WILPINJONG COAL PROJECT

APPENDIX M

Soils, Rural Land Capability and Agricultural Suitability Assessment

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WILPINJONG COAL PROJECT
SOILS, RURAL LAND CAPABILITY AND AGRICULTURAL SUITABILITY ASSESSMENT

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M1 INTRODUCTION

The proposed Wilpinjong Coal Project (herein referred to as the Project) is situated approximately 40 kilometres (km) north-east of Mudgee in central New South Wales (NSW) (Figure M-1).

This report has been prepared to assess the soils, rural land capability and agricultural suitability of the Project area and immediate surrounds. Specifically, the objectives of this report are to:

- detail the soil resources within the Project area;
- specify the rural land capability of the Project area in accordance with the standard NSW eight class system (Cunningham *et al*., undated);
- detail the agricultural suitability of the Project area in accordance with the five class system (Riddler, 1996);
- assess the potential impacts of the Project on soil and land resources and formulate soil resource management measures; and
- provide land resource information useful for the development of the Project rehabilitation strategy.

The soil resources, land capability and agricultural suitability of the Project area have previously been assessed in the following publications/studies:

- Soil Landscapes of the Dubbo 1:250,000 Sheet (DLWC, 1998).
- 1:100,000 Land Capability Series Sheet 8833 - Gulgong (Soil Conservation Service of NSW, 1982).
- Agricultural Land Classification of Mudgee Shire (unpublished) (NSW Agriculture, undated).

A field survey of the lands within the Project area was conducted by JAMMEL Environmental & Planning Services Pty Ltd in July 2004 in accordance with the Department of Land and Water Conservation (DLWC) *Soil and Landscape Issues in Environmental Impact Assessment* guidelines (2000) in order to confirm and supplement the previous mapping and assessments detailed in this report.

M2 GENERAL DESCRIPTION OF THE PROJECT AREA

The Project area includes the lands predominantly within the Mining Lease Application (MLA 1) area (Figure M-2). The Project would include:

- development and operation of an open cut mine within the MLA 1 area to produce coal for domestic electricity generation and export markets;
- selective highwall mining of the Ulan Seam within the MLA 1 area;
- a Coal Handling and Preparation Plant and mine facilities area;
- water management infrastructure including the relocation of Cumbo Creek;
- water supply bores and associated pump and pipeline system;
- placement of mine waste rock (i.e. overburden, interburden/partings and coarse rejects) predominantly within mined-out voids;
- placement of tailings within a combination of out-of-pit and in-pit tailings storages;
- development and rehabilitation of final mine landforms and establishment of woodland vegetation in areas adjacent to the Project;
- a mine access road, temporary construction camp access road, internal access roads and haul roads;
- closure of Wilpinjong Road and Bungulla Road;
- realignment of two sections of Ulan-Wollar Road (including the relocation of two road-rail crossings);

- relocation of the existing 11 kilovolt (kV) electricity transmission line;
- an on-site temporary construction camp to accommodate up to 100 people during the construction phase;
- a rail spur and rail loop;
- coal handling and train loading infrastructure;
- transportation of product coal to market via train; and
- Enhancement and Conservation Areas.

An outline of the extent of the Project open cut mine and contained infrastructure within the Project area is shown on Figure M-2. In addition, minor disturbance would be associated with the development of ancillary infrastructure such as road realignments, relocation of the existing 11 kV electricity transmission line, the on-site temporary construction camp and water supply bores and associated pump and pipeline system. Further details are provided in Section 2 of Volume 1 of the Environmental Impact Statement.

Geologically, the Project area and surrounds comprises mainly Permian and Triassic sediments. The Permian sediments contain the coal measures and also comprise sandstone, conglomerate, coal, tuff and some older basalt. They are overlain by the harder Triassic sandstones of the Narrabeen Group that form the rugged ranges and plateaus of the Goulburn River National Park, Munghorn Gap Nature Reserve and other sandstone-capped ranges bounding the Project area. The broad valley floor of the Project area has developed in the softer Permian sediments. By contrast, the Narrabeen sandstone areas resist erosion forming narrow valleys and gorges with much shallower soils.

The largest drainage features in the Project area are Wilpinjong Creek and Cumbo Creek. A number of minor creeks and watercourses drain the Project area into Wilpinjong Creek from south to north including Bens, Narrow, Spring and Planters Creeks in succession from east to west.

The general landscape in the Project area is cleared and predominantly grazed by cattle and sheep. Only limited cropping occurs. Most native vegetation is restricted to the sandstone plateaus and hill slopes along the MLA 1 boundary.

M3 METHODOLOGY

M3.1 FIELD SURVEY

A field survey of the Project area was conducted by JAMMEL Environmental & Planning Services Pty Ltd between 21 and 30 July 2004. This survey provides information which augments existing soil landscape mapping of the Project area (DLWC, 1998). The field survey focussed mainly on areas where surface disturbance is proposed within the MLA 1 boundary.

Observations were made to identify boundaries between the various soil types and soil landscapes within the Project area. A total of 46 sites were sampled to a depth of 1 m, or to depth of refusal.[1] The locations of the soil sampling sites are shown on Figure M-2. Representative soil samples from each soil type and horizon were analysed for physical and chemical properties (Section M3.2). Soil profiles of the sampled sites were also described (Attachment MA).

The survey also included inspection of Project areas to confirm and augment existing rural land capability and agricultural suitability mapping including aerial photographic interpretations where necessary.

[1] Samples were taken to identify and describe the surface soil A and B horizons (i.e. <1 m). The geochemical characteristics of substrate material (e.g. sandstone) are assessed in Appendix C of the Environmental Impact Statement (EGi, 2005).

M3.2 LABORATORY SOIL TESTING

Chemical analyses were undertaken by a National Association of Testing Authorities, Australia (NATA) accredited soil laboratory. These results have been used for preliminary assessment of soil suitability for rehabilitation purposes (Section M7.2).

Composite samples representing each soil type horizon encountered underwent laboratory analyses. Sampling of the A horizon for laboratory analysis did not differentiate between the A_1 & A_2 sub-horizons of the topsoil as it would all be stripped for re-use. Analytical results (physical and chemical) are presented in Attachment MB.

M4 SOILS OF THE PROJECT AREA

M4.1 SOIL LANDSCAPES

The soil landscapes of the Project area are based on those delineated by the Soil Landscapes of the Dubbo 1:250,000 Sheet (DLWC, 1998) and the soil types encountered during the field survey.

The Soil Landscapes of the Dubbo 1:250,000 Sheet (DLWC, 1998) identifies three main soil landscapes within the Project area *viz.* Barigan Creek, Ulan and Lees Pinch (Figure M-3). The Barigan Creek and Ulan soil landscapes cover the majority of the Project area. The landform characteristics, lithology, typical soils and limitations of these landscapes are summarised in Table M-1. The typical characteristics of the predominant soils of the Barigan Creek and Ulan soil landscapes are also provided in Tables M-2 and M-3.

Table M-1
Soil Landscapes of the Project Area

Landscape	Landform	Lithology	Typical Soils	Limitations
Barigan Creek	Lower slopes of sandstone plateau escarpments. Undulating low rises and flats.	*Illawarra Coal Measures and Shoalhaven Group* Shale, sandstone, siltstone, conglomerate, chert.	Yellow podzolic soils and red podzolic soils.	Moderate erosion hazard with surface soils subject to structural degradation with mechanical disturbance. Imperfectly to moderately drained.
Ulan	Low undulating rises and creek flats.	*Undifferentiated and Illawarra Coal Measures* Shale, sandstone, conglomerate, chert, coal and torbanite.	Yellow podzolic, yellow solodic/ solonetz, yellow and brown earths, and earthy sands.	Moderate to high erosion hazard and susceptible to soil structure degradation. Imperfectly drained on the lower slopes and depressions.
Lees Pinch	Sandstone plateau and hillslopes with boulder debris.	*Narrabeen Group and Illawarra Coal Measures* Sandstone, Wollar sandstone, conglomeratic sandstone, chert, shale coal, torbanite.	Shallow siliceous sands, shallow acid soils, yellow earths, yellow podzolic soils.	Steep slopes have high erosion hazard when cover is low. Low to very low waterholding capacity and high permeability.

After: DLWC (1998)

Table M-2
Typical Characteristics of the Predominant Soils of the Barigan Creek Soil Landscape

Characteristics	Yellow Podzolic Soils	Red Podzolic Soils
Dominance	Dominant	Common
Landform element	Lower slopes, flats	Side slopes, crests
Surface condition	Gravelly	Hardsetting
Drainage	Imperfectly drained	Moderately well-drained
Soil permeability	Slow	Moderate
Watertable depth	Seasonal water logging	None
Available waterholding capacity	Moderate	Low
Depth to bedrock	>60 cm	<60 cm
Flood hazard	Slight	None
pH (topsoil)	Slightly acid to neutral	Slightly acid to neutral
Fertility (chemical)	Low	Low
Expected nutrient deficiencies	Nitrogen, Phosphorus	Nitrogen, Phosphorus
Soil salinity	Isolated areas of salting evident	No salting
Erodibility (topsoil)	Moderate	High
Erodibility (subsoil)	Moderate	Moderate
Erosion hazard	Moderate	Moderate
Structural degradation hazard	High	High
Shrink-swell potential	Low to moderate	Low to moderate
Mass movement hazard	Not evident	Not evident

After: DLWC (1998)

Table M-3
Typical Characteristics of the Predominant Soils of the Ulan Soil Landscape

Characteristics	Yellow Podzolic Soils	Yellow Solodic Soils
Dominance	Common	Common
Landform element	Mid to lower slopes, flats	Drainage lines and depressions
Surface condition	Gravelly or hardsetting	Hardsetting
Drainage	Imperfectly drained	Imperfectly to poorly drained
Soil permeability	Slow	Low to very low
Watertable depth	Occasionally seasonal water logging	Perched and seasonal
Available waterholding capacity	Moderate	Moderate
Depth to bedrock	60 to >100 cm	>100 cm
Flood hazard	Nil	Slight
pH (topsoil)	Slightly acidic	Slightly acidic
Fertility (chemical)	Low	Low
Expected nutrient deficiencies	Nitrogen, Phosphorus, Sulphur	Nitrogen, Phosphorus, Sulphur
Soil salinity	Low	Some salting evident as salt scalds
Erodibility (topsoil)	Moderate	Moderate
Erodibility (subsoil)	High	High to very high
Erosion hazard	Moderate	High
Structural degradation hazard	High	High
Shrink-swell potential	Low	Low
Mass movement hazard	Not evident	Not evident

After: DLWC (1998)

The characteristics of the soil landscapes as provided in Tables M-1, M-2 and M-3 are determined from 1:250,000 scale mapping (DLWC, 1998) which relied upon correlations that may exist between soils and underlying geology, landforms and vegetation. Due to the inherent variability of soil systems, soils that do not necessarily reflect the typical characteristics of the soil landscapes mapped at the 1:250,000 scale (DLWC, 1998) have been identified during the field survey undertaken for the Project.

M4.2 GREAT SOIL GROUPS

The soils of the Project area described in this section are based on the Great Soil Group System (Stace *et al*., 1968). The Great Soil Group system is a wide classification of soils based on soil morphological and chemical properties. Each Great Soil Group represents a range of soils in the field.

The major soil types encountered in the Project area are described in the following sub-sections and include red podzolic, yellow podzolic, earthy sands, brown earths, yellow solodic soils, lithosols and alluvials. The delineated areas where each Great Soil Group occurs within the Project area are shown on Figure M-3.

Soil salinity for the major soil types were characterised using the soil and water salinity criteria provided in Table M-4. The analytical results (physical and chemical) are presented in Attachment MB.

Table M-4
Soil and Water Salinity Criteria (ANZECC, 2000)

Soil or Water Salinity Rating	Average Root Zone Salinity (EC_{se})*
Very low	<0.95 dS/m
Low	0.95-1.9 dS/m
Medium	1.9-4.5 dS/m
High	4.5-7.7 dS/m
Very High	7.7-12.2 dS/m
Extreme	>12.2 dS/m

After: ANZECC (2000)
* 1 dS/m = 1,000 µS/cm

M4.2.1 Red Podzolic

A total of 20 red podzolic soil samples were taken from across the Project area. Red podzolic soils occur over the majority of the Project area on the lower to mid slopes.

Red podzolic soils feature a brownish-greyish A horizon overlaying a red B horizon of much higher clay content. The A horizon is usually weakly structured, whilst the B horizon consists of polyhedral or blocky pedology. A distinct pale A_2 horizon is usually present and the profile is slightly acidic. Soil salinity was generally low to very low, with the exception of one soil sample which exhibited medium soil salinity. Fertility is generally low (with the A horizon retaining some organic matter) and decreases further with depth.

M4.2.2 Yellow Podzolic

A total of 17 yellow podzolic soil samples were taken across the Project area. Yellow podzolic soils generally occur on lower slopes and minor drainage lines across the Project area. The soil pH is neutral to slightly acidic. These soils show a high occurrence of water logging which in some cases results in isolated extreme surface soil salinity (Sites 44 and 46). With the exception of these two saline soil samples, soil salinity for yellow podzolic soils was low.

Yellow podzolic soils are identified by their strongly differentiated profiles with light, medium textured A horizons overlaying a yellow-brown clayey B horizon. The A_2 horizon is usually noticeably leached. Reddish or greyish mottling is common in the B horizon. These soils are of limited fertility, with the A horizon providing moderate accumulation of organic matter.

M4.2.3 Earthy Sands

Three earthy sand soil samples were taken from the Project area. Earthy sands occur along Bens Creek and in small patches at the base of the sandstone escarpments in the east of the Project area.

Earthy sands are characterised by uniform profiles of coherent, clayey sands that are predominantly red in colour but in some cases yellow. These soils are usually deep and are characterised by uniform sand texture and a massive, single-grained structure. Their earthy appearance occurs from coating and bridging of sand grains by clayey materials.

The pH of the earthy sands is neutral to slightly acidic. The soil samples exhibited high soil salinity in the A horizon and very low soil salinity in the B horizon.

M4.2.4 Brown Earths

Two brown earth soil samples were taken from the Project area. Brown earths occur in small patches along the eastern bank of Cumbo Creek. These soil profiles are found intermittently along Cumbo Creek.

Brown earths show little profile differentiation. The profile is a uniform yellow, reddish-brown colour generally becoming more yellow or red with depth. Brown earths range in texture from light loams to clays. The soil pH is neutral to slightly acidic and soil salinity medium to very low.

M4.2.5 Yellow Solodic

Solodic soils occur in the south-east of the Project area amongst the yellow podzolic soils which occur on lower slopes. The land where solodic soils occur in the Project area is still fully timbered and has not been cleared.

Solodic soils are characterised by strong texture contrast profiles with light textured surface soils overlying tough, hard and dense B horizon, which are usually unstable to wetting processes. The boundary between the A and B horizons is abrupt. There is also a characteristic bleached A_2 horizon. The B horizons generally range from sandy clays to medium clays and vary in colour from grey, grey-brown, yellow-brown to red-brown (the duller colour being more common) and are frequently mottled. These soils have low fertility, poor trafficability when wet, and are erodible. The soil pH is slightly acidic and the A horizon is of very low salinity. The B horizon however exhibited high soil salinity.

M4.2.6 Lithosols

Lithosols occur on the higher plateaus and sandstone escarpments associated with the Munghorn Gap Nature Reserve and the steeper slopes to the south and east of the Project area.

Lithosols are stony or gravelly soils with a thin A_1 horizon of organic matter generally occurring on upper slope and hill-top areas. Pedological development is low, consisting of weathering of underlying rocks and the gradual addition of organic matter in the A_1 horizon.

M4.2.7 Alluvials

Alluvial soils identified within the Project area generally occur along Cumbo Creek. Shallow localised alluvial sediments also occur in Spring, Planters, Bens and Narrow Creeks which drain to Wilpinjong Creek[2].

Alluvial soils have no true pedological horizons other than an A horizon and are often weakly developed. They generally occur on flats or valley bottoms where bed-load sedimentation has occurred. The sedimentary layers of these soils can vary greatly in a number of characteristics including texture, stoniness, depth, colour and carbonate content. The soil pH is neutral and soil salinity low. Nutrient supply is good as there is usually a reasonable supply of primary rock minerals.

[2] Source: *Hydrogeological Assessment of the Proposed Wilpinjong Open Cut Coal Mine* (Geoterra, 2004).

M5 RURAL LAND CAPABILITY ASSESSMENT

M5.1 LAND CAPABILITY CLASS SYSTEM

The rural land capability assessment has been conducted in accordance with the standard NSW eight class system (Cunningham *et al*, undated). The system is based on the assessment of biophysical soil properties, with categories of land based on limitations such as erosion hazard, climate and slope. It recognises three types of landuse *viz.*:

- Land suitable for cultivation (Classes I to III).
- Land suitable for grazing (Classes IV to VI).
- Land not suitable for rural production (Classes VII and VIII).

Rural land capability assessment based on the 1:100,000 Land Capability Series Sheet 8833 – Gulgong (Soil Conservation Service of NSW, 1982) identified four classes within the Project area (Classes IV to VII). Field survey undertaken by JAMMEL Environmental & Planning Services Pty Ltd in July 2004 delineated areas mapped as Class VI capability with isolated occurrences of surface soil salinity in the north of the Project area. These saline soil areas were localised where water logging and salt concentration has occurred. The land capability classes identified in the Project area are described in Section M5.2.

M5.2 LAND CAPABILITY CLASSES OF THE PROJECT AREA

The land capability classes specific to the Project area are detailed below and shown on Figure M-4.

M5.2.1 Class IV

> *Land not capable of being regularly cultivated but suitable for grazing with occasional cultivation with soil conservation practices such as pasture improvement, stock control, application of fertiliser and minimal cultivation for the establishment or re-establishment of permanent pasture (Cunningham et al., undated).*

The majority of the valley floor in the Project area is considered to be Class IV capability. Slopes within the mapped area generally range between 1 to 6% with the soil types being generally yellow podzolic or red podzolic. These soils are of typically of low fertility with moderate to high erosion potential. Other limitations of these areas include shallow soil depth and localised surface soil salinity caused by water logging and evapo-concentration of salts.

The land is considered incapable of regular cultivation of annual crops because of these limitations, however it would be capable of occasional cultivation for the establishment of permanent pasture, provided soil conservation practices were employed.

M5.2.2 Class V

> *Land not capable of being regularly cultivated but suitable for grazing with occasional cultivation and structural soil conservation works such as absorption banks, diversion banks and contour ripping, together with the practices as in Class IV (ibid.).*

Class V capability land is generally associated with mid slopes of the Project area which typically range from 1 to 15%. The main limitations of these areas include shallow soil depth, erosion hazard and evidence of localised surface soil salinity caused by water logging and evapo-concentration of salts.

The land is not considered capable of regular cultivation of annual crops because of the limitations described above, however capability would extend to occasional cultivation with the use of structural soil conservation works.

M5.2.3 Class VI

Land not capable of being regularly cultivated but suitable for grazing with soil conservation practices including limitation of stock, broadcasting of seed and fertiliser, prevention of fire and destruction of vermin. This class may require some structural works (ibid.).

Class VI land is generally associated with the mid slopes and areas of gully and sheet erosion within the Project area. The predominant soil types within Class VI capability are red podzolic and alluvials along Cumbo Creek. Fertility of these soil types is generally low, with moderate to high erosion potential.

Class VI land is also characterised by seepages within Class IV land. Areas of saline Class VI land were identified within the Project area including a seepage into Cumbo Creek in the south-east, and four isolated seepages along the northern boundary of MLA 1. The seeps are associated with the watercourses which drain the Project area. The main limitation of these areas is intermittent water logging and surface soil salinity.

The land is not considered capable of regular cultivation of annual crops because of these limitations, and is not suitable for grazing. Occasional cultivation would only be possible if major structural soil conservation works were undertaken.

M5.2.4 Class VII

Land best protected by green timber (ibid.).

Class VII capability land is restricted to the vegetated upper slopes and hill-tops to the east and west of the Project area. Class VII land is generally characterised by steeper slopes with moderate to high erosion potential. Class VII land is predominantly associated with lithosols occurring on the steeper slopes.

M5.2.5 Class VIII

Cliffs, lakes or swamps and other lands incapable of sustaining agricultural or pastoral production (ibid.).

Class VIII capability land is restricted to the elevated plateaus and escarpments associated with the Munghorn Gap Nature Reserve and Goulburn River National Park to the south and north of the Project area, respectively. Stony and gravelly soils (ie. lithosols) predominantly occur along these steeper slopes.

M6 AGRICULTURAL SUITABILITY ASSESSMENT

This agricultural suitability assessment draws on information available from the publications/studies sourced in this report, the Project area field survey (Section M3.1) and aerial photograph interpretation where necessary. It complements the soil resource information (Section M4) along with rural land capability assessment (Section M5) to provide an overall appraisal of the land resource.

M6.1 AGRICULTURAL LAND CLASSIFICATION SYSTEM

The agricultural suitability assessment was conducted in accordance with the five class system (Riddler, 1996), which classifies land according to its productivity for a wide range of agricultural activities.

Based on the Agricultural Land Classification of Mudgee Shire (unpublished) (NSW Agriculture, undated), the Project area comprises Classes 3 and 5 agricultural land (Figure M-5). Field survey undertaken by JAMMEL Environmental & Planning Services Pty Ltd in July 2004 also delineated Class 4 agricultural land. The agricultural land definitions for the respective classes within the Project area are detailed in Section M6.2.

M6.2 AGRICULTURAL SUITABILITY OF THE PROJECT AREA

The agricultural suitability classes specific to the Project area are detailed below and shown on Figure M-5.

M6.2.1 Class 3

> *Grazing land or land well suited to pasture improvement. It may be cultivated or cropped in rotation with pasture. The overall production level is moderate because of edaphic or environmental constraints. Erosion hazard, soil structural breakdown and other factors including climate may limit the capacity for cultivation, and soil conservation or drainage works may be required (ibid.).*

Class 3 agricultural suitability land is predominant on the valley floor and lower slopes of the Project area. Cattle and sheep grazing on pastures currently dominate landuse in Class 3 areas. Erosion hazard, soil structural breakdown and climatic factors limit the capacity for cultivation.

Class 3 areas also include isolated occurrences of surface soil salinity in the north of the Project area where water logging and salt concentration occurs.

M6.2.2 Class 4

> *Land suitable for grazing but not for cultivation. Agriculture is based on native pastures or improved pastures established using minimum tillage techniques. Production may be seasonally high but the overall production level is low as a result of major environmental constraints (ibid.).*

Class 4 agricultural land is associated with the lower slopes in the south-east of the Project area. Class 4 lands in the Project area are generally characterised by solodic soils and lower fertility land.

M6.2.3 Class 5

> *Land unsuitable for agriculture or at best suited to only light grazing. Agricultural production is very low to zero as a result of severe constraints, including economic factors, which preclude land improvement (ibid.).*

Class 5 agricultural land is associated with the escarpments and lower hills within and adjacent the Project area. Class 5 areas are generally characterised by steeper slopes and lower fertility land.

M7 SOIL RESOURCE MANAGEMENT

General soil resource management practices where surface development is proposed within the Project area should involve the stripping and stockpiling of soil resources prior to any mine-related disturbance, other than clearing vegetation. The general strategy should be undertaken for those disturbance areas to be rehabilitated progressively, or at the completion of mining activities.

The objectives of the soil resource management strategies are to:

- Optimise the recovery of topsoil and subsoil available for rehabilitation.
- Identify and quantify potential soil resource.
- Manage topsoil and subsoil reserves so as not to degrade the resource.
- Assist in development of soil stripping and stockpiling procedures.
- Establish effective methods for utilising available soil reserves in future rehabilitation works.

M7.1 CONCEPTUAL SOIL RESOURCE MANAGEMENT STRATEGIES

Conceptual soil resource management strategies proposed for the disturbance areas within the Project area are detailed in Table M-5.

Table M-5
Conceptual Soil Resource Management Strategies

Prior to Commencement of Soil Stripping Activities	During Soil Stripping and Stockpiling Activities	Prior to and During Rehabilitation Activities
• Quantification of soil resources (see below). • Characterisation of the suitability of material for rehabilitation purposes (Section M7.2). • Formulation of stripping and stockpiling guidelines including the nomination of appropriate depths, scheduling, and location of areas to be stripped and stockpile locations (detailed in the Mining Operations Plan).	• Minimise over-clearing. • Selective stockpiling of soil according to soil type (ie. Great Soil Group, topsoil, subsoil) and soil salinity. • Storage of soils in a manner that does not compromise the long-term viability of the resource (Section M7.3).	• Implementation of amelioration measures to ensure the long-term viability of the soil resources and manage surface soil salinity (Section M7.3). • Management of soil suitability for rehabilitation (Section M7.2). • Progressive rehabilitation of final landforms as soon as practicable after completion or when areas are no longer required.

Soil stripping activities would occur within the proposed open cut mine and contained infrastructure areas (some 1,920 ha). Soil type mapping indicates these disturbance areas would predominantly occur on yellow podzolic and red podzolic soils and some areas where earthy sands, brown earths, alluvials and lithosols occur. Disturbance of areas where solodic soils occur would be minimal.

Table M-6 indicates the approximate area each soil type occupies within the Project disturbance area, the recommended stripping depth and approximate volume of topsoil material that would be available for rehabilitation purposes.

Preliminary material balance calculations based on the recommended topsoil stripping depths outlined in Table M-6 indicate an approximate topsoil volume of 3,300,000 m^3 would be available from the Project disturbance areas. Should rehabilitation activities require additional topsoil material, red podzolic soils could be stripped up to a further 30 centimetres (cm) before intersection with the B horizon. Subsoil[3] across the Project disturbance areas would also be suitable for selective use as a subsoil medium for plant growth. Trials of various surface treatments (including subsoil and topsoil depths) should be conducted during the Project life.

Quantification of soil resources available for rehabilitation works, stripping and re-application schedules and stockpiling inventories should be included as part of the Mining Operations Plan (MOP) in accordance with the requirements of the Department of Primary Industries-Mineral Resources during mining operations.

Table M-6
Topsoil Resource Availability

Soil Type	Recommended Stripping Depth (cm)	Stripping Area (ha)	Volume (m^3)
Red Podzolic	15	1,080	1,620,000
Yellow Podzolic	20	585	1,170,000
Brown Earth	25	13	32,500
Alluvial	30	30	90,000
Earthy Sand	30	125	375,000
Lithosol	0	85	0
Yellow Solodic	0	2	0
Total	**N/A**	**1,920**	**3,287,500**

[3] Including topsoil resource unsuitable for topdressing purposes (i.e. yellow solodic soils).

M7.2 SOIL SUITABILITY FOR REHABILITATION PURPOSES AND MANAGEMENT PRACTICES

Chemical and physical assessment of the soil properties within the Project disturbance area (Attachment MB) indicate that the soil resource in Table M-6 would be suitable for rehabilitation purposes provided appropriate management practices are implemented and relevant amelioration measures are applied where necessary.

All soils throughout the Project disturbance area were found to be neutral to slightly acidic and phosphorus levels were all low. The cation exchange capacity (CEC) for most soil types was moderate to low. These levels have the potential to limit structural stability and nutrient availability for plant growth. Soil nutritional issues can be addressed through the application of an appropriate fertiliser prior to re-application on completed landforms during rehabilitation activities.

Exchangeable sodium percentage (ESP) levels for yellow podzolic soils in localised saline areas (Sites 44 and 46) were elevated (i.e. greater than 6%) and the salinity levels (EC_{se}) were greater than 4.5 deciSiemens per metre (dS/m). Elevated ESP levels were also measured for red podzolic and brown earths from the eastern side of the Project disturbance areas. The yellow podzolic soils outside of the saline areas did not exhibit elevated ESP levels, however further testing is recommended during stripping activities. In order to manage potential problems during rehabilitation activities associated with elevated ESP levels in these soils (i.e. crusting, reduction in moisture infiltration, inhibition of vegetation establishment) a soil ameliorant may be applied (e.g. gypsum) at an appropriate rate.

Elevated ESP and EC_{se} levels (5.56 dS/cm) were exhibited by the yellow solodic soils (Sites 6 and 42) B horizon which, by its chemical nature, could be unstable when the soil becomes wet. The A horizon also exhibited structural problems in the form of high ESP values. It is therefore recommended that this soil type be buried so as not to have adverse effects on rehabilitation success and that the use of this soil type for topdressing purposes be avoided.

EC_{se} levels recorded in earthy sands ranged form 0.91 to 6.36 dS/m. These soils have poor structural strength due to their granular structure and weak consistency. Should topsoil stockpiling occur prior to topdressing, a level of leaching would occur reducing the EC_{se} levels due to the physical and chemical characteristics of this soil type. Additionally, use of this soil type to blend with clayey-textured soils would help in creating a good soil medium for plant growth during rehabilitation.

Very low calcium/magnesium ratios were exhibited by all soil types identifying low exchangeable calcium and elevated exchangeable magnesium levels. High magnesium levels (ie. >25% of CEC) can lead to clay dispersion. This potential problem can be overcome by applying a soil ameliorant such as gypsum at an appropriate rate during rehabilitation activities.

Some soil samples exhibiting a slight acidic trend also indicated elevated levels of manganese. Manganese toxicity to plant growth can be overcome by correcting the soil pH with appropriate application of lime.

M7.3 MEASURES TO ENSURE THE LONG-TERM VIABILITY OF SOIL RESOURCES AND TO MANAGE SOIL SALINITY

The following soil stockpile management practices would improve the long-term viability of the soil resource:

- Soil stockpiles to be located outside of active mining areas.
- Stockpiles to be constructed with a rough surface condition to reduce erosion hazard, improve drainage and promote revegetation.
- Stockpiles which are to be inactive for extended periods to be fertilised and seeded to maintain soil structure, organic matter and microbial activity.
- Silt fences to be installed around soil stockpiles to control potential loss of soil where necessary.
- Soil stockpiles to be deep-ripped to establish aerobic conditions, prior to re-application of stockpiled soil for rehabilitation.

For the purposes of addressing potential soil salinity and dispersivity issues it is also recommended that:

- where practicable, saline soil types should be stockpiled separately and then placed in mine waste rock emplacements below the topsoil/subsoil cover layer; and
- gypsum be applied at an appropriate rate to stockpiles of dispersive soil types where necessary.

Details of the above management strategies and practices including timing of implementation and relevant methodology should be included in the MOP.

M8 REFERENCES

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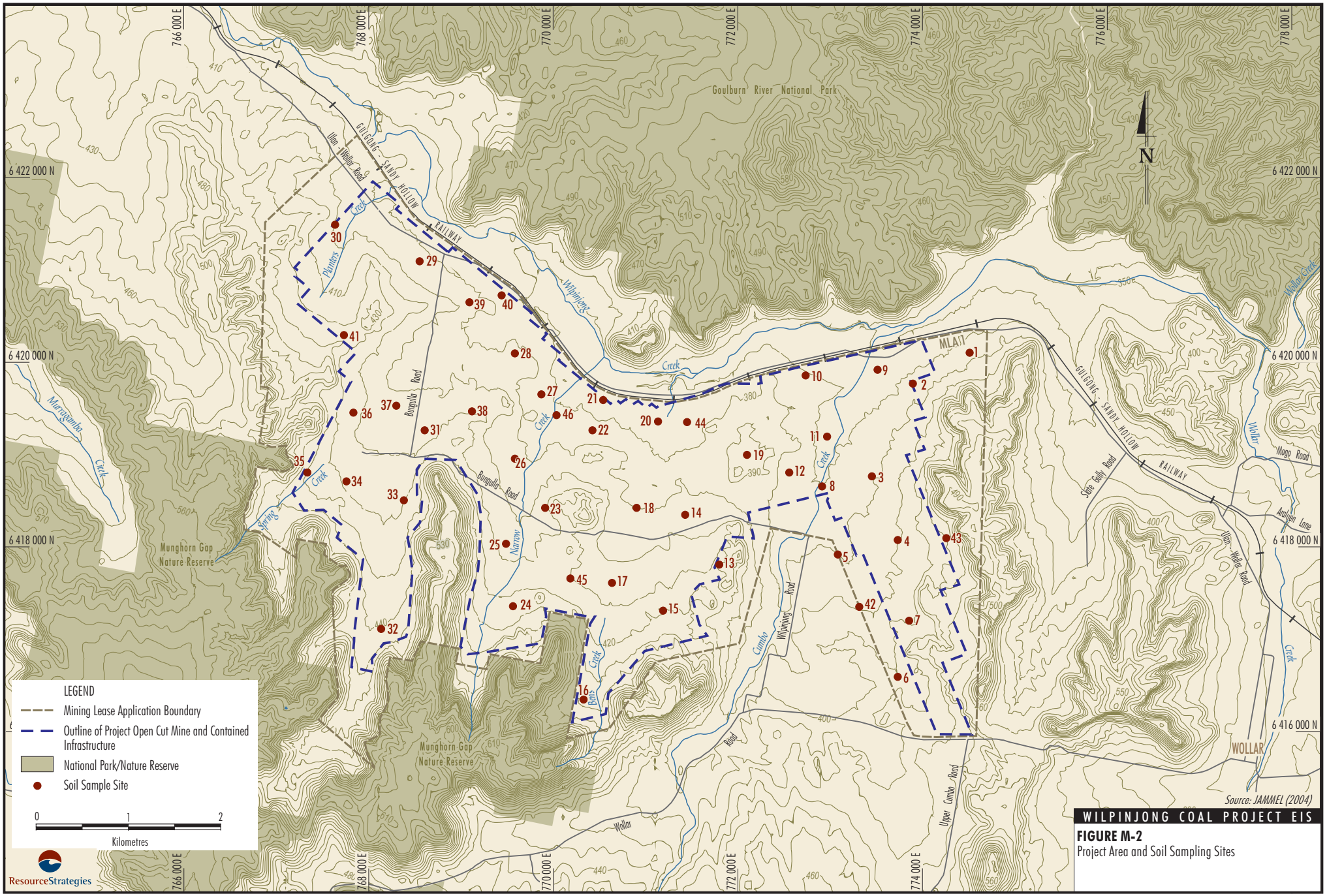
FIGURES

ResourceStrategies

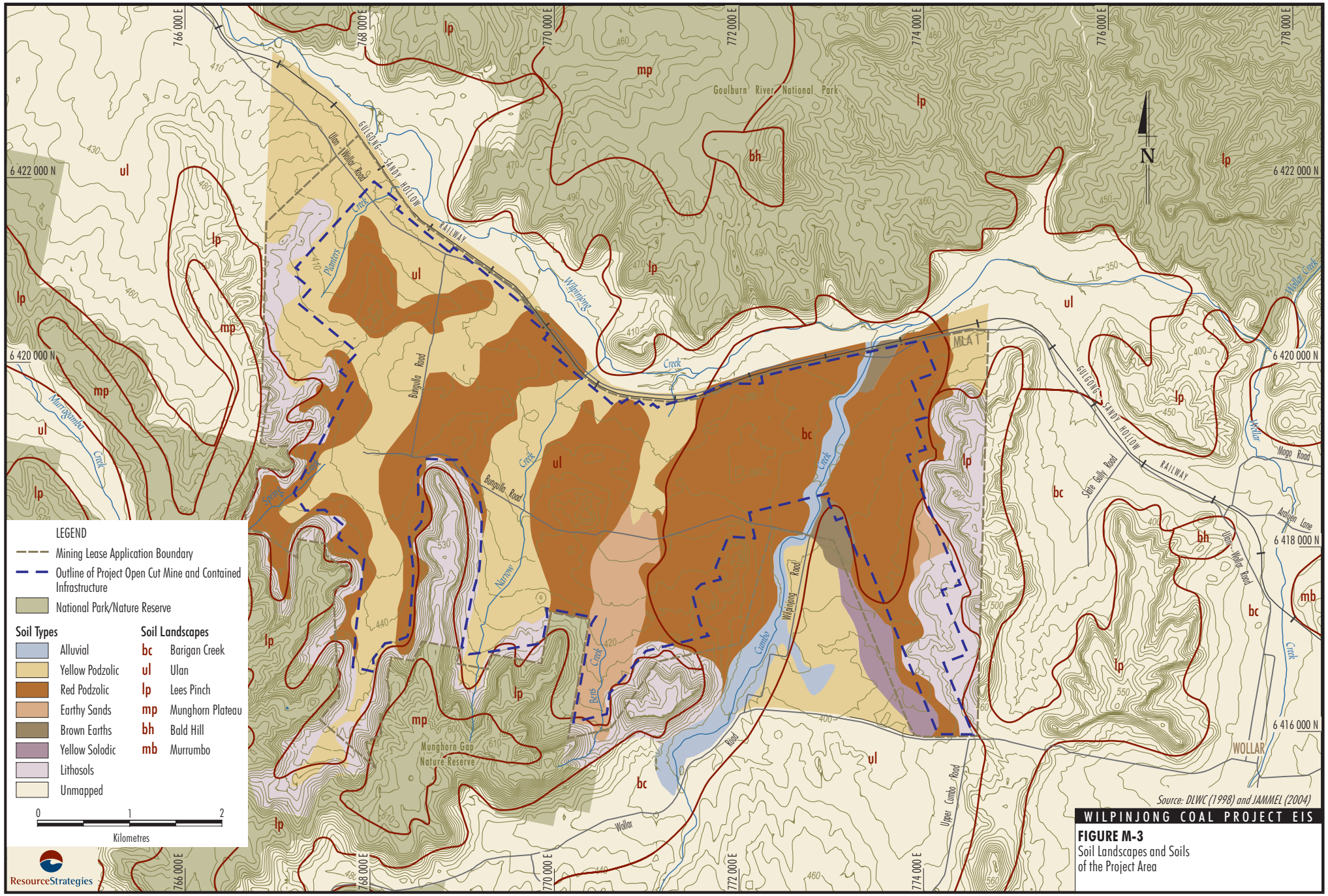
WIL-04-01 Soils_001D

WILPINJONG COAL PROJECT EIS

FIGURE M-1
Regional Location



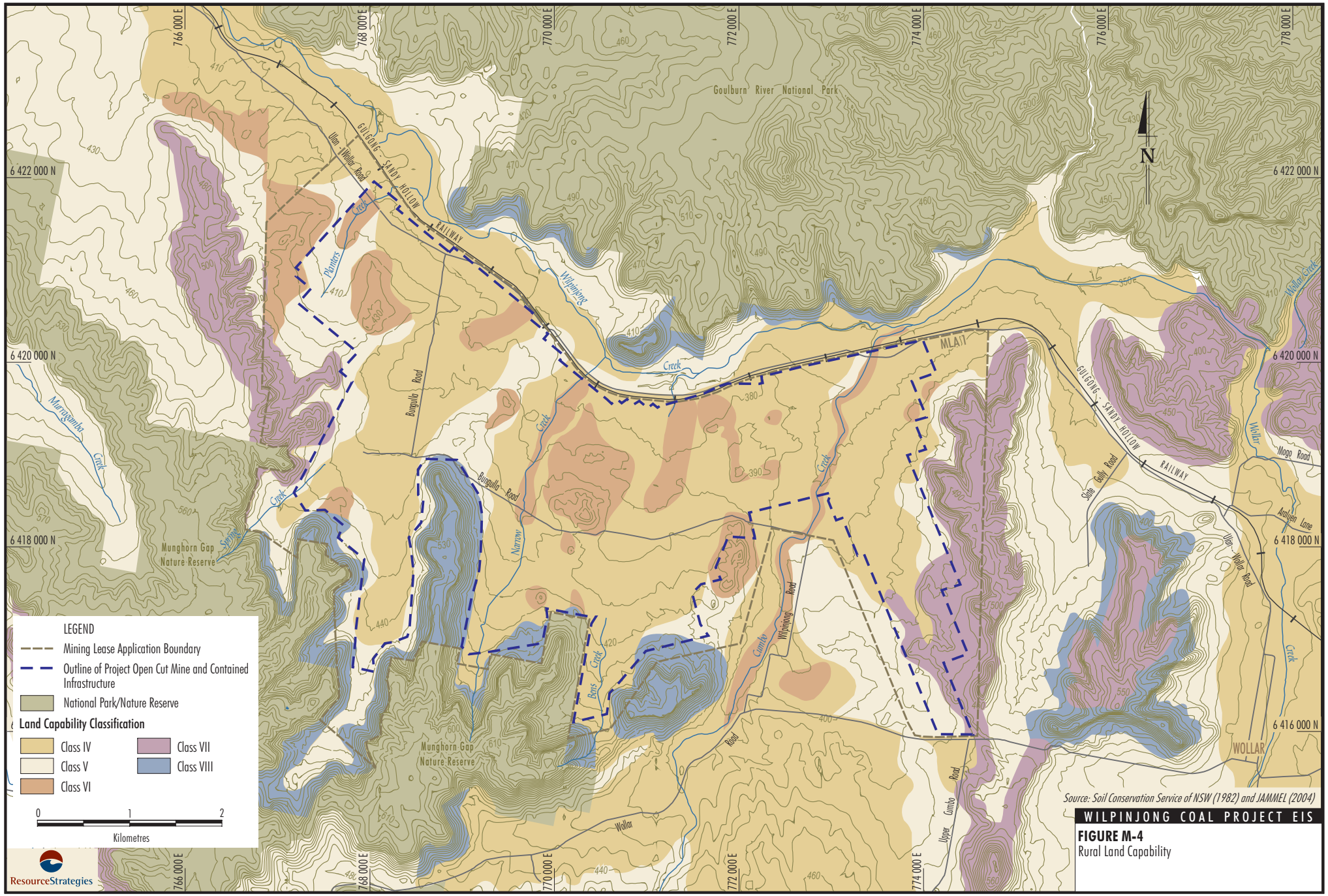
WIL-04-01Soils_002C



WILPINJONG COAL PROJECT EIS

FIGURE M-3
Soil Landscapes and Soils of the Project Area

WIL-04-01 Soils_003D

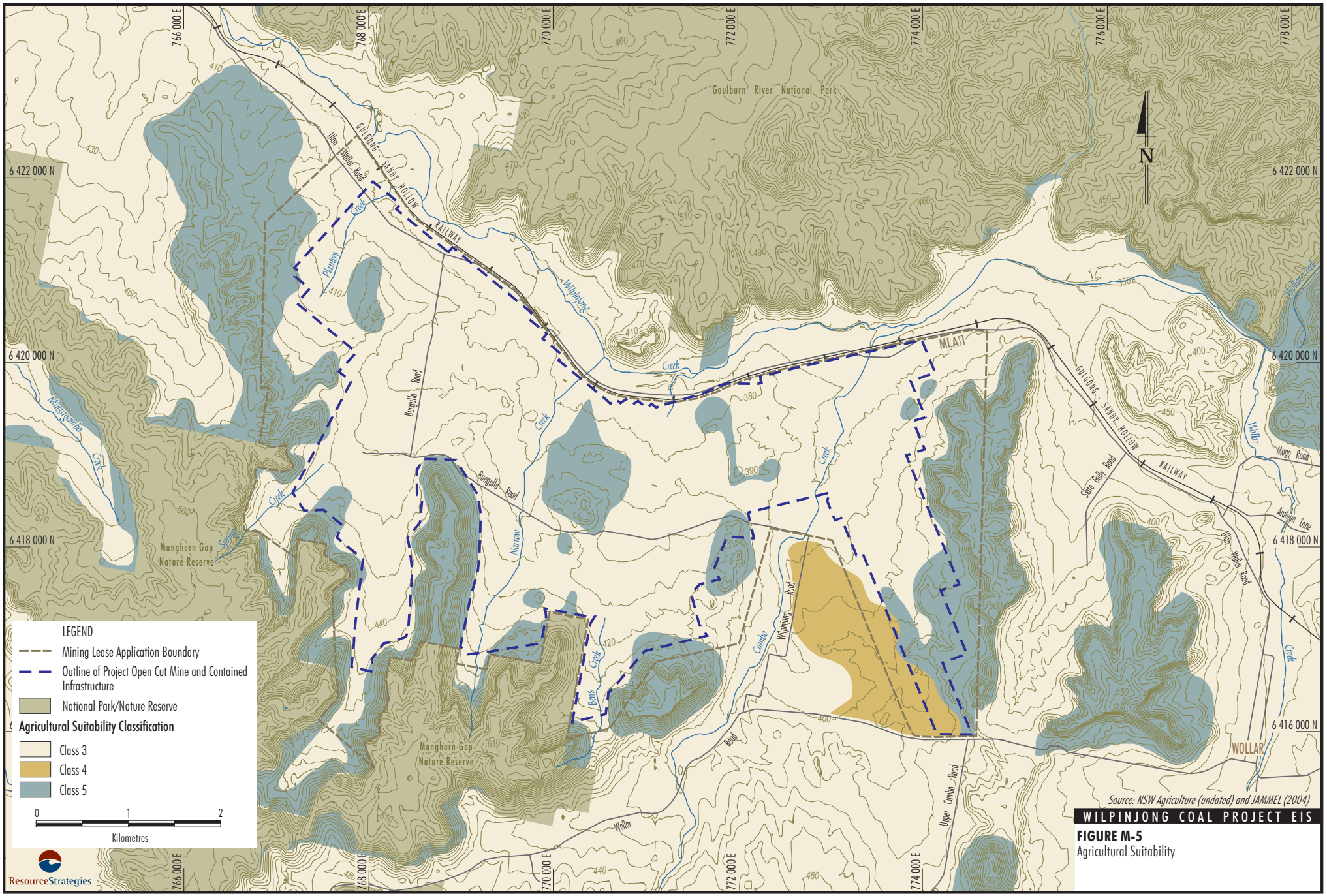


Source: Soil Conservation Service of NSW (1982) and JAMMEL (2004)

WILPINJONG COAL PROJECT EIS

FIGURE M-4
Rural Land Capability

WIL-04-01 Soils_004E



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ATTACHMENT MA

SOIL PROFILE DESCRIPTIONS

(JAMMEL Environmental and Planning Services Pty Ltd, 2004)

Wilpinjong Coal Project
Soil Profile Descriptions

Site No:		**1**	**2**	**3**	**4**
Coordinates (AGD 66)		S 32^0 19.370' E 149^0 54.731'	S 32^0 19.670' E 149^0 54.420'	S 32^0 20.129' E 149^0 54.289'	S 32^0 20.563' E 149^0 54.427'
Runoff:		Medium	Medium	Medium	Rapid/Medium
Permeability:		Moderate	Moderate	Moderate	Slow/Moderate
Drainage:		Moderate	Slow	Slow	Slow
Landform:		Lower Slope	Mid Slope	Mid Slope	Flat
Site Disturbance:		Cleared for grazing	Cleared for grazing	Cleared for grazing	Minor disturbance by logging & track construction
Landuse:		Grazing	Grazing	Grazing	Opportunistic Grazing
Slope:		3%	2%	1%	1%
Vegetation:	Dom. spp./stratum:	Voluntary/Native Grasses - Degraded	Native Grasses	Native Grasses	Native Trees
	Height:	Nil	Nil	Nil	Up to 15 m
	% Foliage Cover:	Nil	Nil	Nil	65%
Microrelief:		Nil	Nil	Nil	Nil
Erosion:	Type:	Sheet/Rill	Sheet/Rill	Sheet/Rill	Sheet/Rill
	Degree:	Minor	Minor	Minor	Moderate
Surface Coarse Fragments:		Yes (Rock Picked)	Yes (Rock Picked)	Yes (Rock Picked)	Nil
Rock Outcrop:		Nil	Nil	Nil	Nil
Salinity Evidence:		Nil	Nil	Nil	Nil
Soil Classification:		Yellow Podzolic (Dy2.43)	Red Podzolic (Dr3.23)	Red Podzolic (Dr3.23)	Red Podzolic (Dr2.13)
Horizon:	Depth:	A_1 0 - 20 A_2 20 - 45 B 45 +	A_1 0 - 20 A_2 20 - 55 B 55 +	A_1 0 - 20 A_2 20 - 60 B 60 +	A_1 0 - 20 A_2 20 - 60 B 60 +
	Boundary:	Sharp	Sharp	Sharp	Clear
	Colour:	A_1 10yr6/3 A_2 7.5yr8/4 Bleached B 10yr6/6	A_1 7.5yr4/4 A_2 10yr7/6 Bleached B 7.5yr5/6	A_1 7.5yr4/6 A_2 7.5yr5/8 Bleached B 7.5yr8/4	A_1 7.5yr5/4 A_2 7.5yr5/6 B 10yr7/6
	Mottles:	A_1 Nil A_2 Nil B Yes	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Nil
	Texture:	A_1 Sandy Loam A_2 Sandy Loam B Sandy Clay	A_1 Sandy Loam A_2 Silty Clay B Silty Clay	A_1 Silty Loam A_2 Silty Clay B Light Clay	A_1 Loam A_2 Light Clay B Medium Clay
	Coarse Fragments:	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Nil
	Structure:	Soil Profile Augured. No structure identified.			
	Consistency:	A_1 Weak A_2 Weak B Moderate	A_1 Weak A_2 Weak B Moderate	A_1 Weak A_2 Weak B Moderate	A_1 Hard A_2 Moderate B Moderate
	Field pH:	A_1 4.5 A_2 5 B 7	A_1 5.5 A_2 6 B 7	A_1 5.5 A_2 6 B 6.5	A_1 5 A_2 7 B 8
	Segregations:	Nil	Nil	Nil	Nil

Wilpinjong Coal Project
Soil Profile Descriptions (Continued)

Site No:		5	6	7	8
Coordinates (AGD 66)		S 32^0 20.610' E 149^0 53.994'	S 32^0 21.495' E 149^0 54.591'	S 32^0 22.990' E 149^0 54.490'	S 32^0 20.287' E 149^0 53.879'
Runoff:		Slow	Rapid/Medium	Rapid/Medium	Slow
Permeability:		Quick	Slow/Moderate	Slow/Moderate	Quick
Drainage:		Moderate	Very Slow	Slow	Rapid
Landform:		Flat	Flat	Mid Slope	Flat
Site Disturbance:		Cleared for grazing	Minor disturbance by logging & track construction	Minor disturbance by logging & track construction	Cleared for grazing
Landuse:		Grazing	Opportunistic Grazing	Opportunistic Grazing	Grazing
Slope:		1%	1%	1%	< 1%
Vegetation:	Dom. spp./stratum:	Voluntary/Native Grasses	Native Trees	Native Trees	Voluntary/Native Grasses
	Height:	Nil	Greater than 15 m	Up to 10 m	Nil
	% Foliage Cover:	Nil	55%	25%	Nil
Microrelief:		Nil	Nil	Nil	Nil
Erosion:	Type:	Sheet/Rill	Sheet/Rill	Sheet/Rill	Sheet
	Degree:	Minor	Severe	Minor	Minor
Surface Coarse Fragments:		Nil	Nil	Nil	Nil
Rock Outcrop:		Nil	Nil	Nil	Nil
Salinity Evidence:		Nil	Nil	Nil	Nil
Soil Classification:		Brown Earth (Gn2.41)	Yellow Solodic (Dy3.41)	Red Podzolic (Dr4.22)	Alluvial (Uc4.43)
Horizon:	Depth:	A_1 0 - 40 B 40 – 50 Refusal	A_1 0 - 15 A_2 15 - 45 B 45 +	A_1 0 - 10 A_2 10 - 30 B 30 +	A_1 0 – 25 A_2 25 - 65 B 65 +
	Boundary:	Clear	Sharp	Sharp	Gradual
	Colour:	A_1 7.5yr4/6 B 7.5r6/6	A_1 7.5yr6/3 A_2 7.5yr8/3 Bleached B 10yr7/3	A_1 7.5yr7/3 A_2 7.5yr8/3 Bleached B 10yr5/6	A_1 7.5yr4/4 A_2 7.5yr7/4 B 7.5yr5/6
	Mottles:	A_1 Nil B Nil	A_1 Nil A_2 Nil B Yes	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Yes
	Texture:	A_1 Loam B Loam	A_1 Silty Loam A_2 Silty Loam B Sandy Clay	A_1 Silty Loam A_2 Silty Loam B Light Clay	A_1 Silty Loam A_2 Sandy Loam B Silty Clay
	Coarse Fragments:	A_1 Nil B Nil	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Yes 5 – 15 mm	A_1 Nil A_2 Nil B Nil
	Structure:	Soil profile augured. No structure identified.	A_1 Granular A_2 Granular B Polyhedral	A_1 Polyhedral A_2 Polyhedral B Polyhedral	A_1 Granular A_2 Granular B Granular
	Consistency:	A_1 Weak B Moderate	A_1 Weak A_2 Weak B Moderate	A_1 Weak A_2 Weak B Moderate	A_1 Weak A_2 Weak B Weak
	Field pH:	A_1 5.5 B 5	A_1 5 A_2 5.5 B 5.5	A_1 6.5 A_2 6 B 6	A_1 6 A_2 7 B 8.5
	Segregations:	Nil	Nil	Nil	Nil

Wilpinjong Coal Project
Soil Profile Descriptions (Continued)

Site No:		9	10	11	12
Coordinates (AGD 66)		S 32^0 19.506' E 149^0 54.245'	S 32^0 19.589' E 149^0 53.867'	S 32^0 19.963' E 149^0 53.895'	S 32^0 20.210' E 149^0 53.647'
Runoff:		Medium	Medium	Low	Medium
Permeability:		Moderate	Moderate	Quick	Moderate
Drainage:		Moderate	Slow	Moderate	Moderate
Landform:		Mid Slope	Mid Slope	Flat	Flat
Site Disturbance:		Cleared for grazing	Cleared for grazing / cultivation	Cleared for grazing	Cleared for grazing
Landuse:		Grazing	Grazing	Grazing	Grazing
Slope:		2%	1%	< 1%	1%
Vegetation:	Dom. spp./stratum:	Native Grasses	Native Grasses	Grasses Saline spp.	Native Grasses
	Height:	Nil	Nil	Nil	Nil
	% Foliage Cover:	Nil	Nil	Nil	Nil
Microrelief:		Nil	Nil		Nil
Erosion:	Type:	Sheet/Rill	Sheet/Rill	Sheet	Sheet/Rill
	Degree:	Minor	Minor	Minor	Minor
Surface Coarse Fragments:		Nil	Yes (Rocked Picked)	Nil	Nil
Rock Outcrop:		Nil	Nil	Nil	Yes
Salinity Evidence:		Nil	Nil	Yes - Adjacent to Cumbo Creek	Nil
Soil Classification:		Brown Earth (Gn2.43)	Red Podzolic (Dr5.43)	Alluvial (Uc4.22)	Red Podzolic (Dr2.63)
Horizon:	Depth:	A_1 0 - 25 B 25 +	A_1 0 - 20 A_2 20 - 50 B 50 +	A_1 0 - 25 B 25 +	A_1 0 - 25 A_2 25 - 75 B 75 +
	Boundary:	Gradual	Sharp	Uniform	Sharp
	Colour:	A_1 7.5yr4/4 B 5yr5/8	A_1 7.5yr5/4 A_2 7.5yr6/8 Bleached B 10yr5/6	A_1 10yr2/2 B 10yr4/1	A_1 7.5yr5/6 A_2 7.5yr7/8 Bleached B 7.5yr6/4
	Mottles:	A_1 Nil B Nil	A_1 Nil A_2 Yes B Yes	A_1 Nil B Nil	A_1 Nil A_2 Nil B Nil
	Texture:	A_1 Silty Loam B Sandy Loam	A_1 Silty Loam A_2 Light Clay B Silty Clay	A_1 Silty Loam B Silty Loam	A_1 Loam A_2 Light Clay B Light Clay
	Coarse Fragments:	A_1 Nil B Nil	A_1 Nil A_2 Nil B Nil	A_1 Nil B Nil	A_1 Nil A_2 Nil B Nil
	Structure:	A_1 Granular B Granular	A_1 Polyhedral A_2 Polyhedral B Polyhedral	A_1 Granular B Granular	Soil profile augured. No structure identified.
	Consistency:	A_1 Weak B Weak	A_1 Weak A_2 Moderate B Moderate	A_1 Weak A_2 Weak B Weak	A_1 Weak A_2 Weak B Weak
	Field pH:	A_1 6.5 B 8	A_1 4 A_2 5.5 B 7	A_1 7.5 B 8.5	A_1 5.5 A_2 5.5 B 6
	Segregations:	Nil	Nil	Nil	Nil

Wilpinjong Coal Project
Soil Profile Descriptions (Continued)

Site No:		13	14	15	16
Coordinates (AGD 66)		S 32^0 20.609' E 149^0 53.193'	S 32^0 20.472' E 149^0 52.932'	S 32^0 20.961' E 149^0 52.911'	S 32^0 21.373' E 149^0 52.354'
Runoff:		Rapid/Medium	Medium/Rapid	Medium	Medium
Permeability:		Slow/Moderate	Moderate	Moderate	Quick
Drainage:		Slow	Moderate	Moderate	Rapid
Landform:		Mid Slope	Mid Slope	Mid Slope	Flat
Site Disturbance:		Cleared for grazing	Cleared for grazing	Cleared for grazing	Cleared for grazing
Landuse:		Grazing	Grazing	Grazing	Grazing
Slope:		2%	2%	2%	2%
Vegetation:	Dom. spp./stratum:	Native Grasses	Voluntary/Native Pasture	Native Pasture	Voluntary/Native Pasture
	Height:	Nil	Nil	Nil	Nil
	% Foliage Cover:	Nil	Nil	Nil	Nil
Microrelief:		Nil	Nil	Nil	Nil
Erosion:	Type:	Sheet/Rill	Sheet/Rill	Sheet/Rill	Sheet/Rill
	Degree:	Severe	Minor	Minor	Minor
Surface Coarse Fragments:		Nil	Nil	Nil	Nil
Rock Outcrop:		Nil	Nil	Nil	Nil
Salinity Evidence:		Nil	Nil	Nil	Nil
Soil Classification:		Red Podzolic (Dr2.63)	Red Podzolic (Dr3.13)	Red Podzolic (Dr3.13)	Earthy Sands (Uc4.21)
Horizon:	Depth:	A_1 0 - 45 A_2 45 - 90 B 90 +	A_1 0 - 20 A_2 20 - 60 B 60 +	A_1 0 - 15 A_2 15 - 40 B 40 +	A 0 – 25 B 25 – 50 Refusal
	Boundary:	Sharp	Clear	Clear	Gradual
	Colour:	A_1 7.5yr8/3 A_2 10yr6/4 B 7.5yr5/6	A_1 7.5yr4/4 A_2 7.5yr5/6 B 7.5yr7/6	A_1 7.5yr4/4 A_2 7.5yr5/6 B 7.5yr7/6	A 7.5yr5/6 (Yellowish Brown) B 7.5yr7/8 (Yellow Orange)
	Mottles:	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Nil	Nil
	Texture:	A_1 Silt Clay A_2 Gravel Clay B Light Clay	A_1 Loam A_2 Loam B Light Clay	A_1 Loam A_2 Loam B Light Clay	A Sandy Loam B Sandy Loam
	Coarse Fragments:	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Nil	A Nil B Nil
	Structure:	A_1 Polyhedral A_2 Polyhedral B Polyhedral	Soil profile augured. No structure identified.		A Granular B Granular
	Consistency:	A_1 Hard A_2 Moderate B Moderate	A_1 Weak A_2 Moderate B Moderate	A_1 Weak A_2 Moderate B Moderate	A Weak B Weak
	Field pH:	A_1 6 A_2 6.5 B 7	A_1 5 A_2 5.5 B 6	A_1 5 A_2 6 B 6.5	A 5 B 6
	Segregations:	Nil	Nil	Nil	Nil

Wilpinjong Coal Project
Soil Profile Descriptions (Continued)

Site No:		17	18	19	20
Coordinates (AGD 66)		S 32^0 20.920' E 149^0 52.523'	S 32^0 20.494' E 149^0 52.629'	S 32^0 20.072' E 149^0 53.341'	S 32^0 19.923' E 149^0 52.771'
Runoff:		Medium	Medium	Low	Medium
Permeability:		Quick	Moderate	Quick	Slow/Moderate
Drainage:		Rapid	Moderate	Rapid	Slow
Landform:		Mid Slope	Flat	Ridge	Flat
Site Disturbance:		Cleared for grazing	Cleared for grazing	Cleared for grazing	Cleared for grazing
Landuse:		Grazing	Grazing	Grazing	Grazing
Slope:		2%	1%	3%	1%
Vegetation:	Dom. spp./stratum:	Voluntary/Native Pasture & Exotics	Voluntary/Native Pasture & Legumes	Voluntary/Native Pasture	Voluntary/Native Pasture & Legumes
	Height:	Nil	Nil	Nil	Nil
	% Foliage Cover:	Nil	Nil	Nil	Nil
Microrelief:		Nil	Nil	Nil	Nil
Erosion:	Type:	Sheet/Rill	Sheet/Gully	Sheet/Rill	Sheet/Gully
	Degree:	Minor	Minor	Minor	Moderate
Surface Coarse Fragments:		Nil	Nil	Nil	Nil
Rock Outcrop:		Nil	Nil	Nil	Nil
Salinity Evidence:		Nil	Nil	Nil	Saline Areas
Soil Classification:		Earthy Sands (Uc4.21)	Yellow Podzolic (Dy3.82)	Red Podzolic (Dr4.63)	Yellow Podzolic (Dy3.82)
Horizon:	Depth:	A 0 – 40 B 40 +	A_1 0 - 10 A_2 10 - 35 B 35 +	A_1 0 - 30 A_2 30 - 50 B 50 +	A_1 0 - 15 A_2 15 - 30 B 30 +
	Boundary:	Gradual	Sharp	Clear	Clear
	Colour:	A 7.5yr5/6 (Yellowish Brown) B 7.5yr7/8 (Yellow Orange)	A_1 7.5yr3/3 A_2 10yr7/6 Bleached B 10yr6/6	A_1 5yr4/6 A_2 5yr5/8 B 5y/r4/8	A_1 7.5yr3/3 A_2 10yr7/6 Bleached B 10yr6/6
	Mottles:	Nil	A_1 Nil A_2 Nil B Yes	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Yes
	Texture:	A Sandy Loam B Sandy Loam	A_1 Silty Loam A_2 Sandy Loam B Light Clay	A_1 Loamy Clay A_2 Silty Clay B Medium Clay	A_1 Silty Loam A_2 Sandy Loam B Light Clay
	Coarse Fragments:	A Nil B Nil	A_1 Nil A_2 Yes 20% B Yes 15%	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Yes 20% B Yes 15%
	Structure:	A Granular B Granular	Soil profile augured. No structure identified.		
	Consistency:	A Weak B Weak	A_1 Weak A_2 Weak B Moderate	A_1 Weak A_2 Weak B Weak	A_1 Weak A_2 Weak B Moderate
	Field pH:	A 5 B 6	A_1 5.5 A_2 6 B 7	A_1 5 A_2 5.5 B 6.5	A_1 5.5 A_2 6 B 7
	Segregations:	Nil	Nil	Nil	Nil

Wilpinjong Coal Project
Soil Profile Descriptions (Continued)

Site No:		21	22	23	24
Coordinates (AGD 66)		S 32^0 19.769' E 149^0 52.390'	S 32^0 19.877' E 149^0 52.325'	S 32^0 20.371' E 149^0 52.037'	S 32^0 21.052' E 149^0 51.648'
Runoff:		Medium	Medium	Medium	Medium
Permeability:		Slow/Moderate	Moderate	Moderate	Moderate
Drainage:		Slow	Well Drained	Well Drained	Slow
Landform:		Flat	Mid Slope	Ridge	Flat
Site Disturbance:		Cleared for grazing	Cleared for grazing	Minor disturbance by logging & track construction	Cleared for grazing/Intensive agriculture
Landuse:		Grazing	Grazing	Opportunistic Grazing	Horticulture
Slope:		1%	2%	11%	2%
Vegetation:	Dom. spp./stratum:	Voluntary/Native Pasture	Native Grasses	Native Trees	Voluntary/Native Pasture
	Height:	Nil	Nil	Greater than 15 m	Nil
	% Foliage Cover:	Nil	Nil	60%	Nil
Microrelief:		Nil	Nil	Nil	Nil
Erosion:	Type:	Sheet/Gully	Sheet/Gully	Sheet/Gully	Sheet/Rill
	Degree:	Moderate	Minor	Moderate	Minor
Surface Coarse Fragments:		Nil	Nil	Yes	Nil
Rock Outcrop:		Nil	Nil	Yes Sandstone/ conglomerate	Nil
Salinity Evidence:		Nil	Nil	Nil	Nil
Soil Classification:		Yellow Podzolic (Dy3.82)	Red Podzolic (Dr4.36)	Red Podzolic (Dr 3.21)	Yellow Podzolic (Dy2.42)
Horizon:	Depth:	A_1 0 - 15 A_2 15 - 30 B 30 +	A_1 0 - 25 A_2 25 - 50 B 50 +	A_1 0 - 35 A_2 35 - 45 B 45 +	A_1 0 - 20 A_2 20 - 40 B 40 +
	Boundary:	Clear	Sharp	Clear	Sharp
	Colour:	A_1 7.5yr3/3 A_2 10yr7/6 Bleached B 10yr6/6	A_1 7.5yr44 A_2 7.5yr4/6 B 7.5yr4/6	A_1 2.5yr5/4 A_2 5yr7/4 Bleached B 2.5yr4.6	A_1 10yr3/4 A_2 10yr8/4 Bleached B 10yr7/6
	Mottles:	A_1 Nil A_2 Nil B Yes	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Yes	A_1 Nil A_2 Nil B Yes
	Texture:	A_1 Silty Loam A_2 Sandy Loam B Light Clay	A_1 Silty Loam A_2 Sandy Loam B Sandy Clay	A_1 Sand A_2 Sand B Sandy Loam	A_1 Loam A_2 Clay Loam B Sandy Light Clay
	Coarse Fragments:	A_1 Nil A_2 Yes 20 % B Yes 15%	A_1 Nil A_2 Yes 5-10 mm B Yes 5-10 mm	A_1 Yes 5-10 mm A_2 Yes 5-10 mm B Nil	A_1 Nil A_2 Nil B Nil
	Structure:	Soil profile augured. No structure identified.		A_1 Granular A_2 Granular B Granular	Soil profile augured. No structure identified.
	Consistency:	A_1 Weak A_2 Weak B Moderate	A_1 Weak A_2 Weak B Weak	A_1 Weak A_2 Weak B Weak	A_1 Weak A_2 Weak B Moderate
	Field pH:	A_1 5.5 A_2 6 B 7	A_1 5.5 A_2 5 B 5.5	A_1 5.5 A_2 5 B 5.5	A_1 5 A_2 6.5 B 5.5
	Segregations:	Nil	Nil	Nil	Nil

Wilpinjong Coal Project
Soil Profile Descriptions (Continued)

Site No:		25	26	27	28
Coordinates (AGD 66):		S 32^0 20.594' E 149^0 51.733'	S 32^0 20.594' E 149^0 51.733'	S 32^0 19.685' E 149^0 51.944'	S 32^0 19.466' E 149^0 51.747'
Runoff:		Rapid	Rapid	Medium	Rapid
Permeability:		Moderate	Moderate	Moderate	Moderate
Drainage:		Slow	Slow	Moderate	Well Drained
Landform:		Flat	Flat	Mid Slope	Mid Slope
Site Disturbance:		Cleared for grazing/Cropping	Cleared for grazing/Cropping	Cleared for grazing	Cleared for grazing
Landuse:		Grazing	Grazing	Grazing	Grazing
Slope:		2%	1%	2%	1%
Vegetation:	Dom. spp./stratum:	Voluntary/Native Pasture	Voluntary/Native Pasture	Voluntary/Native Pasture	Voluntary/Native Pasture
	Height:	Nil	Nil	Nil	Nil
	% Foliage Cover:	Nil	Nil	Nil	Nil
Microrelief:		Nil	Nil	Nil	Nil
Erosion:	Type:	Sheet/Rill	Sheet/Rill	Sheet/Rill	Sheet/Rill
	Degree:	Moderate	Moderate	Minor	Minor
Surface Coarse Fragments:		Nil	Nil	Nil	Yes
Rock Outcrop:		Nil	Nil	Nil	Yes - Sandstone
Salinity Evidence:		Nil	Saline Area	Nil	Nil
Soil Classification:		Yellow Podzolic (Dy3.43)	Yellow Podzolic (Dy3.43)	Yellow Podzolic (Dy3.43)	Red Podzolic (Dr3.32)
Horizon:	Depth:	A_1 0 - 20 A_2 20 - 40 B 40 +	A_1 0 - 30 A_2 30 - 60 B 60 +	A_1 0 - 30 A_2 30 - 40 Refusal	A_1 0 - 20 A_2 20 - 30 B 30 - 45 Refusal
	Boundary:	Sharp	Clear		Clear
	Colour:	A_1 10yr3/4 A_2 10yr8/4 Bleached B 10yr6/6	A_1 10yr4/4 A_2 7.5yr6/6 Bleached B 10yr8/6		A_1 5yr5/3 A_2 5yr5/6 B 2.5yr4/8
	Mottles:	A_1 Nil A_2 Nil B Yes	A_1 Nil A_2 Nil B Yes		A_1 Nil A_2 Nil B Yes
	Texture:	A_1 Loam A_2 Clay Loam B Light Clay	A_1 Loam A_2 Silty Loam B Silty Clay		A_1 Loam A_2 Silty Loam B Light Clay
	Coarse Fragments:	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Nil		A_1 Nil A_2 Nil B Yes 5 - 10 mm
	Structure:	Soil profile augured. No structure identified.			
	Consistency:	A_1 Weak A_2 Weak B Moderate	A_1 Weak A_2 Weak B Moderate		A_1 Weak A_2 Weak B Moderate
	Field pH:	A_1 5 A_2 5.5 B 6.0	A_1 5.5 A_2 6.0 B 5.0		A_1 5.5 A_2 5.5 B 5.5
	Segregations:	Nil	Nil		Nil

Wilpinjong Coal Project
Soil Profile Descriptions (Continued)

Site No:		29	30	31	32
Coordinates (AGD 66)		S 32^0 18.962' E 149^0 51.127'	S 32^0 18.772' E 149^0 50.539'	S 32^0 19.928' E 149^0 51.177'	S 32^0 21.095' E 149^0 50.864'
Runoff:		Rapid	Low	Medium	Rapid/Medium
Permeability:		Moderate/Slow	Moderate/Quick	Moderate	Slow/Moderate
Drainage:		Low	Low	Moderate	Moderate
Landform:		Mid Slope	Flat	Mid Slope	Lower Slope
Site Disturbance:		Cleared for grazing	Cleared for grazing	Cleared for grazing /Cropping	Cleared for grazing
Landuse:		Grazing	Grazing	Cropping	Grazing
Slope:		2%	2%	1%	2%
Vegetation:	Type:	Voluntary/Native Grasses	Voluntary/Native Grasses	Stubble / Grazing	Voluntary/Native Grasses
	Height:	Nil	Nil	Nil	Nil
	% Foliage Cover:	Nil	Nil	Nil	Nil
Microrelief:		Nil	Nil	Nil	Nil
Erosion:	Type:	Sheet/Rill	Sheet/Gully	Sheet/Gully	Rill/Gully
	Degree:	Minor	Moderate	Minor	Minor
Surface Coarse Fragments:		Nil	Nil	Nil	Nil
Rock Outcrop:		Nil	Nil	Nil	Nil
Salinity Evidence:		Nil	Saline Area	Nil	Nil
Soil Classification:		Yellow Podzolic (Dy3.43)	Yellow Podzolic (Dy3.43)	Red Podzolic (Dr2.23)	Yellow Podzolic (Dy2.43)
Horizon:	Depth:	A_1 0 - 20 A_2 20 - 50 B 50 +	A_1 0 - 20 A_2 20 - 40 B 40 +	A_1 0 - 25 A_2 25 - 45 B 45 +	A_1 0 - 10 A_2 10 - 20 B 20 +
	Boundary:	Clear	Clear	Clear	Clear
	Colour:	A_1 7.5yr4/3 A_2 7.5yr7/3 Bleached B 7.5yr6/6	A_1 7.5yr4/3 A_2 7.5yr7/3 Bleached B 7.5yr6/6	A_1 7.5yr4/4 A_2 7.5yr6/8Bleached B 7.5yr4/8	A_1 10yr4/3 A_2 10yr7/3 Bleached B 10yr6/8
	Mottles:	A_1 Nil A_2 Nil B Yes	A_1 Nil A_2 Nil B Yes	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Yes
	Texture:	A_1 Loam A_2 Silty Loam B Light Clay	A_1 Sandy Loam A_2 Silty Loam B Light Clay	A_1 Sandy Loam A_2 Sandy Loam B Light Clay	A_1 Silty Loam A_2 Silty Loam B Light Clay
	Coarse Fragments:	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Nil
	Structure:	Soil profile augured. No structure identified.			
	Consistency:	A_1 Weak A_2 Weak B Moderate	A_1 Weak A_2 Weak B Moderate	A_1 Weak A_2 Weak B Moderate	A_1 Weak A_2 Weak B Moderate
	Field pH:	A_1 4.5 A_2 5 B 6	A_1 5.5 A_2 6 B 7	A_1 5 A_2 5.5 B 6	A_1 5 A_2 5.5 B 6
	Segregations:	Nil	Nil	Nil	Nil

Wilpinjong Coal Project
Soil Profile Descriptions (Continued)

Site No:		33	34	35	36
Coordinates (AGD 66)		S 32^0 20.383' E 149^0 50.888'	S 32^0 20.208' E 149^0 50.597'	S 32^0 20.198' E 149^0 50.371'	S 32^0 19.769' E 149^0 50.707'
Runoff:		Rapid	Rapid/Medium	Medium	Medium
Permeability:		Moderate	Slow/Moderate	Moderate	Moderate
Drainage:		Slow	Slow	Well Drained	Moderate
Landform:		Flat	Flat	Mid Slope	Mid Slope
Site Disturbance:		Cleared for grazing	Cleared for grazing	Cleared for grazing	Cleared for grazing
Landuse:		Grazing	Grazing	Grazing	Grazing
Slope:		1%	1%	4%	3%
Vegetation:	Dom. spp./stratum:	Voluntary/Native Grasses	Sub Clover & Broad Leaves	Native Grasses	Native Grasses
	Height:	Nil	Nil	Nil	Nil
	% Foliage Cover:	Nil	Nil	Nil	Nil
Microrelief:		Nil	Nil	Nil	Nil
Erosion:	Type:	Sheet/Rill	Sheet/Rill	Sheet/Rill	Sheet/Gully
	Degree:	Moderate	Minor	Moderate	Minor
Surface Coarse Fragments:		Nil	Nil	Yes - Sandstone/ Conglomerate	Nil
Rock Outcrop:		Nil	Nil	Nil	Nil
Salinity Evidence:		Nil	Nil	Nil	Nil
Soil Classification:		Red Podzolic (Dr4.23))	Yellow Podzolic (Dy3.41)	Red Podzolic (Dr4.23)	Red Podzolic (Dr4.23)
Horizon:	Depth:	A_1 0 - 25 A_2 25 - 60 B 60 +	A_1 0 - 20 A_2 20 - 45 B 45 +	A_1 0 - 20 A_2 20 - 40 B 40 +	A_1 0 - 20 A_2 20 - 40 Refusal
	Boundary:	Clear	Clear	Clear	
	Colour:	A_1 7.5yr4/4 A_2 7.5yr8/6 Bleached B 10yr7/4	A_1 10yr7/3 A_2 10yr7/3 Bleached B 2.5yr7/3	A_1 10yr4/3 A_2 10yr7/4Bleached B 10yr5/6	
	Mottles:	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Yes	A_1 Nil A_2 Nil B Yes	
	Texture:	A_1 Silty Loam A_2 Silty Loam B Silty Clay	A_1 Loam A_2 Sand Loam B Sandy Clay	A_1 Silty Loam A_2 Silty Loam B Silty Clay	
	Coarse Fragments:	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Nil	
	Structure:	No structure identified.	No structure identified.	A_1 A_2 B Yes 5 - 10 mm	
	Consistency:	A_1 Weak A_2 Weak B Moderate	A_1 Weak A_2 Weak B Moderate	A_1 Weak A_2 Weak B Moderate	
	Field pH:	A_1 4.5 A_2 5 B 5.5	A_1 4.5 A_2 5 B 5	A_1 5 A_2 6 B 6.5	
	Segregations:	Nil	Nil	Nil	

Wilpinjong Coal Project
Soil Profile Descriptions (Continued)

Site No:		37	38	39	40
Coordinates (AGD 66)		S 32^0 19.284' E 149^0 51.385'	S 32^0 19.638' E 149^0 51.489'	Error	S 32^0 19.696' E 149^0 51.005'
Runoff:		Rapid	Rapid	Medium/Rapid	Rapid
Permeability:		Moderate	Moderate	Moderate/Slow	Moderate
Drainage:		Moderate	Well Drained	Low	Slow
Landform:		Mid Slope	Ridge	Flat	Flat
Site Disturbance:		Cleared for grazing	Cleared for grazing	Cleared for grazing	Cleared for grazing
Landuse:		Grazing	Grazing	Grazing	Grazing
Slope:		2%	3%	1%	1%
Vegetation:	Dom. spp./stratum:	Annual Grasses	Annual Grasses	Voluntary/Native Grasses	Voluntary/Native Grasses
	Height:	Nil	Nil	Nil	Nil
	% Foliage Cover:	Nil	Nil	Nil	Nil
Microrelief:		Nil	Nil	Nil	Nil
Erosion:	Type:	Sheet/Rill	Sheet/Rill	Sheet/Rill	Sheet/Rill
	Degree:	Moderate	Minor	Minor	Minor
Surface Coarse Fragments:		Yes - Sandstone/ Conglomerate	Yes - Sandstone/ Mudstone	Nil	Nil
Rock Outcrop:		Nil	Yes	Nil	Nil
Salinity Evidence:		Nil	Nil	Nil	Nil
Soil Classification:		Yellow Podzolic (Dr3.23)	Red Podzolic (Dr4.23)	Red Podzolic (Dy3.43)	Yellow Podzolic (Dy3.43)
Horizon:	Depth:	A_1 0 - 25 A_2 25 - 50 B 50 +	A_1 0 - 20 A_2 20 - 50 B 50 +	A_1 0 - 20 A_2 20 - 50 B 50 +	A_1 0 - 20 A_2 20 - 35 B 35 +
	Boundary:	Clear	Clear	Clear	Clear
	Colour:	A_1 10yr4/4 A_2 10yr7/6Bleached B 10yr4/6	A_1 7.5yr4/6 A_2 7.5yr6/6Bleached B 5yr4/8	A_1 7.5yr4/3 A_2 7.5yr7/3 Bleached B 7.5yr6/6	A_1 10yr4/4 A_2 10yr5/6Bleached B 7.5yr5/4
	Mottles:	A_1 Nil A_2 Nil B Yes	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Yes	A_1 Nil A_2 Nil B Yes
	Texture:	A_1 Silty Loam A_2 Silty Loam B Light Clay	A_1 Sandy Loam A_2 Sand B Sandy Clay	A_1 Loam A_2 Silty Loam B Light Clay	A_1 Loam A_2 Light Clay B Medium Clay
	Coarse Fragments:	A_1 Nil A_2 Nil B Yes 5 - 10 mm	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Nil
	Structure:	Soil profile augured. No structure identified.			
	Consistency:	A_1 Weak A_2 Weak B Moderate	A_1 Weak A_2 Weak B Moderate	A_1 Weak A_2 Weak B Moderate	A_1 Weak A_2 Weak B Hard
	Field pH:	A_1 6 A_2 5 B 6.5	A_1 5 A_2 6 B 6.5	A_1 4.5 A_2 5 B 6	A_1 5 A_2 6 B 6.5
	Segregations:	Nil	Nil	Nil	Nil

Wilpinjong Coal Project
Soil Profile Descriptions (Continued)

Site No:		**41**	**42**	**43**	**44**
Coordinates (AGD 66)		S 32^0 19.376' E 149^0 50.654'	S 32^0 20.827' E 149^0 54.211'	S 32^0 20.633' E 149^0 54.724'	S 32^0 19.890' E 149^0 50.959'
Runoff:		Medium	Rapid/Medium	Medium	Rapid/Medium
Permeability:		Moderate	Slow/Moderate	Moderate	Slow/Moderate
Drainage:		Slow	Slow	Slow	Slow
Landform:		Mid Slope	Flat	Mid Slope	Flat
Site Disturbance:		Cleared for grazing	Minor disturbance by logging & track construction	Minor disturbance by logging & track construction	Cleared for grazing
Landuse:		Grazing	Opportunistic Grazing	Opportunistic Grazing	Grazing
Slope:		2%	1%	2%	1%
Vegetation:	Dom. spp./stratum:	Native Grasses	Native Trees	Native Trees	Degraded Pasture
	Height:	Nil	Greater than 15 m	Greater than 15 m	Nil
	% Foliage Cover:	Nil	Nil	Nil	Nil
Microrelief:		Nil	Nil	Nil	Scald
Erosion:	Type:	Sheet/Rill	Sheet/Rill	Sheet/Rill	Sheet/Gully
	Degree:	Moderate	Moderate	Minor	Severe
Surface Coarse Fragments:		Nil	Nil	Nil	Nil
Rock Outcrop:		Nil	Nil	Nil	Nil
Salinity Evidence:		Nil	Nil	Nil	Saline Area
Soil Classification:		Yellow Podzolic (Dy3.42)	Yellow Solodic (Dy2.42)	Earthy Sand (Dy3.42)	Yellow Podzolic (Dy2.42)
Horizon:	Depth:	A_1 0 - 20 A_2 20 - 40 B 40 +	A_1 0 - 10 A_2 10 - 30 B 30 +	A_1 0 - 15 A_2 15 - 40 B 40 +	A_1 0 - 25 A_2 25 - 45 B 45 +
	Boundary:	Clear	Clear	Clear	Clear
	Colour:	A_1 10yr4/4 A_2 10yr5/6Bleached B 7.5yr5/4	A_1 10yr6/3 A_2 10yr8/1Bleached B 7.5yr8/3	A_1 10yr4/4 A_2 10yr8/6Bleached B 7.5yr7/4	A_1 7.5yr4/6 A_2 7.5yr5/7 B 7.5yr5/8
	Mottles:	A_1 Nil A_2 Nil B Yes	A_1 Nil A_2 Nil B Yes	A_1 Nil A_2 Nil B Yes	A_1 Nil A_2 Nil B Yes
	Texture:	A_1 Loam A_2 Sand Loam B Sandy Clay	A_1 Loam A_2 Sand Loam B Light Clay	A_1 Silty Loam A_2 Sand Loam B Sandy Clay	A_1 Silty Loam A_2 Light Loam B Medium Clay
	Coarse Fragments:	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Nil
	Structure:	Soil profile augured. No structure identified.	A_1 Sub Angular A_2 Sub Angular B Columnar	A_1 Granular A_2 Granular B Granular	A_1 Sub Angular A_2 Sub Angular B Columnar
	Consistency:	A_1 Weak A_2 Weak B Moderate	A_1 Weak A_2 Weak B Moderate	A_1 Weak A_2 Weak B Moderate	A_1 Weak A_2 Weak B Moderate
	Field pH:	A_1 6 A_2 5.5 B 6.5	A_1 6 A_2 5.5 B 5	A_1 5 A_2 5.5 B 6	A_1 5.5 A_2 8.5 B 9
	Segregations:	Nil	Nil	Nil	Nil

Wilpinjong Coal Project
Soil Profile Descriptions (Continued)

Site No:		**45**	**46**
Coordinates (AGD 66)		S 32^0 20.850' E 149^0 50.654'	S 32^0 19.995' E 149^0 51.955'
Runoff:		Medium	Rapid/Medium
Permeability:		Moderate	Slow/Moderate
Drainage:		Moderate	Slow
Landform:		Mid Slope	Flat
Site Disturbance:		Cleared for grazing	Cleared for grazing
Landuse:		Grazing	Grazing
Slope:		2%	1%
Vegetation:	Dom. spp./stratum:	Native Grasses	Degraded Pasture
	Height:	Nil	Nil
	% Foliage Cover:	Nil	Nil
Microrelief:		Nil	Nil
Erosion:	Type:	Sheet/Rill	Sheet/Rill
	Degree:	Moderate	Moderate
Surface Coarse Fragments:		Nil	Nil
Rock Outcrop:		Nil	Nil
Salinity Evidence:		Nil	Saline Area
Soil Classification:		Red Podzolic (Dy3.42)	Yellow Podzolic (Dy2.42)
Horizon:	Depth:	A_1 0 - 20 A_2 20 - 45 B 45 +	A_1 0 - 20 A_2 20 - 40 B 40 +
	Boundary:	Abrupt	Clear
	Colour:	A_1 7.5yr4/6 A_2 7.5yr5/7 B 7.5yr5/8	A_1 7.5yr4/4 A_2 7.5yr6/5 B 5.5yr5/8
	Mottles:	A_1 Nil A_2 Nil B Yes	A_1 Nil A_2 Nil B Yes
	Texture:	A_1 Loam A_2 Sand Loam B Sandy Clay	A_1 Silty Loam A_2 Light Loam B Medium Clay
	Coarse Fragments:	A_1 Nil A_2 Nil B Nil	A_1 Nil A_2 Nil B Nil
	Structure:	Soil profile augured. No structure identified	A_1 Sub Angular A_2 Sub Angular B Columnar
	Consistency:	A_1 Weak A_2 Weak B Moderate	A_1 Weak A_2 Weak B Moderate
	Field pH:	A_1 6 A_2 5.5 B 6.5	A_1 6 A_2 7 B 8
	Segregations:	Nil	Nil

ATTACHMENT MB

SOIL ANALYSES

(JAMMEL Environmental and Planning Services Pty Ltd, 2004)

Soil Laboratory Test Abbreviations

Test	Symbol	Units
Cation exchange capacity	CEC	meq/100g
Exchangeable sodium percentage	ESP	%
Electrical Conductivity (1:5 soil:water)	EC	dS/m
Electrical Conductivity (saturation extract)	EC_{se}	dS/m
pH (1:5 soil:water)	pH_w	pH Units

Wilpinjong Coal Project
Analytical Results of Representative Soil Samples

Parameter	Units	Sample Sites (refer to Figure M-2)			
		6 & 42 Yellow Solodic	6 & 42 Yellow Solodic	8 & 11 Alluvial	8 & 11 Alluvial
Depth	cm	0 - 30	30 +	0 - 30	30 +
Soil Texture		3.5	3.5	3.0	3.0
pH_{CaCl}		5.3	4.8	6.0	6.4
pH_{H2O}		6.2	5.4	6.7	6.9
C	%	1.0	0.24	1.8	0.44
N	mg/kg	3	6	6	2
S	mg/kg	11.9	125	38.3	51.2
P (Colwell)	mg/kg	9	6	10	5
K	meq/100g	1.08	0.37	0.69	0.52
Ca	meq/100g	4.25	2.21	7.76	5.30
Mg	meq/100g	3.17	4.18	4.06	4.08
Al	meq/100g	0.03	0.10	0.00	0.00
Na	meq/100g	0.16	2.75	0.33	0.47
Cl	mg/kg	44	702	35	49
Cu	mg/kg	0.67	0.88	0.76	1.02
Zn	mg/kg	2.13	0.58	3.77	0.45
Mn	mg/kg	45.89	9.44	17.93	6.3
Fe	mg/kg	1243	594	1324	545
B	mg/kg	0.7	0.4	1.1	0.6
EC	dS/m	0.050	0.646	0.108	0.137
Calculations					
CEC	meq/100g	8.69	9.61	12.84	10.37
Ca/Mg Ratio		1.34	0.53	1.91	1.30
ESP	%	1.84	28.62	2.57	4.53
EC_{se}	dS/m	0.48	5.56	1.03	1.30
Al Saturation	%	0.39	1.04	0.00	0.00

Wilpinjong Coal Project
Analytical Results of Representative Soil Samples (Continued)

Parameter	Units	Sample Sites (refer to Figure M-2)			
		16, 17 & 43 Earthy Sand	**16, 17 & 43 Earthy Sand**	**9 & 5 Brown Earth**	**9 & 5 Brown Earth**
Depth	cm	0 - 30	30 +	0 - 25	25 - 50
Soil Texture		3	3	3	2.5
pH_{CaCl}		5.3	6.6	5.6	6.5
pH_{H2O}		6.3	7.4	7.5	7.1
C	%	0.56	0.19	0.73	0.19
N	mg/kg	4	1	5	3
S	mg/kg	12.1	8.7	19.8	47.1
P (Colwell)	mg/kg	7	4	-	5
K	meq/100g	0.47	0.37	0.42	0.31
Ca	meq/100g	1.64	1.91	2.14	1.54
Mg	meq/100g	0.91	2.29	1.51	1.52
Al	meq/100g	0.05	0	0.00	0.00
Na	meq/100g	0.08	0.14	0.68	0.84
Cl	mg/kg	9	12	37	97
Cu	mg/kg	0.37	0.46	0.71	0.45
Zn	mg/kg	0.39	0.09	0.63	0.02
Mn	mg/kg	19.18	5.96	25.83	18.83
Fe	mg/kg	600	578	-	355
B	mg/kg	0.4	0.4	0.4	0.3
EC	dS/m	0.280	0.066	0.073	0.142
Calculations					
CEC	meq/100g	3.10	4.71	4.75	4.21
Ca/Mg Ratio		1.80	0.83	1.42	1.01
ESP	%	2.58	2.97	14.32	19.95
EC_{se}	dS/m	6.36	0.91	0.69	1.96
Al Saturation	%	0.00	0.00	0.00	0.00

Wilpinjong Coal Project
Analytical Results of Representative Soil Samples (Continued)

Parameter	Units	Sample Sites (refer to Figure M-2)			
		44 & 46 Yellow Podzolic (Saline)	**44 & 46 Yellow Podzolic (Saline)**	**1, 18, 20, 21, 24-26, 27, 29, 30, 32, 34, 37, 40 & 41 Yellow Podzolic**	**1, 18, 20, 21, 24-26, 27, 29, 30, 32, 34, 37, 40 & 41 Yellow Podzolic**
Depth	cm	0 - 35	35 +	0 - 35	35 +
Soil Texture		3.0	3.0	3.0	3.0
pH_{CaCl}		6.70	7.40	6.80	6.30
pH_{H2O}		6.90	8.40	7.10	6.60
C	%	0.47	0.31	0.77	0.27
N	mg/kg	2	3	9	11
S	mg/kg	648	255	42.6	40.3
P (Colwell)	mg/kg	11	7	5	4
K	meq/100g	1.04	0.81	0.57	0.59
Ca	meq/100g	3.2	4.51	2.78	3.22
Mg	meq/100g	3.47	3.61	1.39	3.75
Al	meq/100g	0.00	0.00	0.00	0.00
Na	meq/100g	8.9	5.92	0.18	0.75
Cl	mg/kg	1401	572	51	167
Cu	mg/kg	1.97	1.91	0.47	0.73
Zn	mg/kg	1.29	0.37	0.92	0.14
Mn	mg/kg	8.87	7.05	20.59	4.06
Fe	mg/kg	316	802	810	676
B	mg/kg	0.6	0.7	0.4	0.7
EC	dS/m	1.700	0.876	0.065	0.178
Calculations					
CEC	meq/100g	16.61	14.85	4.92	8.31
Ca/Mg Ratio		0.92	1.25	2.00	0.86
ESP	%	16.5	6.57	0.62	1.53
EC_{se}	dS/m	16.15	6.57	0.62	1.53
Al Saturation	%	0.00	0.00	0.00	0.00

Wilpinjong Coal Project
Analytical Results of Representative Soil Samples (Continued)

Parameter	Units	Sample Sites (refer to Figure M-2)			
		2-4, 7, 10, 12, 14, 15 & 19 Red Podzolic #1	**2-4, 7, 10, 12, 14, 15 & 19 Red Podzolic #1**	**22, 23, 28, 31, 33, 35, 36, 38, 39 & 45 Red Podzolic #2**	**22, 23, 28, 31, 33, 35, 36, 38, 39 & 45 Red Podzolic #2**
Depth	cm	0 - 50	50 +	0 – 45	45 +
Soil Texture		3.0	3.0	3.0	3.0
pH_{CaCl}		5.30	4.90	5.30	5.30
pH_{H2O}		6.20	6.10	6.20	6.30
C	%	0.38	1.18	0.65	0.27
N	mg/kg	6	10	5	3
S	mg/kg	39.2	10.60	4.70	5.90
P (Colwell)	mg/kg	4	7	5	4
K	meq/100g	0.60	0.85	0.50	0.36
Ca	meq/100g	2.87	3.79	2.63	1.70
Mg	meq/100g	3.81	1.98	1.55	2.49
Al	meq/100g	0.07	0.05	0.03	0.07
Na	meq/100g	0.64	0.12	0.07	0.09
Cl	mg/kg	119	23	15	13
Cu	mg/kg	1.48	0.72	0.45	0.47
Zn	mg/kg	0.72	1.08	0.47	0.14
Mn	mg/kg	6.15	55.21	17.85	4.18
Fe	mg/kg	27.76	70.05	25.83	14.80
B	mg/kg	0.6	0.5	0.4	0.4
EC	dS/m	0.107	0.046	0.030	0.023
Calculations					
CEC	meq/100g	7.99	6.79	4.78	4.71
Ca/Mg Ratio		0.75	1.91	1.70	0.68
ESP	%	8.01	1.77	1.46	1.91
EC_{se}	dS/m	1.02	0.40	0.29	0.20
Al Saturation	%	0.95	0.84	0.70	1.61

Wilpinjong Coal Project
Analytical Results of Representative Soil Samples (Continued)

Parameter	Units	Sample Sites (refer to Figure M-2)		
		13 Red Podzolic # 3	**13 Red Podzolic # 3**	**13 Red Podzolic # 3**
Depth	cm	0 - 25	25 - 45	45 +
Soil Texture		3.0	3.0	3.5
pH_{CaCl}		5.90	5.90	6.0
pH_{H2O}		6.50	6.30	6.20
C	%	0.59	0.40	0.80
N	mg/kg	19	70	67
S	mg/kg	13.5	29.9	17.4
P (Colwell)	mg/kg	5	5	6
K	meq/100g	0.36	0.95	1.11
Ca	meq/100g	6.94	6.21	7.79
Mg	meq/100g	4.02	4.05	3.82
Al	meq/100g	0.00	0.00	0.00
Na	meq/100g	0.09	0.34	0.48
Cl	mg/kg	51	265	396
Cu	mg/kg	1.89	1.07	1.34
Zn	mg/kg	0.11	0.48	0.13
Mn	mg/kg	3.97	19.09	46.04
Fe	mg/kg	195	369	502
B	mg/kg	0.4	0.5	0.4
EC	dS/m	0.097	0.383	0.298
Calculations				
CEC	meq/100g	11.41	11.55	13.20
Ca/Mg Ratio		1.73	1.53	2.04
ESP	%	0.79	2.94	3.64
EC_{se}	dS/m	0.83	3.64	2.56
Al Saturation	%	0.00	0.00	0.00