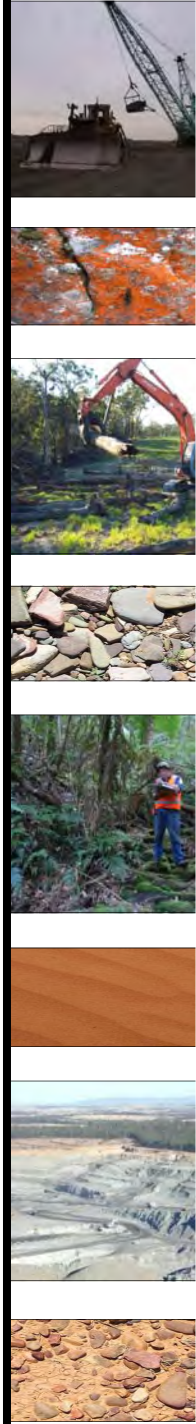

Soil Survey
and
Land Resource
Impact Assessment
(GSSE 2010a)

APPENDIX G

WHITEHAVEN COAL

WHITEHAVEN COAL LIMITED

Rocglen Coal Mine Extension Project

Part 3A of the *EP&A Act 1979*

Environmental Assessment:-

Soil Survey and Land Resource Impact Assessment

December 2010

WHM01-002

GSS ENVIRONMENTAL
Environmental, Land and Project Management Consultants

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1.0 INTRODUCTION

Whitehaven Coal Limited (Whitehaven) is seeking a new Project Approval under Part 3A of the *Environmental Planning & Assessment Act 1979* (*EP&A Act*) to expand operations at the company's Rocglen Coal Mine in the Gunnedah Coalfield of New South Wales (NSW). This project, from herein, is referred to as the Rocglen Extension Project.

GSS Environmental (GSSE) was engaged by Whitehaven to undertake a soil survey and land resource assessment for the Rocglen Extension Project for inclusion in an Environmental Assessment (EA) required to accompany the Project Application. The location and study area boundary of the Project Site is shown in **Figure 1.**

1.1 Objectives

To assist Whitehaven with the post-mining rehabilitation activities, a survey of land resources was undertaken by GSSE. The major objectives of this assessment were to:

- provide a description of the soil types within the Project Site, and highlight areas of unfavourable material that require specific management and handling practices;
- provide a description of, and figures showing, the land capability and agricultural suitability within the Project Site;
- provide recommendations for soil stripping depths in proposed disturbance areas, including any recommendations for handling, stockpiling and amelioration for reuse in rehabilitation; and
- describe necessary erosion and sediment control measures to manage in-situ and stockpiled soil resources.

The following report presents the results of the survey undertaken by GSSE and the assessment of land resources within the Project Site.

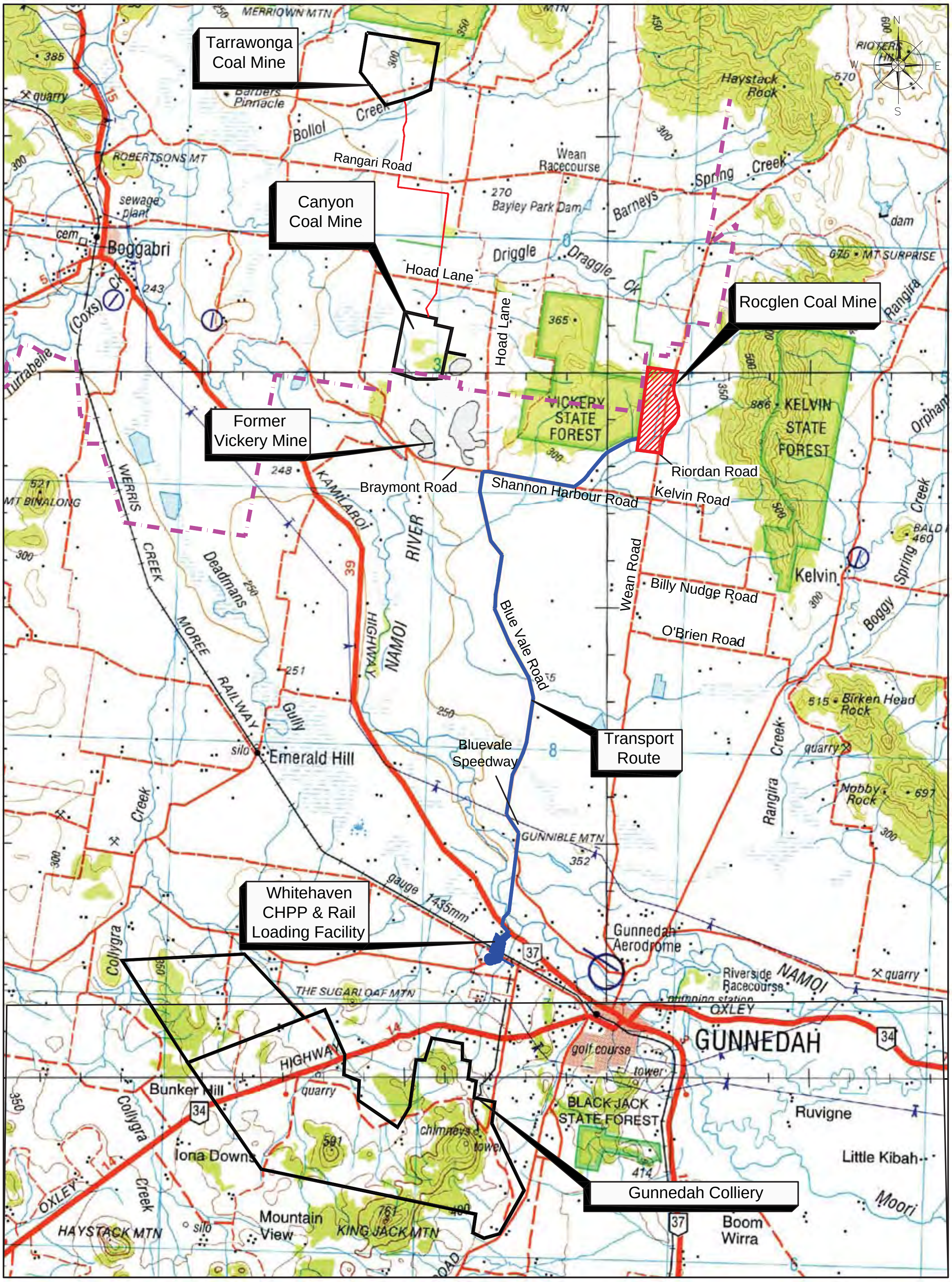
1.2 Location

As shown on **Figure 1**, the Rocglen Coal Mine is located in the Gunnedah Coalfield of NSW, on the Wean Road, approximately 25 km north of Gunnedah and 23 km south-east of Boggabri. The site lies directly adjacent (to the east) of the Vickery State Forest and approximately 3 km west of the Kelvin State Forest.

1.3 Project Site

The study area for the soil survey and land resource assessment encompasses the Project Site defined on **Figure 2**. This Project Site encompasses the areas of land within which mining and mining-related activities are currently approved under PA 06_0198 and those additional areas that are subject to the new Part 3A Project Application. As evident, this area extends beyond the existing Mining Lease (ML 1620).

The Project Site covers approximately 460 hectares within the Parish of Tulcumba, County of Nandewar and Local Government Area (LGA) of Gunnedah.



Grid: MGA (Zone 56)

0 0.25 0.5 0.75 1.0km

Base Plan Data Source: RWC & Australian Surveying & Land Information Group - Manilla SH56-09 1:250 000

LEGEND

- Current Mine Lease Boundary
- Approved Transport Route
- Gunnedah / Narrabri Shire Boundary

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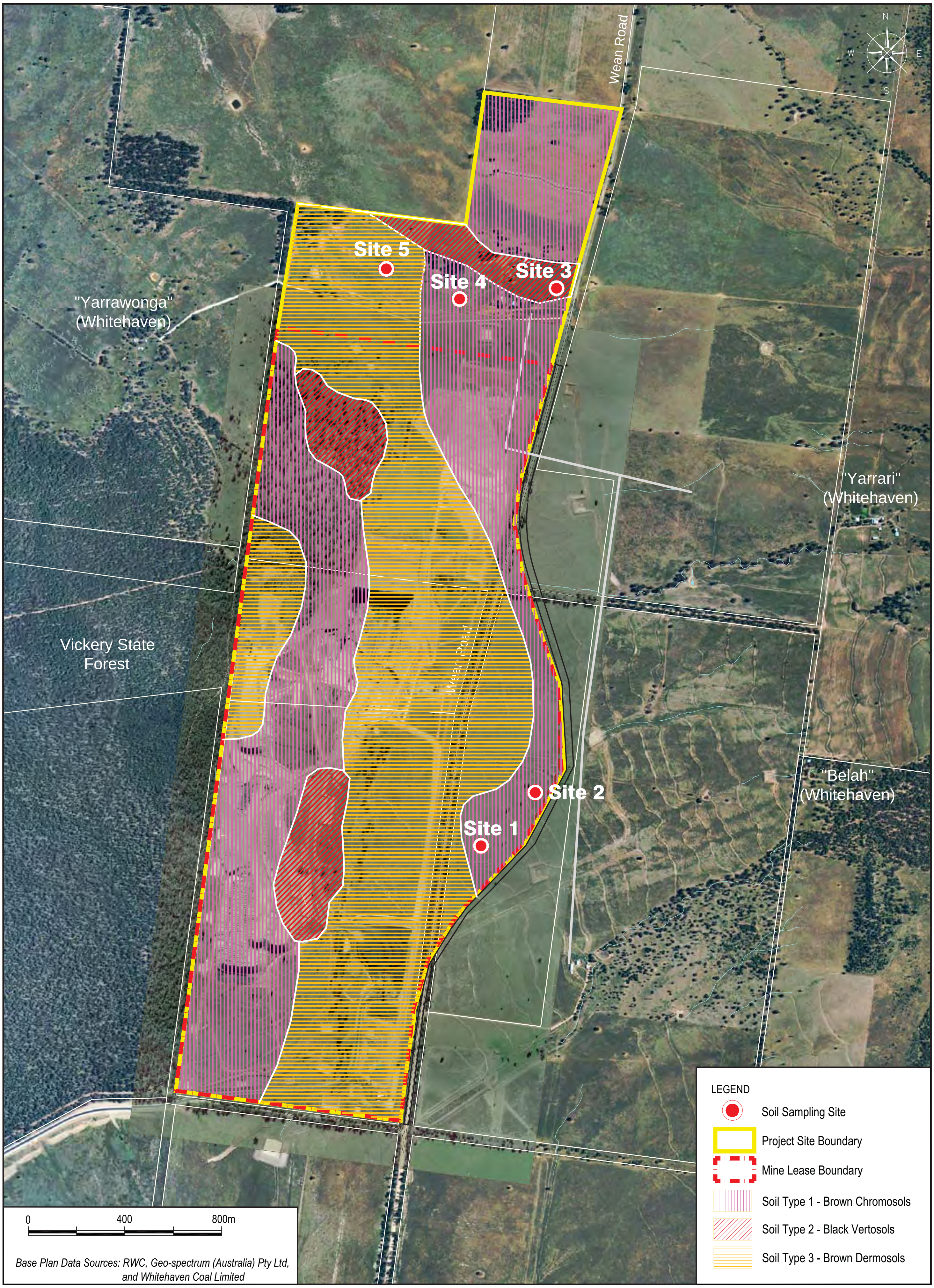
Rocglen Coal Mine Extension Project
Regional Location Plan

FIGURE 1



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Rocglen Coal Mine Extension Project
Soil Units

FIGURE 2

It incorporates all or part of the following land parcels:

- Lot 1 in DP 787417;
- Lots 1 and 4 in DP 1120601; and
- Public roads and road reserves.

All of the freehold land within the Project Site, being Lot 1 in DP 787414 and Lots 1 and 4 in DP 1120601, is owned by Whitehaven.

1.4 Zoning

Under the provisions of the *Gunnedah Local Environmental Plan 1998 (as amended) (LEP),* the entire Project Site is zoned No. 1(a) Rural (Agricultural Protection). Mining is a permissible land use within this zone with development consent. All land adjoining the Project Site is also zoned No. 1(a), with the exception of the Vickery State Forest immediately to the west, which is zoned No. 1(f) Forests.

1.5 Surrounding Land Use

With the exception of the Vickery State Forest adjoining the Project Site to the west, all other surrounding land is primarily utilised for traditional agricultural pursuits comprising a combination of livestock grazing and crop cultivation. No agricultural land within the vicinity of the Project Site is considered sensitive to mining or mining-related activities.

The nearest non-project related residence is located in excess of 1.5 km from the Project Site.

1.6 Topography

The project area lies within the Namoi River Catchment, in a small valley between the Vickery State Forest in the west and the Kelvin State Forest in the east. The project area ranges in elevation between 275 and 335 metres AHD and the general topography is level with slightly undulating mid and lower slopes. There are steeper slopes adjacent to Vickery State Forest on the western edge of the Project Site. The easterly aspect slopes become eroded waning lower slopes to flat plains in the northern and eastern sections of the Project Site. The Site displays an integrated convergent tributary channel pattern amongst the slightly undulating slopes. The lower relief plains in the vicinity of the expanded Northern Emplacement Area and open cut pit exhibit aggraded geomorphological activity with open depression drainage.

1.7 Land Management Units

In March 2009 the Namoi Catchment Management Authority (CMA) created a map titled *Land Management Units (LMU) in the Namoi Catchment.* This map identifies two (2) main LMUs within the Rocglen Project Site. These being -

Central Mixed Soil Floodplains (0 to 2% slope)

There are substantial plain areas of the central catchment (from the Liverpool Plains to Narrabri) that are of very low slope (0 to 2%) which are dominated by a mixture of alluvial soils. This LMU is dominated by very extensive meander plains (which are generally slightly higher in the plain landscape). This LMU generally has a land capability classification range of 2 to 7 and the soils are highly variable with Black Earths, Brown and Grey Clays, Red - Brown Earths and with minor Chernozems and hardsetting duplex soils, depending on the parent material contributing to the alluvium.

Localised extensive shallow saline groundwater is generally not a feature of this LMU, however deep fresh irrigation aquifers are found beneath where the alluvium sits on a coarse gravel fill over basement material. Recharge is generally thought to be from surface streams with gravel beds that are well connected to the underlying aquifers.

Landuse is more of a mosaic of cropping and grazing on native or improved pastures, which is largely determined by the fertility and tilth of the soil. Timber generally occurs as isolated or scattered trees, with occasional open woodlands. Native vegetation is mainly Bimble Box, White Box, Rough - Barked Apple, River Red Gum and Myall, with localised treeless plains dominated by Plains Grass.

Central Black Earth Floodplains (0 to 1% slope)

Black Earth Floodplains exist in association with the major rivers and creeks in the central part of the catchment. This LMU has a land capability classification of 2, 7 or 8. Floodways are where a channel may leave the river, meander, and rejoin steams. The floodplain is that area with a slope of generally <2% slope, dominated by very extensive black plains, with minor swamp and outwash areas.

Soils include deep Black Earths, Brown or Grey clays and some Earthy Sands. Some floodways are farmed, others are managed as pasture and some retain native vegetation of grasses, understorey, River Red Gum, Myall and Grey, Yellow or Bimble Box. The floodplain is intensively farmed and largely cleared of vegetation. This LMU is a dynamic environment and subject to inundation and severe erosion. Shallow saline groundwaters can be locally extensive in this LMU, and deep fresh irrigation aquifers are found beneath where the alluvium sits on a coarse gravel fill over basement material. Most of this LMU is used for cropping (with significant irrigation areas), with a minor portion used for grazing on native and improved pastures.

2.0 SURVEY METHODOLOGY

2.1 Introduction

A soil and land capability survey was undertaken in January 2010 by GSSE in order to:

1. classify and determine the soil profile types within the Project Site;
2. assess the suitability of the current topsoil and subsoil material for future rehabilitation; and
3. identify any potentially unfavourable soil material for future rehabilitation.

The survey was conducted in accordance with the survey methodology outlined in this section. The soils and land capability results are presented below in **Section 3**.

2.2 Soil Mapping

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

(1) Aerial Photography and Topographic Mapping

Aerial photography and topographic mapping interpretation was used as a remote sensing technique, allowing detailed analysis of the landscape and mapping of features expected to be related to the distribution of soils within the Project Site.

(2) Previous Soil Survey Results

In addition to reconnaissance of survey and LMU information provided by the Namoi CMA, GSSE reviewed the Soils and Land Capability Assessment report prepared in 2007 by Geoff Cunningham for the original Rocglen Coal Mine development.

These references were used to provide a framework and background data for the survey undertaken by GSSE in January 2010. While the 2007 study area and assessment included the majority of the new Project Site, the findings reported in the 2007 report were confirmed by GSSE whilst on-site.

(3) Stratified Observations

Following production of a broad soil 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.

2.3 Soil Profiling

Five soil profiles were assessed at selected sites 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 were also taken.

Soil profiles were also observed through the use of surface exposures located in existing erosion gullies, creek banks, roadway cuttings and dams. Soil profile site locations and soil units are shown on **Figure 2**.

2.4 Soil Field Assessment

Soil profiles within the Project Site 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. A more detailed explanation of the Elliot and Veness procedure is presented in **Appendix 1** to this report. The system remains the benchmark for land resource assessment in the Australian coal mining industry.

2.5 Soil Laboratory Testing

Soil samples were collected from the exposed soil profiles and subsequently sent to the NSW Department of Lands Soil and Water Testing Laboratory at Scone (NSW) for analysis. The soil laboratory results are contained in **Appendix 2**. 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**):

- Site 1 – 1/1, 1/2 and 1/3;
- Site 2 – 2/1, 2/2 and 2/3;
- Site 3 – 3/1, 3/2 and 3/3;
- Site 4 – 4/1, 4/2 and 4/3; and
- Site 5 – 5/1, 5/2 and 5/3.

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

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

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 in rehabilitation. Similarly, potentially unfavourable soil material can be identified. The soil test results for the soil survey are provided in **Appendix 3**.

2.6 Land Capability Assessment

The land capability assessment for the Project Site was conducted in accordance with the former NSW Soil Conservation Service's (now part of NSW Government's Land and Property Management Authority) rural land capability classification system.

The system consists of eight (8) classes, which classify land on the basis of an increasing soil erosion hazard and decreasing versatility of use. It recognises the following three (3) types of land uses:

- land suitable for cultivation;
- land suitable for grazing; and
- land not suitable for rural production.

These capability classifications identify limitations on the use of the land as a result of the interaction between the physical resources and a specific land use. The principal limitation recognised by these capability classifications is the stability of the soil mantle (Soil Conservation Service of NSW, 1986).

The method of land capability 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 uses such as crop production, pasture improvement and grazing.

The system allows for land to be allocated into eight (8) possible classes, with land capability decreasing progressively from Class I to Class VIII. The classes are described in **Table 1** below.

Table 1 – Rural Land Capability Classes

Rural Land Capability Classification System		
Land Class	**Land Suitability**	**Land Definition**
Class I	Regular Cultivation	No erosion control requirements
Class II	Regular Cultivation	Simple requirements such as crop rotation and minor strategic works
Class III	Regular Cultivation	Intensive soil conservation measures required, such as contour banks and waterways
Class IV	Grazing, occasional cultivation	Simple practices such as stock control and fertiliser application
Class V	Grazing, occasional cultivation	Intensive soil conservation measures required, such as contour ripping and banks
Class VI	Grazing only	Managed to ensure ground cover is maintained
Class VII	Unsuitable for rural production	Green timber maintained to control erosion
Class VIII	Unsuitable for rural production	Should not be cleared, logged or grazed
Source: Soil Conservation Service of NSW (1986).		

2.7 Agricultural Suitability Assessment

The agricultural suitability assessment for the Project Site was conducted in accordance with the former NSW Agriculture and Fisheries' (now part of Department of Industry and Investment) agricultural suitability classification system. The system consists of five classes, providing a ranking of lands according to their productivity for a wide range of agricultural activities with the objective of determining the potential for crop growth within certain limits.

The classification is based upon the effects of climate, topography and soil characteristics, the cultural and physical requirements for various crops and pastures, and existing socio-economic factors including local infrastructure and geographic location. These factors combine to determine the productive potential of the land and its capacity to produce crops, pastures and livestock. The classes are described in **Table 2** below.

Table 2 – Agricultural Suitability Classes

Agricultural Suitability Classification System		
Land Class	**Agricultural Suitability**	**Land Definition**
Class 1	Highly productive land suited to both row and field crops	Arable land suitable for intensive cultivation where constraints to sustained high levels of agricultural production are minor or absent
Class 2	Highly productive land suited to both row and field crops	Arable land suitable for regular cultivation for crops but not suited to continuous cultivation
Class 3	Moderately productive lands suited to improved pasture and to cropping within a pasture rotation	Grazing land or land well suited to pasture improvement. It may be cultivated or cropped in rotation with pasture
Class 4	Marginal lands not suitable for cultivation and with a low to very low productivity for grazing	Land suitable for grazing but not for cultivation. Agriculture is based on native or improved pastures established using minimum tillage
Class 5	Marginal lands not suitable for cultivation and with a low to very low productivity for grazing	Land unsuitable for agriculture or at best suited only to light grazing
Source: NSW Agriculture & Fisheries (1990).		

3.0 RESULTS

3.1 Soils

Five profile sites were assessed across the Project Site. Sites 1 and 2 were from lower to mid slope sites east of the Wean Road, and Sites 3, 4 and 5 were located on lower lying valley floor sites west of the Wean Road in the general area of the "Glenroc" residence. The profiles at Sites 1 and 2 were classified as Brown Chromosols and generally had sandier topsoils (i.e. sandy loams and fine sandy loams compared with clayey topsoils found in the Vertosol and Dermosol soils along the valley floor). One of the valley floor soils was classified as a Black Vertosol and the other found on the alluvial flat was a Sodic Brown Dermosol. Soils found on gentle interfluves were also Brown Chromosols with fine sandy loam topsoils. These were included in the same soil unit as Sites 1 and 2 for mapping and stripping purposes.

The following three soil units were identified and mapped within the Project Site:

- Soil Unit 1 - Brown Duplex Sandy Loams (Eutrophic Brown Chromosol) – approximately 204 ha;
- Soil Unit 2 - Self Mulching Black Earths (Self Mulching Black Vertosol) – approximately 38 ha; and
- Soil Unit 3 - Sodic Brown Alluvial Clays (Calcic Brown Dermosol) – approximately 218 ha.

The distribution of these soils is illustrated on **Figure 2**.

The three soil units identified and mapped within the Project Site are described and illustrated below, and a glossary of commonly used soils terms is presented in **Appendix 4**.

Soil Unit 1 - Brown Duplex Fine Sandy Loam Profile (Eutrophic Brown Chromosol)

Description: The Brown Duplex Loam soils generally consist of dark brown fine sandy loams with a clear wavy change to strong brown clays. These well-drained soils are moderately strongly alkaline at depth. The soils are generally non saline with moderate fertility characteristics. The topsoil and subsoil are non-sodic.

Location: These soils are found on the midslopes. Test Sites 1, 2 and 4 in the GSSE survey 2010 exhibited this soil type.

Landuse: The land overlying these soils is currently grazed, but has been cropped for many years and due to severe erosion in the past, graded banks and waterways have been constructed. There are scattered silver ironbark, grey box with wire grass and spear grass native pastures.

Management: The top 0.25 m of this soil is suitable for stripping and can be reused as a topdressing material in rehabilitation. The subsoil, up to 1.05 m deep, is suitable as an intermediate layer between overburden and topdressing in rehabilitation. The subsoil below 1.05 m is not recommended for reuse in rehabilitation due to the limiting factors of weathered rock. This soil requires only the standard erosion and sediment control measures if disturbed.

Table 3 – Soil Type 1 Brown Duplex Fine Sandy Loam Profile (GSSE Site 2)

Layer	Depth (m)	Description
1	0.00 to 0.25	Dark Brown (7.5YR 3/4), weak consistence fine sandy loam. Weak crumb structure >20mm that is neutral (pH 7.2), slight to nil dispersion (EAT 8/3(1) non saline (0.01dS/m), roots abundant and only 3% gravel (<20 mm). Approx sample depth 0.25m. Wavy boundary to Layer 2.
2	0.25 to 0.72	Strong Brown (7.5YR 4/6), moderate consistence light medium clay. Smooth strong blocky peds 10-30mm soil that is moderately alkaline (pH 8.3), slight dispersion (EAT 3(2), non saline (0.04dS/m), roots common and 13% gravel Clear boundary to Layer 3
3	0.72 to 1.05	Strong Brown (7.5YR 4/6), moderate consistence sandy clay. Smooth moderate prismatic structure soil that is strongly alkaline (pH 8.7), slight dispersion (EAT 3(2), non saline (0.06dS/m), few roots and 4% gravel overlying weathered conglomerates

Plate 1 – Brown Duplex Fine Sandy Loam Profile

Plate 2 – Brown Duplex Fine Sandy Loam Landscape

Soil Unit 2 - Self Mulching Black Earth Profile (Self Mulching Black Vertosol)

Description: The Black Earths of very dark brown clayey topsoil and sub-surface soil overlies dark brown clayey subsoil. These moderately-drained soils are strongly alkaline throughout. The soils are generally slightly saline to saline at depth but have excellent fertility characteristics. The topsoil is non-sodic whilst the subsoil is sodic.

Location: These soils are found on lower slopes in drainage lines predominately grazing land. Test Site 3 in the GSSE survey 2010 exhibited this soil type.

Landuse: The land overlying these soils includes open grazing farmland. The vegetation consists of isolated poplar box with warrego summer grass and various Stipa spp & Panicum spp native pastures.

Management: The top 0.60 m of soil is suitable for stripping and reused as a topdressing in rehabilitation. The lower layers are generally unsuitable for reuse as topdressing or an intermediate layer due to the limiting factors of salinity, high sodicity and high 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 – Soil Unit 2 Black Self Mulching Clay (GSSE Site 3)

Layer	Depth (m)	Description
1	0.00 to 0.30	Very Dark Brown (10YRYR 2/2) moderate consistence heavy clay. Strong angular blocky (5-10 mm peds) soil that is strongly alkaline (pH 8.9), nil dispersion (EAT 4), non saline (0.14dS/m), roots abundant and 1% gravel (>20 mm). Gradual and wavy boundary to Layer 2.
2	0.30 to 0.60	Very Dark Brown (10YRYR 2/2) strong consistence heavy clay. Strong angular prismatic (20-50 mm peds) soil that is strongly alkaline (pH 8.8), nil dispersion (EAT 4), slightly saline (0.44dS/m), roots common and <1% gravel (>20 mm). Gradual boundary to Layer 3.
3	0.60 to 1.10	Dark Brown (10YRYR 3/3) strong consistence, heavy clay. Strong pedality (0.5-10 mm peds) soil that is strongly alkaline (pH 8.9), nil dispersion (EAT 4), saline (0.74dS/m), roots common and 2% gravel (>20 mm). Gradual and wavy boundary to shale and pallid conglomerates.

Plate 3 - Self Mulching Black Earth Profile

Plate 4 – Self Mulching Black Earth Landscape

Soil Unit 3 - Sodic Brown Alluvial Clay (Calcic Brown Dermosol)

Description: The Brown Alluvial Clays with crusty surfaces and scattered gravel. These moderately well drained soils are strong alkaline in the upper layers and moderately alkaline at depth. The soils are slightly saline in the subsurface but have good fertility characteristics throughout. The topsoil is marginally sodic tending to be highly sodic in the subsoil.

Location: These soils are found on the lower slope, flats and floodplain of the higher quality grazing and cropping soil. Test Site 5 in the GSSE survey 2010 exhibited this soil.

Landuse: The land overlying these soils is used for high quality grazing and cropping activities. Therefore the vegetation ranges from various crops to improved and native pastures. The occasional poplar box and yarran trees are present.

Management: The top 0.25 m of this soil is suitable and therefore recommended for stripping and reuse as topdressing in rehabilitation. However any sections with clay topsoil and all of the subsoil is texturally unsuitable for use as a topdressing and therefore not recommended for reuse in rehabilitation. The high sodicity levels in the subsoil indicate this soil is not recommended for use as an intermediate layer between overburden and topdressing, as the risks associated with erosion are high. This soil requires 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 if exposed to wet conditions over time.

Table 5 – Soil Type 3 Sodic Brown Alluvial Clay Profile (GSSE Site 5)

Layer	Depth (m)	Description
1	0.02 to 0.25	Dark Brown (7.5YR 3/4), moderate consistence medium clay. Strong smooth angular blocky (10-50 mm) soil, strongly alkaline (pH 9), nil to moderate dispersion (EAT 3(2)), marginally sodic (ESP7.9), non saline (0.2dS/m), roots common and 2% small stones. Gradual and even boundary to Layer 2.
2	0.25 to 0.38	Dark Brown (7.5YR 3/4), strong consistence light medium clay. Strong smooth rough sub angular blocky peds (10-20mm), strongly alkaline (pH 9.5), non-dispersion (EAT 3(2)), sodic (ESP 12.6), slightly saline (0.31/m), roots common and <1% gravel Gradual even boundary to Layer 3.
3	0.38 to 0.85	Dark Brown (7.5YR 3/4), strong consistence, light medium clay. Strongly pedal rough sub angular blocky peds (10-30mm), strongly alkaline (pH 8.4), not dispersive (EAT 4) slightly sodic (ESP 6.5), moderately saline (0.37dS/m), roots common and 3% gravel overlying calcareous material (10%)

Plate 5 – Sodic Brown Alluvial Clay Profile

Plate 6 – Sodic Brown Alluvial Clay Landscape

3.2 Topdressing Suitability and Availability

Laboratory soil analytical results (refer **Appendix 3**) were used in conjunction with the field assessment (refer **Appendix 1**) to determine the depth of soil material suitable for recovery and re-use in rehabilitation. Whitehaven's adopted general practice is to include an intermediate layer of subsoil between the overburden rock and the topdressing. This is considered good practice. It assists in improving the water holding capacity of the rehabilitation and reinstates a more natural soil profile.

In order to assist in the calculation of soil material for stripping, stockpiling and replacement for rehabilitation, the soil has been separated into:- (a) subsoil for intermediate layering; and (b) topsoil for topdressing. In general the topdressing material is sourced from the upper horizon (topsoil), whilst the intermediate layer is sourced from the lower horizons (subsoil). Structural and textural properties of subsoils, dispersion potential, sodicity and acidity/alkalinity are the most common and significant limiting factors in determining depth of soil suitability for re-use. The recommended maximum stripping depths for each soil unit, together with the estimated land areas and soil material volumes are provided in **Table 6**.

Table 6 – Topsoil and Subsoil Stripping Resources

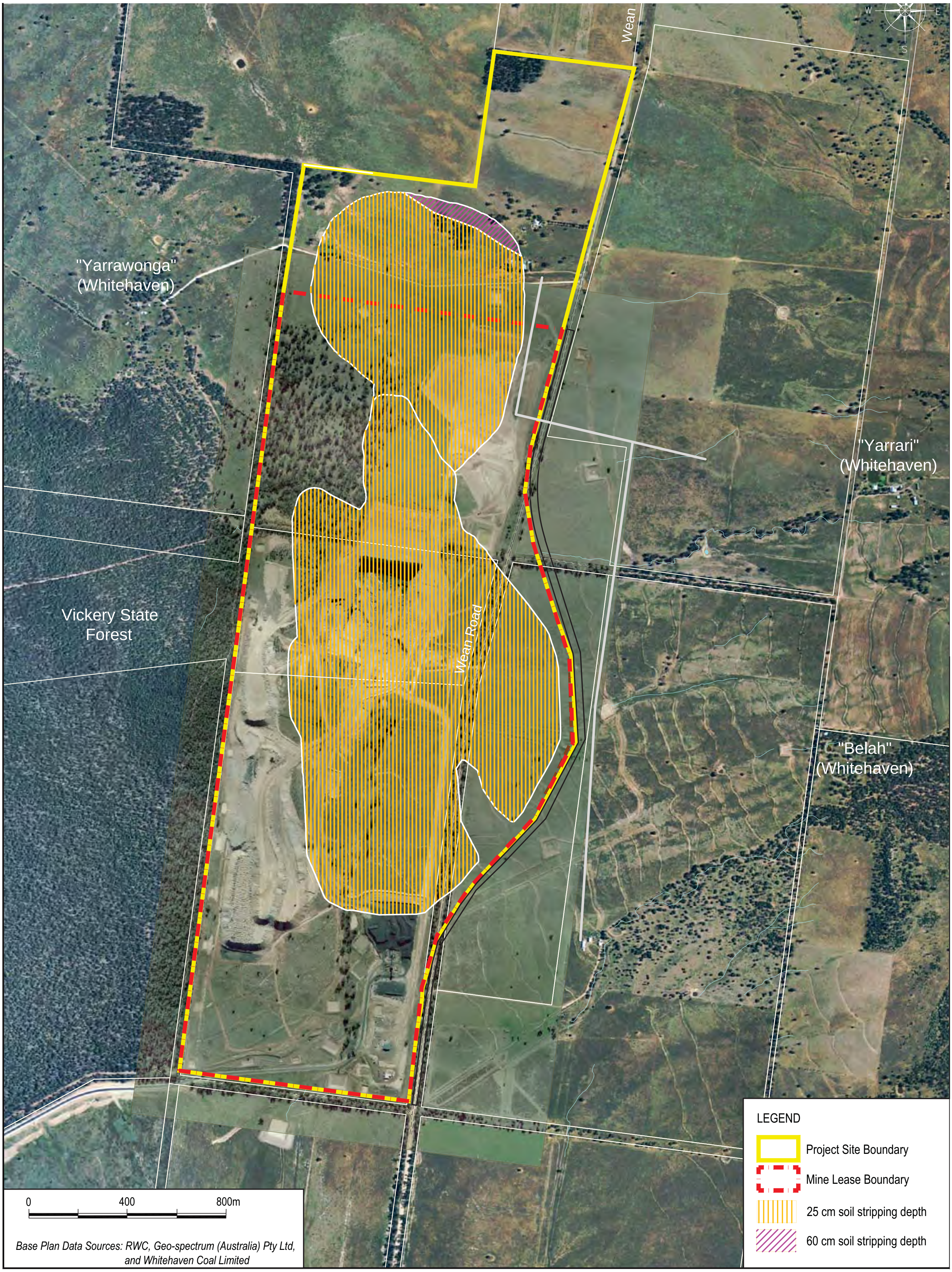
Material	Soil Type	Maximum Stripping Depth (cm)	Approximate Area (ha)	Approximate Volume (1,000m^3)
Topsoil	Brown Chromosol	25	66.7	166.8
	Black Vertosol	60	16.3	97.8
	Brown Dermosol	25	142.8	357.0
		Topsoil Total	**225.8**	**621.6**
		Topsoil Volume (incl. 10% handling loss)		**559.4**
Subsoil	Brown Chromosol	80	66.7	533.6
	Black Vertosol	0	16.3	0.0
	Brown Dermosol	0	142.8	0.0
		Subsoil Total	**225.8**	**533.6**
		Subsoil Volume (incl. 10% handling loss)		**480.2**

Figure 3 illustrates recommended maximum topsoil stripping depths.

Allowing for a 10% handling loss, approximately **559,400 m^3** of suitable topdressing material and **480,200 m^3** of suitable intermediate (subsoil) material is available within the Project Site's disturbance area for rehabilitation purposes.

3.3 Erosion Potential

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 the Sodic Brown Alluvial Clay to have an ESP of 7.9, 12.6 and 6.5 in layers 1, 2 and 3, respectively. The other sites were non sodic in the topsoil and ranged from non sodic to sodic in the subsoil.



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Environmental, Land and Project Management Consultants

Rocglen Coal Mine Extension Project
Topsoil Stripping Depths

FIGURE 3

Appropriate erosion and sediment control measures should be in place prior to surface disturbance of these soils, as the risk of erosion may be high once the subsoil is exposed. Appropriate measures are outlined in **Section 4.1** of this report. The sodic subsoils should also be placed in the overburden emplacement in areas where they are unlikely to be exposed as a result of rainfall and/or drainage for long periods of time. The use of non sodic subsoil as an intermediate layer keyed in between the overburden and the topdressing is current practice on-site and will continue to be standard practice.

3.4 Potential Acid Generating Material

The potential for acid generation from regolith material (topsoil and subsoil) within the Project Site is low. This does not include acid potential within the overburden material (consolidated bedrock below 2 to 3 m depth), which was not assessed during this survey, nor does it include the current level of acidity within the soil (i.e. pH results).

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. There has been little history of acid generation from regolith material in the Gunnedah or Boggabri areas (which is located approximately 250 km from the coast).

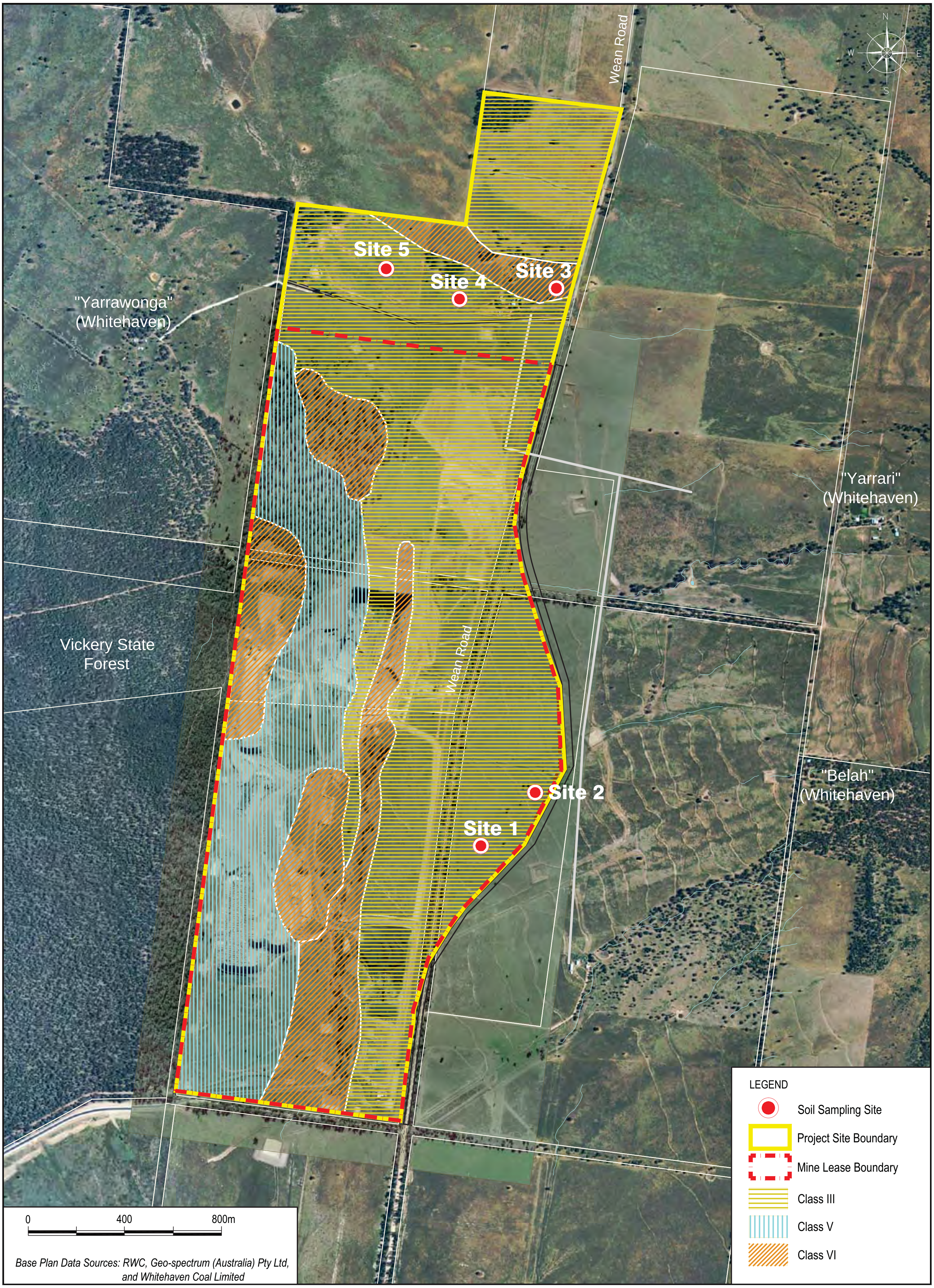
3.5 Land Capability

The pre-mining and post-mining rural land capability classes within the Project Site, as discussed above in **Section 2.6,** are illustrated on **Figure 4** and **Figure 5,** respectively. GSSE assessed the site for land capability classes during the field survey and using the laboratory analysis results. The Soils and Land Capability Assessment report prepared by Cunningham in 2007 was also used as a reference for pre-disturbance land capability.

The pre-mining land capability within the Project Site consists of Class III, V and VI land based on topographic, climatic and soils factors. The post-mining land capability consists of Class III, IV, V, VI, VII and VIII. The extent of each class within the Project Site is summarised in **Table 7**.

Table 7 – Pre and Post-Mining Land Capability Areas

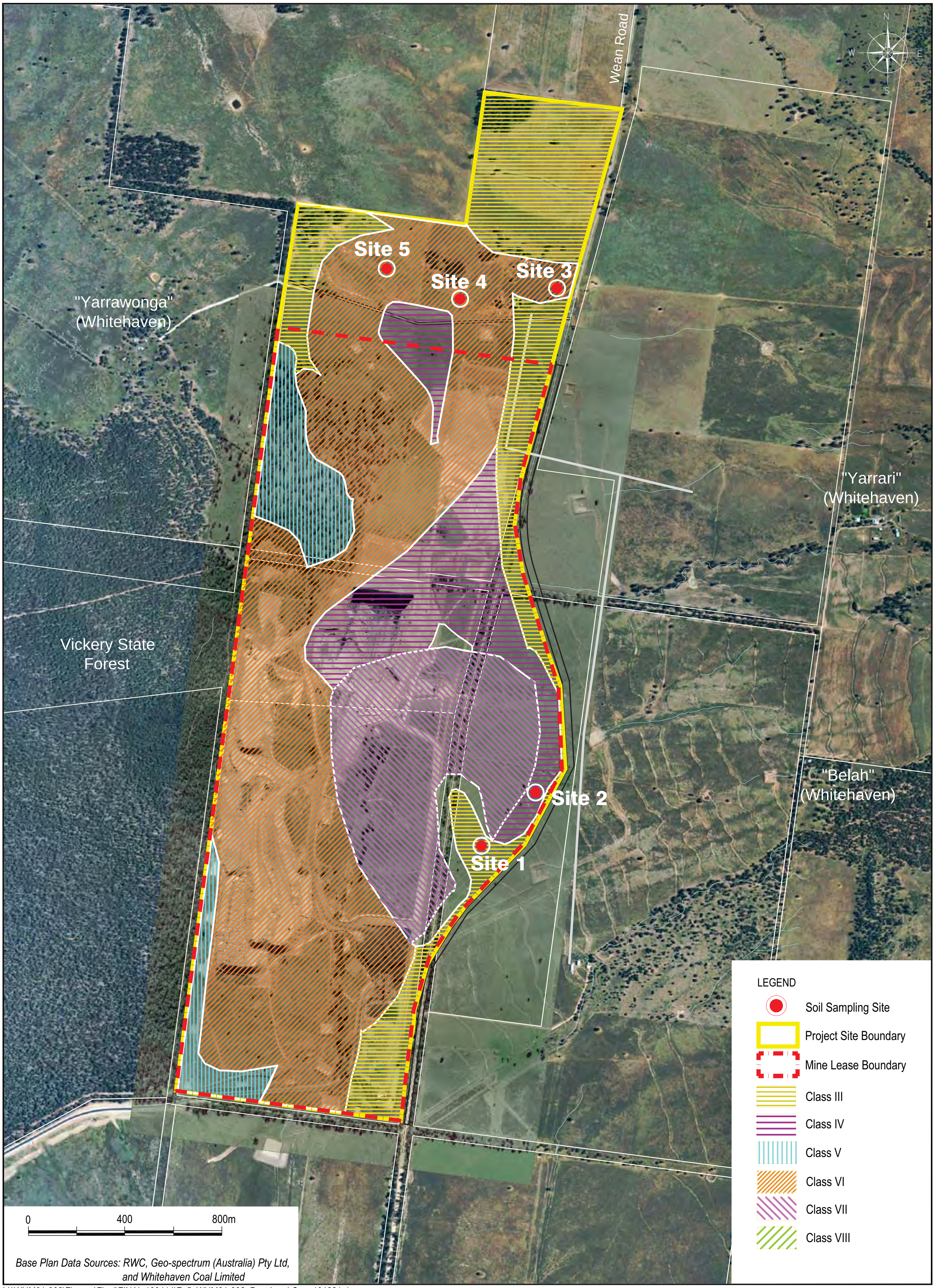
Land Capability Class	Pre-Mining Area		Post-Mining Area	
	ha	%	ha	%
I	0	0%	0	0%
II	0	0%	0	0%
III	265	58%	82	18%
IV	0	0%	57	12%
V	102	22%	29	6%
VI	93	20%	217	47%
VII	0	0%	68	15%
VIII	0	0%	7	2%
Totals	**460**	**100%**	**460**	**100%**



Rocglen Coal Mine Extension Project
Pre-Mining Land Capability

FIGURE 4

GSS ENVIRONMENTAL
Environmental, Land and Project Management Consultants



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GSS ENVIRONMENTAL
Environmental, Land and Project Management Consultants

Rocglen Coal Mine Extension Project
Post-Mining Land Capability

FIGURE 5

3.6 Agricultural Suitability

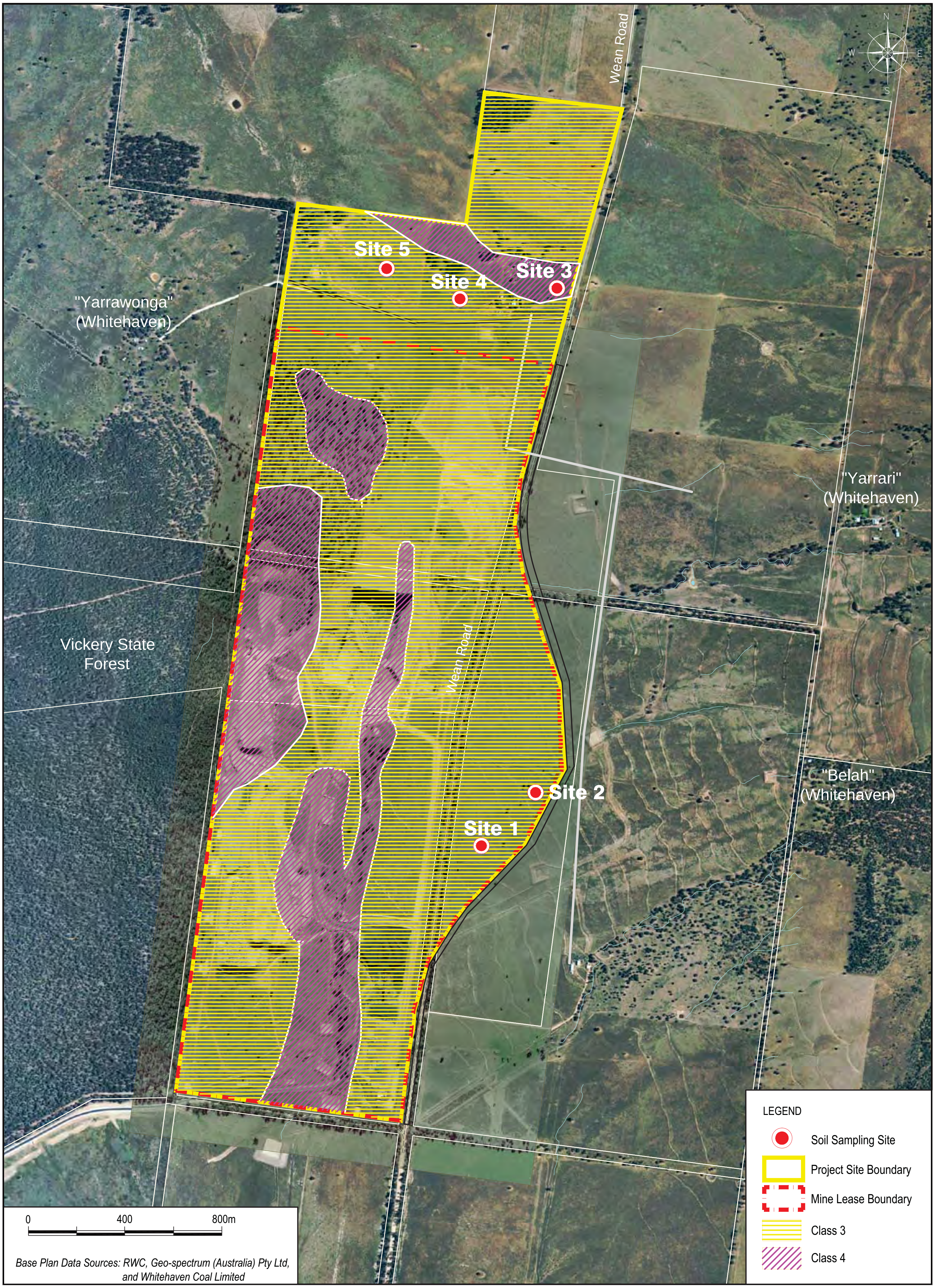
The pre-mining and post-mining agricultural suitability classes within the Project Site, as outlined above in **Section 2.7,** are shown on **Figure 6** and **Figure 7** respectively. The extent of each class within the Project Site is summarised in **Table 8** below.

Table 8 – Pre and Post-Mining Agricultural Suitability Areas

Agricultural Suitability Class	Pre-Mining Area		Post-Mining Area	
	ha	%	ha	%
1	0	0%	0	0%
2	0	0%	0	0%
3	348	76%	82	18%
4	112	24%	302	66%
5	0	0%	76	16%
Totals	**460**	**100%**	**460**	**100%**

The majority of the pre-mining area has an agricultural suitability of Class 3 (348 ha), which means moderately productive lands suited to grazing and pasture improvement. The remaining 112 ha is Class 4 land situated along minor drainage lines and hill slopes, which is marginal land not suitable for cultivation, however minimum till pasture improvement may be possible for grazing enterprises.

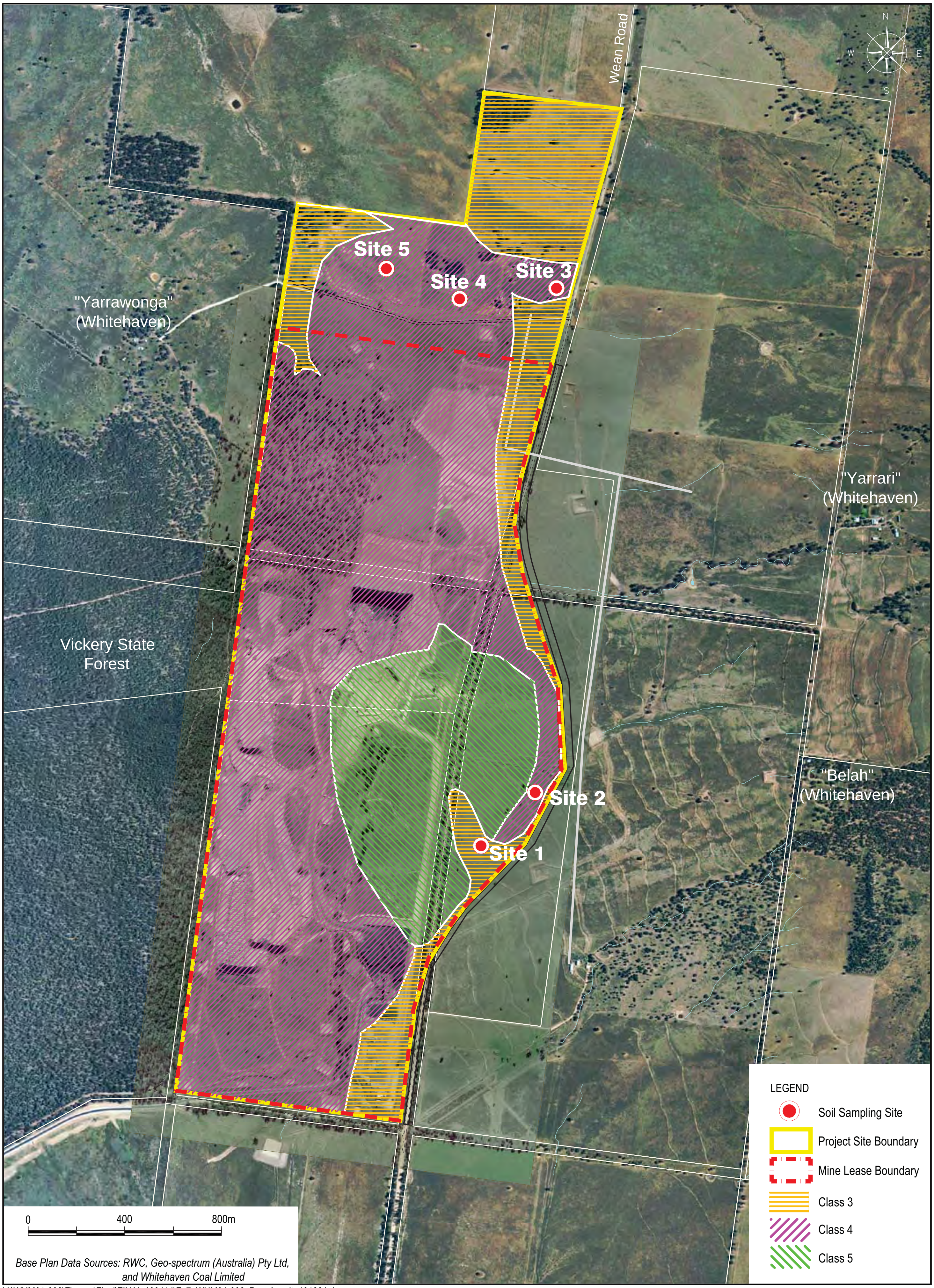
The post-mining land suitability assessment predicts Class 4 (302 ha) land dominates the final landform, including all the rehabilitated overburden emplacements. The sections of Class 3 land (82 ha) will be those areas untouched by mining activities or, if disturbed will be rehabilitated to a Class 3 level. The final void (76 ha) will be Class 5 land which is unsuitable for agriculture.



GSS ENVIRONMENTAL
Environmental, Land and Project Management Consultants

Rocglen Coal Mine Extension Project
Pre-Mining Agricultural Suitability

FIGURE 6



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Rocglen Coal Mine Extension Project
Post-Mining Agricultural Suitability

FIGURE 7

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4.0 DISTURBANCE MANAGEMENT

In order to reduce the potential for degradation within the Project Site and adjoining lands, the following management and mitigation strategies are recommended.

4.1 Soil Stripping and Handling

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

- Topsoil should be stripped within the maximum depths stated in **Table 6**, subject to further investigation as required.
- Soil material should be maintained in a slightly moist condition during stripping. Material should not be stripped in either an excessively dry or wet condition.
- Stripped material should be placed 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 open bowl scrapers, or for loading into rear dump trucks by front-end loaders, are examples of preferential less aggressive soil handling systems. Such methods minimise 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 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.
- It is recommended that topsoil stockpiles be no higher than 3 m. There is generally no hard and fast requirement on limiting the height of subsoil stockpiles, however, if there is adequate available stockpiling area, 3 m is good practice. Clayey soils should be stored in lower stockpiles for shorter periods of time compared to sandier soils.
- If long-term stockpiling is planned (i.e. greater than 3 months), the stockpiles should be seeded and fertilised 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.
- Prior to re-spreading stockpiled material 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 spreading.
- An inventory of available soil should be maintained to ensure adequate material is available for planned rehabilitation activities.

4.2 Soil Re-spreading

Where possible, suitable stripped soil material should be re-spread directly onto reshaped areas available for rehabilitation. Whitehaven's adopted general practice is to place an intermediate subsoil layer between the overburden rock and the topdressing material. This is considered good practice. It provides a higher resemblance to a natural soil profile and increases the water holding capacity throughout the profile.

Where resources allow, topsoil and subsoil will be spread to a nominal depth of 100 to 150 mm each (totalling 200 to 300 mm of re-spread material) on all re-graded spoil. Stripped soil material should be spread, treated with fertiliser and seeded in one consecutive operation in order to reduce the potential for topsoil and subsoil loss to wind and water erosion.

4.3 Landform Design, Erosion Control and Seeding

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

4.3.1 Post Disturbance Regrading

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.

4.3.2 Erosion and Sediment Control

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 shorter 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 down slope.

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 be easily 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. Dispersible clays will require treatment with lime, gypsum and/or bentonite 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.

4.3.3 Seedbed Preparation

Thorough seedbed preparation should be undertaken to ensure optimum establishment and growth of vegetation. All topsoiled areas should be lightly 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.

5.0 REFERENCES

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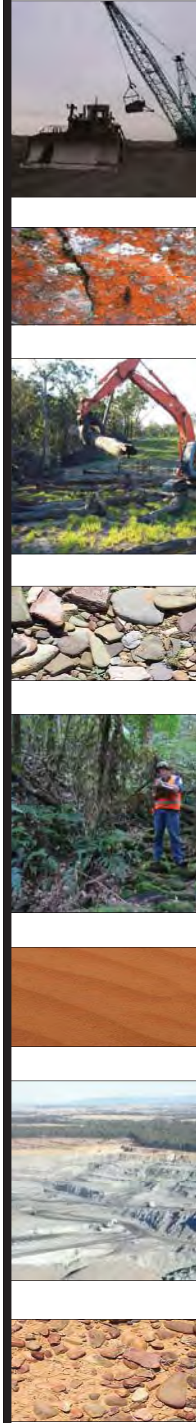
FIELD ASSESSMENT PROCEDURE



APPENDIX 1

FIELD ASSESSMENT PROCEDURE

Elliot 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

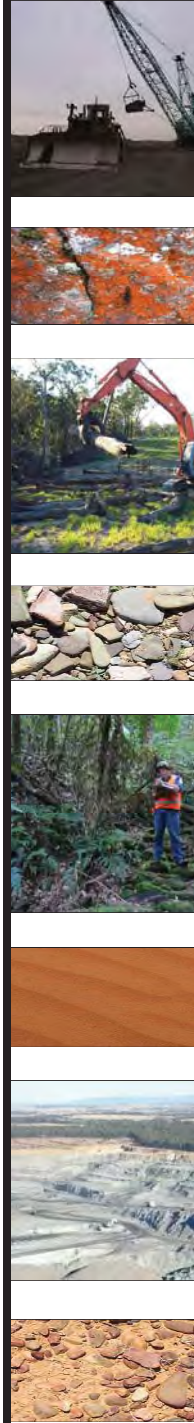
The presence of mottling within the soil may indicate reducing conditions and poor soil aeration. These factors are common in soil with low permeability's; however, some soils are mottled due to other reasons, including proximity to high water-tables or inheritance of mottles from previous conditions.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

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.



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	<0.002mm
silt	0.002 to 0.02mm
fine sand	0.02 to 0.2mm
medium & coarse sand	0.2 to 2mm

Particles greater than 2mm, 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 if 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 susceptibility to high tunnel erosion.
Class 2:	Moderately dispersible soils with some susceptibility to tunnel erosion.
Class 3:	Slightly or non-dispersive 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^{o} (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 0.2-2mm, Fine Sand 0.02-0.2mm, Silt 0.002-0.2mm and Clay <0.002mm; SCS standard method (Bond et al., 1990)

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 class 3 aggregates (Bond et al., 1990).

EC

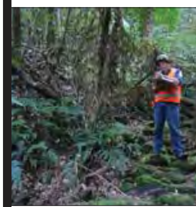
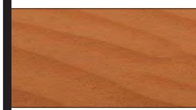
Electrical Conductivity determined on a 1:5 soil:water suspension. Prepared from the sample's fine earth fraction (Bond et al., 1990).

pH

Determined on a 1:5 soil:water suspension, Prepared from the sample's fine earth fraction (Bond et al., 1990).





APPENDIX 3

SOIL TEST RESULTS

Land and Property Management Authority

Soil Conservation Service

SOIL TEST REPORT

Scone Research Centre

REPORT NO:	SCO10/020R1
REPORT TO:	J Lawrie GSS Environmental PO Box 907 Hamilton NSW 2303
REPORT ON:	Fifteen soil samples Roc Glen
PRELIMINARY RESULTS ISSUED:	Not issued
REPORT STATUS:	Final
DATE REPORTED:	12 February 2010
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)

Scone Research Centre, PO Box 283 Scone 2337, 709 Gundy Road Scone 2337
Ph: 02 6545 1666 Fax: 02 6545 2520

SOIL AND WATER TESTING LABORATORY
Scone Research Centre

Report No: SCO10/020R1
Client Reference: J Lawrie
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	C1A/4	C2A/3	C5A/3 CEC & exchangeable cations (me/100g)				
	Sample Id	EC (dS/m)	pH	CEC	Na	K	Ca	Mg
1	Pit 1, 1	0.01	6.3	8.2	0.2	0.9	4.5	1.0
2	Pit 1, 2	0.03	8.4	22.1	0.7	0.5	11.5	5.7
3	Pit 1, 3	0.04	8.7	20.2	1.0	0.5	9.8	5.4
4	Pit 2, 1	0.01	7.2	11.6	0.2	0.8	6.7	1.1
5	Pit 2, 2	0.04	8.3	26.4	0.8	0.6	14.7	6.5
6	Pit 2, 3	0.06	8.7	24.3	1.0	0.6	12.8	6.0
7	Pit 3, 1	0.14	8.9	46.3	1.3	0.8	33.6	7.6
8	Pit 3, 2	0.44	8.9	49.6	4.3	0.2	31.5	11.6
9	Pit 3, 3	0.72	8.8	48.1	5.9	0.3	29.5	12.3
10	Pit 4, 1	0.18	7.2	19.6	0.4	1.2	10.4	5.0
11	Pit 4, 2	0.24	8.9	37.7	2.1	0.6	22.3	13.3
12	Pit 4, 3	0.37	8.9	38.0	2.7	0.8	20.3	13.3
13	Pit 5, 1	0.20	9.0	37.8	3.0	1.3	16.6	13.9
14	Pit 5, 2	0.31	9.5	35.8	4.5	0.7	16.8	13.1
15	Pit 5, 3	0.07	8.4	32.2	2.1	1.1	13.6	11.3

SR Young

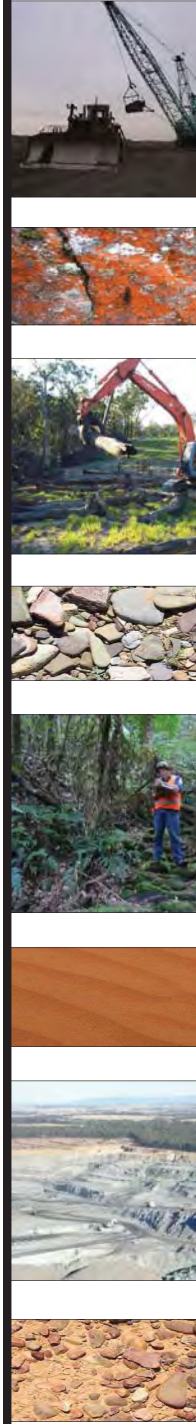
SOIL AND WATER TESTING LABORATORY
Scone Research Centre

Report No: SCO10/020R1
Client Reference: J Lawrie
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/1 particle Size Analysis (%)					P9B/2	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	dry	moist
1	Pit 1, 1	13	11	39	36	1	3(2)	10YR5/4	10YR3/3
2	Pit 1, 2	33	7	31	27	2	3(2)	7.5YR6/4	7.5YR4/6
3	Pit 1, 3	28	8	42	22	<1	2(1)	7.5YR6/4	7.5YR4/4
4	Pit 2, 1	15	11	42	29	3	8/3(1)	10YR4/4	7.5YR3/4
5	Pit 2, 2	41	2	23	21	13	3(2)	7.5YR5/6	7.5YR4/6
6	Pit 2, 3	36	3	29	28	4	3(2)	7.5YR5/6	7.5YR4/6
7	Pit 3, 1	56	11	23	9	1	4	10YR4/2	10YR2/2
8	Pit 3, 2	62	7	21	10	<1	4	10YR4/2	10YR2/2
9	Pit 3, 3	60	8	20	10	2	4	10YR4/2	10YR3/3
10	Pit 4, 1	22	14	36	23	5	3(2)	10YR5/4	10YR3/3
11	Pit 4, 2	51	10	24	15	<1	4	7.5YR4/4	7.5YR3/3
12	Pit 4, 3	45	11	24	17	3	4	10YR4/3	10YR3/6
13	Pit 5, 1	51	7	25	16	1	3(2)	7.5YR5/4	7.5YR3/4
14	Pit 5, 2	41	12	35	11	1	3(2)	7.5YR5/4	7.5YR3/4
15	Pit 5, 3	47	9	26	17	1	3(2)	7.5YR4/3	7.5YR3/4

SR Young

END OF TEST REPORT



GLOSSARY

APPENDIX 4

GLOSSARY

A Horizon

The original top layer of mineral soil divided into A1 (typically from 5 to 30 cm thick; generally referred to as topsoil.

Alluvial Soils

Soils developed from recently deposited alluvium, normally characterise little or no modification of the deposited material by soil forming processes, particularly with respect to soil horizon development.

Brown Clays

Soil determined by high clay contents. Typically, moderately deep to very deep soils with uniform colour and texture profiles, weak horizonation mostly related to structure differentiation.

Consistence

Comprises the attributes of the soil material that are expressed by the degree and kind of cohesion and adhesion or by the resistance to deformation or rupture.

Electrical Conductivity

The property of the conduction of electricity through water extract of soil. Used to determine the soluble salts in the extract, and hence soil stability. (Soil Landscapes of Singleton 1991)

Emmerson's Aggregate Test (EAT)

A classification of soil based on soil aggregate coherence when immersed water. Classifies soils into eight classes and assists in identifying whether soils will slake, swell or disperse (Soil Landscapes of Singleton, 1991)

Gravel

The >2 mm materials that occur on the surface and in the A1 horizon and include hard, coarse fragments.

Lithosols

Stony or gravelly soils lacking horizon and structure development. They are usually shallow and contain a large proportion of fragmented rock. Textures usually range from sands to clay loams.

Loam

A medium, textured soil of approximate composition 10 - 25% clay, 25 - 50%, silt and <50% sand.

Mottling

The presence of more than one soil colour in the same soil horizon, not including different nodule or cutan colours.

Particle Size Analysis (PSA)

The determination of the of the amount of the different size fractions in a soil sample such as clay, silt, fine sand, coarse sand and gravel. (Soil Landscapes of Singleton 1991)

Pedality

Refers to the relative proportion of peds in the soil (as strongly pedal, weakly pedal or non-pedal).

pH

A measure of the acidity or alkalinity of a soil.

Solodic Soils

Strong texture differentiation with a very abrupt wavy boundary between A and B horizons, a well-developed bleached A2 horizon and a medium to coarse blocky clay B horizon.

Soloths

Similar to a solodic soil but acidic throughout the profile. Tends to be a more typical soil of the humid regions where the exchangeable cations in the B Horizon of the solodised soils have been leached out.

Podzolics

Podzolic soils are acidic throughout and have a clear boundary between the topsoil and subsoil. The topsoils are loams with a brownish grey colour. The lower part of the topsoil has a pale light colour and may be bleached with a nearly white, light grey colour.

Ped

An individual, natural soil aggregate. (Soil Landscapes of Singleton 1991)

Sodicity

A measure of exchangeable sodium in the soil. High levels adversely affect soil stability, plant growth and/or land use.

Soil mantle

The upper layer of the Earth's mantle, between consolidated bedrock and the surface, that contains the soil. Also known as the regolith.