS DOCUMENT MAY NOT BE REPRODUCED EXCEPT IN FULL

SR Young

SR Young
(Laboratory Manager)

SOIL AND WATER TESTING LABORATORY
Scone Research Service Centre

Report No: SCO09/293R1
Client Reference: Clayton Richards
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/1 Particle Size Analysis (%)					P9B/2	C1A/4	C2A/3	C5A/3 CEC & ex cation (me/100g)			P18B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	EC (dS/m)	pH	CEC	Na	ESP	MC 15 bar (%)	Dry	Moist
1	Codrilla HR 5/1	9	5	44	14	28	3(1)	<0.01	5.7	5.7	0.5	9	3.7	10YR5/4	10YR4/4
2	Codrilla HR 5/2	24	2	35	14	25	3(3)	0.01	6.4	10.2	1.1	11	8.5	10YR5/4	10YR4/4
3	Codrilla HR 5/3	42	5	34	19	<1	1	0.07	7.9	17.2	3.2	19	14.3	10YR4/6	10YR4/4
4	Codrilla HR 6/1	11	6	64	18	1	8/3(1)	0.02	6.2	8.6	0.4	5	4.0	10YR5/3	10YR3/3
5	Codrilla HR 6/2	11	6	62	21	<1	3(1)	<0.01	6.5	8.9	0.4	4	3.8	10YR5/3	10YR4/3
6	Codrilla HR 6/3	33	4	47	16	<1	2(3)	0.19	8.9	18.9	3.1	16	11.1	7.5YR5/6	7.5YR4/4
7	Codrilla HR 7/1	8	6	71	15	<1	8/3(1)	0.03	5.9	8.7	0.4	5	3.4	10YR5/4	10YR4/4
8	Codrilla HR 7/2	8	9	70	13	<1	3(1)	<0.01	5.7	5.0	0.4	8	2.2	10YR6/4	10YR4/4
9	Codrilla HR 7/3	33	7	51	9	0	2(3)	0.03	7.2	12.1	0.7	6	10.0	5YR5/4	5YR4/4
10	Codrilla HR 8/1	11	10	54	16	9	8/3(1)	0.02	6.3	13.3	0.2	2	5.1	10YR5/2	10YR4/2
11	Codrilla HR 8/2	27	7	34	10	22	2(3)	0.14	8.4	26.8	4.4	16	13.5	7.5YR4/2	7.5YR3/2
12	Codrilla HR 8/3	38	15	39	8	<1	1	0.91	6.0	27.2	10.5	39	14.5	7.5YR6/4	7.5YR5/4

SR Young

SOIL AND WATER TESTING LABORATORY
Scone Research Service Centre

Report No: SCO09/293R1
Client Reference: Clayton Richards
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/1 Particle Size Analysis (%)					P9B/2	C1A/4	C2A/3	C5A/3 CEC & ex cation (me/100g)			P18B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	EC (dS/m)	pH	CEC	Na	ESP	MC 15 bar (%)	Dry	Moist
13	Codrilla HR 11/1	6	11	63	19	1	8/3(1)	0.01	5.9	4.4	0.2	5	2.9	10YR5/2	10YR4/2
14	Codrilla HR 11/2	11	4	63	21	1	3(1)	<0.01	5.9	3.8	<0.1	<3	2.6	10YR5/4	10YR4/4
15	Codrilla HR 11/3	37	5	29	13	16	2(1)	0.03	7.0	8.9	0.5	6	11.5	10YR5/6	10YR4/6
16	Codrilla HR 12/1	9	6	62	23	<1	8/3(1)	0.03	7.0	7.5	0.1	1	3.0	10YR5/2	10YR4/2
17	Codrilla HR 12/2	4	10	61	24	1	3(1)	<0.01	6.8	3.3	<0.1	<3	1.1	7.5YR6/2	7.5YR4/2
18	Codrilla HR 12/3	27	12	42	19	<1	3(1)	0.29	9.2	19.8	1.8	9	10.1	10YR6/4	10YR5/4
19	Codrilla HR 13/1	4	8	59	29	<1	8/3(1)	0.02	6.5	4.2	<0.1	<2	2.3	10YR5/4	10YR4/4
20	Codrilla HR 13/2	8	8	56	28	<1	3(1)	<0.01	5.9	4.5	<0.1	<2	2.7	10YR6/4	10YR4/6
21	Codrilla HR 13/3	32	2	41	24	1	2(3)	0.06	7.3	8.9	2.0	22	10.3	10YR6/4	10YR5/4
22	Codrilla HR 14/1	18	16	50	16	<1	3(1)	0.05	7.4	16.4	0.1	1	7.0	10YR5/2	10YR4/2
23	Codrilla HR 14/2	48	14	28	10	<1	1	0.36	9.3	27.1	6.0	22	15.1	10YR6/3	10YR5/3

SR Young

END OF TEST REPORT