Appendix

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Soil Survey and Land Resource Assessment

Hansen Bailey Pty Limited

FINAL

Continuation of Boggabri Coal Mine Project Environmental Assessment

Soil Survey and Land Resource Impact Assessment Report

May 2010

HAN12-001

GSS ENVIRONMENTAL
Environmental, Land and Project Management Consultants

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1.0 INTRODUCTION

Boggabri Coal Pty Limited (Boggabri Coal) is seeking a Project Approval under Part 3A of the *Environmental Planning & Assessment Act 1979* (EP&A Act) approval to continue its open cut mining and associated activities largely consistent with its existing operation for a further 21 years.

GSS Environmental (GSSE) was commissioned by Hansen Bailey Pty Limited (Hansen Bailey) on behalf of Boggabri Coal Pty Ltd (Boggabri Coal) to undertake a soil and land capability impact assessment for the Boggabri Coal Mine for inclusion in an Environmental Assessment (EA) to support the project application. The study area is shown as the Project Boundary on **Figure 1**.

1.1 Objectives

To assist Boggabri Coal 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 soils types within the study area, and highlight areas of unfavourable material which require specific management and handling practices;
- provide a description of, and figures showing, the land capability and agricultural suitability within the project boundary;
- provide recommendations for stripping depth for 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.

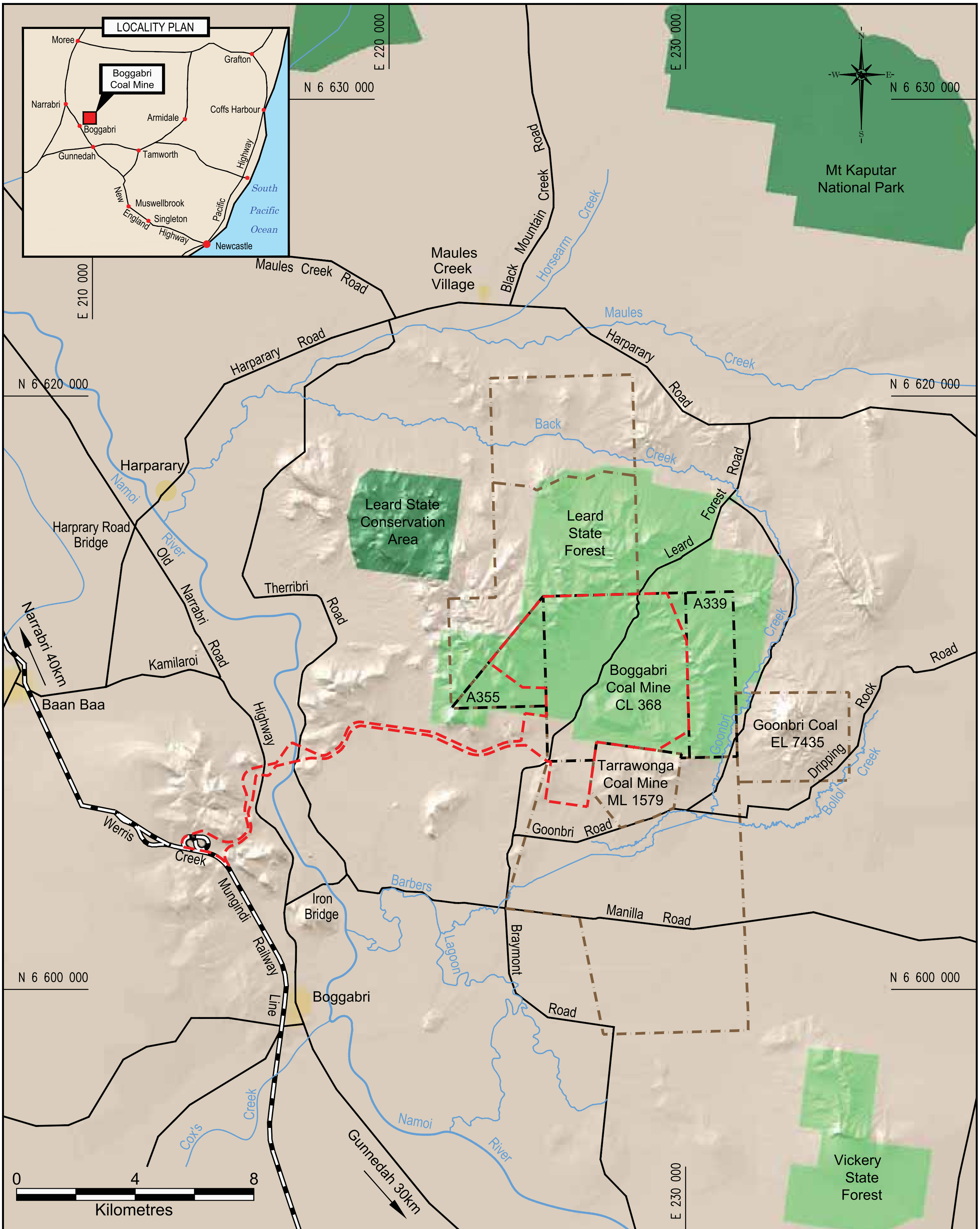
The following report presents the results of the survey undertaken by GSSE and the assessment of land resources within the study area.

1.2 Location

The Boggabri Coal Mine is located in the Gunnedah Coalfields of NSW, approximately 15 kilometres (km) North East of the Boggabri township as shown in the Locality Plan in **Figure 1**. The open cut pit is located in the Leard State Forest to the East of Leard Forest Road and approximately 3 km north of Goonbri Road. A haul road currently runs to a rail loadout facility 15 km in West South West direction from the mine. The haul road crosses over (bridge) the Kamilaroi Highway and the Namoi River approximately 4 km and 5 km respectively North East of the rail loadout facility. The project area for the soil and land capability survey encompasses the Project Boundary as shown on **Figure 2**.

1.3 Topography

The project area ranges in elevation between 240 metres (m) along the Namoi River floodplains to 430 m in the upper hills of the Leard State Forest. The general topography of the project area surrounding the existing mine ranges from steep slopes and crests around the north western, northern and north eastern perimeter having a generally south to southwest aspect, becoming eroded waning mid to lower slopes to flat plains in the south west section of the main pit area. This area around the main pit displays an interrupted convergent tributary channel pattern amongst undulating to rolling low hills with eroded gullies on 5 – 15% slopes. The lower relief alluvial floodplain areas along the proposed rail line corridor exhibit aggraded geomorphological activity with open depression drainage. The proposed rail line crosses the Namoi River and its riparian corridor, traversing the floodplain and waning lower slopes before climbing over the small saddle and around the steep simple slope hillock just east of the rail loadout facility.



Project Boundary	Urban Areas
Boggabri Mining Tenements	
Other Mining Tenements	
Roads	
Railway	
Creeks	
National Park	
State Forest	

Hansen Bailey

IDEMITSU BOGGABRI COAL

Coordinate System: MGA Zone 56
Source: Boggabri Coal 2009/2010, LPI 2009/2010

BOGGABRI COAL MINE

Regional Locality

Cad File: 05482E.dwg	Date: 07.04.2010	Drawn: JD	Figure 1

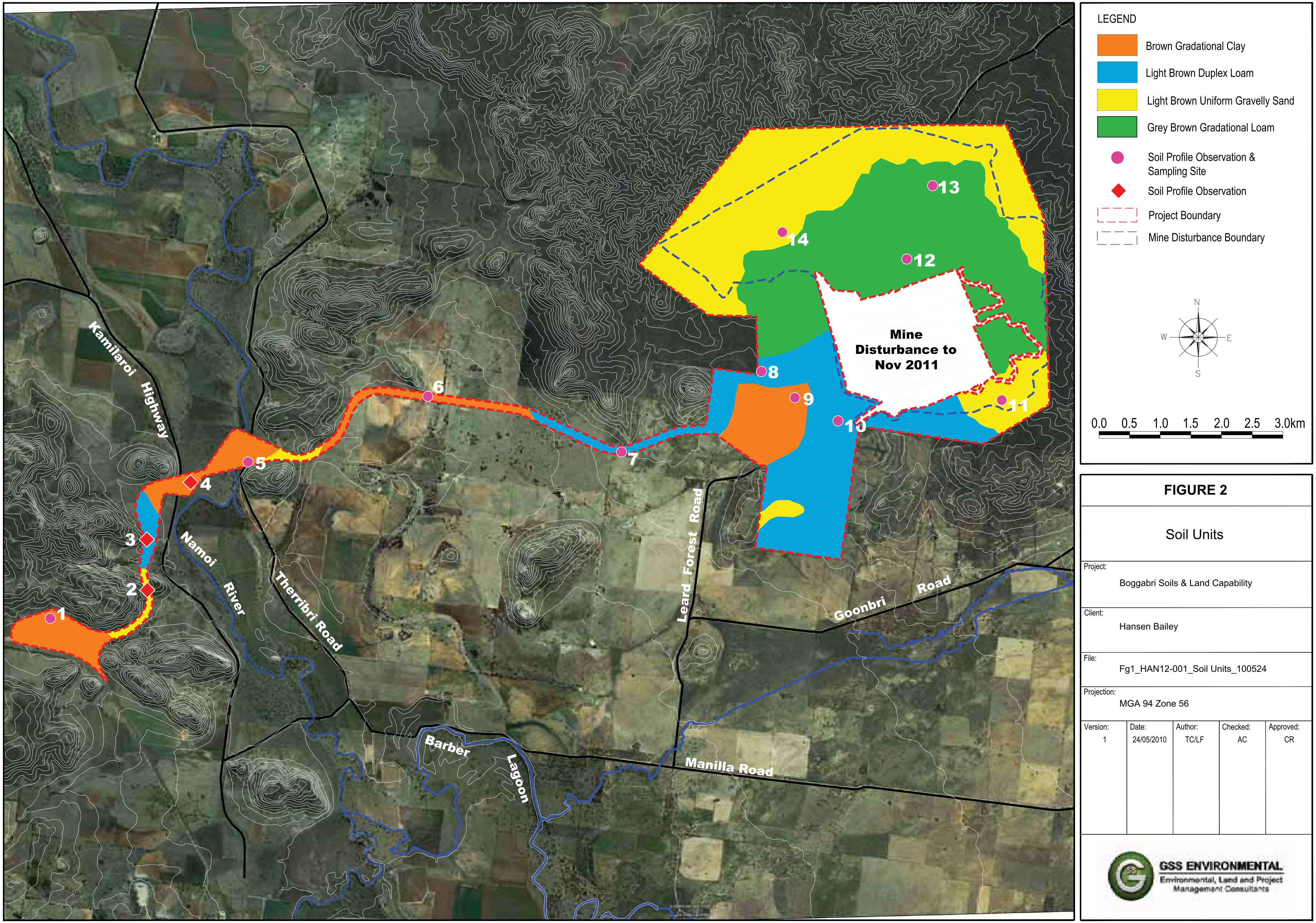


FIGURE 2

Soil Units

Project: Boggabri Soils & Land Capability				
Client: Hansen Bailey				
File: Fg1_HAN12-001_Soil Units_100524				
Projection: MGA 94 Zone 56				
Version: 1	Date: 24/05/2010	Author: TC/LF	Checked: AC	Approved: CR

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1.4 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 was used to identify four main land management units found within the Boggabri Coal Mine Project Area, as described below (Namoi CMA 2009):

Sedimentary Slopes (Generally 8 - 15% slope).

Sedimentary slopes of generally 8 – 15% occur often below LMU Sedimentary Hill Tops as a midslope which fringes the plains and footslopes. This unit also includes areas with slopes of less than 8%, but which have very shallow soils and therefore have limited capability. This LMU is characterised by moderately shallow soils (lithosols and skeletal red - brown earths) and rocky outcrops with minor steep slopes and low, cliff - like benches. There are only minor watertable problems on some of the lower slopes, usually where an impermeable layer of rock interrupts the slope. Land capability is classified as 4 or 5 depending on slope and soil depth. Vegetation communities include natural pasture with Ironbark, White Cypress, Hill Red Gum, Bimble Box, Kurrajong and White Box as scattered timber or as dense tree stands where not cleared. There can be a shrub layer that includes Rosewood, Wilga, Wild Olives and Wattles. Land use is predominantly pasture and some native timber with a minor amount of dryland cropping.

Central Mixed Soil Floodplains (0 - 2% slope).

There are also substantial plain areas of the central catchment (from the Liverpool Plains to Narrabri) that are of very low slope (0 – 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 land management unit generally has a land capability classification range of 2 – 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 this LMU where the alluvium sits on a coarse gravel fill over basement material. Recharge is generally thought to be from surface streams which have gravel beds that are well connected to the underlying aquifers. Landuse 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 is 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.

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, is 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 land management unit is a dynamic environment and subject to inundation and severe erosion. Shallow saline groundwaters can be locally extensive in this LMU. Deep fresh irrigation aquifers are found beneath this LMU 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.

Riparian Corridor.

The riparian corridor land management unit is generally defined as a 20 m wide buffer from each streambank and has a land capability classification of 7. This LMU transects most other LMU's depending on watercourse location and activity throughout the catchment. Soil types vary depending on the base geology of the area and local sedimentation to include brown or grey clays, black earths, red - brown earths and earthy sands. The riparian corridor is dynamic with many geomorphological zones such as terraces and steep banks interacting with frequent flooding and water level changes. It can also be undulating, with unstable soils and a predominance of River Red Gum communities, many of which are mature, and some Belah communities. Stability of this region is important for water quality and biodiversity. In the upper areas of the catchment (and some lower areas) clearing of this LMU has occurred for cropping and improved pasture with most of the native pasture or forested streambanks being in steeper regions of subcatchments.

2.0 SURVEY METHODOLOGY

2.1 Introduction

A soil and land capability survey was undertaken in August 2009 by GSSE to undertake the following assessment:

1. to classify and determine the soil profile types of the study area;
2. to assess the suitability of the current topsoil material for future rehabilitation; and
3. to identify any potentially unfavourable soil material for rehabilitation within the Open Cut Project Extension Area.

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

2.2 Soil Mapping

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

1) Aerial photographs and topographic maps

Aerial photo and topographic map 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 study area.

2) Previous soil survey results

There were no soil landscape maps developed for this region at the time of the survey, however reconnaissance survey information and the land management units were provided by the Namoi CMA. These references were used to provide a framework for the detailed survey undertaken in August 2009.

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

Fourteen(14) 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, however existing exposures were used at sites 2, 3 and 4. 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, dams and disused quarries. Soil profile site locations and soil units are shown in **Figure 2**.

2.4 Soil Field Assessment

Soil profiles within the study 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. 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 & Water Testing Laboratory at Scone, NSW for analysis, 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
- Site 5 – 5/1 & 5/2
- Site 6 – 6/1, 6/2, 6/3 & 6/4
- Site 7 – 7/1, 7/2 & 7/3
- Site 8 – 8/1, 8/2 & 8/3
- Site 9 – 9/1, 9/2 & 9/3
- Site 10 – 10/1, 10/2, 10/3 & 10/4
- Site 11 – 11/1 & 11/2
- Site 12 – 12/1, 12/2 & 12/3
- Site 13 – 13/1, 13/2, 13/3 & 13/4
- Site 14 – 14/1, 14/2 & 14/3

Soil horizons are signified by /1, /2 and /3 in the sample ID with the surface horizon being /1 and subsoil horizons being /2 & /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
- 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 of the study area was conducted in accordance with the Department of Natural Resources (DNR) (formerly the NSW Soil Conservation Service) 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 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, 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 possible classes (with land capability decreasing progressively from Class I to Class VIII). The classes are described in **Table 1** below.

A description of land capability classification for all land within the study area is discussed further in **Section 3.5**.

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 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 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
Special Zonings		
U	Urban areas	Unsuitable for rural production
SF	State Forests	Unsuitable for rural production
M	Mining & quarrying areas	Unsuitable for rural production

Source: Soil Conservation Service of NSW (1986).

2.7 Agricultural Suitability Assessment

The agricultural suitability assessment of the study area was conducted in accordance with the Department of Primary Industries (DPI) (formerly NSW Agriculture & Fisheries) agricultural suitability classification system. The system consists of five (5) 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

The following soil units were identified within the study area:

- Grey Brown Gradational Loam (939.88 ha);
- Light Brown Uniform Gravelly Sand (1,006.36 ha);
- Light Brown Duplex Loam (619 ha); and
- Brown Gradational Clay (359 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.** Landscape photos of areas where each soil unit was observed are shown in **Plates 2, 4, 6** & **8**. A glossary of commonly used soils terms is presented in **Appendix 4**.

Grey Brown Gradational Loam

Description: The Grey Brown Gradational Loam soils generally consist of pale brown to light grey gravelly sandy loam to loams overlying a gradual change to light yellowish brown clay loam. These moderately drained soils range from slightly acidic to neutral in the upper layers to strongly acidic to moderately alkaline at depth. The soils are generally non saline with poor to moderate fertility characteristics. The topsoil is non-sodic tending to moderately sodic in the subsoil.

Location: These soils cover 33% or 939.88 ha of the project area and are found on the waning mid to lower slopes within the Leard State Forest. Profile sites 12 & 13.

Landuse: The land overlying these soils is currently designated state forest, and has been selectively logged for many years. Many tracks transect the vegetation which consists of young to mature trees including cypress and black pines, white box and ironbark species.

Management: The top 0.15 m of this soil is suitable for stripping and reused as a topdressing in rehabilitation. The subsoil is not recommended for reuse in rehabilitation due to the limiting factors of stone content and moderate sodicity at depth. 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 – Grey Brown Gradational Loam Profile

LAYER	DEPTH (m)	DESCRIPTION
1	0.00 to 0.15	Pale Brown (10YR 6/3), weak consistence loam to gravelly sandy loam. A weak pedality (granular 2-5 mm) soil with neutral acidity (pH 6.3-7.6), slight to nil dispersion (EAT 3(2) & 8(5)), non saline (0.03-0.13dS/m), roots few to common and <10% stones (<20 mm). Approx sample depth 0.10 m. Gradual even boundary to Layer 2.
2	0.15 to 0.30	Light grey (10YR 7/2), moderate consistence silty loam to gravelly sandy loam. A moderate pedality (granular <2 mm) soil acidic to neutral (pH 5.5-7.4), slight dispersion (EAT 3(2)), non saline (0.02dS/m), roots few and <10% stones (<20 mm). Approx sample depth 0.20 m. Clear even boundary to Layer 3.
3	0.30 to 1.20	Light Yellowish Brown (10YR 6/4), moderate to strong consistence clay loam. A strong pedality (blocky 10-50 mm) soil with strongly acidic to moderately alkaline (pH 4.9-8.1), slight to high dispersion (EAT 3(2) & 2(2)), non saline (0.14-0.18dS/m), no roots and 0 to 20% stones (10-50 mm). Approx sample depth 0.80 m.

Plate 1 – Grey Brown Gradational Loam Profile

Plate 2 – Grey Brown Gradational Loam Landscape

Light Brown Uniform Gravelly Sand

Description: The Light Brown Uniform Gravelly Sand soils generally consist of light brown to brown very gravelly loamy sands throughout the profile. These well drained soils range from moderately acidic to strongly acidic at depth. The soils are generally non saline with poor fertility characteristics. The topsoil and subsoil are non-sodic.

Location: These soils cover 34% or 1,006.36 ha of the project area and are found on the upper slopes crests and ridgelines within the Leard State Forest. Profile sites 11 & 14.

Landuse: The land overlying these soils is currently designated state forest, and has been selectively logged for many years. Many tracks transect the vegetation which consists of young to mature trees dominated by cypress pines, black pines and ironbark species.

Management: The soil is unsuitable for stripping and reused as a topdressing in rehabilitation due to the high stone content. This soil requires only the standard erosion and sediment control measures if disturbed.

Table 4 – Light Brown Uniform Gravelly Sand Profile

LAYER	DEPTH (m)	DESCRIPTION
1	0.00 to 0.50	Light brown (7.5YR 6/3), very weak consistence very gravelly loamy sand. An apedal single grained soil that is moderate to strong acidity (pH 6.0-4.9), slight to nil dispersion (EAT 3(2) & 8(5)), non saline (0.01-0.02dS/m), roots many (upper level) to few at depth and 20-80% stones (10-100 mm). Approx sample depth 0.25m. Gradual even boundary to Layer 2.
2	0.50 to 1.20	Olive Yellow to Brown (5YR 6/6 – 7.5YR 5/3), very weak to strong consistence gravelly loamy sand. Apedal single grained to apedal massive soil that is strongly acidic (pH 5.3-5.5), slight dispersion (EAT 3(1)), non saline (0.01dS/m), roots none to few and 20-50% stones (10-100 mm). Approx sample depth 0.80 m.

Plate 3 – Light Brown Uniform gravelly Sand Profile

Plate 4 – Light Brown Uniform Gravelly Sand Landscape

Light Brown Duplex Loam

Description: The Light Brown Duplex Loam soils generally consist of a brown to dark yellowish brown sandy loam topsoil overlying pinkish grey sandy loam which overlies a texture contrast to pale brown to yellowish red sandy clay subsoil. These moderately drained soils range from moderately acidic in the upper layers to strongly alkaline at depth. The soils are generally non saline with poor fertility characteristics. The topsoil is non-sodic whilst the subsoil is sodic to very sodic.

Location: These soils cover 21% or 619 ha of the project area and are found on the waning lower slopes within the Leard State Forest and nearby grazing land. Profile sites 7, 8 & 10.

Landuse: The land overlying these soils includes designated state forest and open grazing farmland. The State Forest vegetation consists of young to mature trees dominated by black pines and whitebox, whilst the grazing land generally only contains isolated paddock trees.

Management: The top 0.10m of soil is suitable for stripping and reused as a topdressing in rehabilitation. The lower layers are generally unsuitable due to the limiting factors of massive structure, prohibitive stone content, high sodicity and high alkilinity. 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 – Light Brown Duplex Loam Profile

LAYER	DEPTH (m)	DESCRIPTION
1	0.00 to 0.10	Brown (7.5YR 5/3) weak consistence sandy loam. A weak pedality (2-5 mm peds) soil that is neutral to moderate acidity (pH 7.0-5.6), nil dispersion (EAT 8/3(1)), non saline (0.02dS/m), roots common and nil to 10% stones (<10 mm). Approx sample depth 0.05 m. Sharp and even boundary to Layer 2.
2	0.10 to 0.40	Pinkish grey (7.5YR 6/2), very weak to moderate consistence sandy loam. Apedal single grained soil that is neutral to moderate acidity (pH 6.8-5.7), slight to high dispersion (EAT 8/3(1) & 2(1)), non saline (0.05dS/m), roots few and nil to 90% stones (<10 mm). Approx sample depth 0.25. Clear and even boundary to Layer 3.
3	0.40 to 1.20	Pale brown to yellowish red (10YR 6/3 & 5YR 5/6) strong consistence sandy clay. An apedal massive to strong pedality (10-20 mm peds) soil that is strongly alkaline (pH 7.8-9.3), moderate to high dispersion (EAT 3(3) to 2(3) and highly sodic (ESP 10 to 37%), non saline (0.13 to 0.72dSm), roots nil and stones 10-90% (10-50 mm). Approx sample depth 1.00 m.

Plate 5 – Light Brown Duplex Loam Profile

Plate 6 – Light Brown Duplex Loam Landscape

Brown Gradational Clay

<u>Description:</u> The Brown Gradational Clay soils generally consist of brown loam to clay overlying a clear change to brown clay to clay loam. These poorly drained soils range from neutral to strong alkaline in the upper layers to moderate to strong alkaline at depth. The soils are generally non saline with good fertility characteristics. The topsoil is non-sodic tending to highly sodic in the subsoil.

<u>Location:</u> These soils cover 12% or 359ha of the project area and are found on the lower slope, flats and flood plain of the higher quality grazing and cropping soil. Profile sites 1, 5, 6 & 9.

<u>Landuse:</u> The land overlying these soils is used for high quality grazing and cropping activities. Therefore the vegeration ranges from various crops to improved and native pastures. The occasional paddock tree is evident with large river red gums along the river flood plain.

<u>Management:</u> The top 0.20m of the sections of loamy soil is suitable for stripping and reused as a topdressing in rehabilitation. The sections with clay topsoil and all subsoil is texturally unsuitable and therefore not recommended for reuse in rehabilitation. Other factors limiting the subsoil include 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 6 – Brown Gradational Clay Profile

LAYER	DEPTH (m)	DESCRIPTION
1	0.00 to 0.20	Brown (7.5YR 5/2), weak consistence loam. A moderate pedality (angular blocky peds 5-10 mm) soil with neutral acidity (pH 6.7), nil to moderate dispersion (EAT 8/3(2) & 2(2)), non saline (0.03dS/m), roots common to many and <10% stones (<10 mm). Approx sample depth 0.10 m. Clear and even boundary to Layer 2.
2	0.20 to 0.50	Dark yellowish brown to pale brown (10YR 4/4 & 10YR 6/3), moderate to strong consistence clay loam to clay. An apedal massive soil that is moderately to strongly alkaline (pH 7.9-8.8), non-dispersion to highly dispersive (EAT 3(1) & 2(3)), non saline (0.05-0.17dS/m), roots none to few and 0-50% stones (<20 mm). Approx sample depth 0.35 m. Gradual even boundary to Layer 3.
3	0.50 to 1.20	Brown (10YR 5/4), strong consistence clay loam to Clay. An apedal massive soil that is strongly alkaline (pH 9.0-9.6), borderline dispersive (EAT 2(1) & 2(2)) highly sodic (ESP 20), moderately saline (0.38-0.89dS/m), roots none and <10% stones (<10 mm). Approx sample depth 0.90 m.

Plate 7 – Brown Gradational Clay Profile

Plate 8 – Brown Gradational Clay Landscape

3.2 Topdressing Suitability & 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 as a topdressing material in rehabilitation. Structural and textural properties of subsoils, along with stones, 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 stripping depth for each soil unit, together with area of land and calculated volume are provided in **Table 7**.

Table 7 – Recommended Stripping Depths

Soil Unit Type	Recommended Stripping Depth (m)	Project Boundary Area (ha)	Project Boundary Volume (m^3)	Disturbance Boundary Area (ha)	Disturbance Boundary Volume (m^3)
Grey Brown Gradational Loam	0.15	939.88	1,409,820	787.66	1,181,490
Light Brown Uniform Gravelly Sand	Stripping Not Recommended	1,006.36	0	545.13	0
Light Brown Duplex Loam	0.10	619	619,000	3	3,000
Brown Gradational Clay	0.20	359	718,000	0	0
	Total Volume		**2,746,820**	**-**	**1,184,490**
	Total Volume (10% handling loss allowance)		**2,472,138**	**-**	**1,066,041**

Allowing for a 10% handling loss, approximately 1,066,041 m^3 of suitable topdressing is available within the mining area disturbance boundary. The majority of topsoil disturbance will result from the excavation of the open cut pit, which is located in the Leard State Forest upon the Grey Brown Gradational Loams and the Light Brown Uniform Gravelly Sands. The other key area of disturbance is along the proposed railway, which traverses areas of Light Brown Duplex Loams and Brown Gradational Clays.

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 a similar pattern within the Grey Brown Gradational Loams, Light Brown Duplex Loams and Brown Gradational Clay of the upper layers being non dispersive and non sodic whilst the subsoils tended to moderate to high dispersion and high sodicity with depth.

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 4.1** of this report. These subsoils should also be placed in the overburden dumps in areas where they are unlikely to be exposed to the rainfall or drainage for long periods of time. The light Brown Uniform Gravelly Sands were non dispersive and non saline throughout the profile.

3.4 Potential Acid Generating Material

The potential for acid generation from regolith material (topsoil and subsoil) within the study area is low. This does not include acid potential within the overburden material (consolidated bedrock below 2 – 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 Boggabri area (which is located approximately 250 km from the coast).

3.5 Land Capability

The rural land capability classification of the study area, in accordance with Department of Environment, Climate Change & Water (DECCW) mapping is shown in **Figure 3.** GSSE assessed the site for land capability and confirmed/modified the classes and class boundaries during the field visit and following laboratory results.

The Leard State Forest has a modified land capability classification of 'State Forest' due to the land use zoning of State Forests, which overrides the general capability of the land for this assessment. Furthermore, areas affected by mining activities also hold unique classification specifically for mined land. Therefore the assessment of land capability for this project is restricted to areas not previously zoned state forest or classified as mining land.

The area immediately to the south of the Boggabri Mine and Leard State Forest ranges from Class II and III land on the lower slopes and flats to Class VI land on the steeper rocky hills. Following the proposed rail spur to the west, the land capability continues to be Class II and III dissected at two narrow points, firstly of Class VI land 500 m east of the Namoi River and secondly Class VI and VIII land for 1.5 km east of the rail loadout facility.

3.6 Agricultural Suitability

The agricultural suitability classification of the study area is shown in **Figure 4.** The majority of the study area is Class 4 & 5 agricultural suitability covering areas of approximately 1,164ha and 990ha respectively. Within the proposed disturbance area, there is 773.06 ha and 551.93 ha of Class 4 and Class 5 respectively. Class 4 & 5 lands are marginal lands not suitable for cultivation and with a low to very low productivity for grazing. These lands are located generally within the Leard State Forest and small patches associated with steep hillsides and hilltops. Class 3 land covers 726ha of the study area and includes moderately productive lands suited to improved pasture and to cropping within a pasture rotation. Class 3 lands are located to the south west of the active mining area on the lower slopes and flats and on several areas of land along the proposed rail line. Class 2 land covers 172ha of the study area and includes highly productive land suited to both row and field crops, however not suited to continuous cultivation. Class 2 land is generally associated with the Brown Gradational Clays of the lower slopes and flats along the proposed rail line. Within the proposed mining disturbance boundary there is 25 ha of Class 3 land, 877 ha of Class 4 land and 572 ha of Class 5 land.

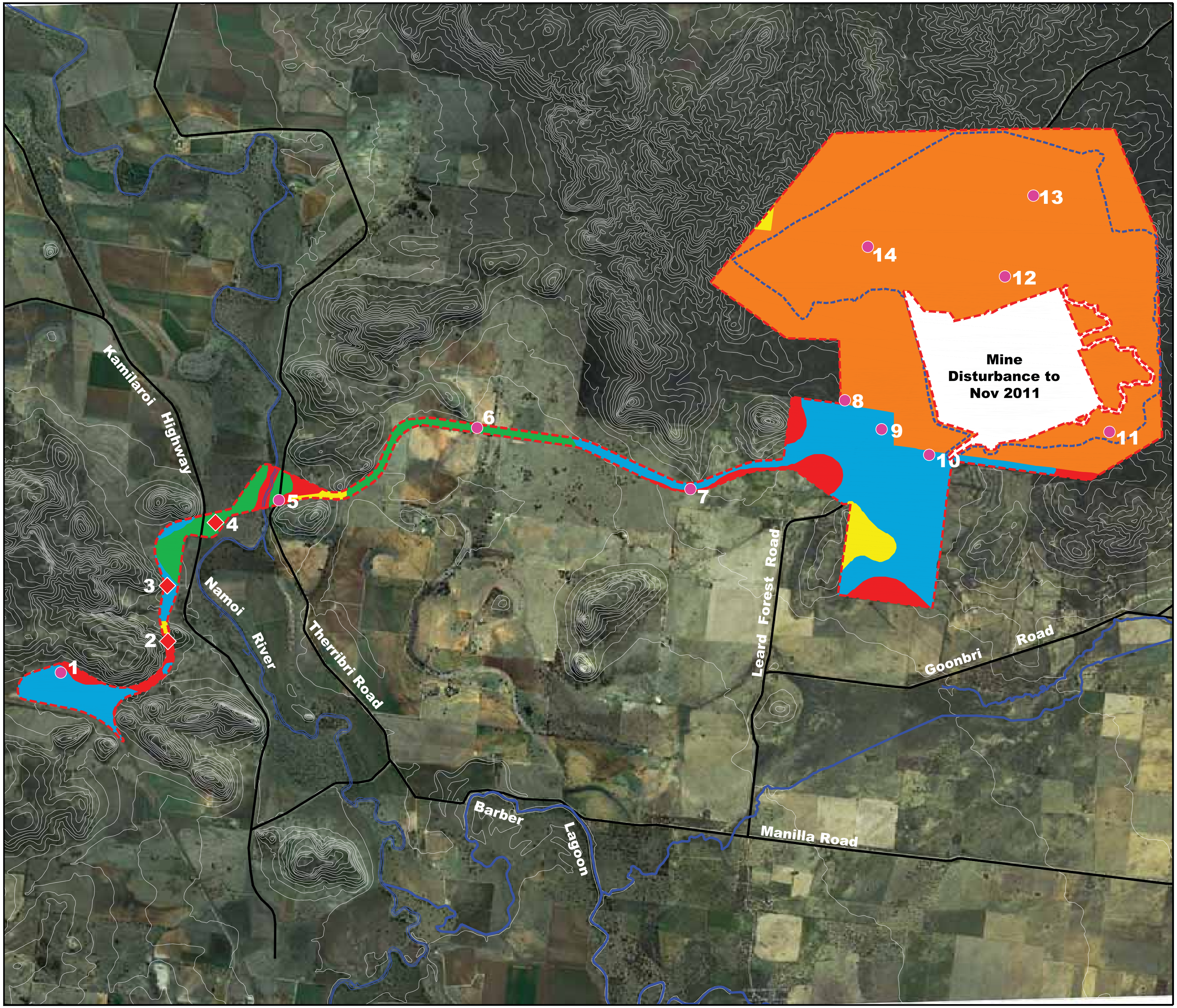

FIGURE 3

Land Capability

Project: Boggabri Soils & Land Capability				
Client: Hansen Bailey				
File: Fg1_HAN12-001_Land Cap_100524				
Projection: MGA 94 Zone 56				
Version: 1	Date: 24/05/2010	Author: TC/LF	Checked: AC	Approved: CR

GSS ENVIRONMENTAL
Environmental, Land and Project Management Consultants

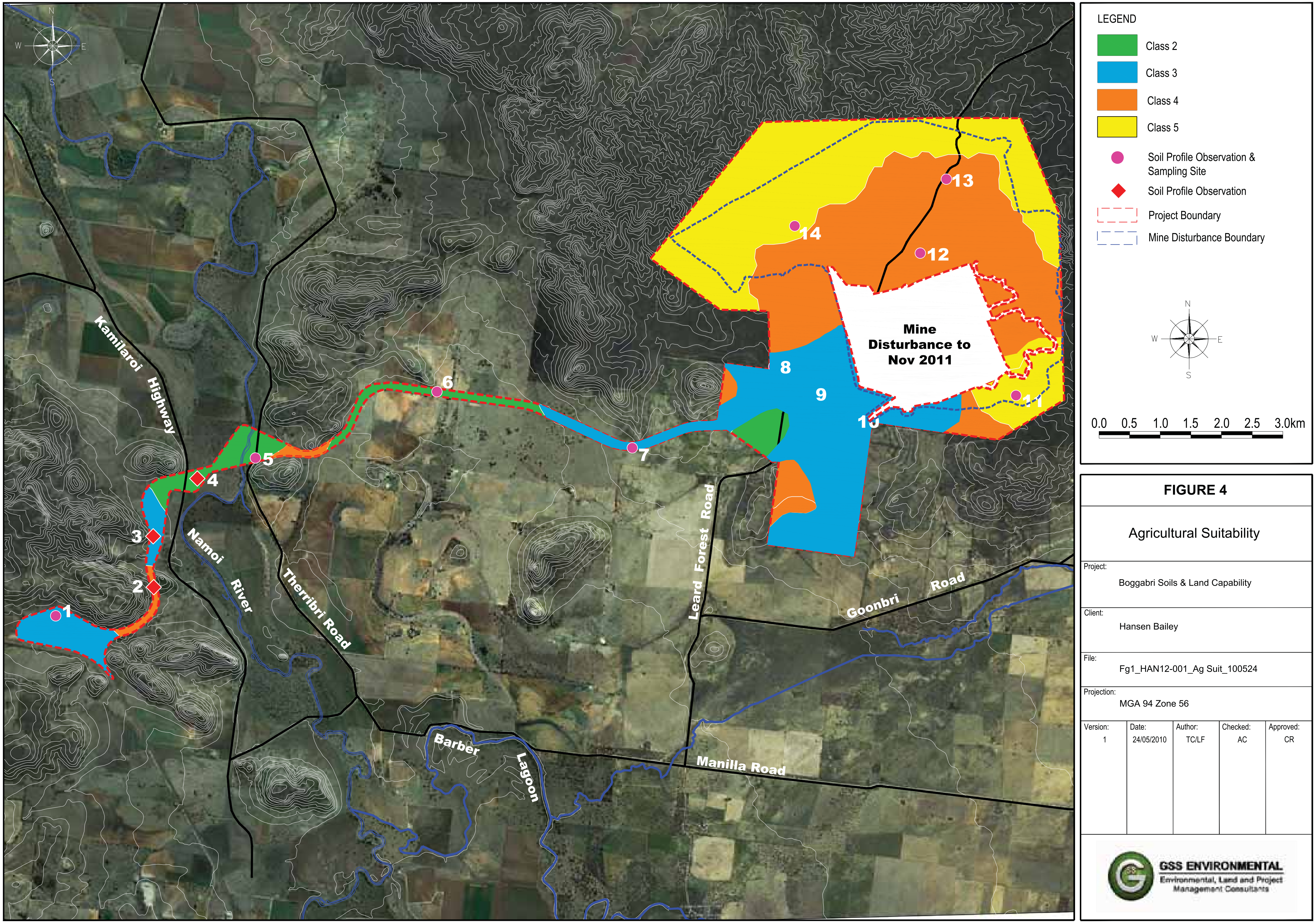

FIGURE 4

Agricultural Suitability

Project:	Boggabri Soils & Land Capability
Client:	Hansen Bailey
File:	Fg1_HAN12-001_Ag Suit_100524
Projection:	MGA 94 Zone 56

Version:	Date:	Author:	Checked:	Approved:
1	24/05/2010	TC/LF	AC	CR

GSS ENVIRONMENTAL
Environmental, Land and Project Management Consultants

4.0 DISTURBANCE MANAGEMENT

In order to reduce the potential for degradation within the study area and adjoining lands, the following management and mitigation strategies are recommended for implementation during mining and construction of the proposed rail line.

4.1 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 7**, 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 open bowl scrapers, or for loading into rear dump trucks by front-end loaders, are examples of preferential 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 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 compared to sandier 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.
- 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.
- An inventory of available soil should be maintained to ensure adequate topsoil materials are available for planned rehabilitation activities.

4.2 Topsoil Re-spreading

Where possible, suitable topsoil should be re-spread directly onto reshaped areas. Where topsoil resources allow, topsoil should be spread to a nominal depth of 100 mm on all re-graded spoil. Topsoil should be spread, treated with fertiliser or ameliorants (if required – refer **Section 3.1** of this report) and seeded in one consecutive operation, to reduce the potential for topsoil 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 & 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 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 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

Department of Natural Resources (2005). *Land Capability Spatial Data*. Resource Information Unit, Hunter Region

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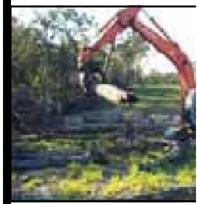
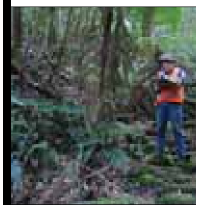
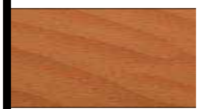
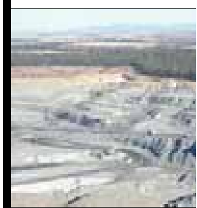



Field Assessment Procedure

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.

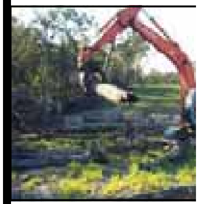
Root Density and Root Pattern

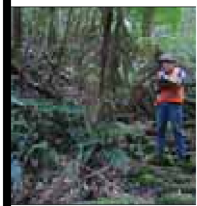
Root abundance and root branching is a reliable indicator of the capability for propagation and stockpiling.

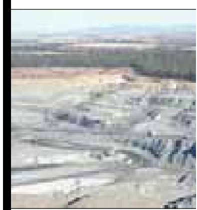
Field Exposure Indicators

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° (*d*S/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.

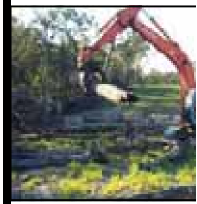
EC

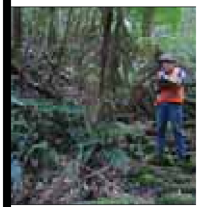
Electrical Conductivity determined on a 1:5 soil:water suspension. Prepared from the fine earth fraction of the sample. Reference - Bond R, Craze B, Rayment G, Higginson FR (in press 1990) **Australian Soil and Land Survey Handbook.** Inkata Press, Melbourne.

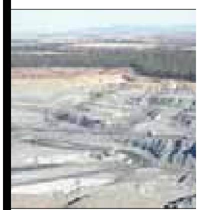
pH

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

Department of Lands

Land Administration & Management
Property & Spatial Information

Soil Conservation Service

SOIL TEST REPORT

Scone Research Centre

REPORT NO:	SCO08/204R1
REPORT TO:	Klay Marchant GSS Environmental PO Box 907 Hamilton NSW 2303
REPORT ON:	Twenty six soil samples Ref: URS0-07-04 Part 3A Approval
PRELIMINARY RESULTS ISSUED:	Not issued
REPORT STATUS:	Final
DATE REPORTED:	15 May 2008
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

G Holman
(Technical Officer)

SOIL AND WATER TESTING LABORATORY
Scone Research Service Centre

Report No: SCO08/204R1

Client Reference: Klay Marchant
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/1 Particle Size Analysis (%)					P9B/2	C1A/4	C2A/3	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	EC (dS/m)	pH	Dry	Moist
1	Site 1/1	34	33	28	5	0	8/3(2)	0.04	6.1	10YR5/4	10YR3/4
2	Site 1/2	69	21	9	1	0	3(2)	0.14	6.8	7.5YR5/4	7.5YR4/6
3	Site 1/3	69	24	5	2	<1	4	0.75	9.2	10YR6/4	10YR4/6
4	Site 2/1	17	20	33	29	1	8/3(1)	0.07	7.0	10YR5/3	10YR3/3
5	Site 2/2	16	13	31	34	6	5	0.07	7.0	10YR6/3	10YR4/4
6	Site 2/3	60	6	12	17	5	6	0.13	6.9	10YR7/6	10YR5/6
7	Site 4/1	17	35	42	6	0	3(1)	0.02	5.8	7.5YR5/4	7.5YR3/4
8	Site 4/2	16	29	39	14	2	2(1)	0.02	5.9	7.5YR6/4	7.5YR4/4
9	Site 4/3	64	19	15	2	0	2(2)	0.23	5.5	5YR5/6	5YR4/6
10	Site 5/1	16	21	43	14	6	3(1)	0.03	6.2	7.5YR5/3	7.5YR3/3
11	Site 5/2	50	16	23	10	1	2(1)	0.20	6.4	10YR6/4	10YR4/6
12	Site 5/3	48	16	31	5	<1	2(3)	0.90	5.5	10YR6/4	10YR4/6
13	Site 7/1	19	18	34	16	13	3(1)	0.05	6.1	7.5YR5.2	7.5YR3/3
14	Site 7/2	42	20	22	13	3	2(3)	0.09	7.2	7.5YR5/3	7.5YR3/3
15	Site 7/3	44	13	20	11	12	2(3)	1.23	8.7	10YR5/4	10YR4/4

SOIL AND WATER TESTING LABORATORY
Scone Research Service Centre

Report No: SCO08/204R1
Client Reference: Klay Marchant
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/1 Particle Size Analysis (%)					P9B/2	C1A/4	C2A/3	Colour	
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	EC (dS/m)	pH	Dry	Moist
16	Site 10/1	11	16	31	32	10	3(1)	0.05	6.0	10YR5/4	10YR3/4
17	Site 10/2	21	12	16	27	24	2(3)	0.15	7.9	10YR6/3	10YR4/3
18	Site 10/3	26	7	12	23	32	2(3)	0.19	6.2	10YR7/3	10YR5/6
19	Site 11/1	37	29	28	6	<1	8/3(3)	0.04	6.1	10YR5/4	10YR3/4
20	Site 11/2	53	24	20	3	<1	2(1)	0.13	5.9	7.5YR6/6	7.5YR4/6
21	Site 11/3	56	26	17	1	<1	2(2)	0.66	5.4	10YR6/4	10YR4/6
22	Site 12/1	14	21	36	26	3	3(1)	0.03	5.9	10YR5/4	10YR3/4
23	Site 12/2	43	16	23	17	1	2(3)	0.13	6.3	10YR6/4	10YR4/6
24	Site 12/3	40	17	19	24	0	2(3)	1.08	7.8	10YR6/4	10YR4/6
25	Site 13/1	19	16	22	35	8	8/3(1)	0.05	6.0	10YR5/4	10YR3/4
26	Site 13/2	16	4	36	39	5	2(2)	0.26	6.7	10YR6/4	10YR4/6

END OF TEST REPORT

APPENDIX 4

Glossary

A Horizon

The original top layer of mineral soil divided into A_1 (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 A_1 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.