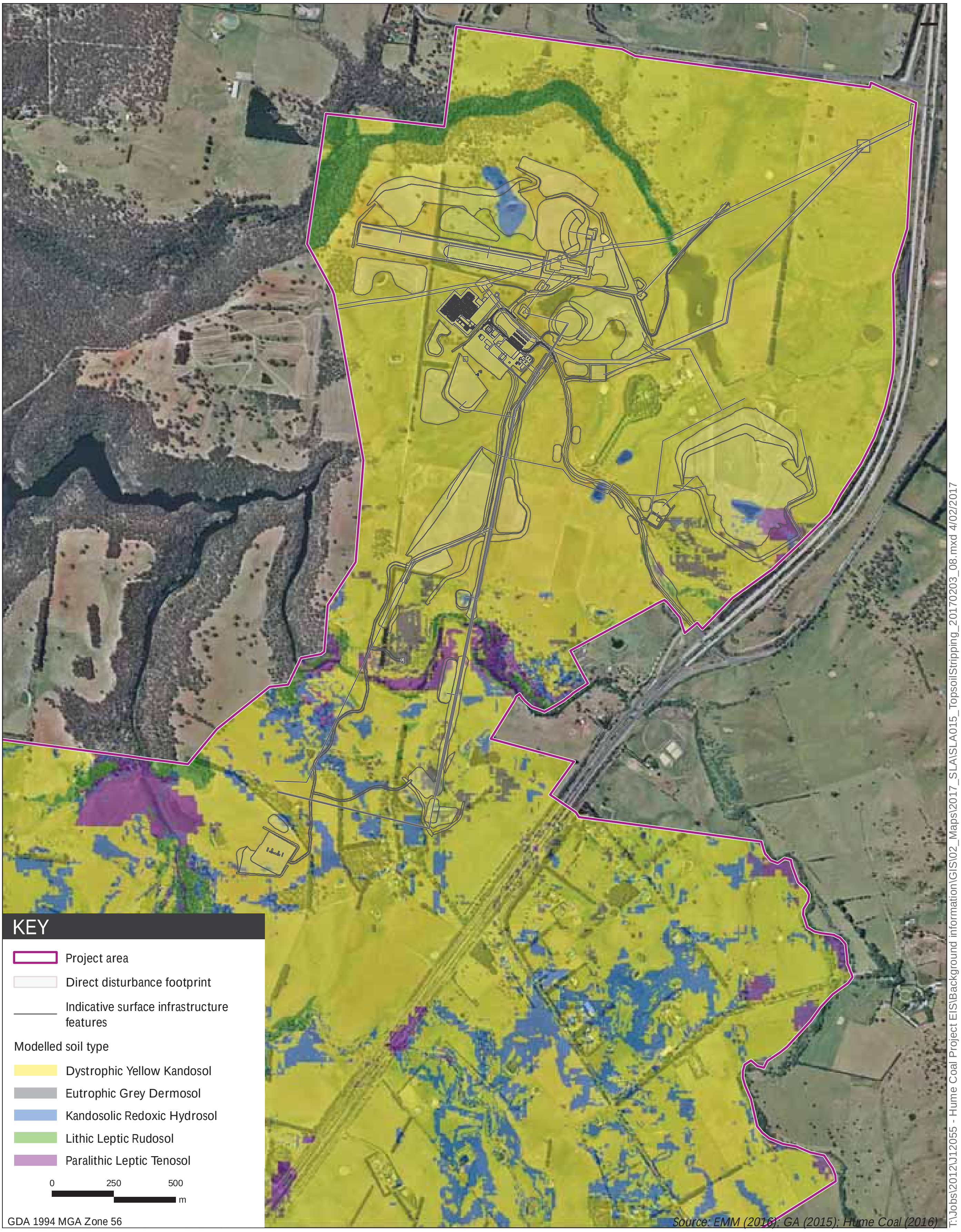

Soil types within the project disturbance footprint

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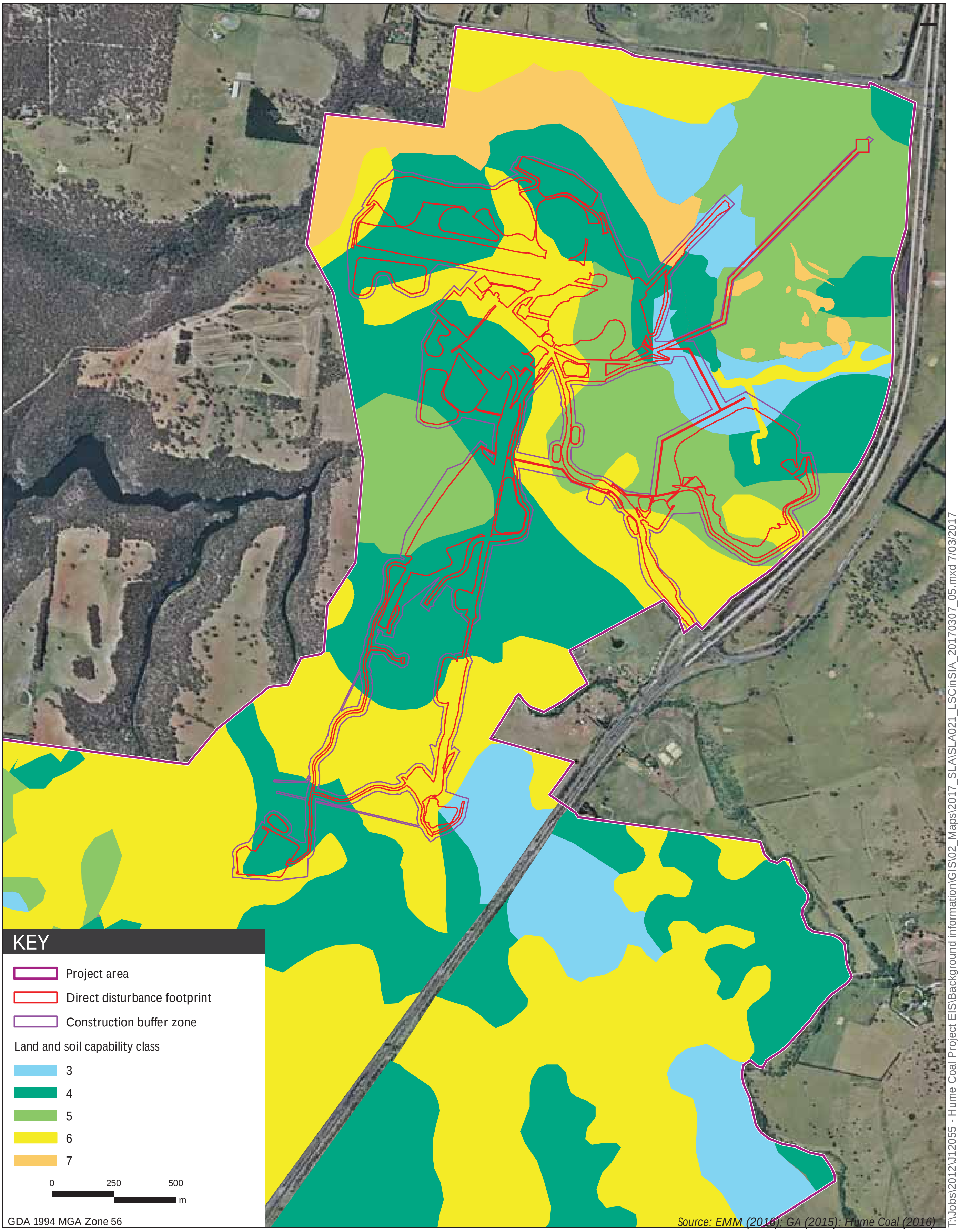
Figure 7.1



Land and soil capability class in the disturbance footprint

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Figure 7.2

7.2.3 Soil stripping depth

The topsoil depth in the area of disturbance ranges between 0.15 m and 0.4 m. The subsoil depth in the area of disturbance ranges between 0.3 m and 0.9 m. The majority of the soils to be disturbed are Kandosols, but the depth is not uniform across the site. Topsoils on the upper slopes tend to be about 0.15m in depth, whilst topsoils in the lower parts of the landscape are up to 0.4 m in depth.

The topsoil stockpile areas only require a shallow depth of topsoil to be stripped (mainly just to remove the vegetation before creating the stockpile), as only topsoil is to be stockpiled on this land. Other areas with minimal surface disturbance such as the construction accommodation village (assuming temporary construction dongas are used and are elevated off the ground) can also be stripped with a minimal depth of topsoil. If the areas are not also subjected to significant compaction and long term use, a return of the shallow topsoil will be sufficient for rehabilitation to be successful and limits the disturbance of the overall soil profile.

All other areas of surface disturbance need to be stripped to at least 0.3 m depth, to allow for sufficient soil to be replaced for rehabilitation at a depth of 0.3 m. As this topsoil will be placed over land that is comprised of fill material, meaning that the original soil profile has been substantially disturbed, a depth of 0.3 m is considered adequate to re-establish pasture for grazing.

In the areas where topsoil is less than 0.3 m in depth, subsoil will need to be stripped down to the overall soil depth of 0.3m. If the depth to bedrock is less than 0.3m in depth, additional soil from an area with deeper soils should be obtained to make up the shortfall.

Soil mapping suggests that up to 3.6 ha of soils to be disturbed could be Hydrosols. There may be less area than this, but there will be some Hydrosols encountered. These soils are found in drainage depressions and near drainage lines and will be easily identified as they will be waterlogged. This soil is unsuitable for rehabilitation purposes and it is not recommended to stockpile these soils for later use. This will result in a shortfall of topsoil resource for later rehabilitation if all areas are to be spread with topsoil to 0.3 m depth.

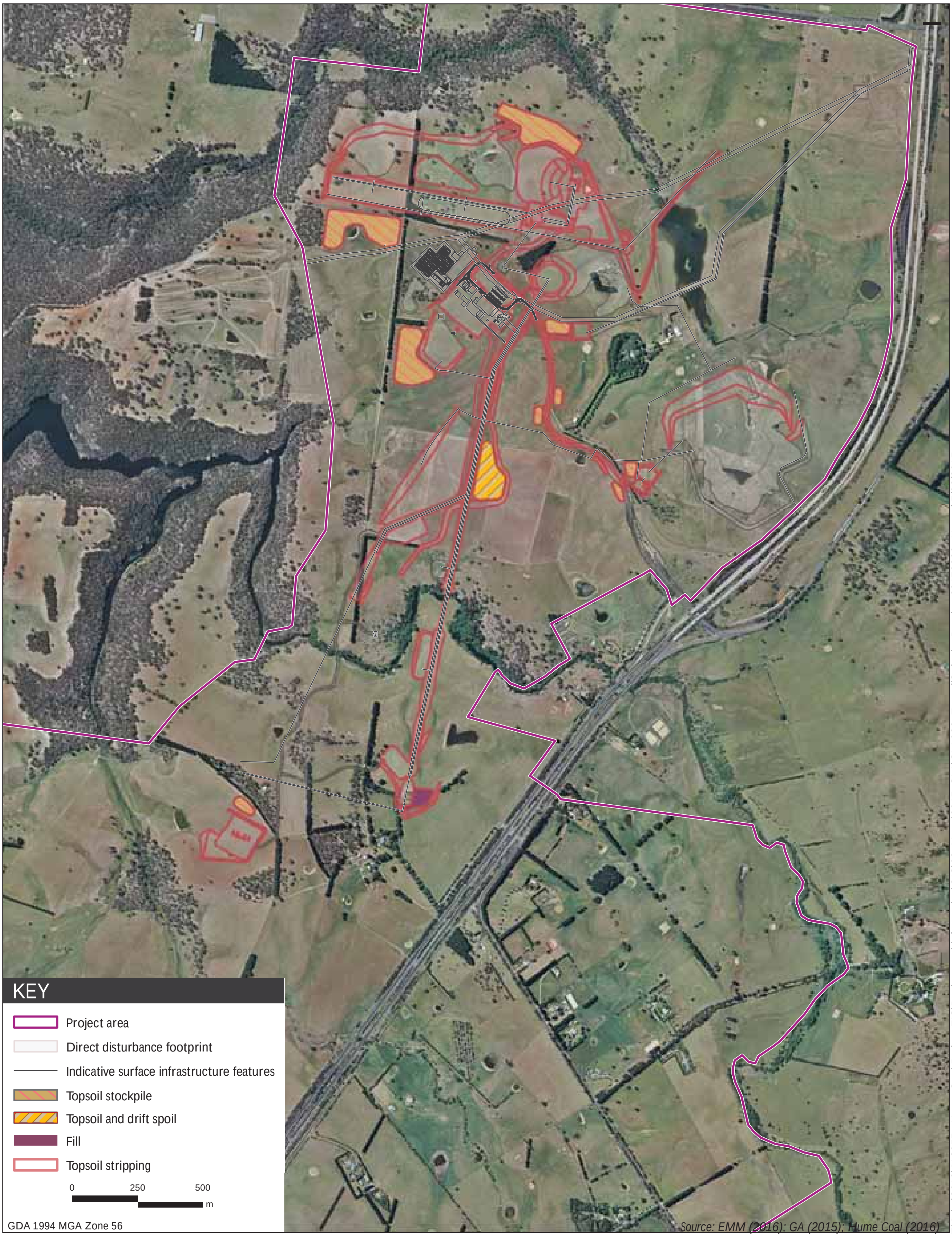
Table 7.3 and Figure 7.3 present the recommended topsoil stripping depths for each part of the project area to be subject to surface disturbance. It also shows the overall depth of soil (topsoil plus subsoil) which indicates areas that may be suitable for salvaging extra soil material. For example, the soil in the area of some the water dams may be salvageable down to 0.5m depth.

Table 7.3 Depths of topsoil and subsoil available for stripping[1]

Surface infrastructure	Depth to strip		Total soil depth (m)
	Topsoil (m)	Subsoil (m)	
Mining Infrastructure Area (MIA)	0.15	0.15	0.3
CHPP precinct	0.15	0.15	0.9[2]
Mine water dams and sediment dams	0.3	0.2	0.5[2]
Construction accommodation village	0.1		0.3
Topsoil stockpiles	0.1		0.3
Overland conveyor and access roads	0.2	0.1	0.4[2]
Vent shaft and associated infrastructure	0.2	0.1	0.3

Notes: 1. Estimated using soil depths recorded in EMM soil survey.

2. Excess soil available for stripping to make up any soil volume shortfall.



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Topsoil stripping

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Figure 7.3

7.3 Post mine land use and land capability

The overriding goal for the project's rehabilitation plan is to return disturbed land to a condition that is stable, and supports the proposed post mining land use which is grazing with improved pasture.

Soil depth will be shallower in the rehabilitated post-mining land because not all soil is suitable for use in rehabilitation. Therefore there will be less soil available resulting in shallower soil depths by comparion to the pre-mining land. Table 7.4 is taken from the LSC assessment scheme guideline, and shows how the depth of soil is translated into a LSC.

Table 7.4 Shallow soils and rockiness LSC class assessment table[1] (OEH 2012)

Rocky outcrop (% coverage)	Soil depth (m)	LSC class
<30 (localised)	>1	2
	0.75 -<1	3
	0.5 - <0.75	4
	0.25 - <0.5	6
	0 - <0.25	7

Notes: 1.only relevant portion of table shown.

2. depths presented in m – modified from original.

Table 7.5 describes the type of disturbance and rehabilitation required for each of the surface infrastructure types. The table also describes the reason for the change in land class.

From the *Australian Soil Classification* and SALIS there are three factors that may come into effect regarding the definition of soil depth in the LSC assessment scheme guideline:

- depth to a hardpan in the mining landscape (ie land which has been compacted by heavy machinery, noting that the impact of trafficking can be overcome by deep ripping);
- depth to rock (ie vegetation cannot grow in rock because of low plant available water capacity and inherent fertility); and
- most importantly the presence of a C horizon (ie the layer of soil above bedrock, which is defined as weathered rock or a mixture of weathered rock and newly developed soil in the *Australian Soil Classification*.

It should be noted in Table 7.5, that the fill used in construction will be sourced mostly from the excavation of the underground mine access (ie drift portal) and will therefore be a mixture of soil and rock. In the rehabilitated land, areas that are likely to be underlain by rocky fill are equivalent to having a C horizon of weathered rock, so only the returned topsoil is counted as the overall soil depth.

Some surface infrastructure may be underlain by subsoil however, the depth of soil may also be constrained by chemical inhibition such as high salinity. Salt is highly water soluble and mobile and there is some potential that it may become concentrated overtime creating a chemical inhibition layer. The assessment shown in Table 7.5 conservatively assumes that salt has been built up under infrastructure. If it is found after rehabilitation that subsoil is not constrained by chemical inhibition then the overall soil depth may increase from the conservative assumptions given in Table 7.5 resulting in a higher capability LSC class.

Table 7.5 Reasons for LSC changes in the post mining land

Surface infrastructure	Disturbance and rehabilitation type	Justification for post-mining LSC
Drift portals, ventilation shafts	Portal and shafts excavated into rock deep underground – rehabilitation involves replacing fill materials and overlaying with 0.3m topsoil.	LSC class 6, based on replaced soil depth of 0.3m (fill material is not equivalent to natural soil profile).
Dam walls	Dam walls constructed with fill material – rehabilitation involves re-profiling of fill material to match surrounding contours and overlaying 0.3m topsoil.	LSC class 6, based on replaced soil depth of 0.3m (fill material is not equivalent to natural soil profile).
Excavated sediment dams	Dams constructed by excavating material – rehabilitation involves filling with excated material or fill removed from dam walls or roadways, and overlaying 0.3m topsoil.	LSC class 6, based on replaced soil depth of 0.3m (fill material is not equivalent to natural soil profile).
Waterbody areas	Dam areas of natural contours which held water for extended periods of time – rehabilitation involves return of topsoil.	LSC class 6, based on the assumption that the subsoil which has been saturated for extended periods has effectively become a Hydrosol soil.
Soil stockpiles	Topsoil stockpiles placed on natural land contours, only topsoil disturbed – rehabilitation involves spreading of topsoil over underlying subsoil.	LSC class the same as the pre-mining LSC, as the soil profile depth is now the same, and all other factors are still the same.
Temporary accommodation and construction facilities	Buildings placed on natural land contours, only topsoil disturbed – rehabilitation involves spreading of topsoil over underlying subsoil.	LSC class the same as the pre-mining LSC, as the soil profile depth is now the same, and all other factors are still the same.
Overland conveyor system	Conveyor footings placed on natural land contours, only topsoil disturbed – rehabilitation involves spreading of topsoil over underlying subsoil.	LSC class the same as the pre-mining LSC, as the soil profile depth is now the same, and all other factors are still the same.
Minor tracks and roads (no cut and fill)	Roads or tracks built on existing land surface, topsoil removed, road base materials placed over the top. Rehabilitation involves the removal of road base and return of topsoil.	LSC class the same as the pre-mining LSC, as the soil profile depth is now the same, and all other factors are still the same.
Constructed roadways and infrastructure areas	Roads and infrastructure areas created by cut and fill of existing land surface. Rehabilitation involves re-profiling the fill material to match surrounding contours and overlaying 0.3m topsoil.	LSC class 6, based on replaced soil depth of 0.3m.
Underground mine area	No surface disturbance, negligible subsidence – no rehabilitation.	No change to LSC class.

Class 6 land will still be suitable for grazing and improved pasture. The LSC guideline says in relation to Class 6 land:

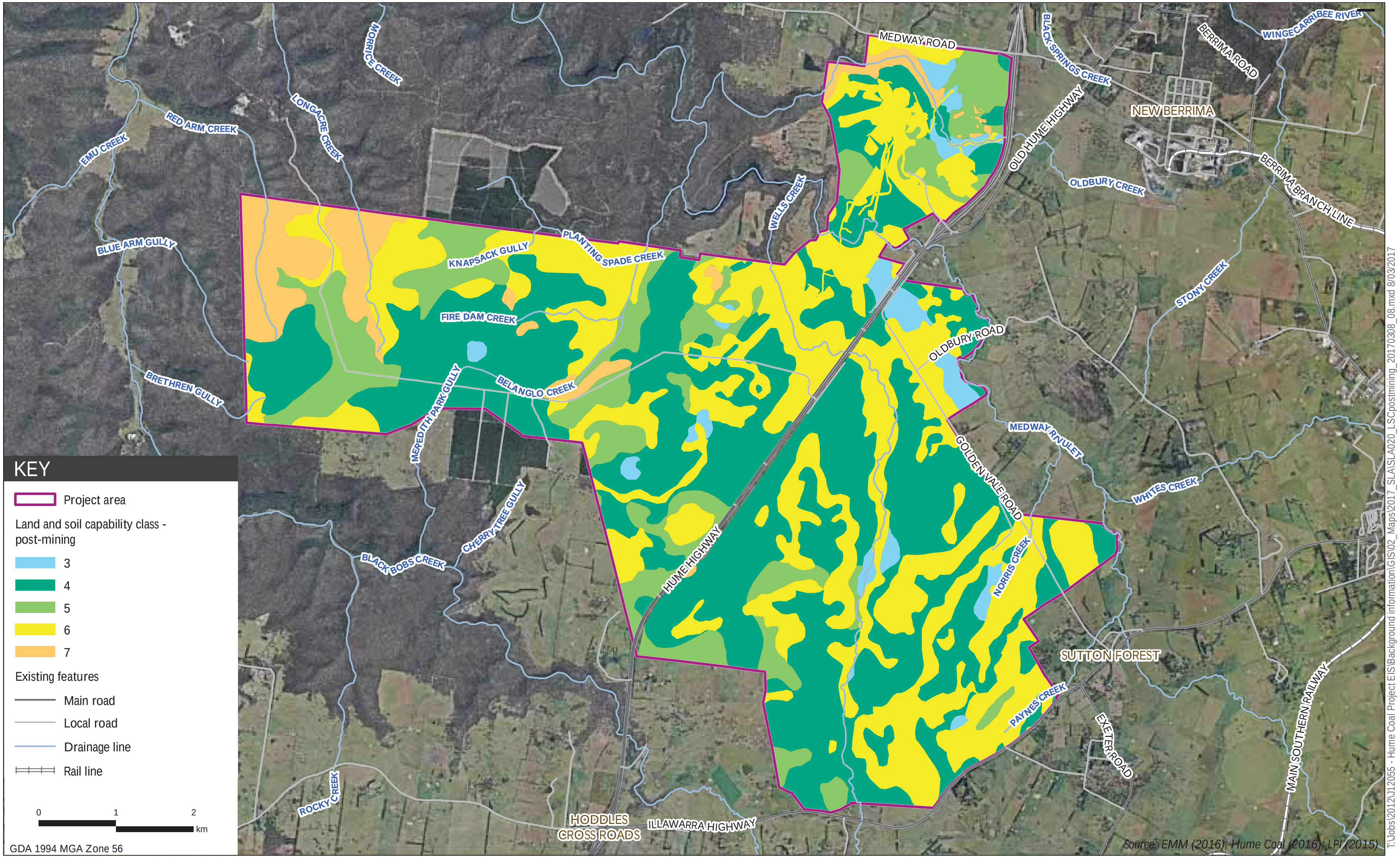
> "...This land requires careful management to maintain good ground cover (maintaining grass or cover taller than 8 cm is a guide). Grazing pressures need to be lower than those used on Class 4 and 5 land. Rotational grazing systems with adequate recovery time for plant regrowth are essential. It is important to minimise soil disturbance, retain perennial ground cover and maintain high organic matter levels...."

Therefore grazing will still be an option for land beneath the infrastructure area and water management areas, even with a lower LSC class compared to pre-mining.

Table 7.6 shows the pre- and post-mining area changes for each LSC class found on land that makes up the project. The post- mining LSC classes are shown on Figure 7.4.

Table 7.6 LSC class pre- and post-mining

LSC Class	Capability	Pre-mining LSC (ha)	Post-mining LSC (ha)	Amount lost or gained (+/- ha)	% change
LSC of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation)					
1	Extremely high	-	-		
2	Very high	-	-		
3	High	144	141	-3	-2%
LSC of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)					
4	Moderate	2221	2184	-37	-2%
5	Moderate-low	704	686	-18	-3%
LSC for a limited set of land uses (grazing, forestry and nature conservation)					
6	Low	1641	1699	+58	+4%
LSC generally incapable of agricultural land use (selective forestry and nature conservation)					
7	Very low	300	300		
8	Extremely low	-	-		
None	Waterbodies, Hume Highway,etc	41	41		



Land and soil capability in the project area - post-mining (EMM mapping)

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Figure 7.4

8 Management and mitigation measures

8.1 Mitigation measures

8.1.1 Measures to prevent loss of soil resource

To mitigate the risk of not enough soil being available for use in rehabilitation works, soil requirements will be accurately determined before construction works begin. The volume of soil required for rehabilitation can be calculated using the area estimated for rehabilitation multiplied by the depth of soil required (see Section 8.3.1). These calculations have been made using current design plans and topsoil depths measured for the soil asessment (see Section 7.2.3). If any alterations to the plans are made, or if site conditions are different than expected (eg shallow soil in places) the required volume of soil for rehabilitation should be re-calculated. An inventory of soil stripped should be prepared, so that if any significant deficit is identified, additional material can be sourced prior to rehabilitation. The recommendations made in the topsoil stripping procedure and the stockpiling procedure addresses all of these measures to prevent loss of soil resource.

8.1.2 Measures to manage soil erosion and sediment transport

The Kandosolic Redoxic Hydrosol soils are sodic and will be highly erosive, and are therefore not recommended to be used in rehabilitation. These soils are restricted to the drainage channels, and are likely to be boggy and waterlogged. The Dystrophic Yellow Kandosol soils are slightly sodic and have the potential to be subject to erosion, particularly on a slope. Therefore soil erosion management will be implemented during construction activities. Drainage structures have been designed for the infrastructure areas to manage water runoff for the life of the operations. Sediment control measures, will also be used during construction in accordance with the guideline *Managing Urban Stormwater, Volume 2E Mines and Quarries* (DECCD 2008).

To minimise the risk of loss from wind and water erosion to stockpiled topsoil, a vegetative cover will be established. Stockpiles will also be located where they are not exposed to overland or flood flow.

Soil may erode after the topsoil has been spread on the rehabilitated areas. Soil erosion and sediment control will be considered where there could potentially be off-site impacts to waterways, as well as impacts to the rehabilitation itself.

8.1.3 Measures to prevent soil contamination

Hydrocarbon management practices will be implemented to prevent hydrocarbon spills during construction activities (eg. re-fuelling, maintenance, hydrocarbon storage) and spill containment materials will be available to clean-up spills if they occurred. If any hydrocarbon spills were to occur during soil stripping, the impact will be isolated and clean-up procedures will mitigate any impacts from the spill. Areas to be used for long-term storage and handling of hydrocarbons and chemicals will be enclosed with concrete bunds.

Any construction material brought onto site will need to be clean and contaminant-free. This will be managed in accordance with procedures to be outlined in the Construction Environmental Management Plan.

Areas used for stockpiling of overburden and coal product will be compacted to minimise potential for water infiltration. If any contamination does occur, the soil material will be removed and disposed of appropriately. All surface water runoff from these stockpiles will be directed to the mine runoff dams. If the coal rejects are found to be potentially acid forming, the risk can be managed by adding fine limestone to the coal reject stockpile. Further assessment and discussion of geochemical related risks are provided in the Hume Geochemical Assessment (RGS Environmental 2016) completed for the project.

8.1.4 Measures to minimise soil degradation

To minimise structural decline of soil, the amount of compaction of soils during stripping and stockpiling will be minimised. This can be achieved by using suitable machinery and stockpile development techniques. Nutrient decline will occur during stockpiling of soils, but can be minimised by managing stockpile methods and heights. Any nutrient decline can be amended at the time of rehabilitation by utilising fertilisers and amendment techniques (eg gypsum application). The recommendations made in the topsoil stripping procedure and the stockpiling procedure addresses all of these risks to soil degradation.

8.1.5 Methods to achieve successful rehabilitation

Top soil and subsoil will be stripped and stockpiled. The soil stripping procedure has been designed to maximise the salvage of suitable materials so pastures can be reinstated to a condition that will support appropriate livestock carrying densities. These measures will be consistent with leading practice and incorporate the full range of reasonable and feasible mitigation methods for soil stripping, with the goal of minimising the degradation of soil nutrients and micro-organisms.

Topsoil and subsoil will be stockpiled, with stockpiles designed and located to prevent contamination, development of anaerobic conditions, and to avoid erosion and dust generation. The stockpiles will be seeded with grasses so that they remain stable and be regularly inspected for weeds.

Disturbed land will be re-profiled once surface structures are removed by re-instating depressions which were filled for mine development, removing dams and bunds so that water is not permanently retained and undertaking deep ripping of compacted areas.

Soil will be applied to provide sufficient depth for ripping and plant growth in a manner which minimises any degradation of soil characteristics. A soil balance plan will be prepared prior to spreading, which will show the depths and volume of soils to be reapplied in particular areas. Topsoil and subsoil will be applied at a thickness appropriate to support the intended land capability. The soil will then be contour-ripped and seeded with pasture grasses.

Pasture grass species will be chosen to suit the chosen grazing strategy, as well as species that are suitable for fast establishment of an initial cover crop.

8.2 Contingency measures

If the topsoil stripping procedure is carried out as currently proposed (Section 8.3.2), no, contingency measures should be needed. However, if there is insufficient volume of topsoil available at the time of rehabilitation, or if the topsoil material has been degraded, the following contingency measures will be implemented:

- Topsoil will be spread at a shallower thickness and/or only on selected parts of the site.
- Subsoil will be used as a topsoil substitute rather than returned as subsoil under the topsoil.
- Fertilisers and other soil additives will be added to the topsoil and subsoil to improve fertility and structure.

Implementation of any of the above contingency measures would enable satisfactory rehabilitation to occur although re-establishment of the target levels of land capability may take longer.

8.3 Topsoil management

8.3.1 Soil volume requirements

To successfully rehabilitate the site, soil will be replaced generally at about 0.3 m over the disturbed land. The area of disturbance is 117 ha, therefore, approximately 351,000 m^3 of soil is needed.

The overall volume of topsoil required for rehabilitation should be confirmed prior to construction, using the most detailed construction plans, to ensure that adequate soil is stockpiled. If any topsoil shortages emerge, due to factors like unanticipated shallowness, waterlogging or soil loss, additional subsoil should be stripped from an area with deeper soils.

The recommended topsoil depths to be stripped for each area of infrastructure has been determined using the depths of soil recorded in the soil assessment, and these are presented in Section 7.2.3.

8.3.2 Soil stripping procedure

A topsoil stripping procedure is outlined below, detailing measures to maximise the salvage of suitable topsoils and subsoils. These measures are consistent with leading practice and incorporate the full range of reasonable and feasible mitigation methods for soil stripping. They also include the soil handling measures that will minimise soil degradation (in terms of nutrients and micro-organisms present) and compaction, thus retaining its value for plant growth.

- The area to be stripped will be clearly defined on the ground, avoiding any waterlogged or similarly constrained areas. The target depths of topsoil and subsoil to be stripped for each location will be clearly communicated to machinery operators and supervisors.
- A combination of suitable earthworks equipment will be used for stripping and placing soils in stockpiles. Machinery circuits will be located to minimise compaction of the stockpiled soil.
- All machinery brought onto the site for soil stripping will have to comply with any weed management protocols and biosecurity established for the site.
- Soil stockpile locations will be identified during planning and will be stripped of topsoil (not subsoil) before used for stockpiles.

- Where the soil surface of the soil stockpile footprint is to be disturbed by the creation of topsoil stockpiles (ie vegetation removal, tracks, turning circles, etc), a nominal 0.1 m topsoil only (not subsoil) will be stripped before stockpiles are developed.

- The surface infrastructure area does not contain significant areas of native vegetation or trees, but any trees present will be cleared and grubbed prior to topsoil salvage.

- Topsoil and subsoil will be stripped to the required depths as nominated in this assessment and then stockpiled. Subsoil will be stripped and stockpiled separately where identified as suitable. Depending on compaction and recovery rates, deep ripping may be required to maximise topsoil recovery. Where soils are shallower, topsoil and subsoils will be stripped and stockpiled together.

- Handling and rehandling of stripped topsoil will be minimised as far as practicable by progressively stripping vegetation and soil only as needed for development activities.

- Soil stripping in very wet conditions will be avoided if practicable, because of the risk of compaction, nutrient deterioration and less volume of suitable materials being available. However, when possible, soils will be stripped when they are slightly moisture conditioned and this will assist in their removal and retain their structure.

- To avoid dust hazards, stripping of soil during particularly dry conditions will be avoided where possible.

8.3.3 Soil stockpile management

Soil stockpile management procedures will be designed to minimise degradation of soil characteristics that are favourable for plant growth. These measures are consistent with leading practices and incorporate all reasonable and feasible mitigation methods.

The following management practices will be implemented:

- Stockpiles will be located at an appropriate distance from water courses and dams (so they are not washed away). Approximate locations of stockpiles in the surface infrastructure area are illustrated in Figure 1.4.

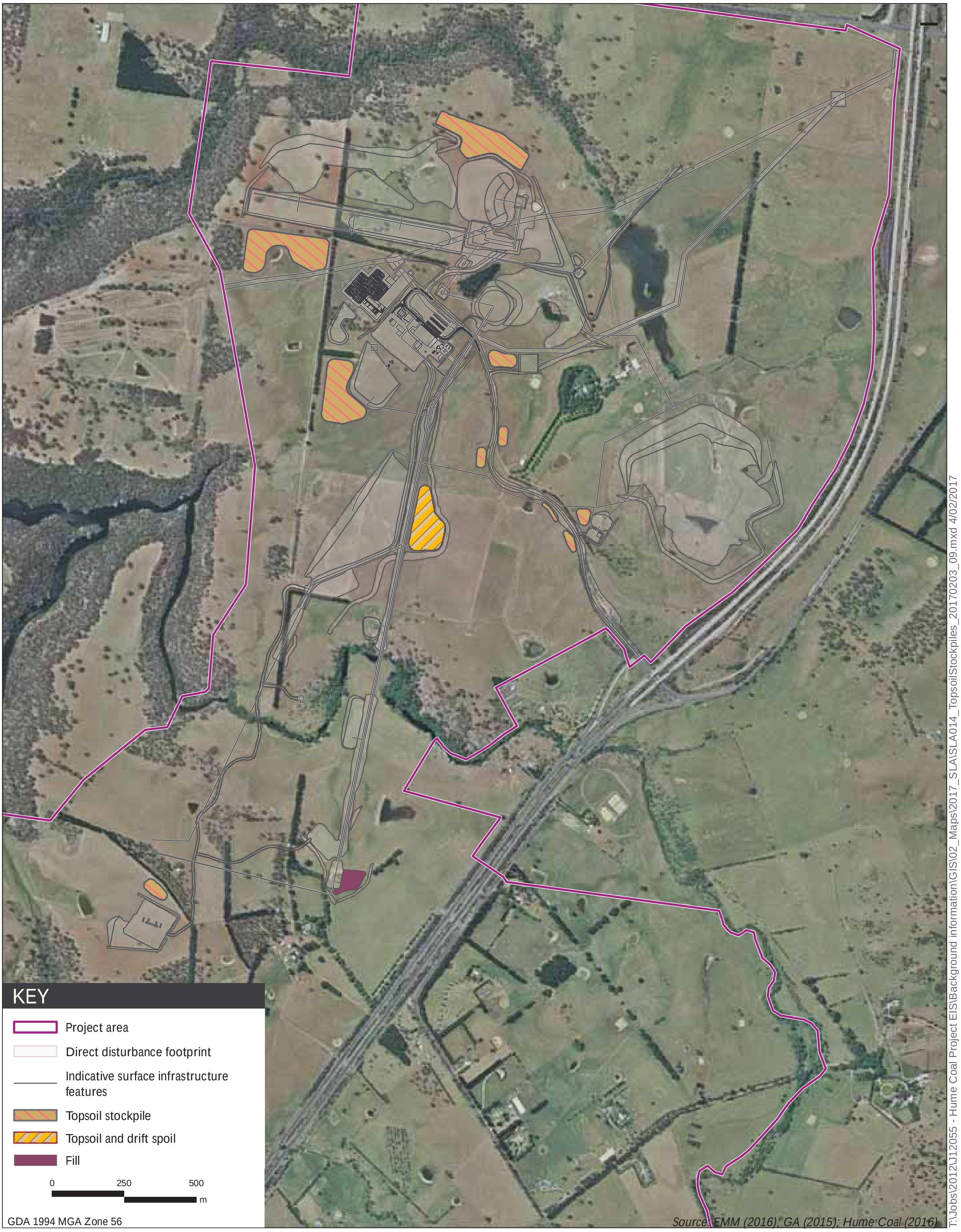
- Where practical, topsoil and subsoil will be stockpiled separately. Where this is not possible, combined topsoil and subsoil stockpiles will still be built to the specifications for topsoil stockpiles.

- Topsoil stockpiles will be designed and constructed to a height of no greater than 3 m in order to limit anaerobic conditions being generated within the stockpile and to minimise deterioration of nutrients, soil biota and seed banks.

- Soil stockpiles will have a slope grade of 1V:4H or less to limit erosion potential.

- Subsoil stockpiles can be designed over 3 m in height; however the slope grade needs to be considered for erosion control and should still be 1V:4H or less.

- The surface of the soil stockpiles should be left in a 'rough' condition to help promote water infiltration and minimise erosion via runoff. If required, sediment controls will be installed downstream of stockpile areas to collect any runoff.



Topsoil stockpile locations

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Figure 8.1

9 Conclusions

The impacts to land and soil resources as a result of the project will be restricted to the footprint of the surface infrastructure, covering approximately 117 ha within the 5,051 ha project area. The main soil type identified in the project area is a Kandosol (Dystrophic Yellow Kandosol), which generally occurs on slopes and crests of low rolling hills on sandstone and shale surface geology. This land is typical of the region, and is extensively cleared and used mainly for grazing improved pastures. Four other soil types (Lithic Leptic Rudosol, Paralithic Leptic Tenosol, Eutrophic Grey Dermosol and Kandosolic Redoxic Hydrosol) were identified in the project area. Small areas of the Hydrosol, Tenosol and Dermosol soil type occur in the infrastructure areas. The Hydrosol is found in the drainage depression and is waterlogged for much of the year. It is therefore not recommended to re-use this material for rehabilitation purposes.

Potential impacts to land and soil resources from the proposed surface infrastructure will be managed through appropriate mitigation techniques aimed at returning the site to a land use similar to the pre-existing land use of agriculture. The topsoils of the area to be disturbed will be stripped (approx. 0.3 m deep) prior to construction and stockpiled for use in later rehabilitation.

Post-mining, the land and soil capability class for the vast majority of the project area (ie 4,993 ha or 99%) will remain unchanged due to the underground nature of the project and the first workings mining method, with negligible associated subsidence, to be employed. There will be a change to the land and soil capability class over 58 ha of land disturbed by the surface infrastructure area and water management areas. The original land class of these areas (3 ha of Class 3, 37 ha of Class 4 and 18 ha of Class 5) will change to Class 6 because the soil depth will be 0.3 m as the replaced topsoil will overlie re-profiled fill materials. However, Class 6 land will still be suitable for grazing and improved pasture, allowing the continuation of an agricultural land-use post-mining.

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Appendix A

Biophysical strategic agricultural land verification assessment

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Biophysical Strategic Agricultural Land Verification Assessment

Prepared for Hume Coal Pty Limited | August 2015

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Biophysical Strategic Agricultural Land Verification Assessment

Hume Coal Project

Prepared for Hume Coal Pty Limited | 17 August 2015

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Biophysical Strategic Agricultural Land Verification Assessment

Final

J12055 | Prepared for Hume Coal Pty Limited | 17 August 2015

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Document Control

Version	Date	Prepared by	Reviewed by
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1 Introduction

1.1 Project background

Hume Coal Pty Limited (Hume Coal) proposes to develop and operate an underground coal mine and associated mine infrastructure (the 'Hume Coal Project') in the Southern Coalfield of New South Wales (NSW). Hume Coal holds exploration authorisation 349 (A349) to the west of Moss Vale, in the Wingecarribee local government area (LGA). The underground mine will be developed within part of A349 and associated surface facilities will be developed within and north of A349. The project's local setting is shown in Figure 1.1.

The mine will be developed and operated over an approximate 22 year-period, producing metallurgical and thermal coal for international and domestic markets. It will extract approximately 50 million tonnes of run of mine (ROM) coal from the Wongawilli Seam using low impact mining methods. To minimise environmental impacts, Hume Coal has devised an innovative 'non-caving' mining method which will have negligible subsidence impacts. It will leave pillars of coal in place so that the overlying strata remain intact and supported, rather than collapsing into the mined-out void and causing subsidence. This mining method will protect the overlying aquifer and surface features and allow existing land uses to continue at the surface. The mine will employ around 300 full-time equivalent personnel at peak production. Post-mining, the mine infrastructure will be decommissioned and these areas rehabilitated over a nominal two year period, to a state where they can support land uses similar to the current land uses. This outcome will be assisted by the surface infrastructure design, which retains as much of the existing landscape as possible.

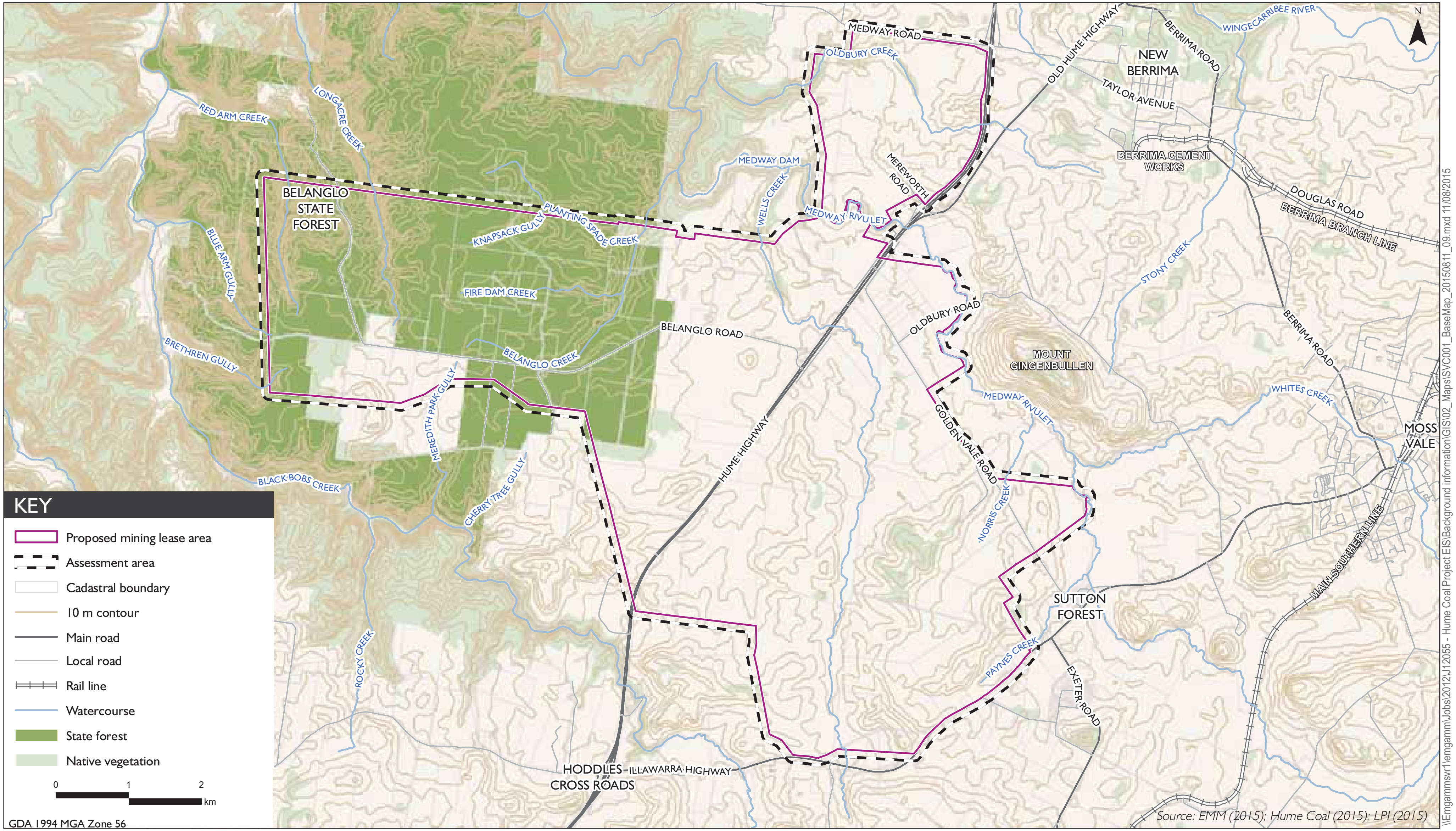
The project has been developed following several years of detailed technical investigations to define the mineable resource and identify and address environmental and other constraints. Numerous alternative designs have been prepared and evaluated. This process has allowed development of a well-considered, practical and economic project design that will enable resource recovery, while minimising environmental impacts and potential land use conflicts.

The project is now in the early stages of the comprehensive assessment processes required by Commonwealth and NSW legislation. Under provisions of the NSW Environmental Planning and Assessment Regulation 2000, either a gateway certificate or a site verification certificate (SVC) is needed before the project's development application is lodged. This process was established by the NSW Government (2012a) *Strategic Regional Land Use Policy* (SRLUP) and an amendment to the State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 (Mining SEPP) in 2013. It applies to State significant mining developments, such as the Hume Coal Project, that require a new or extended mining lease under the NSW *Mining Act 1992*.

The type of certificate required depends on whether or not a proposed development is on 'strategic agricultural land', as defined in the SRLUP. Strategic agricultural land, which makes up less than 4% of all land in NSW (NSW Department of Planning and Infrastructure 2013), falls into two categories: critical industry clusters (CICs) and biophysical strategic agricultural land (BSAL).

Developments that are on the unique and highly productive land classified as strategic agricultural land need to go through the gateway process and obtain a gateway certificate. Conversely, developments which are not on strategic agricultural land need to obtain a SVC, certifying that the land is not BSAL The gateway process does not apply to these types of developments and they cannot go through the gateway process.

The NSW Government has mapped strategic agricultural land across the whole of NSW at a desktop level. This Strategic Agricultural Land Map (attached to the Mining SEPP) shows that there is no strategic agricultural land in Hume Coal's proposed mining lease areas. However, in accordance with the Mining SEPP, detailed site-specific surveys and analysis ('site verification') are required following the NSW Government (2013) *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land* (Interim Protocol), to confirm whether or not any land within Hume Coal's proposed mining lease areas is BSAL. As described in Section 2.1, there are no CICs within or close to the Hume Coal Project and site verification or a SVC are not required in respect of CICs.



SVC application area

Hume Coal Project

Biophysical strategic agricultural land verification assessment

Figure 1.1

Site verification has been completed for the Hume Coal Project and confirmed that, consistent with the NSW Government's mapping, there is no BSAL within Hume Coal's proposed mining lease areas. Hume Coal is therefore applying to the NSW Department of Planning and Environment (DP&E) for a SVC to certify this finding. The verification process and outcomes are documented in this report, which accompanies the SVC application under Part 4AA of the Mining SEPP.

Hume Coal's SVC application is for those parts of A349 and land to the north over which it intends to seek a mining lease (including a lease for mining purposes) under the NSW *Mining Act 1992* (herein the 'SVC application area') (Figure 1.1). The wider BSAL verification assessment area comprises the SVC application area plus a 100 metre (m) buffer, as per Interim Protocol requirements.

1.2 Policy framework

The site verification policy framework is set out in the SRLUP and Mining SEPP.

The NSW Government released the SRLUP in 2012 to "provide greater protection for valuable agricultural land and better balance competing land uses". This was to be by "identifying and protecting strategic agricultural land, protecting valuable water resources and providing greater certainty for companies wanting to invest in mining and coal seam gas projects in regional NSW". The SRLUP provides a strategic framework and a range of initiatives to balance agriculture and resource development.

As mentioned in Section 1.1, the SVC process was established in 2013 by an amendment to the Mining SEPP. The Mining SEPP amendment included addition of the following aims in Clause 2(d):

(i) to recognise the importance of agricultural resources, and

(ii) to ensure protection of strategic agricultural land and water resources, and

(iii) to ensure a balanced use of land by potentially competing industries, and

(iv) to provide for the sustainable growth of mining, petroleum and agricultural industries.

The SRLUP seeks to identify and map the two categories of strategic agricultural land. First, land with a rare combination of natural resources which make it very valuable for agriculture (known as BSAL). Second, land which is important to a highly significant and clustered industry such as wine making or horse breeding (known as CICs). Further discussion of BSAL and CICs is provided in Chapter 2.

The SRLUP applies to mining proposals that are State Significant Development under the Mining SEPP and require a new or extended mining lease. In such cases proponents are required to confirm whether or not they are to be situated on strategic agricultural land. The Hume Coal Project is a State significant mining proposal which requires a new mining lease and so the SRLUP applies.

Hume Coal's SVC application is being lodged under Part 4AA of the Mining SEPP. In accordance with Clause 17C(3) of the Mining SEPP, Hume Coal has given notice of its intent to lodge an SVC application "by advertisement published in a newspaper circulating in the area in which the development is to be carried out no later than 30 days before the application is made". A copy of the advertisement, which was published in the Southern Highland News on 17 July 2015, is provided in Appendix H.

2 Strategic agricultural land assessment

2.1 Critical industry clusters

The NSW Government (2012b) *Draft Guideline for site verification of critical industry clusters* provides guidance for identifying the existence of CICs. They are mapped on the Strategic Agricultural Land Map and comprise land which is important to a highly significant and clustered industry, such as wine making or horse breeding.

The draft guideline describes a CIC as a "localised concentration of interrelated productive industries based on an agricultural product that provides significant employment opportunities and contributes to the identity of the region". It specifies that a CIC must meet the following criteria:

- there is a concentration of enterprises that provides clear development and marketing advantages and is based on an agricultural product;
- the productive industries are interrelated;
- it consists of a unique combination of factors such as location, infrastructure, heritage and natural resources;
- it is of a national and/or international importance;
- it is an iconic industry that contributes to the region's identity; and
- it is potentially substantially impacted by coal seam gas or mining proposals.

The Strategic Agricultural Land Map (attached to the Mining SEPP) shows that there are no CICs within or close to Hume Coal's proposed mining lease areas. There are only two in NSW (an equine and a viticulture CIC), both in the Upper Hunter, more than 200 kilometres north of the SVC application area. The draft guideline states that "projects located outside the mapped CIC are not required to seek site verification". The Hume Coal Project is outside the mapped CIC. Therefore, the application area does not contain CICs and Hume Coal is not required to seek a site verification or gateway certificate in respect of CICs.

2.2 Biophysical strategic agricultural land

BSAL is defined in the Interim Protocol as:

> land with a rare combination of natural resources highly suitable for agriculture. These lands intrinsically have the best quality landforms, soil and water resources which are naturally capable of sustaining high levels of productivity and require minimal management practices to maintain this high quality. BSAL is able to be used sustainably for intensive purposes such as cultivation. Such land is inherently fertile and generally lacks significant biophysical constraints.

The NSW Government has mapped BSAL across the whole of NSW, based on a desktop study, and the resultant maps accompany the Mining SEPP. The BSAL shown on the maps comprises land which meets the following criteria (as described in the Interim Protocol):

- access to a reliable water supply; and
- falls under soil fertility classes 'high' or 'moderately high' under the NSW Office of Environment and Heritage (OEH) *Draft Inherent General Fertility of NSW*, where it is also present with land capability classes I, II or III under OEH's *Land and Soil Capability Mapping of NSW*; or
- falls under soil fertility classes 'moderate' under OEH's *Draft Inherent General Fertility of NSW*, where it is also present with land capability classes I or II under OEH's *Land and Soil Capability Mapping of NSW*.

These maps have generally not been verified by site investigations and site verification in accordance with the Interim Protocol is required to confirm whether or not land is actually BSAL.

The Strategic Agricultural Land Map indicates that there is no BSAL in the SVC application area. Figure 2.1 presents the NSW Government's regional scale BSAL map for the area. BSAL has been mapped nearby, in the south-eastern corner of A349 and at a hill (Mount Gingenbullen) in its north-eastern corner (refer to Figure 2.1), though this land has not been confirmed as BSAL by site investigations. The project does not involve mining under either of these areas. They are outside of the SVC application area (Figure 2.1) and the entirety of the proposed development application area. It is however noted that, based on review of LiDAR data, there is less than 20 hectares (ha) of land at Mount Gingenbullen with slopes less than or equal to 10% and so it does not comprise BSAL (refer to Figures 2.2 and 3.6). Furthermore, the hill includes rocky outcrops and is the site of an old Trachyte quarry.

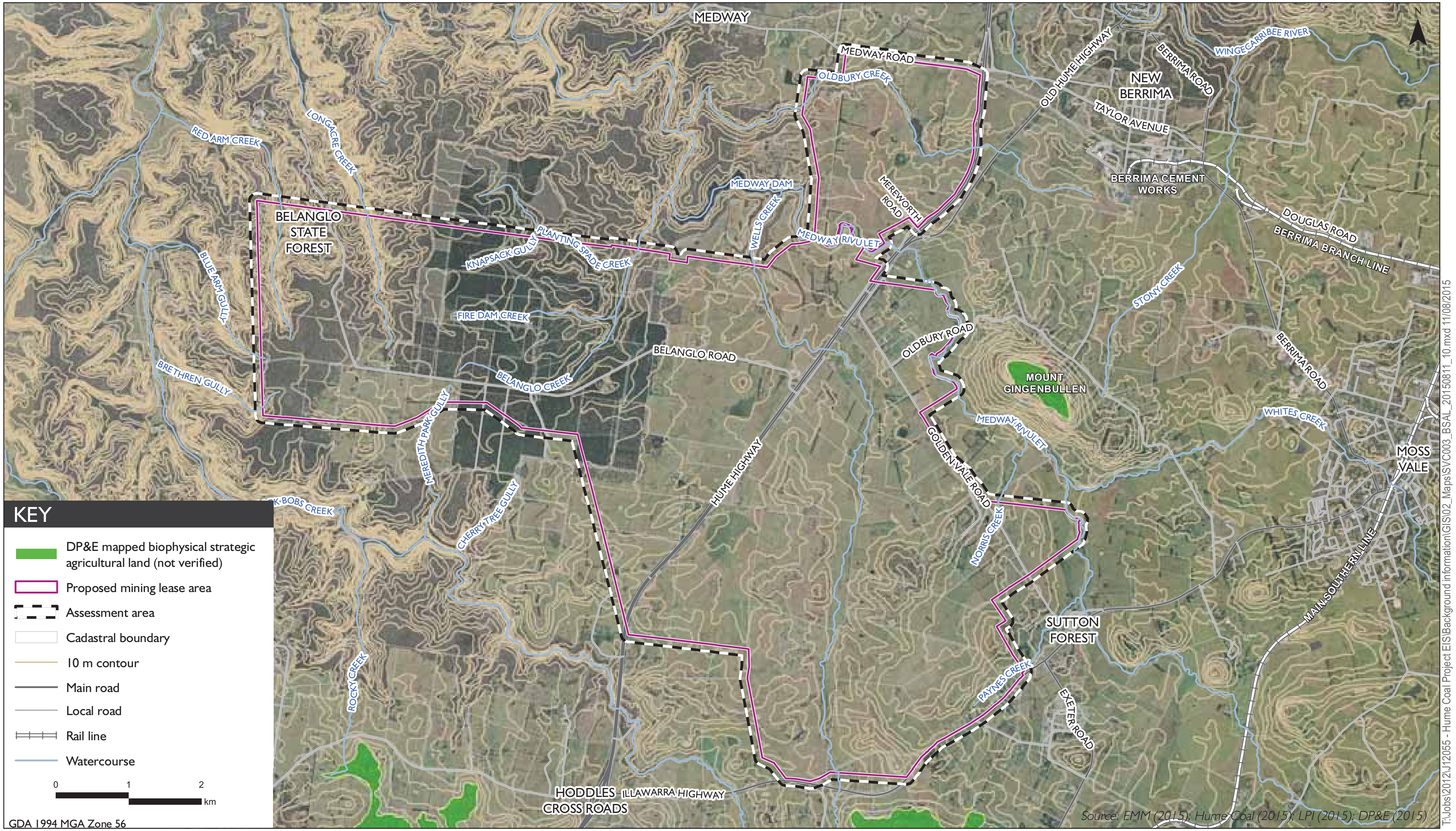
Notwithstanding, the Interim Protocol states that "due to the regional scale of the maps, it is important that appropriate processes are in place to provide for verification that particular sites are in fact BSAL. Verification can apply to both mapped and unmapped BSAL areas." The Mining SEPP requires certain types of development (including the Hume Coal Project) to verify whether or not any land within their proposed mining lease areas is BSAL.

The Interim Protocol outlines the steps and criteria to establish whether an area is BSAL. The criteria relate to:

- slope;
- rock outcrop;
- surface rock fragments;
- gilgais;
- soil fertility;
- effective rooting depth to a physical barrier;
- soil drainage;
- soil pH;
- salinity; and
- effective rooting depth to a chemical barrier.

Figure 2.2 shows the order in which the site verification criteria must be assessed and the decision making sequence to establish whether or not BSAL is present at a particular site. For land to be classified as BSAL, it must meet all of the criteria in Figure 2.2. If any of the criteria are not met, the land is not BSAL and later steps in the assessment are not relevant. In addition, the Interim Protocol specifies a minimum area for BSAL of 20 ha. If the area subject to assessment falls below 20 ha at any point of the assessment because of exclusion of land that does not meet the criteria, then the land is not BSAL and there is no need to continue the assessment. Therefore, for land to be classified as BSAL, it must have access to a reliable water supply; meet all of the criteria in Figure 2.2; and be a contiguous area of at least 20 ha. If any of these criteria are not met, the land is not BSAL. A detailed description of the BSAL classification rules and analysis methods used in this assessment is provided in Appendix F.

It is noted that Figure 2.2 is a direct extract from the Interim Protocol and has a misprint in Step 12. The actual effective rooting depth criteria for a site to be classified as BSAL (as used in the Hume Coal Project's assessment) is greater than or equal to 750 millimetres (mm) (not 75 mm). This is correctly shown in respect of physical barriers in Step 8 of the flow chart, and quoted elsewhere in the Interim Protocol in relation to chemical barriers, for example in Section 6.10: "BSAL soils must have an effective rooting depth to a chemical barrier greater or equal to 750 mm".



EMM

HUMECOAL project

DP&E mapped BSAL

Hume Coal Project

Biophysical strategic agricultural land verification assessment

Figure 2.1

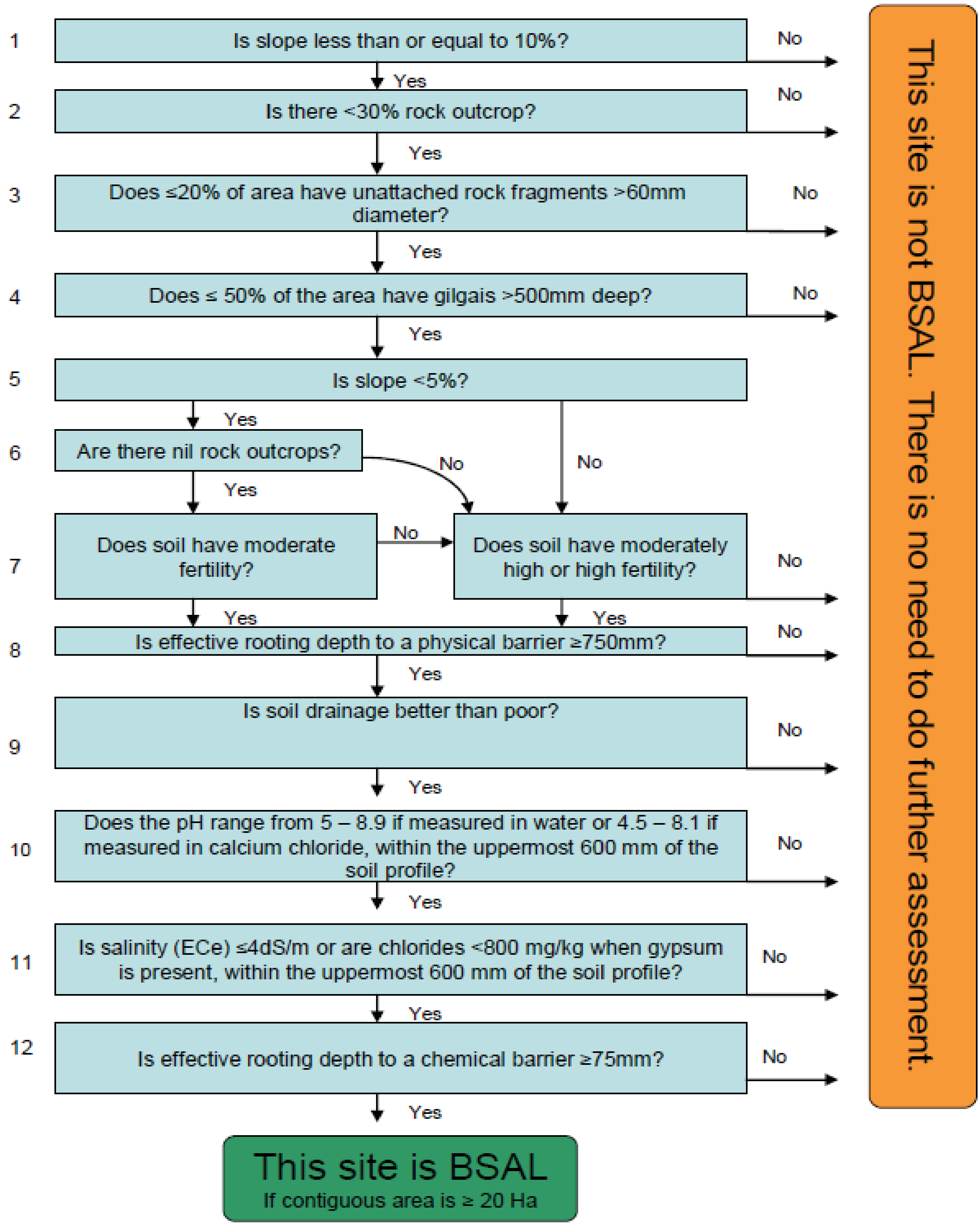


Figure 2.2 Interim Protocol flow chart for site assessment of BSAL

2.3 Statement of qualification

This site verification report has been prepared by Kylie Drapala and Neil Cupples of EMGA Mitchell McLennan Pty Limited (EMM) in accordance with the Interim Protocol. Kylie and Neil are senior soil scientists. The assessment and report have been authorised by Dr Timothy Rohde, who is a certified professional soil scientist, Stage 2 (Australian Society of Soil Science Inc).

2.4 Expert reviews

This site verification report was independently reviewed by Dr David McKenzie. Dr McKenzie is a certified professional soil scientist, Stage 3 (Australian Society of Soil Science Inc.) and a certified soil scientist by the British Society of Soil Science. A letter documenting Dr McKenzie's review is provided in Appendix A.

In addition, preparation of this report required application of remote sensing techniques in soil characterisation and mapping (refer to Appendix B). This process and its outcomes were also subject to independent review, by remote sensing expert Professor Bruce Forster. Professor Forster has a PhD in satellite remote sensing, is a former Director of the Centre for Remote Sensing and Geographic Information Systems (GIS) at the University of New South Wales, and is the Managing Director of Asia Pacific Remote Sensing Pty Ltd. Professor Forster's report is also provided in Appendix A.

2.5 Interim protocol checklist

The Interim Protocol provides a checklist of requirements for a BSAL site verification assessment report. The checklist is reproduced in Table 2.1, with reference to where each of the requirements has been addressed in this report.

Table 2.1 Interim protocol checklist

Requirement	Reference
Method, analysis and data	
A qualified soil scientist is overseeing the verification assessment and has signed off on the quality and extent of the work.	Sections 2.3 and 2.4 and Appendix A.
Laboratories for soil samples are compliant with AS ISO/IEC17025.	Appendix D.
Results with 15% of threshold levels are analysed in a laboratory.	Appendix E.
All soil profile descriptions are recorded and submitted to the NSW Soil and Land Information System (SALIS).	Survey data was recorded on SALIS soil data cards and submitted to OEH for entry into the SALIS database.
Laboratory data is supplied to OEH using their standard spreadsheet templates.	Laboratory data has been provided to OEH in the OEH template.
Report	
Reporting requirements for site verification criteria as described in Appendix 1 of the Interim Protocol.	Table 5.1and Appendix G.
Three 1:25,000 maps showing base level information, soil types and BSAL.	Figures 1.1, 4.1 and 5.1.
GIS output files and metadata statements.	GIS output files and metadata statements are provided with the SVC application.
Laboratory report.	Appendix E.

3 BSAL verification methods and initial steps

3.1 Introduction

The Interim Protocol prescribes four initial steps in verifying BSAL:

- Step 1: identify the project area which will be assessed for BSAL;
- Step 2: confirm access to a reliable water supply;
- Step 3: choose the appropriate approach to map the soils information; and
- Step 4: risk assessment.

These steps are addressed in Sections 3.2 to 3.5 respectively. Section 3.6 describes the field-based survey methodology, including site selection and soils analysis, as well as a review of regional soil, geology and topographic mapping by others.

3.2 Project area

The proposed mining lease application area, which is also the SVC application area, is 5,042 ha and is shown on Figure 1.1. The BSAL verification assessment area comprises the SVC application area plus a 100 m buffer, as per the Interim Protocol, and is 5,491 ha. It is also shown on Figure 1.1.

It should be noted that under clause 17A(2) of the Mining SEPP, mining development, as defined for the purposes of the site verification process, does not include development on land outside of a proposed mining lease. Therefore, any project components outside proposed lease areas, for example linear infrastructure such as rail infrastructure, are not subject to the site verification process. Accordingly, the SVC application area covers land over which Hume Coal intends to seek a mining lease or lease for mining purposes. It does not include some land where the rail spur, electricity transmission lines and other project-related components not subject to a mining lease will be constructed.

The majority of the SVC application area is freehold land, around 1,247 ha of which is owned by Hume Coal or affiliated entities. The north-western corner (Belanglo State Forest) is owned by State Forests of NSW, covering approximately 1,295 ha. The remainder, principally being road reserves, is variously owned by the Crown and Wingecarribee Shire Council.

3.3 Water supply

The SVC application area has a reliable water supply, defined in the Interim Protocol as rainfall of 350 mm or more per annum in nine out of 10 years. Weather records from the nearby town of Moss Vale indicate that for the past 14 years (2000-2014), rainfall has been in the range of 526-873 mm per annum (Bureau of Meteorology 2014). A review of NSW Office of Water mapping (NOW 2013a,b,c) confirms the reliability of rainfall, presence of a highly productive groundwater source and close proximity to reliable surface water supplies.

3.4 Land access and mapping approach

Sufficient land was able to be accessed within the SVC application area to satisfy on-site soil sampling density requirements specified in the Interim Protocol (refer to Sections 3.5 and 3.6.1). However, whilst Hume Coal made every reasonable attempt to access properties across the application area for soil surveys, a number of landholders declined to participate, and so land access was not uniformly spread (refer to Figure 3.1). A combination of field surveys and remote sensing methods were therefore used to identify and map soil types across the assessment area, consistent with guidance in the Interim Protocol. The remote sensing methods used are considered to be more accurate and objective than traditional manual mapping methods.

The Interim Protocol stipulates that where access for sampling is not available, a model of soils distribution should be developed based on landscape characteristics and remotely sensed and other data sources such as aerial photos, geology (extrapolated to identify parent material), electromagnetic and LiDAR data.

Accordingly, high resolution remotely-sensed data (eg digital elevation model derived from LiDAR data, gamma radiometric, geological and satellite imagery) has been used, in conjunction with soils data collected by field and laboratory analyses, to develop a model of soils distribution for the application area. The model employs a ‘maximum likelihood’ method of soil classification, based on statistical relationships between measurements in the field and remotely sensed data. It has been used to map soil types across the assessment area, including on land that could not be accessed, using the Australian Soil Classification (ASC) system. This approach differs from more traditional mapping methods, which involve manually mapping soil type boundaries based on professional judgement and interpretations of field data, maps and aerial/satellite images.

However, the gamma radiometric imagery, which was a key input to the remote sensing model, does not cover the far northern part of the application area. Therefore, soil types in this northern area were not mapped using remote sensing methods. Good field survey coverage was achieved in this northern area and used by EMM’s soil scientists to manually map soil types there (refer to Figures 3.1 and 4.1).

Comparison of the soil types predicted by the model at each field survey point to the actual field results indicates an overall confidence level of approximately 75%, which is considered high. That is, approximately 75% of field survey points were classified as the same soil type by the model. In every instance where the two differed, the field survey point was 50 m or less from the model-predicted boundary of that same soil type. This spatial accuracy would be difficult to achieve with manual soil mapping techniques, especially at high resolutions of 1:25,000 or finer. By way of comparison, using traditional manual mapping methods, if a soil type is deemed to make up greater than 70% of a polygon, then the polygon would be mapped as that dominant soil type. This means there is allowance for ‘error’ of up to 30% in soil mapping using ‘traditional methods’.

The remote sensing and mapping methodologies are described in detail in Appendix B. Details of the field survey methodology are provided in Section 3.6.

It is also noted that landholder objection to digging soil pits (‘test pits’) meant that the soil surveys were mostly completed by taking soil samples with 50 mm diameter core tubes or augers. The core tube and auger sample sites were supplemented with a test pit using a backhoe for four of the five soil types identified, on land where the landholder was receptive to having a soil pit. The sites selected for test pitting were those which were both accessible and adequately representative of the soil type. The latter was determined based on a review of survey results from cored or augered sites at or adjacent to potential test pit locations, to identify those which had relatively consistent average results across both physical, and where available, chemical parameters. The test pit locations are therefore considered to be generally representative of other sites with that same soil type.

It is further noted that this assessment and soil mapping used soil type map units. The option of instead using soil landscape units was considered. Soil landscape units are more appropriate for situations where there is more variability in soil types. They are typically used in areas where there may be a single dominant soil type but two or three common sub-dominants. For the SVC application area, soil map units were chosen due to the relatively low variability observed. The soil map units are referred to as ‘soil types’ in this report for simplicity. Correlations with landforms and geology are made using either method.

3.5 Soil sampling density target

To determine the density of soil sampling required, the Interim Protocol recommends risks to agricultural resources and enterprises be evaluated using guidance in Appendix 3 of the Interim Protocol.

Risks can be classified as low, medium or high. The Interim Protocol states that examples of low risk situations include "areas of land that are unlikely to be BSAL over a proposed underground mine". It stipulates that sampling densities should be one site per 25 to 400 ha (1:25,000 to 1:100,000) for low risk activities and one site per 5 to 25 ha (1:25,000) for high risk activities (Gallant et al. 2008).

The project involves development and operation of mine infrastructure and an underground mine on and under land which is unlikely to be BSAL, based on the NSW Government's BSAL map, an extract of which is shown in Figure 2.1.

The potential for impacts to agricultural resources and enterprises is limited by the project design, which is for an underground mine that uses mining systems designed to avoid subsidence impacts. Direct surface disturbance, conservatively estimated at approximately 115 ha, will largely be restricted to surface infrastructure areas. They are predominantly in the north of the application area, though include some other areas above the underground mine to the south, such as drill pads and access tracks. Surface infrastructure will be on land owned by Hume Coal (or affiliated entities) or for which appropriate access agreements are in place with the landowner. It is noted that, as mentioned in Section 3.2, some project-related elements which will involve surface disturbance, such as rail infrastructure, do not require a mining lease or lease for mining purposes, and therefore are not subject to the site verification process. This infrastructure will extend outside of the SVC application area. The total surface disturbance for the mine and associated facilities (Hume Coal Project), as well as associated rail infrastructure subject of a separate development application (Berrima Rail Project), is conservatively estimated to be approximately 150 ha.

Development and operation of the surface infrastructure will have different impacts on the land's agricultural capability to development and operation of the underground mine. Surface impacts above the mine, proposed to cover approximately 3,400 ha, will be limited by the low impact mining system which will have negligible subsidence impacts; the existing land uses, agricultural or otherwise, will continue at the surface in these areas. Conversely, development of surface infrastructure (principally on land owned by Hume Coal or affiliated entities) would constitute a temporary land use change at that location. Land disturbance at surface infrastructure areas will be reversible and the infrastructure design retains as much of the existing landscape as possible. Post-mining, the mine infrastructure will be decommissioned and these areas rehabilitated to a state where they can support land uses similar to the current land uses.

Based on the above, separate preliminary agricultural risk assessments were undertaken for the surface infrastructure footprint and land overlying the underground mine, respectively, using the risk ranking matrix in the Interim Protocol. The results are presented in Table 3.1. It is noted that, based on the consequence descriptors in Appendix 3 of the Interim Protocol, the preliminary risk assessments are for an unmitigated scenario, which is not realistic. In practice, mitigation and management measures will be developed and implemented to avoid and minimise impacts to agriculture. These measures will be detailed in the environmental impact statement (EIS), though some examples are provided in the comments column of Table 3.1.

It is also noted that there are areas (more than 1,000 ha) within the SVC application area which are outside of both the surface infrastructure footprint and underground mining area, which are also not proposed to be disturbed, and pose negligible risk to agricultural resources. However, the preliminary risk assessment conservatively considers the entire SVC application area as either a 'surface infrastructure footprint' or 'underground mine area'.

Table 3.1 Preliminary agricultural risk assessment (unmitigated scenario)

Aspect	Probability[1]	Consequences[1]	Rating[1]	Comments
Surface infrastructure footprint	A - almost certain	2 - major	A2 - high	Applicable consequence descriptor from risk assessment matrix in Appendix 3 of Interim Protocol: Long-term management implications. EMM comments: This risk ranking rating applies only to the proposed surface disturbance footprint (approximately 115 ha) and is due to the proposed temporary land use change in these areas from agricultural to mine industrial for the duration of the project (nominally 24 years including construction and rehabilitation). Post-mining, the mine infrastructure will be decommissioned and these areas rehabilitated to a state where they can support land uses similar to current land uses.
Underground mine area	A - almost certain	4 - minor	A4 - medium	Applicable consequence descriptor from risk assessment matrix in Appendix 3 of Interim Protocol: Potential for short-term impact to agricultural resources or industries. Can be managed as part of routine operations. EMM comments: Surface impacts will be limited by the 'non-caving', low impact mining system which will have negligible subsidence impacts and will, therefore, protect the overlying aquifer and surface features and allow existing land uses to continue at the surface. The risk rating is based on the potential for other temporary impacts, which will be managed as part of the mine's operations. For example, the potential for groundwater inflows to the mine to result in a temporary decline in the water level within some water supply bores or wells of more than 2 m. In these situations, Hume Coal would offer any affected third parties appropriate compensatory arrangements such as access to an equivalent water supply through enhanced infrastructure or other means such as deepening an existing bore.

Note: *1. Based on the probability and consequence descriptors in Appendix 3 of the Interim Protocol and an unmitigated scenario, which is not realistic. In practice, mitigation and management measures will be implemented to avoid and minimise impacts to agriculture. These measures will be detailed in the EIS, though examples are provided in the comments column.*

A soil survey density target of at least one site per 25 ha was conservatively adopted for BSAL verification purposes.

3.6 Field-based survey methodology

3.6.1 Survey density

Soil survey sites were mostly confined within the project area as recommended by Section 9.2 of the Interim Protocol. A total of 246 sites were surveyed within and immediately adjacent to the SVC application area and an average survey density of about one site per 20.5 ha was achieved. The average survey density achieved meets the conservative target adopted, which was at least one site per 25 ha or 202 sites (refer to Section 3.5). When considering the 100 m buffer, the average density achieved was about one site per 22.3 ha, which also meets the target adopted.

As discussed in Section 3.4, access for soil sampling was not uniformly spread across the application area and the spatial distribution of soil sampling points provides good coverage in some areas, though not in others. Therefore, consistent with guidance in the Interim Protocol, the field surveys were complemented by remote sensing techniques, to identify and map soil types across the assessment area and evaluate other BSAL criteria such as slope.

It is noted that soil surveys have also been conducted at additional locations outside the SVC application area, as part of the broader investigations for the project's EIS. These locations are not considered or described in this report, as they are not directly relevant to the SVC application. They will be detailed in the EIS. It is however noted that the soil types recorded at these additional locations are the same as those found within the SVC application area, none of which are BSAL.

3.6.2 Site selection

Initial positioning of the soil survey sites was based on stratified random sampling across the application area, though designed to provide a relatively even distribution of detailed and check sites. In accordance with the requirements of stratified random sampling, a greater frequency of sampling was proposed for soil types that cover a greater proportion of the application area. Also, topographic maps were reviewed to ensure surveying was representative of the different landform types in the application area. Existing information reviewed is discussed in Section 3.6.3.

The exact locations of soil survey sites were finalised with consideration to land access constraints and site factors, particularly past disturbance, vegetation cover and infrastructure. These constraints meant that some sites initially identified were not available or suitable for surveying. For example, a pre-determined site visited during the field surveys and found to be at a disturbed area, such as within fill material along a road verge, would be unsuitable for sampling. In these inaccessible or unsuitable areas, the nearest available locations with similar landscape features were sampled and spatial co-ordinates recorded. Soil survey sites are shown in Figure 3.1.

Soil survey sites for a BSAL assessment fall into three categories:

- Exclusion sites - fail a readily apparent landscape requirement for BSAL, such as excessive slope, rock outcrop, surface rockiness or gilgai micro relief. Soil profile descriptions or survey are not necessary.
- Detailed sites - soil profiles are described in sufficient detail to allow all major physical and chemical soil features of relevance to BSAL verification to be clearly established.
- Check sites - examined in sufficient detail to enable categorisation according to a soil type and soil map unit.

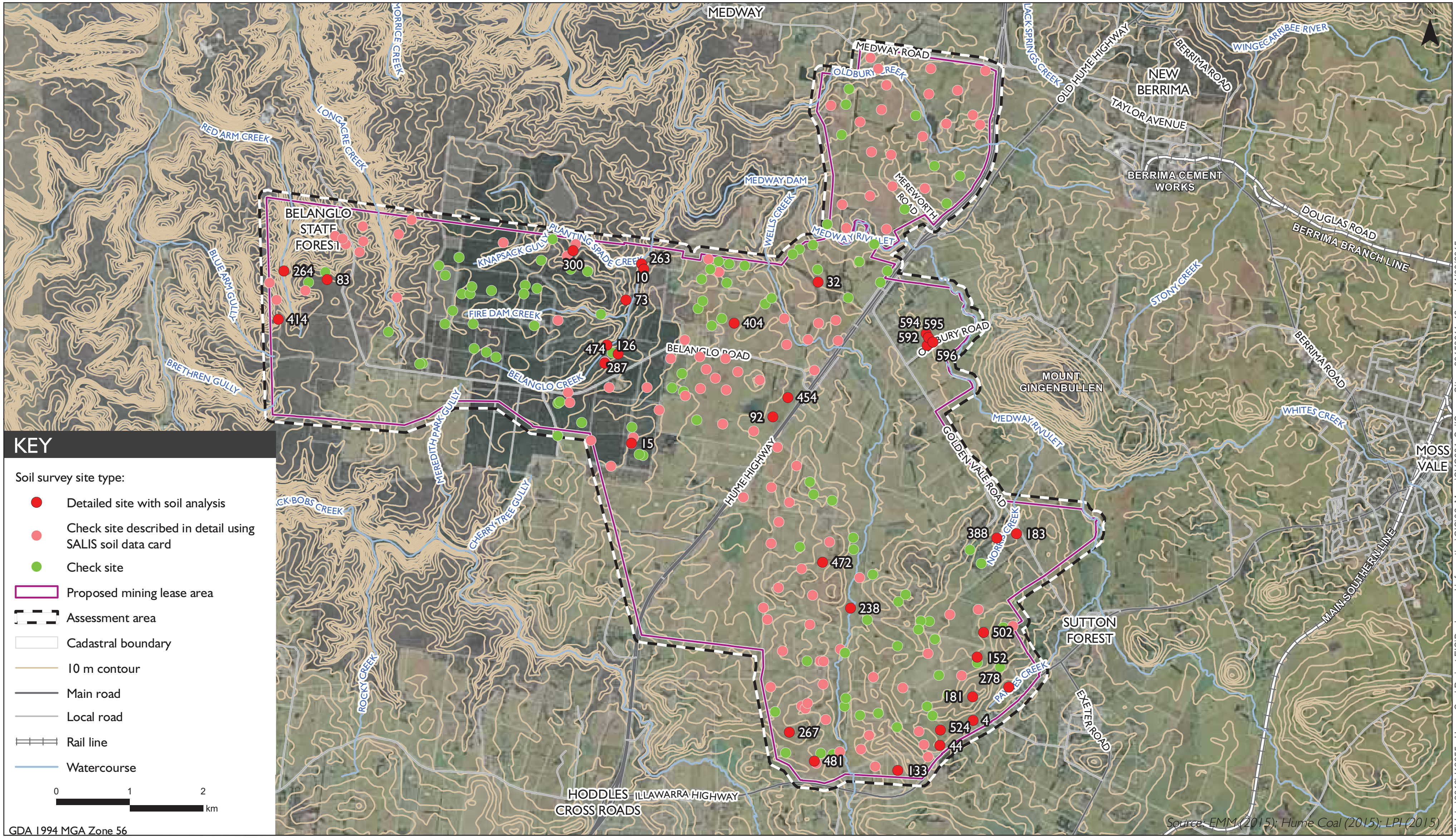
Guidance in the Interim Protocol and the National Committee on Soil and Terrain (NCST) (2009) *Australian Soil and Land Survey Field Handbook* (the Handbook) was followed in the site assessments. The Interim Protocol suggests that each soil type identified should be examined in detail and samples analysed from at least three sites from each of the soil types. For example, an assessment area with five soil types would require at least 15 detailed site soil analyses. The Handbook suggests:

- 10-30% of sites should be described in detail;
- 1-5% of the sites described in detail should be subject to soil analysis; and
- remaining sites should be used as check sites.

In this way, a total of 246 soil survey sites were assessed, comprising 141 described in detail using the SALIS detailed soil data card (of which 33 were subjected to laboratory analysis), and 105 used as check sites. This meant that all relevant guidance in the Handbook was achieved or exceeded, with 57% of the sites described in detail and 23% of these subject to analysis.

Applying the definitions from the Interim Protocol, the 33 sites subjected to laboratory analysis were also classified as detailed sites for the purpose of BSAL assessment, with the remainder check sites. Samples from a minimum of three sites from each of the five soil types identified were submitted for laboratory analysis (refer to Table 3.5), which meets the Interim Protocol requirement. Detailed descriptions of each of these soil types are provided in Chapter 4.

For the purpose of BSAL verification, a site was defined as occurring within a 10-20 m radius of the point of observation of the soil profile. Soil profile data were recorded in the field on SALIS data cards. Photographic records of detailed sites and their soil profiles were taken in the field using a digital camera and are presented in Chapter 4 and Appendix C.



Soil survey sites

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Biophysical strategic agricultural land verification assessment

Figure 3.1

3.6.3 Review of available mapping

The soil survey sites were initially planned based on a review of Australian Soil Resource Information System (ASRIS) regional soil maps, geology maps and topographic maps. Regional soil mapping and information from the NSW Government's online soil mapping database eSPADE, released in 2014, was also reviewed.

i ASRIS mapping

The ASRIS mapping indicated that seven soil types were present in the application area, with Kurosols and Tenosols dominant. The agricultural potential of the mapped soils was also referenced. Soils across 89% of the assessment area were classified as having very low agricultural potential. The regional scale map is shown in Figure 3.2 and Table 3.2 summarises the soil types and coverage mapped within the assessment area, along with their respective agricultural potentials.

Table 3.2 Summary of regional soil mapping by ASRIS: SVC application area plus 100 m buffer

Soil type	Area (ha)[1]	Agricultural potential[2]
Chromosol	2	Moderate agricultural potential with moderate chemical fertility and water-holding capacity.
Dermosol	49	High with good structure and moderate to high chemical fertility and water-holding capacity with few problems.
Ferrosol	409	Generally high because of their good structure and moderate to high chemical fertility and water-holding capacity.
Hydrosol	21	Very low due to seasonal or permanent saturation.
Kandosol	160	Low to moderate with low to moderate chemical fertility and water-holding capacity.
Kurosol	3,027	Very low with high acidity (pH < 5.5), low chemical fertility, low water-holding capacity and often sodic.
Tenosol	1,823	Very low with low chemical fertility, poor structure and low water-holding capacity.

Notes: *1. Totals not exact due to rounding.*
2. Based on Gray and Murphy (2002).

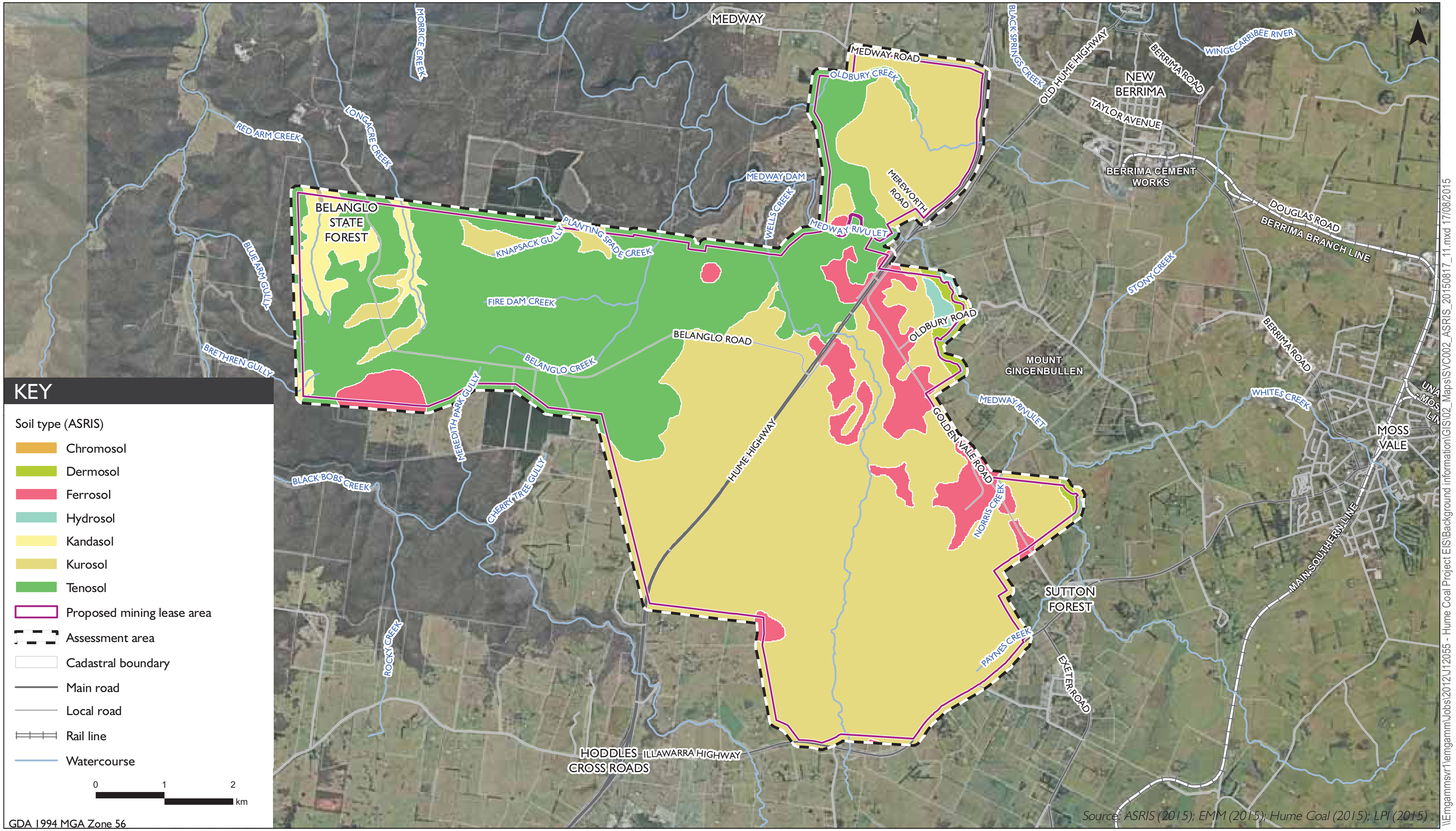
ii eSPADE mapping

The eSPADE (OEH 2014) regional soil mapping showed six ASC orders within the assessment area with one suborder also mapped. The mapping indicated that Dermosols and Kurosols were dominant. Figure 3.3 shows the regional scale soil mapping and Table 3.3 summarises the ASC soil orders and coverage within the assessment area. Table 3.3 also shows the inherent soil fertility for each ASC order, as indicated by the eSPADE regional soil mapping portal. This information suggests that soils across 49% of the assessment area were classified as having low to moderately low soil fertility and a further 49% as having moderate soil fertility.

Table 3.3 Summary of regional soil mapping by eSPADE: SVC application area plus 100 m buffer

eSPADE ASC soil type	Area (ha)[1]	eSPADE inherent soil fertility
Dermosol	2,629	Moderate
Ferrosol	89	Moderately high
Hydrosol	68	Moderate
Kurosol	2,042	Moderately low
Kurosol, Natric	2	Moderately low
Rudosol	160	Low
Rudosol and Tenosol	500	Low

Note: *1. Totals not exact due to rounding.*



EMM
HUMECOAL

Australian Soil Resource Information System map of soils

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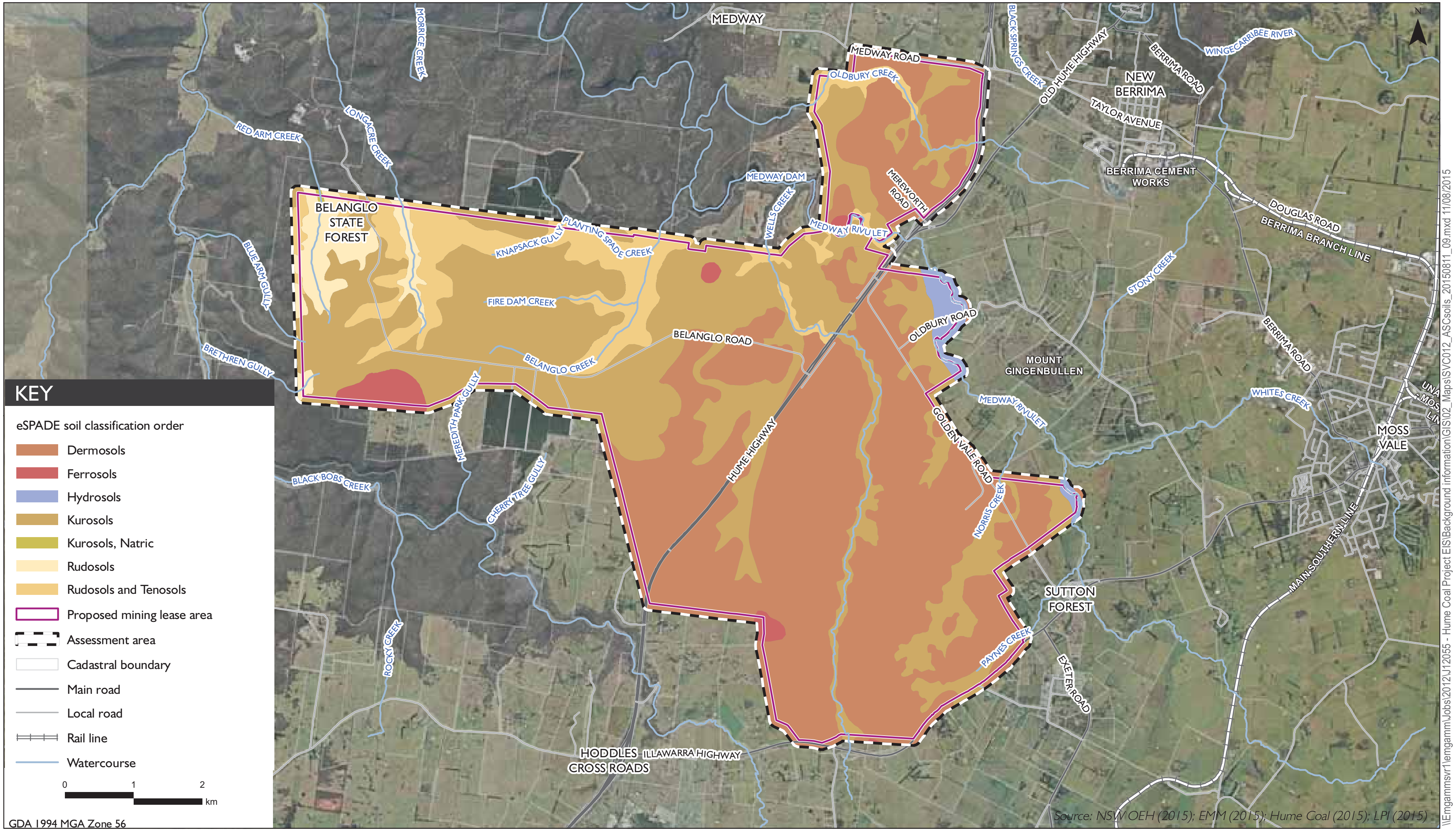
Figure 3.2



EMM
HUMECOAL

eSPADE map of soils

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Figure 3.3

iii Geology mapping

A review of geological mapping was done to differentiate between potential landscapes in the application area. The Moss Vale 1:100,000 Geological Sheet (Trigg and Campbell 2009) extract in Figure 3.4 shows Hawkesbury Sandstone to be dominant on the western side of the application area. The majority of the central and eastern parts of the application area are shown to be covered by unconsolidated clayey sands and weakly consolidated sandy clays, interspersed with Bringelly Shale, quaternary alluvial sand and silt, Ashfield Shale, alkaline olivine basalt and conglomerate.

During the field surveys, observations of surface geology were made. Geology is an important determinant of soil characteristics and a strong relationship between the two has been identified within the SVC application area. Table 3.4 summarises soil types most commonly identified in association with each of the observed geological formations in the application area.

Table 3.4 Soil and geology relationships within the application area

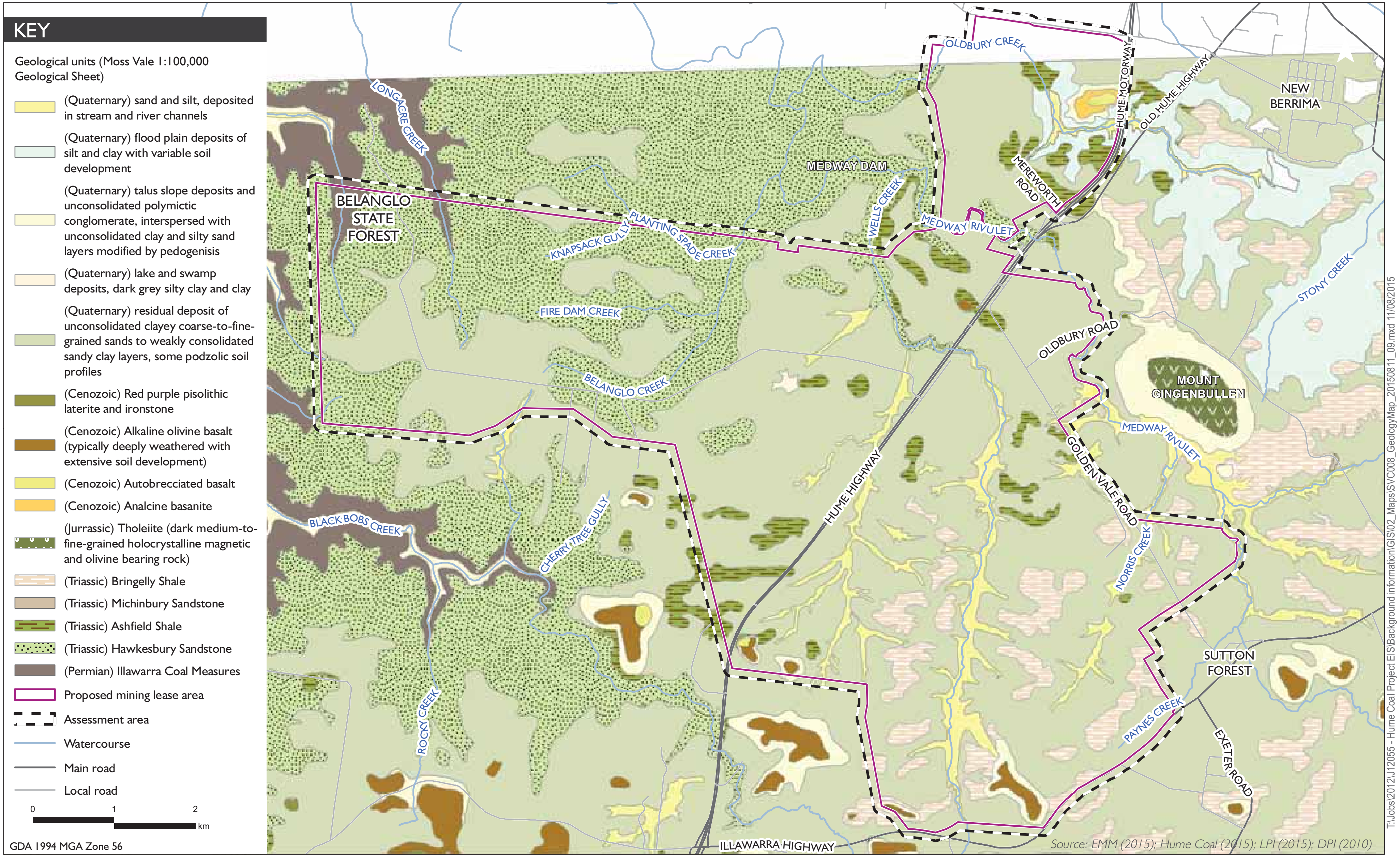
Mapped geology (Moss Vale 1:100,000 Geological Sheet)	Surface geology (observed in the field)	Common soil types
Hawkesbury Sandstone	Sandstone parent material	Paralithic Leptic Tenosol and Lithic Leptic Rudosol
Quaternary clayey sands-sandy clays, alkaline olivine basalt, Bringelly Shale and Ashfield Shale	Shale parent material	Dystrophic Yellow Kandosol
Quaternary alluvial sand and silt	Alluvium	Kandosolic Redoxic Hydrosol
Alkaline olivine basalt and Bringelly Shale	Basalt parent material	Eutrophic Grey Dermosol

iv Slope and elevation mapping

A review of slope and elevation maps was done to differentiate between potential landscapes in the application area. The elevation map in Figure 3.5 shows that the majority of the central and eastern parts of the application area have very low rolling hills with occasional elevated ridge lines. There are steeper slopes in the west of the application area, in Belanglo State Forest, associated with steeply incised valleys, gorges and drainage lines.

The slope map in Figure 3.6 shows that the majority of the application area has slopes of 10% or less. However, there are steeper slopes associated with the deeply incised drainage lines in the west of the application area and the elevated ridge lines through the central and eastern parts of the application area. This slope data has been taken into account in BSAL verification (refer to Chapter 5, Figure 5.1 and Appendix G).

The soil descriptions in Chapter 4 reference the different landforms where each of the identified soil types typically occur.



EMM
HUMECOAL

Geology map

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Figure 3.4

EMM
HUMECOAL

Elevation map

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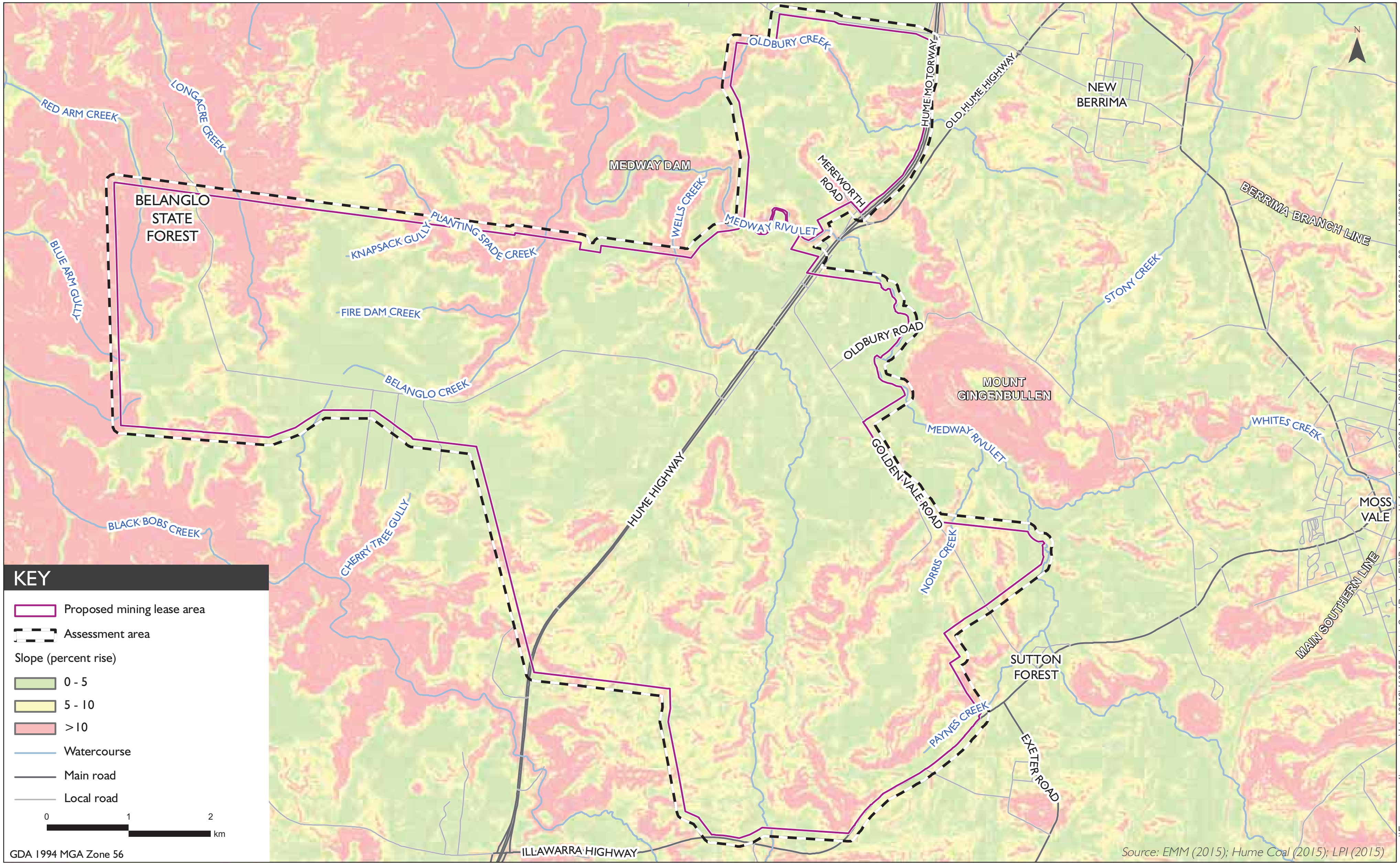
Figure 3.5



EMM

HUMECOAL

Slope map

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Figure 3.6

3.6.4 Soils analysis

Analysis of soil samples from each of the 33 sites identified in Table 3.5 was undertaken at a 'suitable laboratory', as described in the Interim Protocol, to determine physical and chemical characteristics. Samples were taken from various depths at each site, so as to characterise properties throughout the soil profiles. Evidence of the laboratory's accreditation is presented in Appendix D.

The physical and chemical analyses of samples were based on measurements described in the NSW Department of Primary Industries (2014) *Agricultural Impact Statement technical notes: A companion to the Agricultural Impact Statement guideline*.

The physical properties measured were:

- dispersion;
- soil texture;
- particle size analysis of particles less than 2 mm;
- gravel content; and
- other specified significant soil characteristics where these occurred.

The chemical properties measured were:

- organic carbon;
- pH_{water};
- total and available nitrogen;
- available phosphorus;
- exchangeable potassium;
- cation exchange capacity;
- exchangeable sodium;
- exchangeable calcium;
- exchangeable potassium;
- exchangeable magnesium;
- exchangeable aluminium;
- soluble cations; and
- electrical conductivity.

On occasion, pH and electrical conductivity were measured in the field at detailed soil survey sites, using accepted methods described in the Handbook. The results were recorded on the SALIS soil data cards.

A summary of the number of soil samples analysed from each soil type found in the application area is presented in Table 3.5. The locations of detailed sites subjected to laboratory analysis are shown in Figure 3.1 Laboratory results are presented in Appendix E.

Table 3.5 Soil analysis sites

Soil type	Number of sites subjected to laboratory analysis	Site numbers	Horizons analysed
Dystrophic Yellow Kandosol	15	15, 32, 44, 133, 183, 267, 388, 404, 472, 481, 502, 592, 594, 595, 596	72
Paralithic Leptic Tenosol	6	73, 83, 126, 263, 287, 300	29
Kandosolic Redoxic Hydrosol	6	4, 10, 92, 238, 454, 524	28
Lithic Leptic Rudosol	3	264, 414, 474	7
Eutrophic Grey Dermosol	3	152, 181, 278	14

4 Soil descriptions

4.1 Overview

4.1.1 Results summary

The soil surveys identified five dominant soil types. The mapped distribution of soil types in the SVC application area and 100 m buffer zone is summarised in Table 4.1 and shown in Figure 4.1. The dominant soil type is Dystrophic Yellow Kandosol, found across approximately 60% of the area. Descriptions of each soil type identified are provided in this chapter.

The soil types identified below were keyed out to Great Group level in accordance with *The Australian Soil Classification* (Isbell 1996). Soil types were validated using *The Australian Soil Classification - An Interactive Key* (Jacquier, McKenzie and Brown 2000). It is important to note that, as stated in the Interim Protocol:

> all soil map units will have some variation. The dominant soil type upon which BSAL status is determined should comprise greater than 70 per cent of a soil map unit.

Some variability in soil properties does occur within each of the mapped soil units. However, consistent with requirements of the Interim Protocol, each soil map unit is comprised of greater than 70% of the dominant soil type.

Table 4.1 Soil map unit distribution: SVC application area plus 100 m buffer

Soil type	Area (ha)	Distribution (%)
Dystrophic Yellow Kandosol	3,308	60
Paralithic Leptic Tenosol	800	15
Kandosolic Redoxic Hydrosol	266	5
Lithic Leptic Rudosol	941	17
Eutrophic Grey Dermosol	179	3

4.1.2 Comparison with soil mapping by others

There are some broad similarities between the ASRIS and eSPADE soil mapping (outlined in Sections 3.6.3i and ii), and the field-based soil survey results from this assessment, in terms of soil orders present and general patterns of distribution. However, comparison of Figures 3.2, 3.3 and 4.1 shows that the three soil maps differ. The results are summarised below.

Western part of the application area:

- ASRIS mapping: dominated by Tenosols, with smaller areas of Kandosols, Kurosols and Ferrosols;
- eSPADE mapping: dominated by Kurosols with some Rudosols and Tenosols and minor areas of Ferrosols in similar locations to those predicted by ASRIS; and
- EMM soil survey: dominated by Rudosols and Tenosols, with Kandosols in the south.

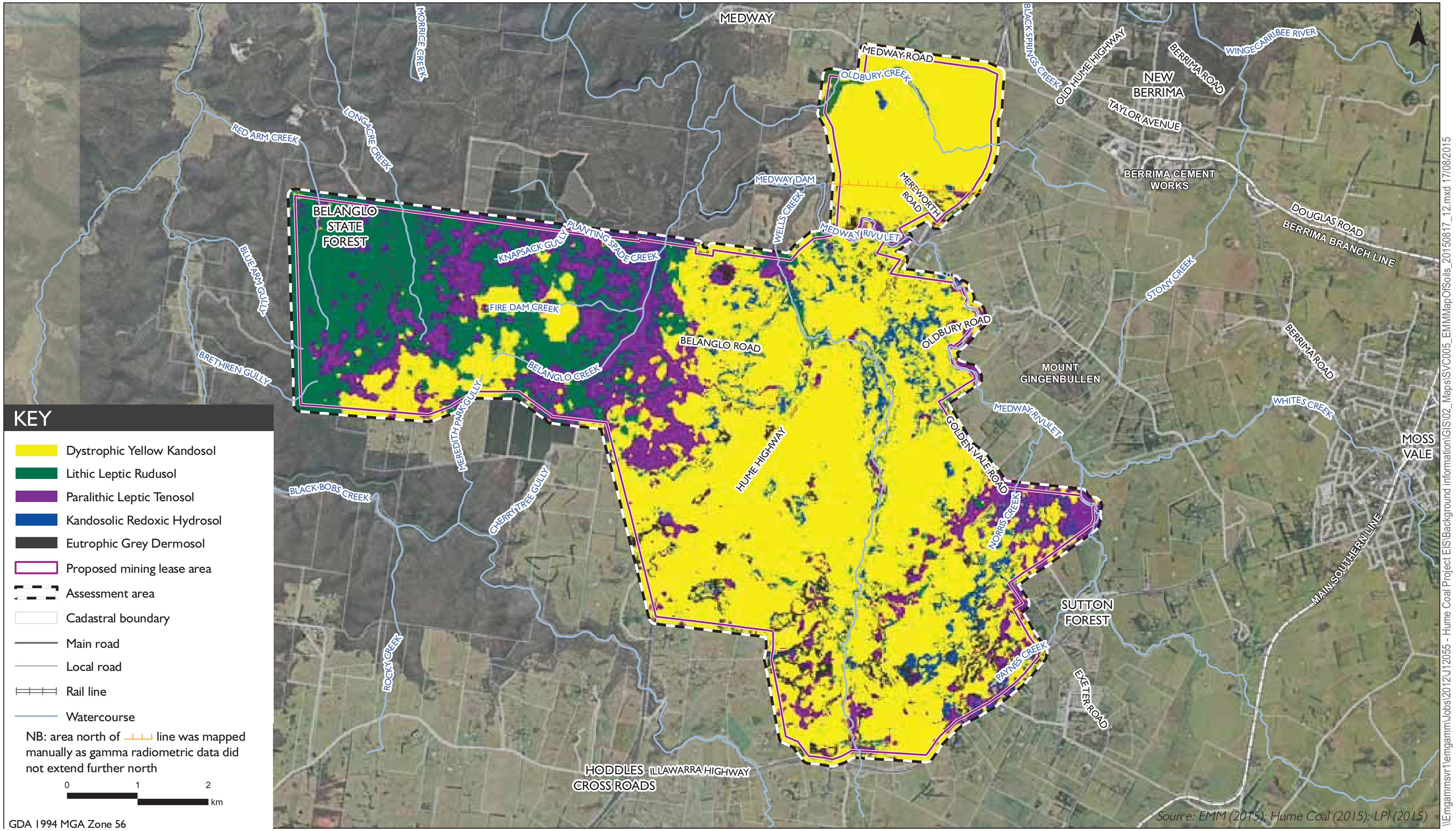
Eastern and central parts of the application area:

- ASRIS mapping: dominated by Kurosols, with some Tenosols and Ferrosols and a small area of Hydrosols and Dermosols in the north-east;
- eSPADE mapping: dominated by Dermosols, with some Kurosols and a small area of Hydrosols in the north-east; and
- EMM soil survey: dominated by Kandosols with smaller areas of Hydrosols, Tenosols and Dermosols.

The eSPADE mapping did not identify any Kandosols within the application area, while the ASRIS mapping did not identify any Rudosols. Field investigations found these to be the two dominant soil types occurring throughout the application area. Kurosols, which were dominant in both the ASRIS and eSPADE mapping, were not identified in the field, nor were Ferrosols.

Given the differences in information from the above-listed sources, and difficulty in verifying the methods or results of studies by others, the ASRIS and eSPADE data was not used further in this assessment. The assessments and soil mapping within this report have been based on results of field surveys and laboratory analyses from the current study, which were conducted in accordance with the Interim Protocol, and remotely-sensed datasets. In particular, the field and laboratory investigations for this study provided information which confirmed the presence or absence of various soil orders, including the following:

- Kurosols: none identified - field surveys did not identify any soils with consistent indication of strong texture contrast, in line with the definition provided by Isbell (1996);
- Ferrosols: none identified - laboratory testing (Method 13C1 in Rayment and Higginson 1992) did not identify any soils with free iron oxide contents greater than 5%; and
- Dermosols: small areas of Dermosols were identified in the central and eastern parts of the application area associated with isolated basalt intrusions or flow remnants. However, the majority of sites sampled in this region (shown to be dominated by Dermosols in the eSPADE mapping) did not have any consistent indication of structured B horizons, as defined by NCST (2009). Instead they displayed massive B horizons.



EMM map of soils

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Figure 4.1

4.2 Dystrophic Yellow Kandosol

This soil unit occurs on slopes and crests of low rolling hills on shale surface geology. Soils are lacking strong texture contrast, with silty clay loams over light clays transitioning to medium clays at depth.

The soil surface is mostly firm when dry and without coarse fragments. Topsoils have few coarse fragments and are without mottling. Subsoils have few coarse fragments, massive structure and are imperfectly drained. A test pit was dug at a previously sampled detailed site (Site 481) and confirmed the massive structure. There are no strong texture contrasts. Mottling abundance is common. Mottle colour is typically orange or red. The Dystrophic Yellow Kandosol can be strongly acidic and is most commonly non-saline and non-sodic.

Two variations were noted, a shallow phase variation (around 10% of total occurrences) and a variation with a red hue in the upper B2 horizon (around 10% of total occurrences). The shallow phase variation typically exists on steep slopes or hillcrests. The second variation exists on spurs and ridge lines. Laboratory testing using a citrate-dithionite extractable iron procedure confirmed that the percentage of free iron oxide is less than 5% and so the red variation is not a Ferrosol.

Land within the application area that is characterised by this soil type is extensively cleared and primarily used for grazing of improved pastures and to a lesser extent pine forestry.

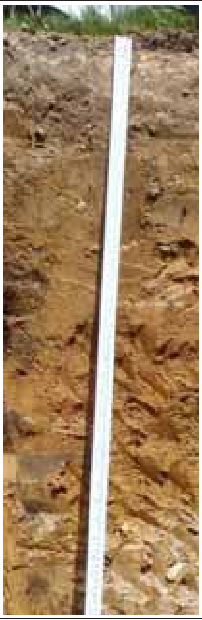
The Dystrophic Yellow Kandosol is more common across the eastern and central parts of the SVC application area where shale surface geology and low rolling hills are common. It occurs less regularly within the Belanglo State Forest due to the increased presence of sandstone surface geology.

A soil profile description for a typical Dystrophic Yellow Kandosol is provided in Table 4.2. It is noted that the laboratory pH values presented in Table 4.2 are median values.

Soil chemistry results for the Dystrophic Yellow Kandosol are presented in Table 4.3. The results presented are the median value for each horizon from the 15 sampled locations (refer to Table 3.5), with the lowest and highest recorded values also provided in brackets. Appendix E presents individual soil chemistry results for each of the 15 sampled locations. The soil chemistry constituent values highlighted in the 'soil sufficiency' column in Table 4.3 are agricultural industry benchmarks (Baker and Eldershaw 1993; Department of the Environment and Resource Management (DERM) 2011; Peverill, Sparrow and Reuter 1999) and have been referenced in interpreting the laboratory results. The outcomes are presented in the comments column of Table 4.3. The comments are in reference to the median values with increasing depth.

Table 4.4 summarises soil chemistry for the Dystrophic Yellow Kandosol and comments on whether there are restrictions to agriculture. Note that Table 4.4 includes a comparison of inherent soil fertility (NSW Government 2013) to measured field results by applying Murphy et al. (2007). This is particularly useful because the comparison justifies the inherent soil fertility ranking in instances where the Interim Protocol assigns the soil order more than one ranking.

Table 4.2 Dystrophic Yellow Kandosol typical soil profile summary

ASC:	Horizon name and depth (average) (m)	Colour, mottles and bleach	Moisture, laboratory pH (median value) and drainage	Texture and structure	Coarse fragments, segregations and roots
	A1 0-0.19	Dark greyish brown, 10YR4/2 and no mottles or bleaching.	Moderately moist, pH 5.2 and well drained.	Silty loam and sub-angular blocky or massive.	No surface rock, few coarse fragments, no segregations and many roots.
	A2 0.19-0.36 (Sometimes A2e)	Pale brown, 10YR6/3 and no mottles or bleaching.	Moderately moist, pH 6.1 and well drained.	Clay loam sandy and sub-angular blocky or massive.	Few coarse fragments, no segregations and common roots.
	B21 0.36-0.53	Brownish yellow, 10YR6/8, common orange or red mottles and no bleaching.	Moist, pH 4.3 and imperfectly drained.	Light clay and massive.	Common coarse fragments, no segregations and few roots.
	B21 0.53-0.76	Brownish yellow, 10YR6/8, common to many orange or red mottles and no bleaching.	Moist to wet, pH 4.3 and imperfectly to poorly drained.	Medium clay and massive.	Common coarse fragments, no segregations and few to no roots.

Note: 1. Description in accordance with the Australian Soil and Land Survey Field Handbook (NCST 2009).

Table 4.3 Dystrophic Yellow Kandosol soil chemistry results – median values (and ranges)

Constituents	Unit	Soil sufficiency[1]	A1 0-0.19	A2 0.19-0.36	B21 0.36-0.53	B22 0.53-0.76	Comments on median values (in increasing depth)
pH_{water}	pH units	6.0-7.5	5.2 (3.8-6.2)	6.1 (4.3-6.5)	4.3 (3.8-7.1)	4.3 (4.0-7.2)	Strong (top of A horizon) to extreme acidity (B horizon).
Electrical conductivity – saturated extract (EC_{se})	dS/m	<1.9	0.49 (0.16-4.63)	0.26 (0.23-0.66)	0.19 (0.09-1.17)	0.13 (0.07-1.51)	Very low soil salinity.
Chloride (Cl^-)	mg/kg	<800	30 (20-50)	50 (50-50)	20 (10-140)	105 (30-200)	Not restrictive.
Plant available water capacity (PAWC)	mm	>80	11.4 (L-ZCL)	13.6 (ZL-ZCL)	17.0 (LC-LMC)	27.6 (LMC-HC)	Small (total of 69.6).
Macronutrients							
Nitrite + Nitrate as N (Sol.)	mg/kg	>15	19.6 (0.1-333)	13.7 (12.9-14.5)	2.8 (0.1-12.2)	2.1 (0.8-6.8)	Moderate (top of A horizon) to very low (with depth).
Total Nitrogen as N	mg/kg	>1500	1485 (520-2680)	520 (390-940)	410 (200-960)	380 (110-530)	Deficient.
Phosphorous (P) (Colwell)	mg/kg	>10	3 (<2-46)	<2 (<2-5)	<2 (<2-24)	<2 (<2-26)	Very low (except in the A1 horizon).

Table 4.3 Dystrophic Yellow Kandosol soil chemistry results – median values (and ranges)

Constituents	Unit	Soil sufficiency[1]	A1 0-0.19	A2 0.19-0.36	B21 0.36-0.53	B22 0.53-0.76	Comments on median values (in increasing depth)
Potassium (K) (Acid Extract)	mg/kg	>117	<100 (<100-300)	<100 (<100-<100)	<100 (<100-<100)	<100 (<100-200)	Insufficient.
K (Total)	mg/kg	>150	275 (200-790)	260 (220-320)	390 (140-610)	420 (170-830)	High (A horizon) to very high (B horizon).
Micronutrients							
Copper (Cu)	mg/kg	>0.3	<1.0 (<1.0-<1.0)	<1.0 (<1.0-<1.0)	<1.0 (<1.0-<1.0)	<1.0 (<1.0-<1.0)	Low (inconclusive).
Zinc (Zn)	mg/kg	>0.5 (pH<7) >0.8 (pH>7)	<1.0 (<1.0-8.1)	<1.0 (<1.0-<0.1)	<1.0 (<1.0-2.9)	<1.0 (<1.0-2.0)	Low (inconclusive).
Manganese (Mn)	mg/kg	>2	47.0 (<1.0-74)	21.0 (<1.0-44)	<1.0 (<1.0-14)	<1.0 (<1.0-9)	Moderate (A horizon) to very low (B horizon).
Boron (B)	mg/kg	>1	0.95 (<0.2-1.6)	0.50 (<0.2-0.7)	0.50 (<0.2-3.3)	0.50 (<0.2-1.7)	Low (A1 horizon) to very low (A2 and B horizons).
Cation Exchange Capacity (CEC)	meq/ 100g	12-25	3.8 (0.6-11.8)	2.1 (1.4-3.5)	0.8 (0.1-3.9)	0.3 (0.04-4.3)	Very low.
Calcium (Ca)	meq/ 100g	>5	2.9 (0.3-8.4)	1.7 (0.7-4.7)	1.1 (<0.1-4.4)	1.0 (0.2-5.5)	Low (A horizon) to very low (B horizon).
Magnesium (Mg)	meq/ 100g	>1	0.8 (0.3-3.5)	0.8 (0.2-3.3)	0.7 (0.4-5.9)	1.6 (0.6-7.7)	Low (A and B1 horizons) to moderate.
Sodium (Na)	meq/ 100g	<0.7	<0.1 (<0.1-0.2)	<0.1 (<0.1-0.2)	<0.1 (<0.1-0.3)	<0.1 (<0.1-0.4)	Very low.
K	meq/ 100g	>0.3	0.3 (<0.1-1.2)	<0.1 (<0.1-0.1)	<0.1 (<0.1-0.2)	<0.1 (<0.1-0.4)	Low (A1 horizon) to very low (A2 and B horizons).
Exchangeable sodium percentage (ESP)	%	<6	<2.70* (1.7-16.7)	<3.90* (2.41-11.1)	4.35 (2.8-16.7)	3.60 (2.8-11.1)	Non-sodic.
Ca:Mg ratio		>2	3.40 (1.0-6)	2.10 (1.4-3.5)	0.83 (0.1-3.9)	0.30 (0.04-4.3)	Stable A horizon. Unstable B horizon.
Organic Carbon	%	>1.2	2.0 (<0.5-4.1)	<0.5 (<0.5-2.2)	<0.5 (<0.5-1.8)	<0.5 (<0.5-1.8)	Moderate (A1 horizon) to very low (A2 and B horizons).

Notes: 1. Plant sufficiency sources: Baker and Eldershaw (1993), DERM (2011) and Peverill, Sparrow and Reuter (1999).

2. Values in brackets are the ranges measured.

* These values are an approximation based on calculations using the lowest measurable level.

Table 4.4 Dystrophic Yellow Kandosol soil chemistry summary

Elements	Comments
pH_{water}	Strongly acid at the surface, progressing to extremely acidic with depth. Outside of the desirable range for agriculture throughout most of the profile. Would restrict agriculture.
EC	Very low salinity levels that would not restrict agriculture.
Cl	Acceptable chloride levels that would not restrict agriculture.
PAWC	At the upper limit of a small PAWC, which would restrict agriculture.
Fertility	
Macronutrients	Mostly low levels of macronutrients, which present fertility issues. Would restrict agriculture.
Micronutrients	Mostly low to very low levels of micronutrients, which present fertility issues. Would restrict agriculture.
CEC	Very low CEC, which may present some fertility issues.
Fertility ranking	Relative Fertility of ASC Classes (NSW Government 2013):
	Moderately low - Kandosols (order), Any (sub-order), Dystrophic (Great Group)
	EMM applied Relative Fertility of ASC Classes (lab and field data applied to Murphy et al. 2007):
	Moderately low (Group 2)
	Explanation (Murphy et al. 2007):
	Low fertilities that generally only support plants suited to grazing. Generally deficient in nitrogen, phosphorus and many other elements.
ESP	Low ESP indicating a non-sodic soil, which would not restrict agriculture.
Ca:Mg ratio	A mostly stable Ca:Mg ratio in the topsoil, but decreasing with depth to levels that suggest strong soil instability.
Organic Carbon	Indicative of good structural condition and structural stability in the A1 horizon. Low levels below this horizon.
Major limitations to agriculture	PAWC
	Macronutrients (eg nitrate, total nitrogen, phosphorus, potassium extract)
	Micronutrients (eg boron, calcium, magnesium, sodium, potassium)

4.3 Paralithic Leptic Tenosol

This soil unit occurs on rises and low hills on the Hawkesbury Sandstone formation (sandstone-quartz). Soils are weakly developed with a slight increase in clay content and lightening of soil colour with depth.

Typically the A1 horizon is sandy and the A2 horizon is a sandy loam. The soil surface is without coarse fragments and of loose condition. Paralithic Leptic Tenosols have few coarse fragments, which are spread evenly throughout the profile. Subsoils typically have few orange mottles with no segregations. Paralithic Leptic Tenosols are typically extremely acidic, highly permeable, rapidly drained and non-saline.

Within the application area, land use on this soil type is typically for native and pine forestry, with low intensity grazing in some locations.

Paralithic Leptic Tenosols are associated with low gradient slopes on sandstone surface geology and less commonly on depositional foot slopes on shale geology. Their location is independent of elevation, with Tenosols just as likely to be present on low gradient hilltops as in stable low lying areas. Within the SVC application area, they are most commonly found within and immediately surrounding the Belanglo State Forest. A transitional Tenosol (grading to a Kandosol) was recorded on an isolated sandstone outcrop to the east of Belanglo State Forest.

A soil profile description for a typical Paralithic Leptic Tenosol is presented in Table 4.5. Generally the Tenosol sites were underlain by a hard material, usually weathered rock, which varied in depth between sites from <500 mm to approximately 750 mm. It is noted that the laboratory pH values presented in Table 4.5 are median values.

Soil chemistry results for the Paralithic Leptic Tenosol are presented in Table 4.6. The results presented are the median value for each horizon from six sampled locations (refer to Table 3.5), with the lowest and highest recorded values also provided in brackets. Appendix E presents individual soil chemistry results for each of the six sampled locations. The soil chemistry constituent values highlighted in the 'soil sufficiency' column in Table 4.6 are agricultural industry benchmarks (Baker and Eldershaw 1993, DERM 2011 and Peverill, Sparrow and Reuter 1999) and have been referenced in interpreting the laboratory results. The outcomes are presented in the comments column of Table 4.6. The comments are in reference to the median values with increasing depth.

Table 4.7 summarises soil chemistry for the Paralithic Leptic Tenosol and comments on whether there are restrictions to agriculture. Note that Table 4.7 includes a comparison of inherent soil fertility ranking (NSW Government 2013) to field constituent results by applying Murphy et al. (2007). This is particularly useful because the comparison justifies the inherent soil fertility ranking in instances where the Interim Protocol assigns the soil order more than one ranking.

It is noted that using Isbell (2002), the subgroup would be Brown-Orthic rather than Leptic. This difference would not affect interpretation of the soil's characteristics or the BSAL assessment outcome.

Table 4.5 Paralithic Leptic Tenosol typical soil profile summary

ASC:	Horizon name and depth (average) (m)	Colour, mottles and bleach	Moisture, laboratory pH (median value) and drainage	Texture, structure and consistence	Coarse fragments, segregations and roots
	A11 0-0.12	Yellowish brownish, no mottles and no bleaching.	Dry, pH 4.6 and rapidly drained.	Clayey sand, granular and loose.	Few surface coarse fragments, few coarse fragments, no segregations and few roots.
	A12 0.12-0.31	Yellowish brownish, few orange mottles and no bleaching.	Dry, pH 4.4 and rapidly drained.	Clayey sand, granular and loose.	Few coarse fragments, no segregations and few roots.
	A21 0.31-0.53	Brownish yellow, few orange mottles and no bleaching.	Dry, pH 4.4 and rapidly drained.	Loamy sandy, granular and loose.	Few coarse fragments, no segregations and no roots.
	A21 0.53-0.74	Pale yellow, few orange mottles and no bleaching.	Dry, pH 4.4 and rapidly drained.	Loamy sandy, granular and loose.	Few coarse fragments, no segregations and no roots.

Note: 1. Description in accordance with the Australian Soil and Land Survey Field Handbook (NCST 2009).

Table 4.6 Paralithic Leptic Tenosol soil chemistry results – median values (and ranges)

Constituents	Unit	Soil sufficiency[1]	A11 0-0.12	A12 0.12-0.31	A21 0.31-0.53	A22 0.53-0.74	Comments on median values (in increasing depth)
pH_{water}	pH units	6.0-7.5	4.6 (4.0-4.6)	4.4 (4.3-4.5)	4.4 (4.4-4.5)	4.4 (4.3-7.4)	Very strong (A11 horizon) to extreme acidity (below A11 horizon).
EC_{se}	dS/m	<1.9	1.17 (0.36-2.53)	0.39 (0.26-0.62)	0.26 (0.17-0.38)	0.17 (0.08-0.24)	Low (A11 horizon) to very low soil salinity (below A11 horizon).
Cl^-	mg/kg	<800	20 (20-50)	50 (30-110)	150 (50-880)	290 (50-1500)	Not restrictive.
PAWC	mm	>80	4.8 (S-ZL)	7.6 (LS-ZL)	8.8 (LS-CLS)	8.4 (LS-CLS)	Very small (total of 29.6).
Macronutrients							
Nitrite + Nitrate as N (Sol.)	mg/kg	>15	19.8 (0.4-87.1)	10.4 (1.4-13.0)	6.0 (1.2-9.9)	1.1 (0.6-2.8)	Moderate (A11 horizon) to very low (below A11 horizon).
Total Nitrogen as N	mg/kg	>1500	980 (270-2540)	550 (280-1150)	530 (280-740)	230 (140-320)	Deficient.
P (Colwell)	mg/kg	>10	11 (9-13)	3 (3-3)	2 (<2-2)	2 (<2-2)	Moderate (A11 horizon) to very low (below A11 horizon).
K (Acid Extract)	mg/kg	>117	<100 (<100-100)	<100 (<100-<100)	<100 (<100-<100)	<100 (<100-200)	Low (inconclusive).
K (Total)	mg/kg	>150	165 (60-310)	150 (80-160)	165 (80-240)	140 (80-280)	Moderate (A11 horizon) to low (generally below A11 horizon).
Micronutrients							
Cu	mg/kg	>0.3	<1.0 (<1.0-<1.0)	<1.0 (<1.0-<1.0)	<1.0 (<1.0-<1.0)	<1.0 (<1.0-<1.0)	Low (inconclusive).
Zn	mg/kg	>0.5 (pH<7) >0.8 (pH>7)	<1.0 (<1.0-8.1)	<1.0 (<1.0-<0.1)	<1.0 (<1.0-2.9)	<1.0 (<1.0-2.0)	Low (inconclusive).
Mn	mg/kg	>2	7.7 (<1.0-19.3)	<1.0 (<1.0-1.5)	<1.0 (<1.0-<1.0)	<1.0 (<1.0-<1.0)	Moderate (A11 horizon) to very low (below A11 horizon).
B	mg/kg	>1	1.6 (0.4-5.0)	0.5 (0.4-3.4)	0.5 (0.5-3.0)	0.5 (0.4-2.6)	Moderate (A11 horizon) to very low (below A11 horizon).
CEC	meq/100g	12-25	2.15 (1.2-4.0)	1.40 (1.1-2.3)	0.85 (0.6-2.3)	0.60 (0.1-1.3)	Very low.
Ca	meq/100g	>5	3.2 (2.2-5.7)	3.0 (0.2-3.6)	2.7 (0.3-10.7)	2.2 (0.2-12.8)	Low.
Mg	meq/100g	>1	3.1 (1.7-4.7)	3.2 (0.4-4)	3.8 (0.5-12.7)	4.8 (1-19.8)	Moderate.
Na	meq/100g	<0.7	0.5 (0.5-0.5)	0.5 (0.1-0.5)	0.4 (0.1-1.1)	0.6 (0.2-2.1)	Very low.

Table 4.6 Paralithic Leptic Tenosol soil chemistry results – median values (and ranges)

Constituents	Unit	Soil sufficiency[1]	A11 0-0.12	A12 0.12-0.31	A21 0.31-0.53	A22 0.53-0.74	Comments on median values (in increasing depth)
K	meq/ 100g	>0.3	0.3 (0.2-0.3)	0.1 (0.1-0.1)	0.1 (0.1-0.3)	0.1 (0.1-0.2)	Very low.
ESP	%	<6	<2.38* (1.54-4.46)	<6.81* (1.45-12.5)	<4.44* (3.08-16.70)	5.89* (3.33-16.42)	Generally non-sodic though sodic in A12 horizon.
Ca:Mg ratio		>2	1.21 (1.03-1.29)	0.85 (0.5-1.1)	0.56 (0.2-0.84)	0.47 (0.2-0.65)	Moderate (A11 horizon) to strongly unstable (below A11 horizon).
Organic Carbon	%	>1.2	3.1 (2.4-5.0)	1.4 (0.6-1.9)	1.0 (0.5-4.5)	0.95 (0.8-1.1)	High (A11 horizon) to low (A21 and A22 horizons).

Notes: 1. Sources: Baker and Eldershaw (1993), DERM (2011) and Peverill, Sparrow and Reuter (1999).
2. Values in brackets are the ranges measured.
** These values are an approximation based on calculations using the lowest measurable level.*

Table 4.7 Paralithic Leptic Tenosol soil chemistry summary

Elements	Comments
pH_{water}	Very strongly acid at the surface, progressing to extreme acidity with depth. Outside of the desirable range for agriculture throughout most of the profile. Would restrict agriculture.
EC	Low to very low soil salinity levels that would not restrict agriculture.
Cl	Acceptable chloride levels that would not restrict agriculture.
PAWC	At the upper limit of a small PAWC, which would restrict agriculture.
Fertility	
Macronutrients	Moderate to mostly low levels of macronutrients, which present fertility issues. Would restrict agriculture.
Micronutrients	Mostly low to very low levels of micronutrients, which present fertility issues. Would restrict agriculture.
CEC	Very low CEC, which may present some fertility issues.
Fertility ranking	Relative Fertility of ASC Classes (NSW Government 2013): Low - Tenosols (order), Leptic (sub-order), Any (Great Group) EMM applied Relative Fertility of ASC Classes (lab and field data applied to Murphy et al. 2007): Low (Group 1) Explanation (Murphy et al. 2007): Soils which, due to their poor physical and/or chemical status, only support limited agriculture. The maximum agricultural use of these soils is low intensity grazing. Include sandy soils which by virtue of their poor water retention characteristics, can only support limited agriculture.
ESP	ESP indicating a sodic soil. The low sodium levels for all samples analysed make it difficult to be conclusive in the topsoil.
Ca:Mg ratio	A moderate Ca:Mg ratio in the topsoil, but decreasing with depth to levels that suggest soil instability.
Organic Carbon	Indicative of good structural condition and structural stability in the A1 horizons. Low levels below this horizon.
Major limitations to agriculture	pH PAWC Macronutrients (eg nitrate, total nitrogen, phosphorus, potassium extract) Micronutrients (eg manganese, boron, calcium, magnesium, sodium, potassium)

4.4 Kandosolic Redoxic Hydrosol

The Kandosolic Redoxic Hydrosol occurs on raised or lower drainage depressions and valley flats. Soils are weakly to moderately developed with variable textures and colour grades depending on the localised site morphology.

A horizons are silty clay loam to light clay grading with depth towards medium to heavy clay B horizons. Surface condition is cracked and without coarse fragments and there are also no coarse fragments throughout the profile. Orange mottles may be present at depth. Subsoils typically have no segregations.

Kandosolic Redoxic Hydrosols have moderately low fertility, are strongly acidic, slowly permeable, poorly drained, sodic in the B horizon and moderately saline in the A horizon.

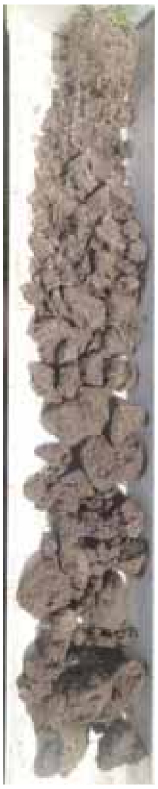
Within the application area, land use on this soil type is generally for improved and native pastures. Coverage of the Kandosolic Redoxic Hydrosol is limited to drainage depressions and associated floodplains that experience regular inundation. This soil unit is spread throughout the SVC application area and is directly associated with drainage lines and water bodies.

A soil profile description for a typical Kandosolic Redoxic Hydrosol is presented in Table 4.8. It is noted that the laboratory pH values presented in Table 4.8 are median values.

Soil chemistry results for the Kandosolic Redoxic Hydrosol are presented in Table 4.9. The results presented are the median value for each horizon from the six sampled locations (refer to Table 3.5), with the lowest and highest recorded values also provided in brackets. Appendix E presents individual soil chemistry results for each of the six sampled locations. The soil chemistry constituent values highlighted in the soil sufficiency column in Table 4.9 are agricultural industry benchmarks (Baker and Eldershaw 1993; DERM 2011; Peverill, Sparrow and Reuter 1999) and have been referenced in interpreting the laboratory results. The outcomes are presented in the comments column of Table 4.9. The comments are in reference to the median values with increasing depth.

Table 4.10 summarises soil chemistry for the Kandosolic Redoxic Hydrosol and comments on whether there are restrictions to agriculture. Note that Table 4.10 provides a comparison of inherent soil fertility ranking (NSW Government 2013) to field constituent results by applying Murphy et al. (2007). This is particularly useful because the comparison justifies the inherent soil fertility ranking in instances where the Interim Protocol assigns the soil order more than one ranking.

Table 4.8 Kandosolic Redoxic Hydrosol typical soil profile summary

ASC:	Horizon name and depth (average) (m)	Colour, mottles and bleach	Moisture, laboratory pH (median value) and drainage	Texture, structure and consistence	Coarse fragments, segregations and roots
	A11 0-0.18	Yellowish brown, no mottles and no bleaching.	Moderately moist, pH 4.5 and poorly drained.	Light clay, sub-angular blocky and moderately weak force.	No surface coarse fragments, no coarse fragments, no segregations and many roots.
	A12 0.18-0.33	Yellowish brown, few orange mottles and no bleaching.	Moist, pH 5.2 and poorly drained.	Light clay, sub-angular blocky and moderately weak force.	No coarse fragments, no segregations and few roots.
	B21 0.33-0.58	Very dark greyish brown, few orange mottles and no bleaching.	Wet, pH 5.0 and poorly drained.	Light-medium clay, massive and moderately weak force.	No coarse fragments, no segregations and few roots.
	B22 0.58-0.80+	Dark greyish brown, common orange mottles and no bleaching.	Moist, pH 4.9 and poorly drained.	Medium-heavy clay, massive and very firm force.	No coarse fragments, no segregations and few roots.

Note: 1. Description in accordance with the Australian Soil and Land Survey Field Handbook (NCST 2009).

Table 4.9 Kandosolic Redoxic Hydrosol soil chemistry results – median values (and ranges)

Constituents	Unit	Soil sufficiency[1]	A11 0-0.18	A12 0.18-0.33	B21 0.33-0.58	B22 0.58-0.80+	Comments on median values (in increasing depth)
pH_{water}	pH units	6.0-7.5	4.5 (3.7-5.2)	5.2 (3.8-5.2)	5.0 (4.0-5.1)	4.9 (4.3-6.5)	Extreme (A11 horizon) to very strong acidity (A12 horizon and below).
EC_{se}	dS/m	<1.9	1.39 (0.89-4.46)	0.20 (0.19-1.02)	0.32 (0.13-3.27)	0.37 (0.13-5.53)	Low soil salinity.
Cl^-	mg/kg	<800	20 (20-50)	50 (30-110)	150 (50-880)	290 (50-1500)	Not restrictive.
PAWC	mm	>80	18.0 (ZL-MC)	15.0 (LC-LMC)	30.0 (LC-HC)	26.4 (LC-HC)	Moderate (total of 89.4).
Macronutrients							
Total Nitrogen as N	mg/kg	>1500	2540 (2320-2900)	1295 (670-1760)	890 (440-2000)	745 (400-1320)	Sufficient (A11 horizon) to deficient (below A12 horizon)

Table 4.9 Kandosolic Redoxic Hydrosol soil chemistry results – median values (and ranges)

Constituents	Unit	Soil sufficiency[1]	A11 0-0.18	A12 0.18-0.33	B21 0.33-0.58	B22 0.58-0.80+	Comments on median values (in increasing depth)
P (Colwell)	mg/kg	>10	11 (9-13)	2 (<2-3)	2 (<2-2)	2 (<2-2)	Moderate (A11 horizon) to very low (A12 horizon and below).
K (Acid Extract)	mg/kg	>117	200 (100-200)	<100 (<100-<100)	<100 (<100-<100)	<100 (<100-100)	Moderate (A11 horizon) to low – insufficient (A12 horizon and below).
K (Total)	mg/kg	>150	490 (360-680)	380 (150-520)	450 (180-930)	455 (360-1040)	Very high.
Micronutrients							
Cu	mg/kg	>0.3	1.91 (<1-3.1)	1.78 (<1-2.5)	1.05 (<1-1.9)	1.10 (<1-1.8)	Moderate.
Zn	mg/kg	>0.5 (pH<7) >0.8 (pH>7)	2.3 (1.9-2.8)	<1.0 (<1.0-<0.1)	<1.0 (<1.0-1.1)	<1.0 (<1.0-<1.0)	High (A11 horizon) to low (inconclusive) (A12 horizon and below).
Mn	mg/kg	>2	39.5 (31.4-123.0)	93.8 (4.25-138.0)	<1.0 (<1.0-78.8)	<1.0 (<1.0-17.9)	High (A horizon) to very low (B horizon).
B	mg/kg	>1	1.40 (1.4-1.6)	0.75 (0.6-1)	0.80 (0.6-1.8)	0.75 (0.3-1.8)	Moderate (A11 horizon) to low (A12 horizon and below).
CEC	meq/ 100g	12-25	6.50 (4.2-11.2)	7.00 (0.8-7.6)	6.50 (0.7-24.8)	7.95 (1.6-34.9)	Low.
Ca	meq/ 100g	>5	3.20 (2.2-5.7)	3.00 (0.2-3.6)	2.75 (0.3-10.7)	2.20 (0.2-12.8)	Low.
Mg	meq/ 100g	>1	3.10 (1.7-4.7)	3.25 (0.4-4.0)	3.80 (0.5-12.7)	4.80 (1.0-19.8)	High.
Na	meq/ 100g	<0.7	<0.10 (<0.1-0.5)	0.30 (<0.1-0.5)	0.40 (0.1-1.1)	0.50 (<0.1-2.1)	Low to moderate.
K	meq/ 100g	>0.3	0.3 (0.2-0.3)	0.1 (<0.1-0.1)	0.1 (<0.1-0.3)	0.1 (<0.1-0.2)	Low to very low.
ESP	%	<6	2.40 (<1.5*-4.5)	6.81 (1.5-<12.5*)	4.40 (3.1-16.7)	5.90 (<3.3*-16.4)	Non-sodic to sodic.
Ca:Mg ratio		>2	1.2 (1.0-1.3)	0.9 (0.5-1.1)	0.6 (0.2-0.8)	0.5 (0.2-0.7)	Unstable to strongly unstable.
Organic Carbon	%	>1.2	3.1 (2.4-5.0)	1.4 (0.6-1.9)	1.0 (<0.5-4.5)	0.9 (<0.5-1.1)	Very high to low.

Notes: 1. Sources: Baker and Eldershaw (1993), DERM (2011) and Peverill, Sparrow and Reuter (1999).
2. Values in brackets are the ranges measured.
** These values are an approximation based on calculations using the lowest measurable level.*

Table 4.10 Kandosolic Redoxic Hydrosol soil chemistry summary

Elements	Comments
pH_{water}	Varying from extremely to very strongly acidic throughout the profile. Outside of the desirable range for agriculture. Would restrict agriculture.
EC	Moderate to low soil salinity levels that would not restrict agriculture.
Cl	Acceptable chloride levels that would not restrict agriculture.
PAWC	A moderate PAWC, which would not restrict agriculture.
Fertility	
Macronutrients	Very high to very low levels of nitrogen in the A horizons. Moderate to low levels of phosphorus and potassium extract in the A horizons. Mostly low levels of macronutrients in the B horizons. Would restrict agriculture.
Micronutrients	Variable levels of macronutrients in the A horizons, ranging from high to low depending on the parameter, and generally decreasing to moderate to very low levels in the B horizons. Would restrict agriculture.
CEC	Low CEC levels throughout the soil. Would restrict agriculture.
Fertility ranking	Relative Fertility of ASC Classes (NSW Government 2013): Moderately low - Hydrosol (order), Redoxic (sub-order), any but some Sulfuric (Great Group) EMM applied Relative Fertility of ASC Classes (lab and field data applied to Murphy et al. 2007): Moderately low (Group 2) Explanation (Murphy et al. 2007): Low fertilities that generally only support plants suited to grazing. Large inputs of fertiliser are required to make soil usable for arable purposes. Generally deficient in nitrogen, phosphorus and many other elements.
ESP	ESP indicating sodic soils. Would restrict agriculture.
Ca:Mg ratio	Unstable Ca:Mg ratio indicating soil instability.
Organic Carbon	Indicative of good structural condition and structural stability in the upper A horizon, but reducing with depth to low levels. Would not restrict agriculture.
Major limitations to agriculture	pH Macronutrients (eg phosphorus, potassium extract) Micronutrients (eg boron, calcium, potassium) Sodicity

4.5 Lithic Leptic Rudosol

The Lithic Leptic Rudosol is a shallow soil that occurs on the plateaus, scarps and benches of steep hills on Hawkesbury Sandstone (sandstone-quartz and shale). Slopes vary from very gently inclined on the plateaus to steeply inclined on scarps with an average gradient of around 17%.

Soils are shallow weakly developed sands (most commonly clayey sands) to a depth of approximately 0.18 m over weakly to highly weathered sandstone. The soil surface is loose with common surface coarse fragments and rock outcrops. Lithic Leptic Rudosols have few coarse fragments throughout, no mottling and are highly permeable and rapidly drained. These soils typically have low fertility, are strongly acidic, non-sodic and non-saline.

Within the application area, common land uses on this soil type are low intensity grazing on native pastures and forestry. Coverage of the Lithic Leptic Rudosols is limited to the steep slopes associated with sandstone surface geology most commonly found within Belanglo State Forest.

A soil profile description for a typical Lithic Leptic Rudosol is presented in Table 4.11. It is noted that the laboratory pH values presented in Table 4.11 are median values.

Soil chemistry results for the Lithic Leptic Rudosol are presented in Table 4.12. The results presented are the median value for each horizon from the three sampled locations (refer to Table 3.5), with the lowest and highest recorded values also provided in brackets. Appendix E presents individual soil chemistry results for each of the three sampled locations. The soil chemistry constituent values highlighted in the soil sufficiency column in Table 4.12 are agricultural industry benchmarks (Baker and Eldershaw 1993; DERM 2011; Peverill, Sparrow and Reuter 1999) and have been referenced in interpreting the laboratory results. The outcomes are presented in the comments column of Table 4.12. The comments are in reference to the median values with increasing depth.

Table 4.13 summarises soil chemistry for the Lithic Leptic Rudosol and comments on whether there are restrictions to agriculture. Note that Table 4.13 provides a comparison of inherent soil fertility ranking (NSW Government 2013) to field constituent results by applying Murphy et al. (2007). This is particularly useful because the comparison justifies the inherent soil fertility ranking in instances where the Interim Protocol assigns the soil order more than one ranking.

Table 4.11 Lithic Leptic Rudosol typical soil profile summary

ASC:	Horizon name and depth (m) (average)	Colour, mottles and bleach	Moisture, laboratory pH (median value) and drainage	Texture, structure and consistence	Coarse fragments, segregations and roots
	O 0-0.02	Very dark brown, no mottles and no bleaching.	Dry, pH 4.4, rapidly drained.	Loamy sand, crumb or granular and very weak force.	Surface coarse fragments of 10-20% stones and boulders, few coarse fragments, very high organic matter, no segregations and common roots.
	A11 0.02-0.09	Dark greyish brown, no mottles and no bleaching.	Dry, pH 4.6, rapidly drained.	Sandy loam, crumb or granular and very weak force.	Few coarse fragments, high organic matter, no segregations and common roots.
	A12 0.09-0.18	Dark greyish brown, no mottles and no bleaching.	Dry, pH 4.75, rapidly drained.	Sandy loam, crumb or granular and very weak force.	2-10% gravel, no segregations and common roots.
	R 0.18+	Parent material - Hawkesbury Sandstone			

Note: 1. Description in accordance with the Australian Soil and Land Survey Field Handbook (NCST 2009).

Table 4.12 Lithic Leptic Rudosol soil chemistry results – median values (and ranges)

Constituents	Unit	Soil sufficiency[1]	A11 0.02-0.09	A12 0.09-0.18	Comments on median values (in increasing depth)
pH_{water}	pH units	6.0-7.5	4.60 (4.4-5.8)	4.75 (4.2-5.3)	Very strong acidity.
EC_{se}	dS/m	<1.9	0.46 (0.21-0.46)	0.34 (0.24-0.44)	Very low soil salinity.
Cl^-	mg/kg	<800	30 (20-40)	30 (30-30)	Not restrictive.
PAWC	mm	>80	3.5 (CS-ZCL)	4.5 (CS-ZCL)	Very small (total of 8).
Macronutrients					
Nitrite + Nitrate as N (Sol.)	mg/kg	>15	0.20 (0.2-0.5)	0.35 (0.2-0.5)	Very low.

Table 4.12 Lithic Leptic Rudosol soil chemistry results – median values (and ranges)

Constituents	Unit	Soil sufficiency[1]	A11 0.02-0.09	A12 0.09-0.18	Comments on median values (in increasing depth)
Total Nitrogen as N	mg/kg	>1500	1270 (1270-2700)	1215 (750-1680)	Deficient.
P (Colwell)	mg/kg	>10	<2 (<2-6)	<2 (<2-5)	Very low.
K (Acid Extract)	mg/kg	>117	100 (<100-100)	<100 (<100-<100)	Insufficient - low.
K (Total)	mg/kg	>150	150 (130-180)	165 (120-210)	Moderate.
Micronutrients					
Cu	mg/kg	>0.3	<1.0 (<1.0-<1.0)	<1.0 (<1.0-<1.0)	Inconclusive.
Zn	mg/kg	>0.5 (pH<7) >0.8 (pH>7)	<1.0 (<1.00-3.19)	<1.0 (<1.0-<0.1)	Inconclusive.
Mn	mg/kg	>2	<1.00 (<1.0-14.6)	2.79 (<1.00-4.57)	Very low (A11 horizon) to moderate (A12 horizon).
B	mg/kg	>1	<1.0 (<1.00-3.19)	<1.0 (<1.0-<1.0)	Low.
CEC	meq/ 100g	12-25	0.70 (0.6-7.5)	3.05 (0.4-5.7)	Very low.
Ca	meq/ 100g	>5	0.20 (0.1-6.1)	2.40 (<0.1-4.7)	Very low (A11 horizon) to low (A12 horizon).
Mg	meq/ 100g	>1	0.20 (0.1-1.2)	0.45 (<0.1-0.8)	Very low (A11 horizon) to low (A12 horizon).
Na	meq/ 100g	<0.7	0.2 (<0.1-0.2)	<0.1 (<0.1-0.1)	Low (A11 horizon) to very low (A12 horizon).
K	meq/ 100g	>0.3	<0.1 (<0.1-0.2)	0.2 (<0.1-0.2)	Very low.
ESP	%	<6	0.33 (0.29-1.33*)	1.00* (0.25-1.75*)	Non-sodic.
Ca:Mg ratio		>2	1.00 (1.0-5.1)	3.44 (1.0-5.9)	Unstable (A11 horizon) to stable (A12 horizon).
Organic Carbon	%	>1.2	3.4 (2.9-7.0)	2.7 (1.8-3.9)	Very high.

Notes: 1. Sources: Baker and Eldershaw (1993), DERM (2011) and Peverill, Sparrow and Reuter (1999).

2. Values in brackets are the ranges measured.

** These values are an approximation based on calculations using the lowest measurable level.*

Table 4.13 Lithic Leptic Rudosol soil chemistry summary

Elements	Comments
pH_{water}	Very strongly acidic throughout the profile. Outside of the desirable range for agriculture throughout most of the profile. Would restrict agriculture.
EC	Very low soil salinity levels that would not restrict agriculture.
Cl	Acceptable chloride levels that would not restrict agriculture.
PAWC	A very small PAWC, which would restrict agriculture.
Fertility	
Macronutrients	Mostly low levels of macronutrients, which present fertility issues. Would restrict agriculture.
Micronutrients	Mostly low to very low levels of micronutrients, which present fertility issues. Would restrict agriculture.
CEC	Very low CEC, which may present some fertility issues.
Fertility ranking	Relative Fertility of ASC Classes (NSW Government 2013): Low - Rudosols (order), Leptic (sub-order), Any (Great Group) EMM applied Relative Fertility of ASC Classes (lab and field data applied to Murphy et al. 2007): Low (Group 1) Explanation (Murphy et al. 2007): Soils which, due to their poor physical and/or chemical status, only support limited agriculture. The maximum agricultural use of these soils is low intensity grazing. Include shallow and sandy soils which by virtue of their poor water retention characteristics can only support limited agriculture.
ESP	ESP indicating a non-sodic soil that would not restrict agriculture.
Ca:Mg ratio	Unstable Ca:Mg ratio in the topsoil, but increasing stability with depth to levels that suggest soil stability.
Organic Carbon	Indicative of good structural condition and structural stability. Very high levels throughout that would not restrict agriculture.
Major limitations to agriculture	pH PAWC Macronutrients (eg nitrate, total nitrogen, phosphorus, potassium extract) Micronutrients (eg manganese, boron, calcium, magnesium, sodium, potassium)

4.6 Eutrophic Grey Dermosol

Eutrophic Grey Dermosols occur on gently to moderately inclined rolling low hills to rolling hills on small, randomly distributed, isolated basalt intrusions. Soils are moderately to well developed (depending on landform element). The soil lacks strong texture contrast and has increasing clay content with depth.

A horizons are typically greyish brown silty loam over grey medium to heavy clay B horizons. The soil surface is mostly without coarse fragments and of firm to cracked condition. Eutrophic Grey Dermosols generally have few or no coarse fragments in the lower A and upper B horizons with coarse fragments more common in the lower B horizon. Subsoils commonly have red and orange mottling with no segregations.

Eutrophic Grey Dermosols are of moderately high fertility, moderately permeable, poorly drained and have moderate to low salinity. They have sodic B horizons and very strongly acidic A horizons.

Within the application area, land use on this soil type is for grazing of native and improved pastures. Grey Dermosols appear to be limited to the small, randomly distributed, isolated basalt intrusions. They were not recorded away from these surface geology expressions.

A soil profile description for a typical Eutrophic Grey Dermosol is presented in Table 4.14. Land access to undertake a test pit was not provided on any land which contained a representative Dermosol. It is noted that the laboratory pH values presented in Table 4.14 are median values.

Soil chemistry results for the Eutrophic Grey Dermosol are presented in Table 4.15. The results presented are the median values for each horizon from the three sampled locations (refer to Table 3.5), with the lowest and highest recorded values also provided in brackets. Appendix E presents individual soil chemistry results for each of the three sampled locations. The soil chemistry constituent values highlighted in the soil sufficiency column in Table 4.15 are agricultural industry benchmarks (Baker and Eldershaw 1993; DERM 2011; Peverill, Sparrow and Reuter 1999) and have been referenced in interpreting the laboratory results. The outcomes are presented in the comments column of Table 4.15. The comments are in reference to the median values with increasing depth.

Table 4.16 summarises soil chemistry for the Eutrophic Grey Dermosol and comments on whether there are restrictions to agriculture. Note that Table 4.16 provides a comparison of inherent soil fertility ranking (NSW Government 2013) to field constituent results by applying Murphy et al. (2007). This is particularly useful because the comparison justifies the inherent soil fertility ranking in instances where the Interim Protocol assigns the soil order more than one ranking.

Table 4.14 Eutrophic Grey Dermosol typical soil profile summary

ASC:	Horizon name and depth (m) (average)	Colour, mottles and bleach	Moisture, laboratory pH (median value) and drainage	Texture, structure and consistence	Coarse fragments, segregations and roots
	A1 0-0.18	Dark greyish brown, no mottles and no bleaching.	Moist, pH 4.9 and moderately well drained.	Silty loam, sub-angular blocky and moderately weak force.	No surface coarse fragments, no coarse fragments, no segregations and many roots.
	A2 0.18-0.30	Dark greyish brown, few red mottles and no bleaching.	Moderately moist, pH 4.8 and imperfectly drained.	Silty clay loam, sub-angular blocky and very firm force.	No coarse fragments, no segregations and common roots.
	B21 0.30-0.50	Greyish brown, common orange mottles and no bleaching.	Moderately moist, pH 5.1 and imperfectly drained.	Medium heavy clay, sub-angular blocky and very firm force.	Few coarse fragments, no segregations and few roots.
	B22 0.50-0.67	Grey, many orange mottles and no bleaching.	Dry, pH 6.8 and poorly drained.	Heavy clay, sub-angular blocky and moderately strong force.	Few coarse fragments, no segregations and few roots.

Note: 1. Description in accordance with the Australian Soil and Land Survey Field Handbook (NCST 2009).

Table 4.15 Eutrophic Grey Dermosol soil chemistry results – median values (and ranges)

Constituents	Unit	Soil sufficiency[1]	A1 0-0.18	A2 0.18-0.30	B21 0.30-0.50	B22 0.50-0.67	Comments on median values (in increasing depth)
pH_{water}	pH units	6.0-7.5	4.9 (4.5-5.4)	4.8 (4.7-4.9)	5.1 (4.8-7.4)	6.8 (5.2-8.3)	Very strong acidity (A1 to B21 horizons) to neutral (B22 horizon).
EC_{se}	dS/m	<1.9	1.51 (0.26-2.37)	0.56 (0.13-0.98)	0.22 (0.07-1.10)	1.21 (0.05-2.36)	Moderate to low soil salinity.
Cl^-	mg/kg	<800	10 (<10-10)	10 (10-10)	20 (10-140)	105 (30-200)	Not restrictive.
PAWC	mm	>80	10.8 (ZL-ZCL)	9.6 (ZL-ZCL)	24.0 (MC-HC)	20.4 (MC-HC)	Small (total of 64.8).
Macronutrients							
Nitrite + Nitrate as N (Sol.)	mg/kg	>15	104.70 (14-164)	36.60 (1.2-71.9)	1.60 (1.1-5.8)	0.35 (0.3-0.4)	Very high (A horizon) to very low (B horizon).
Total Nitrogen as N	mg/kg	>1500	3690 (1510-5650)	2645 (1240-4050)	990 (900-1330)	635 (560-710)	Sufficient (A horizon) to deficient (B horizon).
P (Colwell)	mg/kg	>10	12.0 (3.0-25.0)	8.5 (2.0-15.0)	<2.0 (<2.0-<2.0)	<2.0 (<2.0-<2.0)	Moderate (A1 horizon), low (A2 horizon) to very low (B horizon).
K (Acid Extract)	mg/kg	>117	200 (100-400)	200 (<100-300)	<100 (<100-<100)	<100 (<100-100)	Moderate (A horizon) to low - insufficient (B horizon).
K (Total)	mg/kg	>150	595 (370-840)	515 (320-710)	570 (490-740)	570 (490-650)	Very high.
Micronutrients							
Cu	mg/kg	>0.3	1.51 (<1.00-1.71)	<1.00 (<1.00-<1.00)	<1.00 (<1.00-<1.00)	<1.00 (<1.00-<1.00)	Moderate (A1 horizon) to low - inconclusive (A2 horizon and below).
Zn	mg/kg	>0.5 (pH<7) >0.8 (pH>7)	<1.0 (<1.0-8.1)	<1.0 (<1.0-<0.1)	<1.0 (<1.0-<1.0)	<1.0 (<1.0-<1.0)	Low (inconclusive).
Mn	mg/kg	>2	45.10 (37.9-51.8)	31.30 (28.4-34.1)	1.23 (<1.0-1.46)	<1.00 (<1.0-<1.0)	Very high (A horizon) to low (B21 horizon) to very low (B22 horizon).
B	mg/kg	>1	1.65 (0.8-2.4)	1.60 (1.2-2.0)	1.20 (0.7-1.7)	0.45 (0.4-0.5)	Moderate (A1 to B21 horizons) to very low (B22 horizon).
CEC	meq/ 100g	12-25	8.55 (6.9-10.4)	8.25 (6.6-9.9)	17.90 (12.0-21.0)	16.80 (12.6-21.0)	Low (A horizon) to moderate (B horizon).
Ca	meq/ 100g	>5	6.0 (5.0-6.9)	5.7 (4.4-6.9)	6.5 (5.4-7.1)	5.5 (4.7-6.2)	Moderate.
Mg	meq/ 100g	>1	2.1 (1.5-2.8)	2.1 (1.8-2.4)	10.6 (4.9-12.4)	9.9 (5.6-14.1)	Moderate (A horizon) to high (B horizon).

Table 4.15 Eutrophic Grey Dermosol soil chemistry results – median values (and ranges)

Constituents	Unit	Soil sufficiency[1]	A1 0-0.18	A2 0.18-0.30	B21 0.30-0.50	B22 0.50-0.67	Comments on median values (in increasing depth)
Na	meq/ 100g	<0.7	0.10 (<0.1-0.2)	0.15 (<0.1-0.2)	1.30 (0.4-1.4)	1.25 (0.4-2.1)	Low (A horizon) to moderate (B horizon).
K	meq/ 100g	>0.3	0.4 (0.2-0.6)	0.4 (0.2-0.6)	0.3 (0.2-0.5)	0.2 (0.1-0.3)	Moderate (A horizon) to low (B horizon).
ESP	%	<6	<1.20* (0.96-2.9)	2.00 (1.0-3.0)	6.19 (3.3-7.8)	6.60 (3.2-10.0)	Non-sodic (A horizon) to sodic (B horizon).
Ca:Mg ratio		>2	3.00 (2.5-3.4)	2.70 (2.4-2.9)	0.57 (0.5-1.3)	0.72 (0.3-1.1)	Stable (A horizon) to strongly unstable (B horizon).
Organic Carbon	%	>1.2	3.75 (1.6-4.9)	2.80 (1.3-4.3)	1.00 (0.7-1.1)	<0.50 (<0.5-0.5)	Very high (A horizon) to very low (B horizon).

Notes: *1. Sources: Baker and Eldershaw (1993), DERM (2011) and Peverill, Sparrow and Reuter (1999).*

2. Values in brackets are the ranges measured.

** These values are an approximation based on calculations using the lowest measurable level.*

Table 4.16 Eutrophic Grey Dermosol soil chemistry summary

Elements	Comments
pH_{water}	Very strongly acidic at the surface grading to neutral in the subsoil. Outside of the desirable range for agriculture in the upper profile. Would restrict agriculture.
EC	Moderate to low soil salinity levels that would not restrict agriculture.
Cl	Acceptable chloride levels that would not restrict agriculture.
PAWC	A small PAWC, which would restrict agriculture.
Fertility	
Macronutrients	Moderate to high levels of macronutrients in the A horizon. Would not restrict agriculture. Note: there was evidence of recent cultivation at the detailed survey sites on this soil type and demonstrated field and laboratory signs of recent fertiliser application, including non-soil related white substance noted in the field and high nutrient levels in the A horizon.
Micronutrients	Moderate to low levels of micronutrients in the A horizon. Would not restrict agriculture.
CEC	Low CEC levels in the A horizon, which may present some fertility issues.
Fertility ranking	Relative Fertility of ASC Classes (NSW Government 2013): Moderately high - Dermosol (order), any (sub-order), Eutrophic (Great Group) EMM applied Relative Fertility of ASC Classes (lab and field data applied to Murphy et al. 2007): Moderate (Group 3) Explanation (Murphy et al. 2007): Soils have moderate fertility and usually require fertiliser and/or have some physical restrictions for arable use. Soils within this group are moderately deficient in nitrogen, phosphorus and some other elements. The grey, red and brown clays have a somewhat better chemical status than the other soils within this group. The high clay content and strongly coherent nature of some subsoils restrict water and root penetration. Note: The laboratory results class the soil as moderately high to high fertility, particularly with the very high nitrogen and total potassium levels recorded in the A horizon. However, the moderate to very low levels of most other macronutrients and micronutrients indicated by the laboratory results, particularly below 30 centimetres depth, suggest moderate natural fertility. Field and laboratory results suggest recent application of fertiliser.

Table 4.16 Eutrophic Grey Dermosol soil chemistry summary

Elements	Comments
ESP	ESP indicating a sodic subsoil that would restrict agriculture.
Ca:Mg ratio	Stable Ca:Mg ratio in the topsoil, but decreasing with depth to levels that suggest soil instability.
Organic Carbon	Indicative of good structural condition and structural stability in the A horizon, but reducing with depth to low levels. Would not restrict agriculture.
Major limitations to agriculture	Surface pH PAWC Subsoil sodicity

5 BSAL verification

For land to be classified as BSAL it must have access to a reliable water supply; meet all of the criteria presented in Figure 2.2; and be a contiguous area of at least 20 ha. Under the Interim Protocol if any individual criterion is not met, the site is not BSAL. The BSAL verification criteria have been evaluated for the assessment area, based on analysis of field, laboratory and remotely sensed data. Section 5.1 explains the BSAL exclusion criteria and more detail is provided in Appendix F. Section 5.2 presents the results of the BSAL assessment and more detail is provided in Appendix G.

5.1 Exclusion criteria

5.1.1 Slope

A slope assessment for the entire assessment area was conducted using a digital elevation model and site observations were made using a hand held clinometer. Areas with slopes greater than 10% were identified as BSAL exclusion areas.

5.1.2 Rock outcrop

The area of rock outcrop at each soil survey site, estimated as a percentage of the survey site, was determined by visual inspection in the field and recorded on SALIS data cards. Sites with 30% or greater rock outcrop were identified as BSAL exclusion areas.

5.1.3 Surface rockiness

Rockiness refers to the presence of unattached coarse rock fragments and/or rock outcrops at the soil surface. The area of surface rockiness, estimated as a percentage of each survey site, as well as the physical characteristics and size of rock fragments, was determined in the field and recorded on SALIS data cards.

Sites with greater than 20% coverage of unattached rock fragments, with diameters larger than 60 mm, were identified as BSAL exclusion areas.

5.1.4 Gilgai

Gilgai microrelief is a natural soil feature of mounds and depressions commonly associated with cracking clays or Vertosols. The review of NSW regional soils mapping indicated that gilgai microrelief was unlikely to be present within the application area and this was supported by the field observations.

Under the Interim Protocol, sites with average gilgai depressions deeper than 500 mm over more than 50% of the area are identified as BSAL exclusion areas. However, in the SVC application area no significant areas of gilgai were identified and thus no areas were excluded as BSAL on this basis.

5.1.5 Soil fertility

Soil types with fertility less than ‘moderate’, based on the relative fertility of ASC classes presented in Appendix 2 of the Interim Protocol, were identified as BSAL exclusion areas. This was based on the soil type distribution map presented as Figure 4.1.

5.1.6 Effective rooting depth

Effective rooting depth refers to the depth of soil in which roots can function effectively. That is, above any physical or chemical barrier.

Physical and chemical barriers were identified in the field and recorded on SALIS data cards, and/or by laboratory analysis. In the context of BSAL, the depth of soil material from the surface to a physical barrier such as bedrock, weathered rock, hard pans or continuous gravel layers was noted during field surveys. Chemical barriers were identified based on laboratory analysis of soil profile samples, being where limiting values of soil pH, chloride content, electrical conductivity, exchangeable sodium percentage and/or the calcium to magnesium ratio (Ca:Mg) exist.

Survey sites with a physical or chemical barrier to rooting depth at less than 750 mm were identified as BSAL exclusion areas.

5.1.7 Drainage

The hydrology at soil survey sites was observed in the field and recorded on SALIS data cards. Poorly drained sites were identified as BSAL exclusion areas. Poorly drained sites were defined as those in low-lying landscapes with drainage restrictions and potential for waterlogging.

5.1.8 Soil pH

Soil pH was measured in the laboratory and occasionally in the field. Sites where the pH in the uppermost 600 mm of the soil profile was outside of the range 5.0-8.9, measured in water, were identified as BSAL exclusion areas.

5.1.9 Soil salinity

Soil salinity was measured in the laboratory. Sites where soil salinity in the uppermost 600 mm of the soil profile had any of the following properties were identified as BSAL exclusion areas:

- electrical conductivity of greater than 4 deciSiemens per metre (dS/m); or
- the presence of chlorides at 800 milligrams/kilogram (mg/kg) or more, with gypsum present.

5.2 Results of BSAL assessment

Detailed survey sites in the SVC application area which were subject to soil analysis (refer to Table 3.5) have been classified according to their soil type under the ASC, to Great Group level. These survey sites were assessed against each of the BSAL criteria specified in the Interim Protocol, to determine whether or not the criterion is satisfied. The detailed results are provided in Appendix G and summarised in Table 5.1, using the following code:

- yes (Y) highlighted in green, for a decisive ‘yes’ to meeting the subject criterion for BSAL;
- no (N) highlighted in orange, where a site fails the BSAL verification criteria but assessment against subsequent criteria is required to determine whether the site is BSAL or not (applies to criteria 5 to 7b); and
- N highlighted in red, for a decisive ‘no’ to meeting the subject criterion, meaning the site is excluded as BSAL on this basis alone.

Table 5.1 BSAL verification assessment by soil survey site

Site no.[1]	ASC soil type (to Great Group)	BSAL verification criteria: Water	1	2	3	4	5	6	7a	7b	8	9	10	11	12	Area	Is the site BSAL?
		Access to reliable water supply?	Slope ≤ 10%?	< 30% rock outcrop?	≤ 20% of area has unattached rock fragments > 60 mm diameter?	≤ 50% of the area has gilgais > 500 mm deep?	Slope < 5 %?	Nil rock outcrops?	Moderate soil fertility?	Moderately high or high soil fertility?	Effective rooting depth to physical barrier is ≥750 mm?	Soil drainage is better than poor?	pH 5-8.9 if measured in water or 4.5-8.1 if measured in calcium chloride, within the uppermost 600 mm of the soil profile?	Salinity is ≤ 4 dS/m or chlorides < 800 mg/kg when gypsum is present, within the uppermost 600 mm of the soil profile?	Effective rooting depth to a chemical barrier is ≥750 mm?	Is the contiguous area ≥20 ha?	
Dystrophic Yellow Kandosol																	
15	Acidic-Mottled Dystrophic Grey Kandosol	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y	N	Y	No
32	Acidic Dystrophic Brown Kandosol	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y	N	Y	N	Y	No
44	Bleached Mesotrophic Yellow Kandosol	Y	Y	Y	Y	Y	N	Y	N	N	Y	Y	Y	Y	Y	Y	No
133	Acidic-Mottled Dystrophic Yellow Kandosol	Y	N	Y	Y	Y	N	Y	N	N	Y	Y	N	Y	N	Y	No
183	Palic-Acidic Paralithic Leptic Tenosol	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	No
267	Acidic-Sodic Dystrophic Yellow Kandosol	Y	Y	Y	Y	Y	Y	Y	N	N	Y	N	N	Y	N	Y	No
388	Bleached-Mottled Dystrophic Yellow Kandosol	Y	Y	Y	Y	Y	N	Y	N	N	Y	Y	Y	Y	Y	Y	No
404	Acidic-Mottled Dystrophic Brown Kandosol	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	Y	N	Y	No
472	Acidic-Sodic Dystrophic Yellow Kandosol	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y	N	N	N	Y	No
481	Acidic-Mottled Dystrophic Yellow Kandosol	Y	Y	Y	Y	Y	N	Y	N	N	Y	Y	N	Y	N	Y	No
502	Mottled Dystrophic Yellow Kandosol	Y	Y	Y	Y	Y	N	Y	N	N	N	Y	N	Y	N	Y	No
592	Haplic Dystrophic Red Kandosol	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	N	No
594	Mottled Dystrophic Yellow Kandosol	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	No
595	Haplic Dystrophic Red Kandosol	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	N	No
596	Mottled Dystrophic Yellow Kandosol	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	No

Table 5.1 BSAL verification assessment by soil survey site

Site no.[1]	ASC soil type (to Great Group)	BSAL verification criteria															Is the site BSAL?
		Water	1	2	3	4	5	6	7a	7b	8	9	10	11	12	Area	
		Access to reliable water supply?	Slope ≤ 10%?	< 30% rock outcrop?	≤ 20% of area has unattached rock fragments > 60 mm diameter?	≤ 50% of the area has gilgais > 500 mm deep?	Slope < 5 %?	Nil rock outcrops?	Moderate soil fertility?	Moderately high or high soil fertility?	Effective rooting depth to physical barrier is ≥750 mm?	Soil drainage is better than poor?	pH 5-8.9 if measured in water or 4.5-8.1 if measured in calcium chloride, within the uppermost 600 mm of the soil profile?	Salinity is ≤ 4 dS/m or chlorides < 800 mg/kg when gypsum is present, within the uppermost 600 mm of the soil profile?	Effective rooting depth to a chemical barrier is ≥750 mm?	Is the contiguous area ≥20 ha?	
Paralithic Leptic Tenosol																	
73	Palic-Acidic Paralithic Leptic Tenosol	Y	N	Y	Y	Y	N	Y	N	N	Y	Y	N	Y	N	Y	No
83	Palic-Acidic Paralithic Leptic Tenosol	Y	Y	Y	Y	Y	N	Y	N	N	Y	Y	N	Y	N	Y	No
126	Palic-Acidic Paralithic Leptic Tenosol	Y	N	Y	Y	Y	N	Y	N	N	Y	Y	N	Y	N	Y	No
263	Palic-Acidic Paralithic Leptic Tenosol	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	Y	N	Y	No
287	Palic-Acidic Paralithic Leptic Tenosol	Y	Y	Y	Y	Y	N	Y	N	N	Y	Y	Y	Y	N	Y	No
300	Palic-Acidic Paralithic Leptic Tenosol	Y	Y	Y	Y	Y	N	Y	N	N	Y	Y	N	Y	N	Y	No
Kandosolic Redoxic Hydrosol																	
4	Acidic-Sodic Dermosolic Redoxic Hydrosol	Y	Y	Y	Y	Y	Y	Y	N	N	Y	N	Y	N	N	Y	No
10	Acidic-Sodic Tenosolic Oxyaquic Hydrosol	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	Y	N	Y	No
92	Acidic-Sodic Kandosolic Redoxic Hydrosol	Y	Y	Y	Y	Y	Y	Y	N	N	Y	N	N	Y	N	Y	No
238	Acidic-Sodic Kandosolic Redoxic Hydrosol	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	Y	N	Y	No
454	Acidic-Sodic Kandosolic Redoxic Hydrosol	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	Y	Y	Y	No
524	Acidic-Sodic Kandosolic Redoxic Hydrosol	Y	Y	Y	Y	Y	Y	Y	N	N	Y	N	N	Y	N	Y	No

Table 5.1 BSAL verification assessment by soil survey site

Site no.[1]	ASC soil type (to Great Group)	BSAL verification criteria															Is the site BSAL?
		Water	1	2	3	4	5	6	7a	7b	8	9	10	11	12	Area	
		Access to reliable water supply?	Slope ≤ 10%?	< 30% rock outcrop?	≤ 20% of area has unattached rock fragments > 60 mm diameter?	≤ 50% of the area has gilgais > 500 mm deep?	Slope < 5 %?	Nil rock outcrops?	Moderate soil fertility?	Moderately high or high soil fertility?	Effective rooting depth to physical barrier is ≥750 mm?	Soil drainage is better than poor?	pH 5-8.9 if measured in water or 4.5-8.1 if measured in calcium chloride, within the uppermost 600 mm of the soil profile?	Salinity is ≤ 4 dS/m or chlorides < 800 mg/kg when gypsum is present, within the uppermost 600 mm of the soil profile?	Effective rooting depth to a chemical barrier is ≥750 mm?	Is the contiguous area ≥20 ha?	
Lithic Leptic Rudosol																	
264	Acidic Lithic Leptic Rudosol	Y	N	Y	N	Y	N	N	N	N	N	Y	N	N	N	Y	No
414	Acidic Lithic Leptic Rudosol	Y	N	N	N	Y	N	N	N	N	N	Y	N	Y	N	Y	No
474	Acidic Lithic Leptic Rudosol	Y	N	Y	Y	Y	N	N	N	N	N	Y	Y	Y	Y	Y	No
Eutrophic Grey Dermosol																	
152	Mottled-Sodic Eutrophic Grey Dermosol	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y	N	No
181	Acidic-Sodic Eutrophic Brown Dermosol	Y	Y	Y	Y	Y	N	Y	Y	N	Y	N	N	Y	N	N	No
278	Acidic- Mottled Mesotrophic Grey Dermosol	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N	Y	Y	Y	N	No

Note: 1. Refer to Figure 3.1 for the locations of survey sites.

The results in Table 5.1 show that there is no BSAL in the SVC application area or wider assessment area. Most areas and/or soils fail the BSAL tests on multiple criteria. The principal exclusion criteria across the assessment area are shown in Figure 5.1 and are summarised as follows:

- steep slope BSAL exclusion areas (slopes greater than 10%) occur in much of the western part of the SVC application area associated with the deep sandstone gorges in Belanglo State Forest, as well as along some elevated ridge lines through the central and eastern parts of the application area; and

- physical and chemical soil characteristics BSAL exclusion areas:

  - Dystrophic Yellow Kandosols were excluded because of moderately low soil fertility;

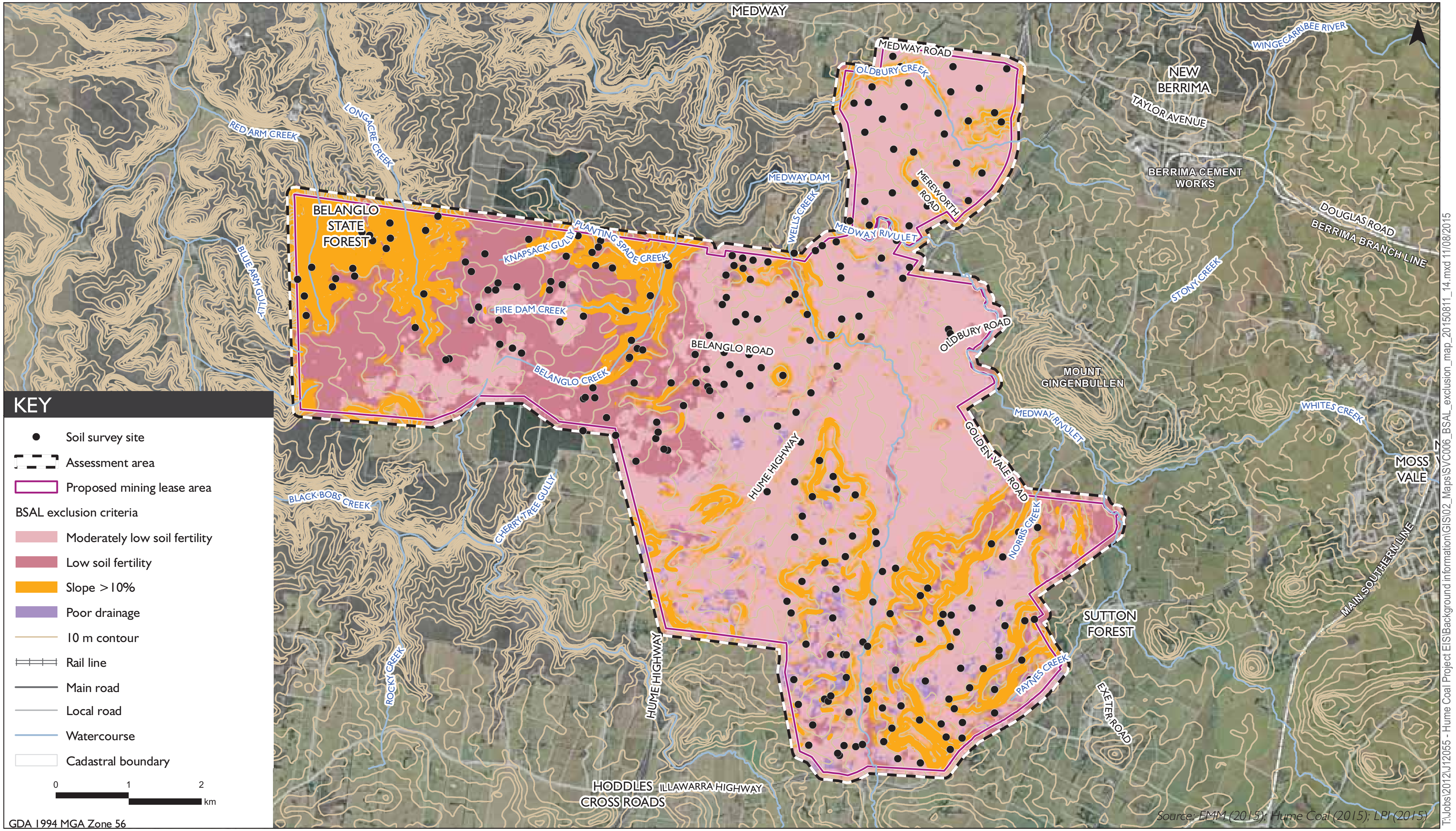
  - Paralithic Leptic Tenosols were excluded because of low soil fertility;

  - Kandosolic Redoxic Hydrosols were excluded because of moderately low soil fertility;

  - Lithic Leptic Rudosols were excluded because of low fertility (and typically occur on land which failed BSAL slope criteria); and

  - Eutrophic Grey Dermosols were excluded because of poor drainage.

Most soils also do not meet other BSAL criteria. For example many of the soils have high acidity (soil pH less than 5), high salinity (ECe greater than 4 dS/m and/or chloride greater than or equal to 800 mg/kg), chemical barriers to plant rooting such as sodicity (exchangeable sodium percentage greater than or equal to 15%) and/or physical barriers to plant rooting such as rock. Further detail is provided in the BSAL verification assessment tables in Appendix G.



EMM
HUMECOAL

BSAL exclusion map

Hume Coal Project

Biophysical strategic agricultural land verification assessment

Figure 5.1

6 Conclusion

A robust site verification assessment has been conducted over more than two years, by certified professional soil scientists, following the relevant guidelines. This has included field surveys, laboratory analyses and remote sensing techniques to analyse soils and landforms across the assessment area and determine whether the BSAL criteria shown in Figure 2.2 were met. The BSAL verification assessment area was defined as the land that will be subject to a mining lease application plus a 100 m buffer. This resulted in a total assessment area of 5,488 ha.

Based on the assessment results, Hume Coal needs to apply for a SVC as opposed to a gateway certificate. This site verification report has been prepared in accordance with the Interim Protocol to accompany the SVC application. As the Hume Coal Project is not on strategic agricultural land, the gateway process does not apply and the project cannot go through the gateway process. Nonetheless any agricultural impacts will be comprehensively assessed through an Agricultural Impact Statement that will be part of the EIS, and will be assessed by the relevant agencies at the development application stage.

Field-based site surveys and laboratory analyses of soils were undertaken based on recommendations in the Handbook and Interim Protocol. Where land access or other constraints precluded field surveys, soil types were identified by applying remote sensing techniques. Soil type boundaries were identified by remote sensing techniques with correlation provided by site survey and soil analysis results.

Five soil types were identified in the SVC application area: Dystrophic Yellow Kandosol, Paralithic Leptic Tenosol, Kandosolic Redoxic Hydrosol, Lithic Leptic Rudosol and Eutrophic Grey Dermosol.

Each soil type was assessed against the BSAL verification criteria and no soil type was found to satisfy the criteria, with most failing multiple physical and chemical criteria. In addition, an analysis of slope in the SVC application area determined that some land failed the slope criterion. The result is that no BSAL is present in the SVC application area or wider assessment area, a conclusion that is consistent with the results of the NSW Government's BSAL mapping.

Abbreviations

A349	exploration authorisation 349
ASC	Australian Soil Classification
ASRIS	Australian Soil Resource Information System
B	boron
BSAL	biophysical strategic agricultural land
Ca	calcium
Ca:Mg	calcium to magnesium ratio
CEC	cation exchange capacity
CIC	critical industry cluster
Cl-	chloride
Cu	copper
DERM	QLD Department of the Environment and Resource Management
DP&E	NSW Department of Planning and Environment
DP&I	former NSW Department of Planning and Infrastructure
dS/m	deciSiemens per metre
EC	electrical conductivity
ECse	electrical conductivity – saturated extract
EIS	environmental impact statement
EMM	EMGA Mitchell McLennan Pty Limited
ESP	exchangeable sodium percentage
GIS	Geographic Information Systems
ha	hectares
Handbook	NCST (2009) *Australian Soil and Land Survey Field Handbook*
Hume Coal	Hume Coal Pty Limited
Interim Protocol	NSW Government (2013) *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land*
K	potassium
kg	kilograms
LGA	local government area
m	metres
meq/100g	milliequivalent of hydrogen per 100 grams of dry soil
mg	milligrams
Mg	magnesium
Mining SEPP	State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007
mm	millimetres
Mn	manganese
N	nitrogen
Na	sodium
NCST	National Committee on Soil and Terrain
NOW	NSW Office of Water
NSW	New South Wales
OEH	NSW Office of Environment and Heritage
P	phosphorus
PAWC	plant available water capacity
ROM	run of mine
SALIS	NSW Soil and Land Information System

SRLUP	NSW Government (2012a) *Strategic Regional Land Use Policy*
SVC	site verification certificate
Zn	zinc

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Appendix A

Expert review letters

13 August 2015

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COMMENTS REGARDING EMM's 'BIOPHYSICAL STRATEGIC AGRICULTURAL LAND VERIFICATION ASSESSMENT', HUME COAL PROJECT, AUGUST 2015

Dear Jodi

In March 2014, I was invited to carry out a technical review for Hume Coal and EMM of their 'Biophysical Strategic Agricultural Land (BSAL) Verification Assessment' for the Hume Coal Project near Sutton Forest, NSW. I have 38 years experience as a soil scientist. My qualifications include a PhD (soil physics) from University of Sydney and a MScAg degree (soil chemistry & agronomy) from University of New England. I have 'Certified Professional Soil Scientist (Stage 3)' and 'CPSS Competent in Australian Soil Survey' accreditation from Soil Science Australia, and I am a 'Chartered Scientist' with British Society of Soil Science.

I met with EMM and Hume Coal staff at Moss Vale on 6 June 2014 and visited the study site. At that time, the soil survey field work was at a standstill because of land access constraints.

One potential solution raised was the possibility of hiring an expert in landscape modelling and remote sensing to assist with filling in the gaps on the soil maps that were being prepared. Since that time, access was successfully negotiated to several additional properties and further field-based soil survey completed. Nonetheless EMM proceeded with using innovative remote sensing techniques to complement the soil survey field work and map soils across the project area.

In addition to the initial face-to-face meeting, I have liaised with EMM on several occasions over the past year, via phone and email correspondence, to discuss the assessment methodology and results.

The 'Interim BSAL Protocol' from NSW Government is written in a way that provides experienced soil surveyors with some flexibility when selecting soil sampling techniques and assessment thresholds for each new field site requiring BSAL assessment. I generally support the way that EMM soil surveyors interpreted the protocol when selecting soil survey and BSAL verification methods for their study area near Sutton Forest in early-2013. However, I note that the EMM field description and sampling techniques were based mainly on the use of 50 mm diameter soil cores, with test pits using a backhoe at a limited number of representative sites. My personal preference is to use backhoe pits wherever possible in BSAL assessments (each with soil laboratory analysis unless the site obviously is non-BSAL based on field observations), as demonstrated in my soil survey reports for Malabar Coal and BHP Billiton:

- Spur Hill underground coal mine proposal (Malabar Coal)
  http://www.mpgp.nsw.gov.au/index.pl?action=view_job&job_id=6335
- Caroona underground coal mine proposal (BHP Billiton)
  http://www.mpgp.nsw.gov.au/index.pl?action=view_job&job_id=6474

I was advised that landholder objection towards the use of backhoe pits by EMM meant that coring was considered to be the only way of getting the job done. The intensity of sampling sites in accessible areas was appropriate.

I was not present in the field whilst the EMM soil description and sampling was being carried out. However, my discussions with the EMM soil surveyors (Tim Rohde, Neil Cupples) did not create any doubts in my mind about their commitment to quality of workmanship and honesty in reporting.

The BSAL Verification Assessment Report is presented concisely and very clearly. I received a draft of the report on 11 November 2014 and provided detailed comments to EMM soon afterwards. I note that all of the comments were taken on board by EMM and a revised draft issued on 5 December 2015. EMM have systematically and clearly explained how they have addressed all of the relevant requirements in the Interim BSAL Protocol.

I was impressed by the way that soil nutrient data have been linked in with the Fertility Rankings. EMM's reference to Baker & Eldershaw, DERM and Peverill *et al.* takes the soil fertility component of BSAL assessment well beyond that carried out by Murphy et al. (2007). I consider this to be innovative and valuable.

The information presented to me by EMM has convinced me that declarable areas of BSAL almost certainly do not exist within the Hume Coal study site boundaries.

Nevertheless, Hume Coal have noted (see page 77 of their 'Preliminary Environmental Assessment', July 2015) that when their EIS document is prepared for NSW Government, a detailed soil and land resources assessment will be undertaken that builds on the SVC soil assessment, and which is in accordance with all of the applicable guidelines. The emphasis on a new mining and backfilling technique which apparently results in negligible subsidence impacts is an excellent feature of their proposal.

Yours sincerely

Dr David McKenzie
Soil Science Consultant

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Mr. Luke Edminson 6th August, 2015

Hume Coal Pty Ltd

Manager – Environmental Planning

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9 Clarence Street, Moss Vale, NSW, 2577

Dear Mr. Edminson

I have been asked to provide a review of the methods and report "Soil Mapping using Remote Sensing Techniques" prepared by EMM for the Hume Coal Project. I am an internationally recognized expert in remote sensing and recently a Visiting Professorial Fellow in the Faculty of Engineering at the University of NSW (UNSW), Managing Director of Asia-Pacific Remote Sensing Pty Ltd, and formerly the Director of the Centre for Remote Sensing and GIS at UNSW. I have a Bachelor and Master Degree in surveying and mapping from Melbourne University, a Master of Science degree from the University of Reading, and a PhD in satellite remote sensing from UNSW. I have undertaken consulting for a wide range of organizations both nationally and internationally, including BHP, Unisearch, Murray Darling Authority, AusAid, World Bank and the Asian Development Bank.

The aim of the remote sensing work was to use a combination of satellite remotely sensed digital image data and airborne radiometric data, combined with other spatial data sources, including elevation and slope data, and soil data collected by field surveys, to predict and map soil types over the Hume Coal Project area.

A preliminary meeting was held with Roshni Sharma of EMM on the 11th of September, 2014, at the University of NSW, to review both the remotely sensed and field sampled soil data and to discuss the range of methods that might be appropriate for predicting soil types. Further meetings were held on a weekly basis at UNSW ranging from one to two hours, through to the 22nd of October, to discuss the methods and examine the results of a number of different approaches that I had recommended. In addition, I independently reviewed interim results outside of these meetings.

The analysis stages decided upon in joint discussions, and varied and added to as work progressed, were as follows –

(1) Undertake a multivariate analysis of all the spatial data, to determine the correlation between the variables and to extract principal components to allow a better understanding of the relationship between, and the importance of, each of the variables.

(2) Resample all spatial data to a 5m resolution to allow extracted results to be presented at a finer scale than 1:25,000 and all data to be spatially registered.

(3) Produce overlay maps of the principal components and individual variables, with the soil type point data established from field surveys, to determine and examine any obvious spatial correlation.

(4) Undertake preliminary testing of a number of different methods, including decision trees and maximum likelihood classification, and analysis and comparison of the results.

(5) Use a Normalised Difference Vegetation Index (NDVI) as a vegetation surrogate to offset the attenuating effects of the spatially variable forest cover on the airborne radiometric data, so as to improve the correlation between soil properties (established from field surveys) and this data. The NDVI has low values for bare soil and high values for dense forest, and as the amount of attenuation, to a first order, is directly related to the density of forest cover, then the NDVI will allow separation of attenuated and non-attenuated data.

(6) Examine a number of Landsat TM satellite images from different dates to select an image that was clear of cloud and was acquired at a similar seasonal time to the radiometric data.

(7) Calculate a Normalised Difference Vegetation Index (NDVI), from the near infrared and visible red spectral bands of Landsat TM over the project area.

(8) Develop a maximum likelihood classification approach using selected radiometric data, elevation and slope data. The use of two separate classes for each soil – one under forest and one in open fields – to counteract the effects of forest attenuation on the radiometric data, was initially considered but rejected due to limited sampled points in each soil class. Subsequently, use an alternative approach, by incorporating the NDVI layer into the maximum likelihood classification

(9) Test the confidence of the resulting soil classification using an omission – commission error matrix.

(10) Jointly review the results.

I believe the maximum likelihood classification approach, with the inclusion of the NDVI data that was used in the final analysis, is theoretically sound and is the method that produced the most accurate results. It therefore meets the aim of predicting and classifying soil classes using remotely sensed data.

The omission- commission error matrix indicates that the soil map has a confidence level of 75% or above. It can be seen from the results that some classified soils do not accord with the field sampled soil results. However international mapping standards dictate that well defined points and boundaries should have a 90% probability of being no more than +/- 0.5mm error at map scale. At a 1:25,000 map scale, this means an acceptable error of +/- 12.5m. Thus a predicted soil type boundary and a sampled point of the same soil type could, theoretically, be 25m apart before an error was assumed. In addition soil boundaries are not well defined lines, but more zones of transition between one soil class and another, where the probability of being one or other soil varies across the zone, being approximately 50:50 near the centre of the zone. In a similar way, based on probabilities, the maximum likelihood classifier gives a label to a class if it has a greater than 50% probability of belonging to that class rather than another. Probability will therefore decrease to 50% at the boundary but will greatly increase away from the boundary.

Considering these factors, I would estimate that overall the results have a better confidence level than the 75% indicated by the error matrix.

Yours sincerely

Dr Bruce Forster, AM, FIE(Aust.)

Appendix B

Soil mapping using remote sensing techniques

Soil mapping using remote sensing techniques

Hume Coal Project

Prepared for Hume Coal Pty Limited | 17 August 2015

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Soil mapping using remote sensing techniques

Final

J12055 | Prepared for Hume Coal Pty Limited | 17 August 2015

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Signature	RSharma.	Signature	
Date	17 August 2015	Date	17 August 2015

Document Control

Version	Date	Prepared by	Reviewed by
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Executive Summary

Hume Coal Pty Limited (Hume Coal) proposes to develop and operate an underground coal mine and associated mine infrastructure (the 'Hume Coal Project') west of Moss Vale, in the Southern Coalfield of New South Wales (NSW).

Under NSW legislation, State significant mining developments, such as the Hume Coal Project, which require a new or extended mining lease, also need either a gateway certificate or a site verification certificate (SVC) before their development application can be lodged. The type of certificate required depends on whether or not the proposed development is to be on 'strategic agricultural land'. 'Site verification' following procedures in the NSW Government (2013) *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land* (Interim Protocol) is required to confirm whether or not the development is to be on a type of strategic agricultural land referred to as biophysical strategic agricultural land (BSAL).

Site verification has been undertaken, including identifying and mapping soil types across the assessment area using a combination of field-based soil surveys, laboratory analysis and remote sensing techniques. The site verification process confirmed that the land over which Hume Coal intends to seek a mining lease, including a lease for mining purposes, is not BSAL (EMM 2015). Hume Coal is therefore applying for a SVC to certify this finding. This report documents the remote sensing rationale, methods and results and accompanies the SVC application. Full details of the BSAL verification process and outcomes are provided in the main report.

Field-based soil surveys and analyses were undertaken at 246 sites within and immediately adjacent to the SVC application area, equating to more than one site per 25 hectares, which satisfies the Interim Protocol's sampling density requirements. However, some landowners did not agree to sampling on their properties, meaning coverage is better in some areas than others.

The Interim Protocol stipulates that where access for sampling is not available, a model of soils distribution should be developed based on landscape characteristics and remotely sensed and other data sources such as aerial photos, geology (extrapolated to identify parent material), electromagnetic and LiDAR data.

Accordingly, high resolution remotely-sensed data has been used, in conjunction with soils data collected by the field and laboratory analyses, to develop a model of soils distribution. The model employs a 'maximum likelihood' method of soil classification, based on statistical relationships between measurements in the field and remotely sensed data. It has been used to map soil types across the entire application area, including properties that could not be accessed, at a scale finer than 1:25,000. Key steps were as follows:

1. Collation and processing of high resolution remotely sensed data and its derivatives, including LiDAR, gamma radiometric and satellite imagery.

2. Selection of data layers which provide information on soil properties and distribution, such as terrain, landscape and geological source material data. For example, geology, interpreted through gamma radiometric imagery, was used because it is an important determinant of soil type, given that weathering of this parent material leads to soil formation.

3. Extraction of spectral data from the remotely sensed data layers at the location of each field survey point, and grouping the extracted values by known soil type (as determined from the field surveys).

4. Statistical analyses to determine the characteristics of each soil type in each remotely sensed data layer and thus derive statistical relationships between the field results and each data layer, and sets of values characteristic of each soil type.

5. Application of the derived statistical relationships between the field results and each data layer to model soil type across the assessment area on a pixel-by-pixel basis, and determine the probable soil type for each 5 metre (m) by 5 m pixel. The results were used to build a soil map on a 5 m grid, which is better than the 1:25,000 map resolution required by the Interim Protocol.

The remote sensing mapping method, based on statistical analysis, is considered to be more objective than traditional methods, which involve manually mapping soil type boundaries based on interpretation of field data, maps, aerial/satellite images and professional judgement.

Comparison of the soil type predicted by the model at each field survey point to the actual field results indicated high confidence levels. Approximately 75% of field survey points were classified as the same soil type by the model. In every instance where the two differed, the field survey point was 50 m or less from the model-predicted boundary of that same soil type. This spatial accuracy would be difficult to achieve with manual soil mapping techniques, especially at a high resolution of 1:25,000 or finer.

In understanding the limitations in mapping soil type boundaries, it is important to note that soil type definitions require thresholds where one soil type is considered to become another. However, there are often transition zones and graded (indeterminate) boundaries between soil types, which make it difficult to delineate distinct boundaries. It is therefore likely that some of the points where field survey and model-predicted soil types differ are within the transition zone between two soil types, and in fact some combination of the two may be present within the 5 m by 5 m pixel area. Regardless of where actual soil type boundaries occur, none of the soil types found in the field surveys or predicted by the model have the capacity to be BSAL.

The field surveys and remote sensing model identified and mapped five soil types in the SVC application area: Dystrophic Yellow Kandosols, Kandosolic Redoxic Hydrosols, Paralithic Leptic Tenosols, Lithic Leptic Rudosols and Eutrophic Grey Dermosols. None of these soil types have the capacity to be BSAL. This is due to physical and chemical limitations such as low to moderately low fertility, poor drainage, high acidity, high salinity and chemical and physical barriers to plant rooting such as sodicity or rock.

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1 Introduction

1.1 Project background

Hume Coal Pty Limited (Hume Coal) proposes to develop and operate an underground coal mine and associated mine infrastructure (the 'Hume Coal Project') in the Southern Coalfield of New South Wales (NSW). Hume Coal holds exploration authorisation 349 (A349) to the west of Moss Vale, in the Wingecarribee local government area (LGA). The underground mine will be developed within part of A349 and associated surface facilities will be developed within and north of A349. The project's local setting is shown in Figure 1.1.

The project is in the early stages of the comprehensive assessment processes required by Commonwealth and NSW legislation. An environmental impact statement (EIS) is being prepared as part of this.

In addition, under provisions of the NSW Environmental Planning and Assessment Regulation 2000, either a gateway certificate or a site verification certificate (SVC) is needed before the project's development application is lodged. This process was established by the NSW Government (2012a) *Strategic Regional Land Use Policy* (SRLUP) and an amendment to the State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 (Mining SEPP) in 2013. It applies to State significant mining developments, such as the Hume Coal Project, that require a new or extended mining lease under the NSW *Mining Act 1992*.

The type of certificate required depends on whether or not a proposed development is on 'strategic agricultural land', as defined in the SRLUP. Strategic agricultural land falls into two categories. First, land shown on the Strategic Agricultural Land Map, which accompanies the Mining SEPP, to be a critical industry cluster (CIC), important to a highly significant and clustered industry such as wine making or horse breeding. Second, biophysical strategic agricultural land (BSAL), being land with a rare combination of natural resources highly suitable for agriculture.

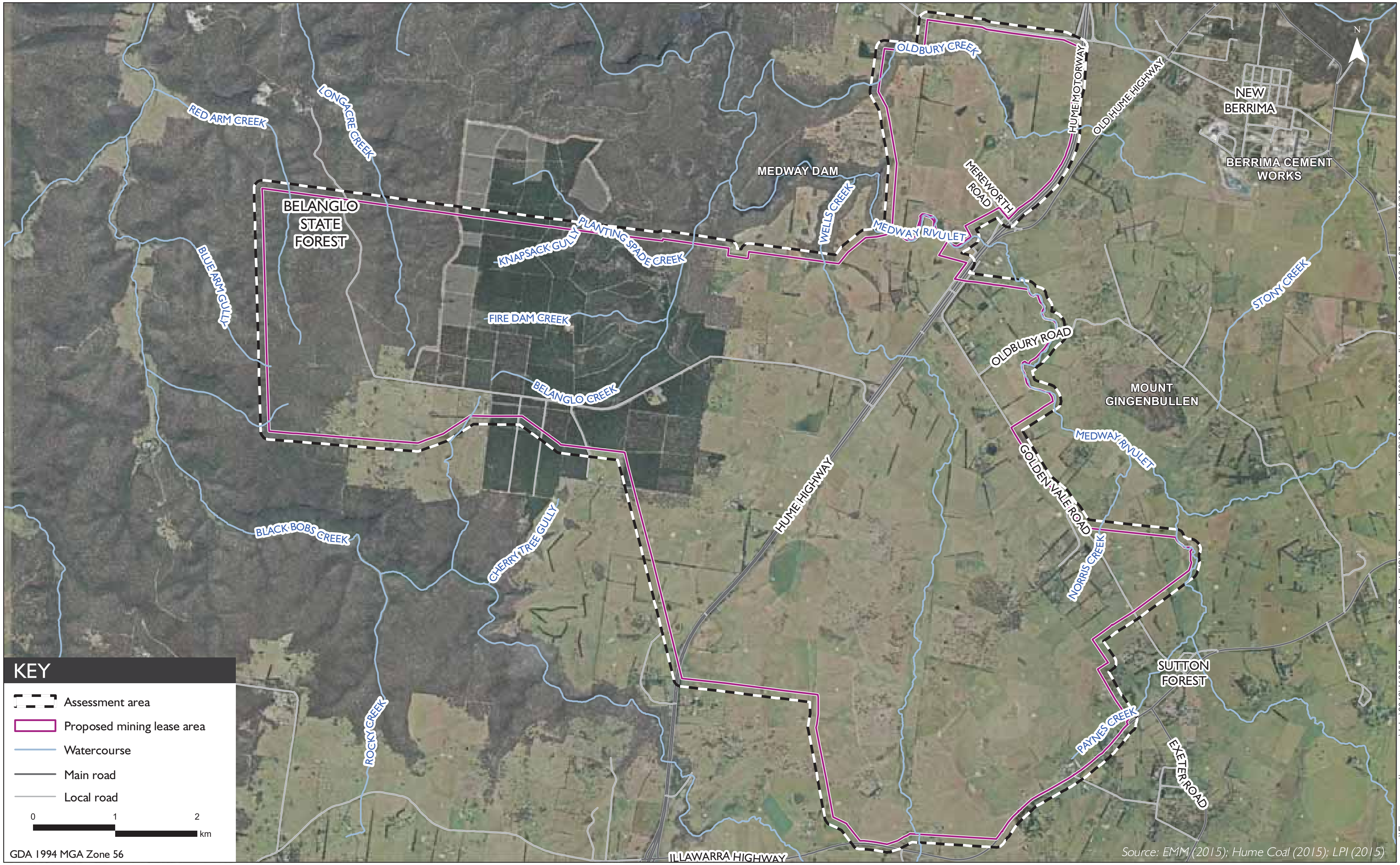
Developments that are on strategic agricultural land need to go through the gateway process and obtain a gateway certificate. Conversely, developments which are not on strategic agricultural land need to obtain a SVC, certifying that the land is not BSAL The gateway process does not apply to these types of developments and they cannot go through the gateway process.

The land is not shown on the Strategic Agricultural Land Map to be a CIC. Therefore it is not a CIC. The NSW Government (2012b) *Draft Guideline for site verification of critical industry clusters* states that "projects located outside the mapped CIC are not required to seek site verification". Accordingly, Hume Coal is not required to seek a site verification or gateway certificate in respect of CICs.

In accordance with the Mining SEPP, detailed site-specific surveys and analysis ('site verification') are required following the NSW Government (2013) *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land* (Interim Protocol), to confirm whether or not any land within Hume Coal's proposed mining lease areas is BSAL.

Site verification has been completed for the Hume Coal Project in accordance with the Interim Protocol and confirmed that there is no BSAL within the proposed mining lease areas (EMM 2015). Hume Coal is therefore applying for a SVC (certifying that the land is not BSAL) under Part 4AA of the Mining SEPP. The application relates to those areas over which Hume Coal intends to seek a mining lease, including a lease for mining purposes (the 'SVC application area'), which are shown in Figure 1.1.

As part of the BSAL site verification process, and to inform the agricultural impact statement and land and soil capability assessment components of the EIS, EMM has identified and mapped soil types across the SVC application area. This has been by field surveys, laboratory analyses and remote sensing techniques. This report documents the remote sensing rationale, methods and results and accompanies the SVC application.



SVC application area

Hume Coal Project

Soil mapping using remote sensing techniques

Figure 1.1

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1.2 Interim Protocol requirements for BSAL verification

1.2.1 Overview

The Interim Protocol outlines the process for identifying and mapping BSAL. This includes assessment of sites against specific criteria to determine whether or not they are BSAL. The criteria relate to:

- slope;
- rock outcrop;
- surface rock fragments;
- gilgais;
- soil fertility (inferred from soil type);
- effective rooting depth to a physical barrier;
- soil drainage;
- soil pH;
- salinity; and
- effective rooting depth to a chemical barrier.

The "Flow chart for site assessment of BSAL" (Figure 2 of the Interim Protocol) provides twelve steps for consideration of these criteria.

Soil type identification and mapping is an important part of a BSAL verification assessment as it provides a good indication of the chemical and physical properties of soil and therefore soil fertility.

As described in the EMM (2015) *Biophysical Strategic Agricultural Land Verification Assessment*, the Interim Protocol requires soil mapping to be at a scale of 1:25,000.

1.2.2 Site types

The Interim Protocol defines 'exclusion', 'detailed' and 'check' soil survey site types. These are described below.

i Exclusion sites (Interim Protocol Section 9.4.1)

The Interim Protocol defines exclusion sites as being:

> within areas that fail the obvious landscape requirements, that is, slope, rock outcrop, surface rockiness or gilgai microrelief criteria as explained in steps 1 to 6 in Figure 2 [Flow chart for site assessment of BSAL].

For these sites:

> Neither soil profile description nor soil survey is necessary.

ii Detailed sites (Interim Protocol Section 9.4.2)

The Interim Protocol requires detailed sites to be:

> described in sufficient detail to allow all major physical and chemical soil features of relevance to BSAL to be clearly identified as described from steps 1 to 12 in [Interim Protocol] Figure 2.

The Interim Protocol (Section 5, Step 3) states:

> Access to the project area will define the level of investigation that the proponent can undertake. If the proponent has access to the land then the BSAL verification requirements for on-site soils assessment as described in sections 6 [Soils and landscape verification criteria] and 9 [Collecting and presenting soils information] should be met. If the proponent does not have access then the proponent should develop a model of soils distribution guided by sections 6 and 9.6 based on landscape characteristics using the information listed below. This approach can also be used if the proponent has access but the area is not used for agriculture (for example, heavily forested areas) or the proponent needs to identify the boundary of BSAL outside the project area. Relevant information includes:
>
> - estimate of BSAL criteria for slope, rockiness, and gilgais;
> - available soils datasets;
> - geology extrapolated to identify parent material;
> - local knowledge;
> - vegetation;
> - aerial photography;
> - other remotely-sensed resources (eg EM [electromagnetic], LiDAR); and
> - soils assessment of nearby accessible sites of similar landscape.

The Interim Protocol recognises that where site access is not available, steps 1 to 6 should be completed using other methods. This is described in Section 6 of the Interim Protocol:

> Steps 1-6 in Figure 2 can be measured with relative ease in the field or via remotely sensed data as these are basically landscape criteria that can be ascertained without soil profile information. If these landscape requirements are not met, simple observation sites called exclusion sites are used. However, Steps 7-12 in Figure 2 are determined by soil profile description and will require detailed assessment sites complemented by check sites. These assessment sites are explained in section 9.4 [Sites].

iii Check sites (Interim Protocol Section 9.4)

The Interim Protocol describes check sites as follows:

> Check sites are examined in sufficient detail to allocate the site to a soil type and soil map unit. Check sites are commonly used to accurately position the boundaries of soil map units, to describe the variability within a soil map unit and to validate soil predictions. Check sites complement detailed sites.
>
> If existing soil mapping is available, check sites could be used to investigate its accuracy and relevance of the existing mapping to the assessment area. If the check sites confirm the existing mapping, then the existing soil map units may be sufficient to support a BSAL assessment. However if the on-ground assessment shows inconsistencies or errors in the available information, then more detailed site descriptions and mapping will be required.

1.3 Field soil surveys

EMM has, to date, conducted soil surveys at 246 sites (or 'points') within and immediately adjacent to the SVC application area. These surveys have been conducted with the aim of classifying soil types to the required mapping scale of 1:25,000, necessitating a density target of at least one site per 25 hectares (ha). The sampling points are a combination of detailed and check sites. Access to many sites required extensive landholder negotiations. Details of soil survey sites are provided in the *Biophysical Strategic Agricultural Land Verification Assessment* (EMM 2015).

Based on the proposed mining lease boundary ('SVC application area') of approximately 5,042 ha, an average field survey density of about one site per 20.5 ha has been achieved. For the broader assessment area of 5,491 ha, comprising the proposed mining lease application areas plus a 100 metre (m) buffer, as per the Interim Protocol, an average field survey density of about one site per 22.3 ha has been reached. Both of these meet the required mapping scale of 1:25,000, however, land access was not uniformly spread across the application area.

Hume Coal has made every reasonable attempt to access properties across the application area for soil surveys, however, a number of landholders declined to participate. Accordingly, consistent with guidance in the Interim Protocol for areas where the proponent does not have access, a model of soils distribution across the entire application area, including land that could not be accessed, has been developed using remote sensing techniques.

It is noted that soil surveys have also been conducted at additional locations outside the SVC application area, as part of the broader investigations for the EIS. These locations are not considered or described in this report, as they are not directly relevant to the SVC application. They will be detailed in the EIS. It is however noted that the soil types recorded at these additional locations are the same as those found within the SVC application area, none of which are BSAL.

1.4 Remote sensing as a complementary method to field soil surveys

The *Report by the Mining & Petroleum Gateway Panel to accompany a Conditional Gateway Certificate for the Caroona Coal Project* (NSW Government Gateway Panel 2014) advises that, in the event that physical soil sampling is not possible, remote sensing techniques are appropriate to undertake soil mapping:

> Every effort should be made to negotiate access to physically sample these areas and apply the BSAL verification protocol.
>
> Where physical soil sampling remains unachievable, a desktop interpretation is acceptable for determination of the presence of BSAL but the process needs to be fully elucidated and include all available, relevant information. The Gateway Panel believes such information should include the remote electromagnetic survey information ... this information has the potential to assist with the mapping of variability in key soil factors and soil landscape units.

Remote electromagnetic survey methods include a wide range of satellite and airborne data collection from parts of the electromagnetic spectrum (eg infrared, visible and gamma bands). These methods were used for the project's soil mapping, as described in Chapter 2.

As of July 2014, it was not possible to gain landowner agreement to undertake field sampling on some properties in the application area. It was therefore decided to use remote sensing techniques to complete soil mapping across the application area.

Since July 2014, successful negotiations have allowed access to additional properties and further field-based sampling to be completed. The average field sampling density now meets the Interim Protocol requirements and the spatial distribution of soil sampling points provides good coverage in some areas, though not in others. The remote sensing program was continued as:

- it is a complementary method to field soil surveys and allows soils to be mapped across the whole application area on a 5 m grid (better than 1:25,000 resolution);

- it is informed by electromagnetic survey information from a range of bands, which provide real-world detailed information on soil attributes;
- soil type distributions are mapped based on statistical relationships between measurements in the field and remotely sensed data, which provides a level of objectivity;
- comparison of field and modelled soil types provides an understanding of the accuracy and precision of soil mapping, which is not possible for soil mapping based on field sampling alone; and
- it meets the Interim Protocol's requirements.

1.5 Expert review

An expert review of the methods and results of the remote sensing soil type classification was conducted by Professor Bruce Forster. Professor Forster has a PhD in satellite remote sensing, is a former Director of the Centre for Remote Sensing and Geographic Information Systems at the University of New South Wales, and is the Managing Director of Asia Pacific Remote Sensing Pty Ltd. The expert review report is provided in Appendix A.

2 Remote sensing analysis of soil type classes in the application area

2.1 Overview

High resolution remotely-sensed data has been collated and statistically analysed, in conjunction with known soil properties determined from field surveys, to predict and map soil types across the application area.

Remote sensing is the science of accurate measurement of properties of surfaces without physical contact, often using electromagnetic radiation detected by airborne or satellite sensors. Remotely sensed data can be statistically and mathematically analysed to understand properties of environmental and other phenomena and associated processes (Jensen 2005).

The following general steps have been followed in this analysis:

1. Field and remote data collation, review and preparation.

2. Data analysis and mapping.

3. Assessment of confidence limits.

2.2 Remote sensing for soil type identification

Digital soil mapping applies remote sensing and spatial analysis techniques to soil sciences (Hartemink 2012). These techniques allow a combination of field measurements and remotely sensed data to be used to reliably map soil types between field soil survey points.

A soil type map created using remote sensing applications has the capacity to provide a statistical understanding of soil type distribution across the entire assessment area based on field survey results and remotely sensed data. This differs from a traditional soil map, which involves manually mapping soil type boundaries based on interpretation of field data, maps, aerial/satellite images and professional judgement.

This method extracts spectral data at the location of each field survey point from a range of remotely sensed data layers. It groups these values according to known soil type (as determined from the field program). Statistical analyses are then done to determine the characteristics of each soil type in each remotely sensed data layer. The derived statistical relationships between the field results and each data layer are then used to model soil type across the entire assessment area on a pixel-by-pixel basis and build the soil map.

Unlike traditional soil mapping techniques, use of remote sensing techniques also allows a transparent understanding of the uncertainty in the soil map produced (Rossiter 2012).

2.3 Method selection

2.3.1 Overview

There are many remote soil mapping approaches and methods available (Hartemink 2012). The applicability of a given method depends on a range of factors including the environment being mapped, available data and geographic scale.

A number of methods were considered for modelling soil type distribution in this assessment, including:

- principal component analysis;
- boosted regression trees; and
- supervised classification methods, including maximum likelihood analysis.

These methods were each trialled in consultation with Professor Bruce Forster from the University of New South Wales (refer to Section 1.5).

2.3.2 Principal component analysis – rejected

Principal component analysis was trialled but did not show relationships that revealed soil type distributions. The principal component layers produced provided information on surface cover but were not able to extend to inferring relationships to the soil beneath the surface cover.

2.3.3 Boosted regression trees – rejected

Boosted regression trees were trialled but were not able to effectively discern between soil types within the application area. In addition, this method included a small amount of randomness within each iteration, producing slightly different results each time the model was run. Because some of the soil types identified in the application area during field surveys show very similar characteristics, it was difficult to understand the relative accuracy of results each time the model was run.

2.3.4 Supervised classification – adopted

In a supervised classification of remotely sensed imagery, the analyst defines spectral 'regions of interest' (pixels which exemplify a particular soil type, also known as a 'class') in the application area, generally based on field survey results. The analyst selects imagery input layers which quantitatively and spatially describe features of the assessment area important in soil type distribution. The geographic coordinates of the regions of interests are then used to select training regions in the input imagery layers. The resultant groups of pixels within each remotely sensed layer give the features of each soil type in that layer. These clusters are analysed statistically to characterise each class. The relationships established in this way are then applied to each pixel in the assessment area, and a soil type class assigned to each pixel.

Supervised classification is useful in instances where there is reasonably good field survey coverage but without adequate spatial distribution, as is the case for the Hume Coal Project. There are a number of supervised classification methods, including 'parallel piped', 'minimum distance to mean' and 'maximum likelihood'. These are each based on different ways of statistically defining classes, based on the user-defined regions of interest.

Maximum likelihood analysis is a supervised classification method based on probability. Probability distribution plots are generated for each class by the cluster of pixel values of its region of interest in each imagery band (Figure 2.1). Each pixel is then assigned a class type based on the highest probability class fit for that pixel (Atkinson and Lewis 2000; Lo and Yeung 2002; Jensen 2005). Compared to other supervised classification methods, the maximum likelihood method is most effective for correctly classifying data where classes may be similar to each other. It is also able to compute statistical relationships for regions of interest across multiple bands of remotely sensed data.

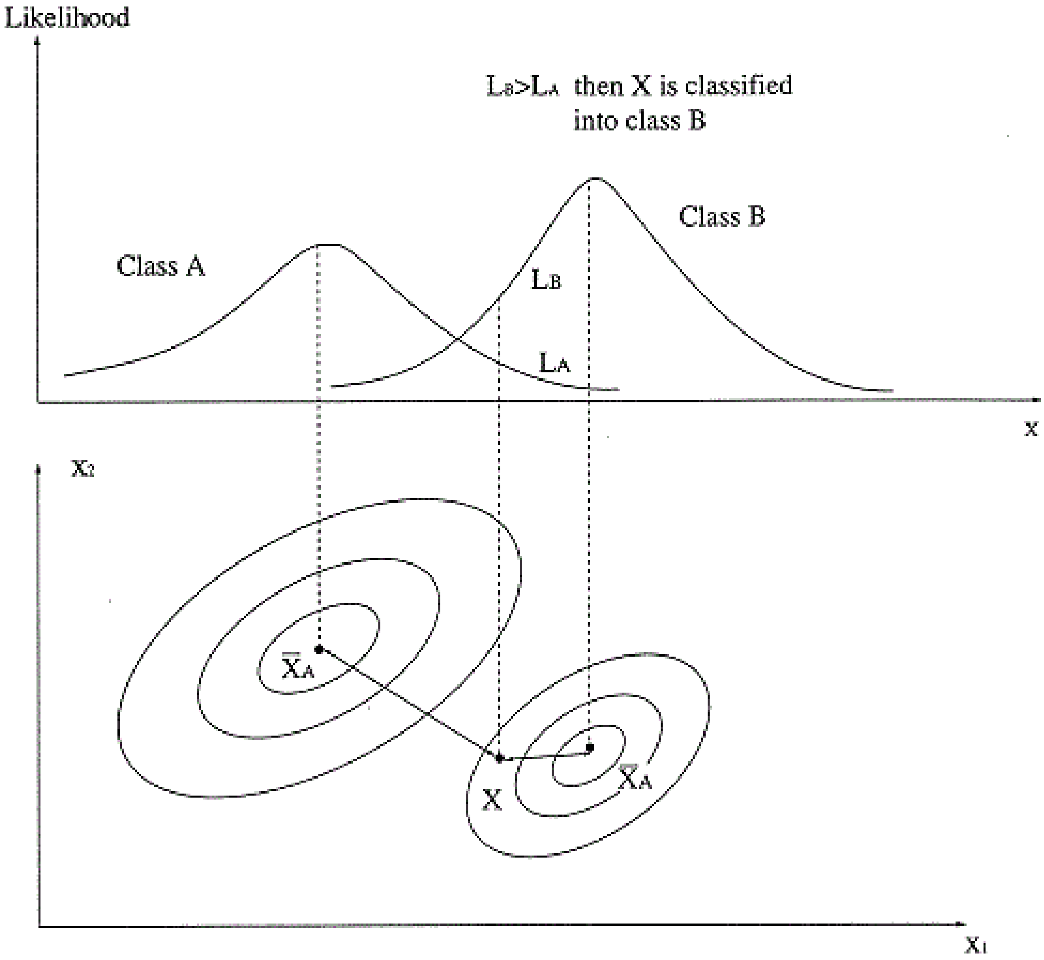


Figure 2.1 Example probability density curves (ACRoRS 1999)

The maximum likelihood analysis method was selected for the Hume Coal Project's soil mapping because:

- the application area is relatively small;
- the application area needs to be mapped in relatively high resolution (1:25,000); and
- some soil types identified in field surveys are similar to each other and the analysis plots probability density for each class in the input datasets, so is able to correctly differentiate between different classes with better accuracy than other methods (Jensen 2005).

2.4 Data collation, review and preparation

2.4.1 Input datasets

The SCORPAN framework was used in this assessment to inform the selection of appropriate input remote sensing datasets. The SCORPAN model (McBratney et al 2003) is a modification of Jenny's (1941) seminal model for soil type classifications. The SCORPAN model defines the factors that control soil development as:

$$S_c = f(c, o, r, p, a, n)$$

Where:

S_c: soil

c: climate

o: organisms (vegetation, fauna, human activity)

r: topography, landscape attributes

p: parent material, lithology

a: age, time

n: space, spatial position

Reliable data for each of the SCORPAN factors is not always available. Further, some factors may be more informative about soil types than others depending on the mapping scale and location.

Only the most relevant input layers should be used for maximum likelihood analysis. This minimises statistical 'noise' and maximises output accuracy (Jensen 2005), by maintaining precision in the probability distribution boundaries (see Figure 2.1). The resulting relationships improve the accuracy of classification results and minimise misclassification of soil types.

A number of potential raster remote sensing datasets were reviewed to determine their suitability for inclusion in the maximum likelihood analysis. These included a range of gamma radiometric data layers, geology and vegetation data. Some datasets were not in the correct format for implementation by the model and/or produced statistical relationships which distorted the model's ability to predict more than one soil type; these datasets were not used.

After data review, six raster datasets and one layer of point data from field surveys were used for the maximum likelihood classification (Table 2.1).

Table 2.1 Input datasets for maximum likelihood classification

Data type	SCORPAN factor	Input dataset	Source
Topography	r, n	Digital elevation model	Airborne survey conducted by AAM (25 October 2013)
Topography	r	Slope model	Derived from digital elevation model data (above)
Gamma radiometric imagery	p, c, a	Gamma radiometrics – total count	Airborne survey conducted by Fugro Airborne Surveys (December 2001)
Gamma radiometric imagery	p, c, a	Gamma radiometrics – thorium	Airborne survey conducted by Fugro Airborne Surveys (December 2001)

Table 2.1 Input datasets for maximum likelihood classification

Data type	SCORPAN factor	Input dataset	Source
Gamma radiometric imagery	p, c, a	Gamma radiometrics – potassium	Airborne survey conducted by Fugro Airborne Surveys (December 2001)
Satellite imagery	o	Normalised Difference Vegetation Index (NDVI)	Landsat ETM+ image (captured on 31 January 2014)
Field survey data[1]	S_c	Point soil type classification data	Check and detailed survey site data from field soil sampling in the application area, based on the *Australian Soil Classification* (McDonald et al. 1990)

Note: *1. Details of field soil sampling and soil point classification are provided in the EMM (2015) Biophysical Strategic Agricultural Land Verification Assessment.*

The remotely sensed imagery datasets were in raster format (ESRI GRID files). All raster datasets were resampled to a 5 m by 5 m cell to provide a resolution better than 1:25,000. All datasets were clipped to the assessment area boundary, comprising the proposed mining and mining purposes lease application areas plus a 100 m buffer, as per the Interim Protocol.

The gamma radiometric imagery does not cover a small area in the north of the application area (Figure 3.1). Given that this imagery was a key dataset to map soil types, the soil types in this northern area were not mapped using remote sensing methods. Good field survey coverage was achieved in this northern area and used by EMM's soil scientists to manually map soil types there (refer to Figure 4.1 in main report for results).

Of the 246 soil sampling points within and immediately to the application area, 221 were used in the maximum likelihood analysis. These were the points within the region covered by the input datasets, and had been assigned a soil type based on the field survey program. One check site was excluded from the analysis because it comprised rock outcrop and so had not been assigned a soil type in the field. The remaining 24 soil sampling points were excluded as they are beyond the model domain, being in the northern portion of the application area not covered by the gamma radiometric imagery (Figure 3.2).

2.4.2 Topography

Terrain and landscape are significant factors in soil type distribution, facilitating weathering from ridges and slopes, accumulation of weathered material in valleys and erosion of parent material by river channels. They also influence the moisture contents of soils (McBratney et al 2003).

Airborne LiDAR surveys were conducted by AAM for Hume Coal in 2013. The results were used to prepare a digital elevation model for the assessment area. The digital elevation model provides terrain data and allows slopes to be calculated.

2.4.3 Gamma radiometric imagery

An airborne magnetic and radiometric survey was conducted by Fugro Airborne Services Pty Ltd in December 2001 for Anglo Coal Australia Pty Ltd (Encom 2002).

High resolution spatial data about geological source material can be a useful tool to ascertain soil type because soil formation occurs with weathering of parent material (Wilford et al 1997; International Atomic Energy Agency 1991). Thorium is generally immobile in the environment and is used as a proxy for parent material. Potassium is slightly more mobile and can indicate areas of weathering as well as parent material of different types (Wilford et al 1997; International Atomic Energy Agency 2010, 1991).

Gamma radiometric imagery measures thorium and potassium levels, and therefore provides information on the mineralogy and geochemistry of soils. This indicates geological source material, an important determinant of soil type (Viscarra Rossel et al 2007; Taylor et al 2002). This imagery can be included in a model to account for the geology of an area.

2.4.4 Satellite imagery

Dense vegetation cover can attenuate the electromagnetic signals that form the basis of a remote sensing dataset, distorting the data. A vegetation index can be used to identify areas where dense vegetation cover exists, assisting the model to factor this into the statistical relationships made for each class.

This assessment used the Normalised Difference Vegetation Index (NDVI), which is widely used to identify vegetation cover density across a multispectral image. The NDVI differentiates between densely vegetated areas, less densely vegetated areas (for example cropland), and sparsely vegetated areas (Jensen 2005).

Landsat ETM+ imagery was used to calculate the NDVI. Landsat TM and Landsat ETM+ imagery for the application area are captured every 16 days. The 31 January 2014 Landsat ETM+ imagery used for the assessment was captured during relatively dry ground conditions and has minimal cloud cover interference. Higher soil water content and higher vegetation density attenuate the radiometric signal in the visible and near infrared bands captured by Landsat imagery. Imagery captured in drier conditions is therefore more useful for understanding soils, though corrections still need to be applied to counteract the differential effects of differing vegetation densities on the radiometric signal across an area. That is, to isolate the soils-related component as much as possible.

The Landsat ETM+ imagery captured closer to when the gamma airborne survey was conducted (2001) is less suitable for determining the NDVI because the land surface was covered by much higher vegetation density at that time. Increased vegetation cover results in increased attenuation of electromagnetic radiation, resulting in the return signal giving less accurate data regarding soil properties and more data about vegetation properties. For the purposes of this study, satellite imagery taken during drier conditions, where there is less vegetation cover on the ground, provides a more effective input for analysis and mapping of soil type distribution in the area. After reviewing all Landsat imagery over this area captured between 2001 and 2014, the more recent (2014) imagery, captured when conditions were considerably drier, was selected and used in analysis.

In applying the 2014-derived NDVI to the 2001 gamma radiometric data, it was important to check that the areas of grassland and forest vegetation had not significantly changed in extent in the intervening period. All Landsat ETM+ imagery captured from 2001 to 2014 was reviewed. The spatial distribution of grassland and forested areas remained consistent between 2001 and 2014. Therefore, use of the NDVI generated from recent Landsat ETM+ imagery (2014) is applicable to all input raster datasets and appropriately shows differences in vegetation density across the assessment area.

2.5 Data analysis and mapping

The maximum likelihood analysis was performed using ArcMap 10.2.2 software to produce a map of soil types across the assessment area (Figure 3.1). This was undertaken by the following steps:

1. Field-derived soil type data were plotted to understand spatial distribution.

2. Univariate statistical analyses of the properties of each of these soil types was undertaken to understand the ranges in which values fall for each factor considered and properties of each distribution.

3. A number of remotely sensed data layers, including airborne and satellite imagery and their derivatives were pre-processed.

4. Geostatistical analyses of remotely sensed data were undertaken in relation to soil survey points to understand the relationships between the soil types in the area.

5. Supervised classification using the maximum likelihood method was used to generate a map of soil type distribution, showing the probable soil type for each cell in the assessment area.

6. The similarity between field survey results at each of the sampling points with soil type distribution predicted by the maximum likelihood method was assessed to understand confidence levels of results.

3 Results

3.1 Soil type classification map

Modelled soil types in the application area, determined using remote sensing methods, are shown in Figure 3.1.

3.2 Confidence levels

As with any model, it is important to understand the confidence level associated with the results. This is established by ground-truthing across the assessment area to assess the degree to which the model is able to correctly predict the point data classifications and patterns established from soil surveys.

3.2.1 Classification similarities and differences by soil type

The soil type classification similarities and differences, that is, which points were classified the same by field survey and remote sensing and which were classified differently, are summarised in Table 3.1 and shown on Figure 3.2.

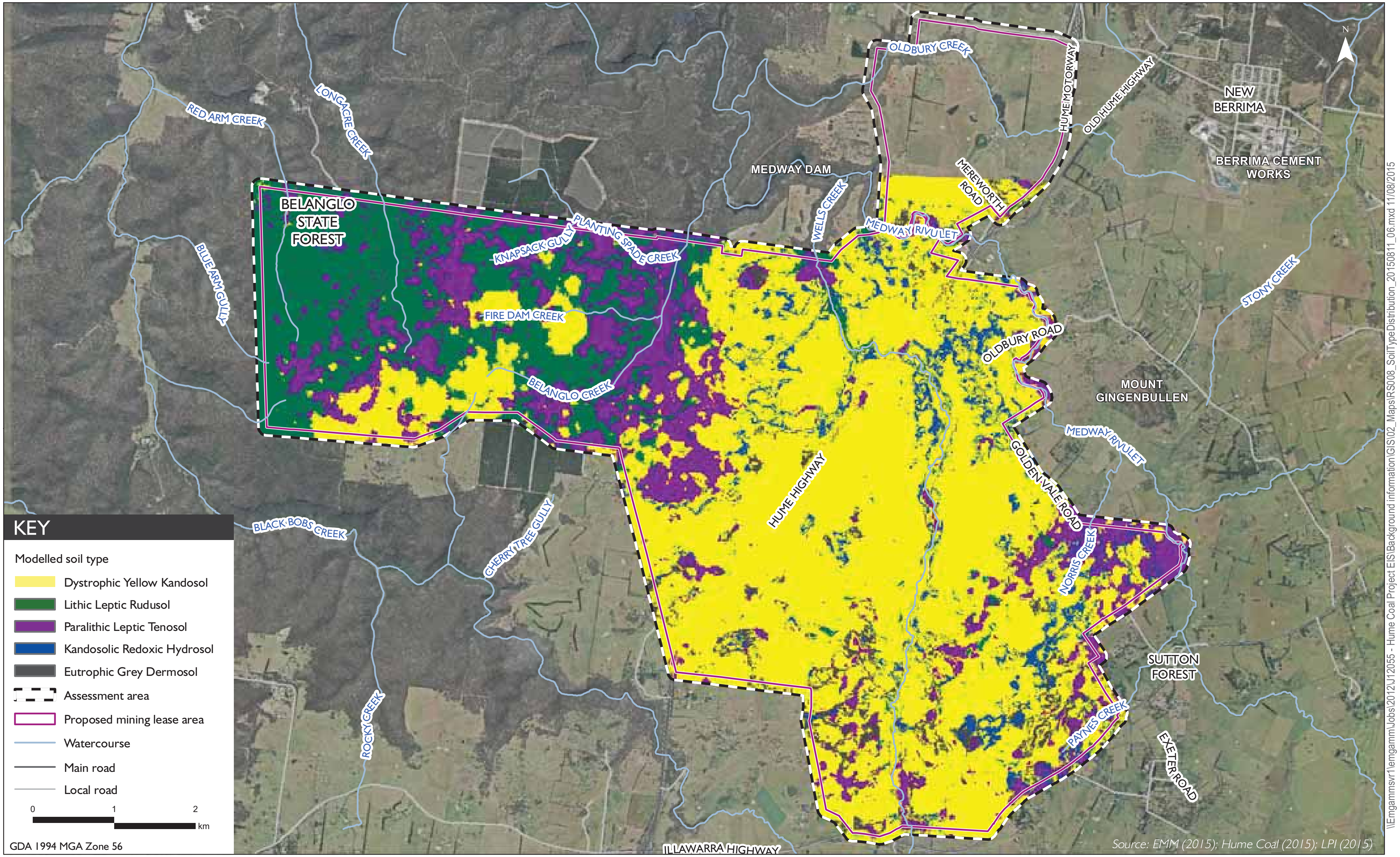
Table 3.1 Classification similarities and differences

		Soil types – classified by remote sensing					
		Dystrophic Yellow Kandosol	Eutrophic Grey Dermosol	Kandosolic Redoxic Hydrosol	Lithic Leptic Rudosol	Paralithic Leptic Tenosol	Total
Soil types – classified by field survey	Dystrophic Yellow Kandosol	114	3	11	9	17	154
	Eutrophic Grey Dermosol		7				7
	Kandosolic Redoxic Hydrosol		1	5	1		7
	Lithic Leptic Rudosol	2			22	5	29
	Paralithic Leptic Tenosol	3			4	17	24
	Total	119	11	16	36	39	221

Note: Shaded cells indicate a match between the soil types determined by field survey and remote sensing.

In summary, of the 221 field survey points used in the analysis, approximately 75% were classified as the same soil type by the model and approximately 25% were classified differently. In each instance where the two differed, the field survey point was 50 m or less from the model-predicted boundary of that same soil type (Figure 3.2), even in regions which showed complex soil formation factors. This spatial accuracy would be difficult to achieve with manual soil mapping techniques, especially at a high resolution of 1:25,000.

Most instances where there are differences between field survey and model predicted soil type classifications are for Dystrophic Yellow Kandosols. However, results still show high levels of correct classification (>74%). The differences were mainly where soil survey points classified as Dystrophic Yellow Kandosols in the field were predicted to be a different soil type by the model (40 locations). However in some instances, soil survey points classified as something other than a Kandosol in the field were classified as Dystrophic Yellow Kandosols by the model (five locations). These results suggest that the probability distribution for Dystrophic Yellow Kandosols has a wider spread within the maximum likelihood model compared to the other soil types (and therefore more overlap with the probability distributions for other soil types). Accordingly, it is possible that in some areas with more complex soil formation factors, Dystrophic Yellow Kandosols may exist but have been classified by the model as a different soil type. This is not likely to be extensive, or to extend to areas with less complex soil formation factors.



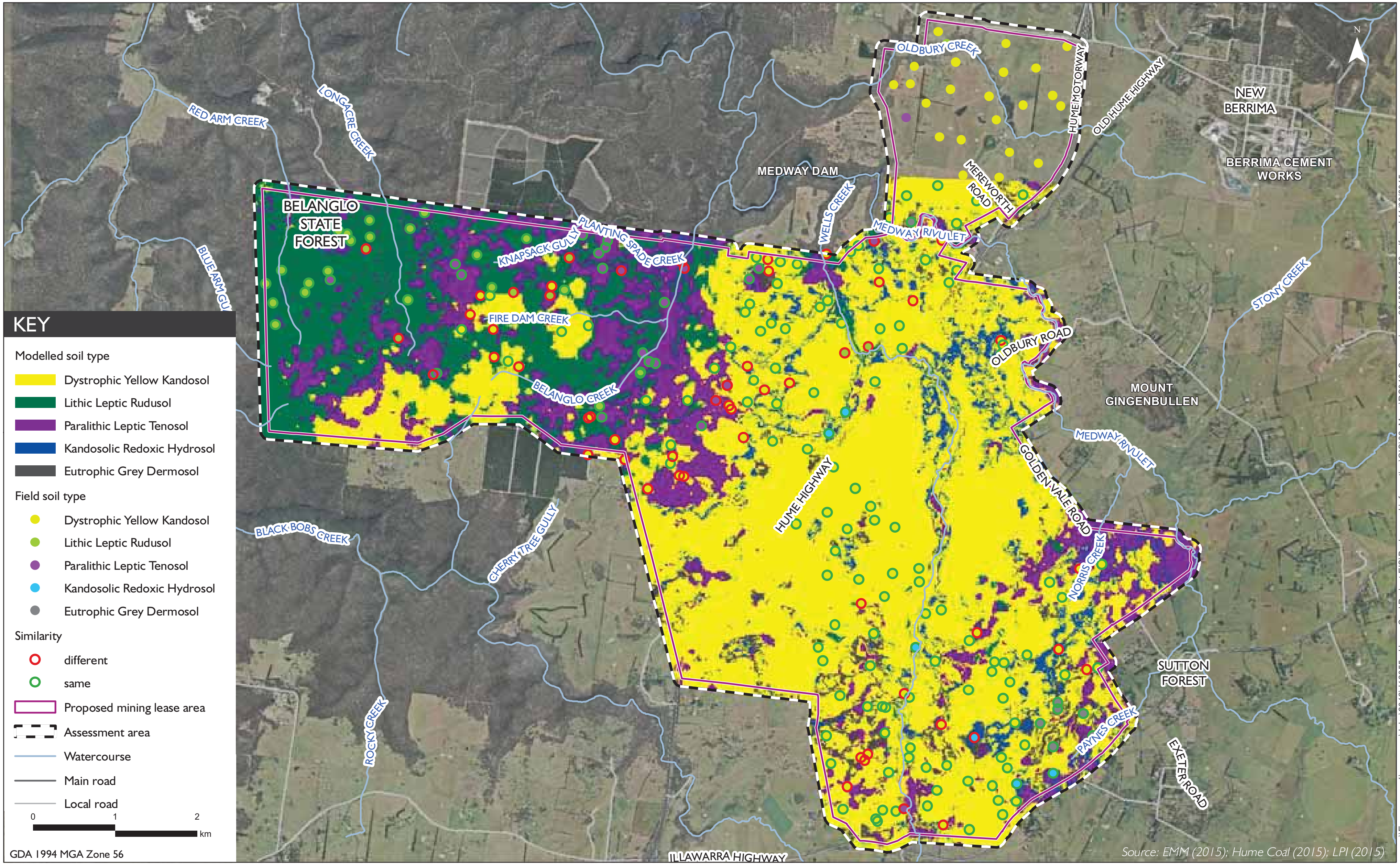
EMM HUMECOAL

Soil type distribution

Hume Coal Project

Soil mapping using remote sensing techniques

Figure 3.1



EMM
HUMECOAL project

Comparison between maximum likelihood model and field survey results

Hume Coal Project

Soil mapping using remote sensing techniques

Figure 3.2

Eutrophic Grey Dermosols are generally classified well by the maximum likelihood model, with 100% of soil survey points classified as this soil type in the field predicted correctly by the model. There were four instances of the model predicting a pixel of Eutrophic Grey Dermosol where field surveys showed a different soil type.

The model also has high levels of accuracy in its ability to predict regions where Kandosolic Redoxic Hydrosols occur, accurately predicting five of the seven points classified as this soil type in the field. However, the results indicate some overlap between the probability distributions for Kandosolic Redoxic Hydrosols and Dystrophic Yellow Kandosols and in some instances this soil type may be predicted where Kandosols actually occur.

Of the 29 sites classified as Lithic Leptic Rudosols in the field surveys, 22 (76%) were similarly classified by the model, which indicates that it is reasonably accurate in predicting occurrence of this soil type. The results indicate that, as is the case with Kandosolic Redoxic Hydrosols (and Paralithic Leptic Tenosols), there is some overlap between its probability distributions with those for Dystrophic Yellow Kandosols.

Of the 24 sites classified as Paralithic Leptic Tenosols in the field surveys, 17 (71%) were similarly classified by the model, with the remainder predicted to be either Dystrophic Yellow Kandosols or Lithic Leptic Rudosols by the model. There is some overlap between the probability distributions for Paralithic Leptic Tenosols with those for Dystrophic Yellow Kandosols and Lithic Leptic Rudosols.

3.2.2 Classification differences by area

The spatial distribution of field survey point soil type classification compared to model soil type classification across the assessment area is shown in Figure 3.2.

There is a strip of land from north-east to south-west across the centre of the application area where field-classified soil types have a higher likelihood of differing from the model results, albeit that all disparate points are within 50 m of the modelled soil type of the same class. This region is a transition zone between extensive Dystrophic Yellow Kandosol soils to the east and a mixture of Paralithic Leptic Tenosol and Lithic Leptic Rudosol soils to the west. This area shows complexity in all of the input layers. There are many small regions of different soil types in this transition zone, and so the soil type classification for any given 5 m by 5 m pixel in this region is more likely to be between two or more soil type probability density curves (Figure 2.1).

The topography and surface cover of the western region of the application area, in Belanglo State Forest, is similarly complex. Use of an NDVI layer to account for dense vegetation in this area is believed to have improved the ability of the model to correctly classify soil types in this area, however some differences between field and model results are still apparent.

Sites where there are differences between field results and model predictions are generally close to a modelled soil type boundary. Soil type definitions provide a tool for naming soils and require thresholds where one soil type is considered to become another. Soils are also mobile. Hence, there are often graded (indeterminate) boundaries between soil types, which can make it difficult to delineate a soil type boundary, particularly distinct boundaries in complex areas and transition zones (Burroughs 1996). Indeed, a transitional Tenosol (grading to a Kandosol) was identified within the application area during the field surveys, on an isolated sandstone outcrop just east of Belanglo State Forest (EMM 2015). It is therefore likely that some of the points where the field survey and model-predicted soil types differ are within the transition zone between two or more soil types, and in fact some combination of these soil types may be present within the 5 m by 5 m pixel area.

Regardless of where actual soil type boundaries occur, it is important to note that none of the soil types found in the field surveys or predicted by the model have the capacity to be BSAL. This is due to a range of limitations such as low to moderately low soil fertility, poor drainage, high acidity, high salinity and chemical and physical barriers to plant rooting such as sodicity or rock, as discussed in the main report (EMM 2015).

4 Conclusion

To fulfil the Interim Protocol's requirements to map soil types in the Hume Coal Project's SVC application area, the spatial distribution of soil types has been mapped using remote sensing techniques to complement the field-based soil surveys. The mapping of soil types by remote sensing used maximum likelihood classification to produce a map with a pixel size of 5 m by 5 m and a resolution better than 1:25,000.

Field surveys and remote sensing model predictions show the presence of Dystrophic Yellow Kandosols, Kandosolic Redoxic Hydrosols, Paralithic Leptic Tenosols, Lithic Leptic Rudosols and Eutrophic Grey Dermosols in the SVC application area. These soil types do not have the capacity to be BSAL.

Abbreviations

A349	exploration authorisation 349
BSAL	biophysical strategic agricultural land
CIC	critical industry cluster
EIS	environmental impact statement
EM	electromagnetic
EMM	EMGA Mitchell McLennan Pty Limited
ha	hectares
Hume Coal	Hume Coal Pty Limited
Interim Protocol	NSW Government (2013) *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land*
LGA	local government area
m	metres
Mining SEPP	State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007
NDVI	Normalised Difference Vegetation Index
NSW	New South Wales
SRLUP	NSW Government (2012a) *Strategic Regional Land Use Policy*
SVC	site verification certificate

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Appendix A

Expert review letter

Asia-Pacific Remote Sensing

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Email: forster.bruce@gmail.com

Mr. Luke Edminson 6th August, 2015

Hume Coal Pty Ltd

Manager – Environmental Planning

Unit 7-8 Clarence House

9 Clarence Street, Moss Vale, NSW, 2577

Dear Mr. Edminson

I have been asked to provide a review of the methods and report "Soil Mapping using Remote Sensing Techniques" prepared by EMM for the Hume Coal Project. I am an internationally recognized expert in remote sensing and recently a Visiting Professorial Fellow in the Faculty of Engineering at the University of NSW (UNSW), Managing Director of Asia-Pacific Remote Sensing Pty Ltd, and formerly the Director of the Centre for Remote Sensing and GIS at UNSW. I have a Bachelor and Master Degree in surveying and mapping from Melbourne University, a Master of Science degree from the University of Reading, and a PhD in satellite remote sensing from UNSW. I have undertaken consulting for a wide range of organizations both nationally and internationally, including BHP, Unisearch, Murray Darling Authority, AusAid, World Bank and the Asian Development Bank.

The aim of the remote sensing work was to use a combination of satellite remotely sensed digital image data and airborne radiometric data, combined with other spatial data sources, including elevation and slope data, and soil data collected by field surveys, to predict and map soil types over the Hume Coal Project area.

A preliminary meeting was held with Roshni Sharma of EMM on the 11th of September, 2014, at the University of NSW, to review both the remotely sensed and field sampled soil data and to discuss the range of methods that might be appropriate for predicting soil types. Further meetings were held on a weekly basis at UNSW ranging from one to two hours, through to the 22nd of October, to discuss the methods and examine the results of a number of different approaches that I had recommended. In addition, I independently reviewed interim results outside of these meetings.

The analysis stages decided upon in joint discussions, and varied and added to as work progressed, were as follows –

(1) Undertake a multivariate analysis of all the spatial data, to determine the correlation between the variables and to extract principal components to allow a better understanding of the relationship between, and the importance of, each of the variables.

(2) Resample all spatial data to a 5m resolution to allow extracted results to be presented at a finer scale than 1:25,000 and all data to be spatially registered.

(3) Produce overlay maps of the principal components and individual variables, with the soil type point data established from field surveys, to determine and examine any obvious spatial correlation.

(4) Undertake preliminary testing of a number of different methods, including decision trees and maximum likelihood classification, and analysis and comparison of the results.

(5) Use a Normalised Difference Vegetation Index (NDVI) as a vegetation surrogate to offset the attenuating effects of the spatially variable forest cover on the airborne radiometric data, so as to improve the correlation between soil properties (established from field surveys) and this data. The NDVI has low values for bare soil and high values for dense forest, and as the amount of attenuation, to a first order, is directly related to the density of forest cover, then the NDVI will allow separation of attenuated and non-attenuated data.

(6) Examine a number of Landsat TM satellite images from different dates to select an image that was clear of cloud and was acquired at a similar seasonal time to the radiometric data.

(7) Calculate a Normalised Difference Vegetation Index (NDVI), from the near infrared and visible red spectral bands of Landsat TM over the project area.

(8) Develop a maximum likelihood classification approach using selected radiometric data, elevation and slope data. The use of two separate classes for each soil – one under forest and one in open fields – to counteract the effects of forest attenuation on the radiometric data, was initially considered but rejected due to limited sampled points in each soil class. Subsequently, use an alternative approach, by incorporating the NDVI layer into the maximum likelihood classification

(9) Test the confidence of the resulting soil classification using an omission – commission error matrix.

(10) Jointly review the results.

I believe the maximum likelihood classification approach, with the inclusion of the NDVI data that was used in the final analysis, is theoretically sound and is the method that produced the most accurate results. It therefore meets the aim of predicting and classifying soil classes using remotely sensed data.

The omission- commission error matrix indicates that the soil map has a confidence level of 75% or above. It can be seen from the results that some classified soils do not accord with the field sampled soil results. However international mapping standards dictate that well defined points and boundaries should have a 90% probability of being no more than +/- 0.5mm error at map scale. At a 1:25,000 map scale, this means an acceptable error of +/- 12.5m. Thus a predicted soil type boundary and a sampled point of the same soil type could, theoretically, be 25m apart before an error was assumed. In addition soil boundaries are not well defined lines, but more zones of transition between one soil class and another, where the probability of being one or other soil varies across the zone, being approximately 50:50 near the centre of the zone. In a similar way, based on probabilities, the maximum likelihood classifier gives a label to a class if it has a greater than 50% probability of belonging to that class rather than another. Probability will therefore decrease to 50% at the boundary but will greatly increase away from the boundary.

Considering these factors, I would estimate that overall the results have a better confidence level than the 75% indicated by the error matrix.

Yours sincerely

Dr Bruce Forster, AM, FIE(Aust.)

Appendix C

Site photographs

Table C.1 shows landscape and profile photographs for all detailed survey sites with laboratory analysis.

Table C.1 Landscape and soil profile photographs

Site number	Landscape	Profile
Dystrophic Yellow Kandosol		
15		
32		
44		

Table C.1 Landscape and soil profile photographs

Site number	Landscape	Profile
133		
183		
267		

Table C.1 Landscape and soil profile photographs

Site number	Landscape	Profile
388		
404		
472		

Table C.1 Landscape and soil profile photographs

Site number	Landscape	Profile
481		
502		

Table C.1 Landscape and soil profile photographs

Site number	Landscape	Profile
592		
594		
595		

Table C.1 Landscape and soil profile photographs

Site number	Landscape	Profile
596		
Kandosolic Redoxic Hydrosol		
4		
10		

Table C.1 Landscape and soil profile photographs

Site number	Landscape	Profile
92		
238		
454		

Table C.1 Landscape and soil profile photographs

Site number	Landscape	Profile
524		
	For information purposes only, the adjacent photograph shows a Kandosolic Redoxic Hydrosol soil profile within a soil pit dug within the SVC application area, at an area representative of this soil type. The site is classified as a check site, in accordance with the Interim Protocol, as laboratory analysis has not been undertaken. Accordingly detailed results from this site have not been provided elsewhere in this BSAL Verification Assessment report.	

Table C.1 Landscape and soil profile photographs

Site number	Landscape	Profile
Paralithic Leptic Tenosol		
73		
83		
126		

Table C.1 Landscape and soil profile photographs

Site number	Landscape	Profile
263		
287		
300		

Table C.1 Landscape and soil profile photographs

Site number	Landscape	Profile
Lithic Leptic Rudosol		
264		
414		
474		

Table C.1 Landscape and soil profile photographs

Site number	Landscape	Profile
Eutrophic Grey Dermosol		
152		
181		
278		

Appendix D

Laboratory accreditation

Australasian Soil and Plant Analysis Council Inc.

This is to certify that

Australian Laboratory Services

meets ASPAC's proficiency criteria for the following methods conducted in the Soil Proficiency Testing Programme, 2013/14

• **Exchangeable Calcium**	**15A1**
• **Exchangeable Potassium**	**15A1**
• **Exchangeable Magnesium**	**15A1**
• **Exchangeable Sodium**	**15A1**
• **Extractable Copper**	**12A1**
• **Extractable Manganese**	**12A1**
• **Bray Extractable P**	**9E1, 9E2**
• **Colwell Extractable P**	**9B1, 9B2**
• **Olsen Extractable P**	**9C1, 9C2**
• **Nitrate Nitrogen**	**7B1**
• **Soil pH**	**4A1**
• **Soil pH**	**4B2, 4B4**
• **Total Phosphorus**	**Pooled**

Method codes are from Rayment and Lyons (2011)

T. Fowles

T. Fowles
Chairperson, ASPAC

R. Hill

R. Hill
Convenor, Lab Proficiency Committee

NATA Accredited Laboratory

National Association of Testing Authorities, Australia
(ABN 59 004 379 748)

has accredited

ALS Laboratory Group
Brisbane Laboratory

following demonstration of its technical competence
to operate in accordance with

ISO/IEC 17025

This facility is accredited in the field of

Chemical Testing

for the tests shown on the *Scope of Accreditation* issued by NATA

Alan Patterson
Chief Executive

Date of accreditation: 10 April 1970
Accreditation number: 825
Corporate site number: 818

NATA
WORLD RECOGNISED
ACCREDITATION

NATA is Australia's government-endorsed laboratory accreditor, and a leader in accreditation internationally. NATA is a signatory to the international mutual recognition arrangements of the International Laboratory Accreditation Cooperation (ILAC) and the Asia Pacific Laboratory Accreditation Cooperation (APLAC).

Appendix E

Laboratory analysis results

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1317604**	Page	: 1 of 10
Amendment	: **2**		
Client	: **EMGA MITCHELL MCLENNAN**	Laboratory	: Environmental Division Brisbane
Contact	: MR NEIL CUPPLES	Contact	: Customer Services EB
Address	: 1/4 87 WICKHAM TERRACE SPRING HILL QLD 4000	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: ncupples@emgamm.com	E-mail	: ALSEnviro.Brisbane@alsglobal.com
Telephone	: 07 3839 1800	Telephone	: +61 7 3243 7222
Facsimile	: 07 3839 1866	Facsimile	: +61 7 3243 7218
Project	: Hume Coal Project	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 24-JUL-2013
Sampler	: Neil Cupples	Issue Date	: 11-AUG-2015
Site	: ----		
		No. of samples received	: 20
Quote number	: BN/005/13 v2	No. of samples analysed	: 20

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA

WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Hamish Murray	Supervisor - Soils	Newcastle - Inorganics
Jonathon Angell	Inorganic Coordinator	Brisbane Inorganics
Satishkumar Trivedi	Acid Sulfate Soils Supervisor	Brisbane Acid Sulphate Soils
Satishkumar Trivedi	Acid Sulfate Soils Supervisor	Brisbane Inorganics

General Comments

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

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

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **EK059G (Nitrite and Nitrate as N): Some samples were diluted due to matrix interference. LOR adjusted accordingly.**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	474 0-3	474 3-10	388 0-10	388 10-20	388 20-30
			Client sampling date / time	18-JUL-2013 15:00	18-JUL-2013 15:00	18-JUL-2013 15:00	18-JUL-2013 15:00	18-JUL-2013 15:00
Compound	CAS Number	LOR	Unit	EB1317604-001	EB1317604-002	EB1317604-003	EB1317604-004	EB1317604-005
EA150: Particle Sizing								
+75µm	----	1	%	64	74	51	54	55
+150µm	----	1	%	58	65	28	31	31
+300µm	----	1	%	42	39	5	9	10
+425µm	----	1	%	33	24	3	7	9
+600µm	----	1	%	24	14	2	6	9
+1180µm	----	1	%	16	7	1	6	8
+2.36mm	----	1	%	11	5	<1	4	6
+4.75mm	----	1	%	2	2	<1	<1	3
+9.5mm	----	1	%	<1	<1	<1	<1	<1
+19.0mm	----	1	%	<1	<1	<1	<1	<1
+37.5mm	----	1	%	<1	<1	<1	<1	<1
+75.0mm	----	1	%	<1	<1	<1	<1	<1
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.8	5.3	5.9	5.9	6.1
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	15	22	24	24	18
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	30.2	18.3	21.8	19.5	16.2
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	9	11	16	15	18
Silt (2-60 µm)	----	1	%	27	14	32	29	25
Sand (0.06-2.00 mm)	----	1	%	53	70	51	52	51
Gravel (>2mm)	----	1	%	11	5	1	4	6
Cobbles (>6cm)	----	1	%	<1	<1	<1	<1	<1
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	6.1	4.7	2.8	2.6	2.4
Exchangeable Magnesium	----	0.1	meq/100g	1.2	0.8	0.9	0.7	0.5
Exchangeable Potassium	----	0.1	meq/100g	0.2	0.2	0.2	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	7.5	5.7	3.9	3.3	3.0
ED022: Acid Extractable Pottasium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	100	<100	100	<100	<100
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	474 0-3	474 3-10	388 0-10	388 10-20	388 20-30
			Client sampling date / time	18-JUL-2013 15:00	18-JUL-2013 15:00	18-JUL-2013 15:00	18-JUL-2013 15:00	18-JUL-2013 15:00
Compound	CAS Number	LOR	Unit	EB1317604-001	EB1317604-002	EB1317604-003	EB1317604-004	EB1317604-005
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM) - Continued								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	<50	<50	<50	<50
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.05**	**0.05**	**0.05**	**0.04**	**0.04**
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	**40**	**30**	**30**	**30**	**20**
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
Iron	7439-89-6	1.00	mg/kg	**512**	**226**	**151**	**155**	**92.6**
Manganese	7439-96-5	1.00	mg/kg	**14.6**	**4.57**	**67.5**	**62.4**	**70.6**
Zinc	7440-66-6	1.00	mg/kg	**3.19**	<1.00	**1.04**	<1.00	<1.00
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	**130**	**210**	**300**	**240**	**220**
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**1560**	**5770**	**4180**	**5430**	**6070**
Molybdenum	7439-98-7	2	mg/kg	**3**	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	<0.5	<0.5	**0.3**	**0.1**	<0.1
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**2700**	**1680**	**1550**	**1200**	**880**
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	**2700**	**1680**	**1550**	**1200**	**880**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**230**	**179**	**253**	**202**	**207**
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	**4**	**6**	**4**	**2**	<2
EP004: Organic Matter								
Organic Matter	----	0.5	%	**12.0**	**6.2**	**4.1**	**2.0**	**0.8**
Total Organic Carbon	----	0.5	%	**7.0**	**3.6**	**2.4**	**1.2**	<0.5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	388 42-50	388 50-60	388 70-75	287 0-10	287 10-20
			Client sampling date / time	18-JUL-2013 15:00	18-JUL-2013 15:00	18-JUL-2013 15:00	18-JUL-2013 15:00	18-JUL-2013 15:00
Compound	CAS Number	LOR	Unit	EB1317604-006	EB1317604-007	EB1317604-008	EB1317604-009	EB1317604-010
EA150: Particle Sizing								
+75µm	----	1	%	53	50	36	80	78
+150µm	----	1	%	31	29	19	70	66
+300µm	----	1	%	10	10	4	34	28
+425µm	----	1	%	9	9	4	18	12
+600µm	----	1	%	9	9	4	7	4
+1180µm	----	1	%	8	8	3	3	1
+2.36mm	----	1	%	6	6	2	1	<1
+4.75mm	----	1	%	2	<1	1	<1	<1
+9.5mm	----	1	%	<1	<1	<1	<1	<1
+19.0mm	----	1	%	<1	<1	<1	<1	<1
+37.5mm	----	1	%	<1	<1	<1	<1	<1
+75.0mm	----	1	%	<1	<1	<1	<1	<1
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	6.1	5.8	5.1	5.6	5.3
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	34	48	99	9	8
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	13.8	14.8	18.4	11.2	10.0
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	21	24	39	11	12
Silt (2-60 µm)	----	1	%	23	22	21	8	10
Sand (0.06-2.00 mm)	----	1	%	50	48	37	80	78
Gravel (>2mm)	----	1	%	6	6	3	1	<1
Cobbles (>6cm)	----	1	%	<1	<1	<1	<1	<1
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	1.7	1.5	0.9	0.9	0.1
Exchangeable Magnesium	----	0.1	meq/100g	0.8	1.0	2.1	0.4	0.1
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.1	0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	2.6	2.7	3.2	1.4	0.3
ED022: Acid Extractable Pottasium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	<100	<100	<100	<100	<100
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	388 42-50	388 50-60	388 70-75	287 0-10	287 10-20
			Client sampling date / time	18-JUL-2013 15:00	18-JUL-2013 15:00	18-JUL-2013 15:00	18-JUL-2013 15:00	18-JUL-2013 15:00
Compound	CAS Number	LOR	Unit	EB1317604-006	EB1317604-007	EB1317604-008	EB1317604-009	EB1317604-010
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM) - Continued								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	<50	<50	<50	<50
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	**50**	**70**	**170**	<10	<10
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
Iron	7439-89-6	1.00	mg/kg	**26.5**	**17.8**	**16.8**	**101**	**55.0**
Manganese	7439-96-5	1.00	mg/kg	**21.1**	**3.00**	<1.00	**2.26**	<1.00
Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	**220**	**260**	**400**	**140**	**120**
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**6310**	**7430**	**12400**	**8460**	**9380**
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**520**	**370**	**330**	**540**	**460**
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	**520**	**370**	**330**	**540**	**460**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**161**	**189**	**181**	**112**	**83**
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	<2	<2	<2	**3**	<2
EP004: Organic Matter								
Organic Matter	----	0.5	%	**0.8**	**1.2**	**3.1**	**2.3**	**2.2**
Total Organic Carbon	----	0.5	%	<0.5	**0.7**	**1.8**	**1.3**	**1.3**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	287 20-30	287 50-60	287 70-75	15 0-10	15 15-20
Client sampling date / time				18-JUL-2013 15:00	18-JUL-2013 15:00	18-JUL-2013 15:00	17-JUL-2013 15:00	17-JUL-2013 15:00
				EB1317604-011	EB1317604-012	EB1317604-013	EB1317604-014	EB1317604-015
EA150: Particle Sizing								
+75µm	----	1	%	74	72	69	60	56
+150µm	----	1	%	62	62	59	38	35
+300µm	----	1	%	24	27	28	22	18
+425µm	----	1	%	10	12	13	12	9
+600µm	----	1	%	2	3	3	7	4
+1180µm	----	1	%	<1	<1	<1	3	1
+2.36mm	----	1	%	<1	<1	<1	1	<1
+4.75mm	----	1	%	<1	<1	<1	<1	<1
+9.5mm	----	1	%	<1	<1	<1	<1	<1
+19.0mm	----	1	%	<1	<1	<1	<1	<1
+37.5mm	----	1	%	<1	<1	<1	<1	<1
+75.0mm	----	1	%	<1	<1	<1	<1	<1
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.3	5.2	5.3	5.1	5.2
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	9	10	10	13	9
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	9.1	8.5	8.8	15.8	14.8
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	15	16	19	15	19
Silt (2-60 µm)	----	1	%	10	11	11	22	21
Sand (0.06-2.00 mm)	----	1	%	75	73	70	62	59
Gravel (>2mm)	----	1	%	<1	<1	<1	1	1
Cobbles (>6cm)	----	1	%	<1	<1	<1	<1	<1
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	<0.1	<0.1	<0.1	0.5	<0.1
Exchangeable Magnesium	----	0.1	meq/100g	0.2	0.5	0.6	0.4	0.2
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	0.3	0.5	0.6	1.0	0.3
ED022: Acid Extractable Pottasium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	<100	<100	<100	<100	<100
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	287 20-30	287 50-60	287 70-75	15 0-10	15 15-20
Client sampling date / time				18-JUL-2013 15:00	18-JUL-2013 15:00	18-JUL-2013 15:00	17-JUL-2013 15:00	17-JUL-2013 15:00
				EB1317604-011	EB1317604-012	EB1317604-013	EB1317604-014	EB1317604-015
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM) - Continued								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	<50	**70**	<50	<50
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.03**	**0.03**	**0.03**	**0.04**	**0.03**
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	<10	<10	<10	**10**	<10
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
Iron	7439-89-6	1.00	mg/kg	**39.3**	**9.88**	**8.17**	**400**	**106**
Manganese	7439-96-5	1.00	mg/kg	<1.00	<1.00	<1.00	**1.56**	<1.00
Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	**110**	**130**	**130**	**120**	**100**
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**9310**	**9230**	**7660**	**6060**	**6880**
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	**0.1**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**340**	**150**	**130**	**990**	**400**
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	**340**	**150**	**130**	**990**	**400**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**89**	**81**	**71**	**114**	**51**
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	<2	<2	<2	<2	<2
EP004: Organic Matter								
Organic Matter	----	0.5	%	**1.4**	**0.8**	**0.7**	**4.5**	**1.4**
Total Organic Carbon	----	0.5	%	**0.8**	<0.5	<0.5	**2.6**	**0.8**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	15 20-25	15 30-40	15 50-60	183 0-10	183 12-20
			Client sampling date / time	17-JUL-2013 15:00	17-JUL-2013 15:00	17-JUL-2013 15:00	19-JUL-2013 15:00	19-JUL-2013 15:00
				EB1317604-016	**EB1317604-017**	**EB1317604-018**	**EB1317604-019**	**EB1317604-020**
EA150: Particle Sizing								
+75µm	----	1	%	**56**	**53**	**52**	**53**	**69**
+150µm	----	1	%	**35**	**32**	**36**	**30**	**52**
+300µm	----	1	%	**19**	**17**	**26**	**20**	**46**
+425µm	----	1	%	**9**	**9**	**20**	**19**	**46**
+600µm	----	1	%	**4**	**3**	**17**	**18**	**45**
+1180µm	----	1	%	**1**	<1	**15**	**15**	**43**
+2.36mm	----	1	%	**1**	<1	**13**	**8**	**38**
+4.75mm	----	1	%	<1	<1	**6**	**2**	**30**
+9.5mm	----	1	%	<1	<1	<1	<1	**17**
+19.0mm	----	1	%	<1	<1	<1	<1	**8**
+37.5mm	----	1	%	<1	<1	<1	<1	<1
+75.0mm	----	1	%	<1	<1	<1	<1	<1
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**5.3**	**5.3**	**5.4**	**5.4**	**5.6**
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**10**	**14**	**17**	**15**	**13**
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	**14.0**	**14.2**	**14.2**	**20.8**	**11.6**
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	**19**	**22**	**25**	**15**	**13**
Silt (2-60 µm)	----	1	%	**22**	**22**	**21**	**31**	**17**
Sand (0.06-2.00 mm)	----	1	%	**58**	**56**	**41**	**46**	**32**
Gravel (>2mm)	----	1	%	**1**	<1	**13**	**8**	**38**
Cobbles (>6cm)	----	1	%	<1	<1	<1	<1	<1
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	<0.1	<0.1	<0.1	**3.9**	**3.0**
Exchangeable Magnesium	----	0.1	meq/100g	**0.3**	**0.5**	**0.8**	**1.0**	**0.4**
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	<0.1	**0.1**	<0.1
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	**0.4**	**0.6**	**0.9**	**5.0**	**3.5**
ED022: Acid Extractable Pottasium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	<100	<100	<100	**200**	**100**
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	15 20-25	15 30-40	15 50-60	183 0-10	183 12-20
Client sampling date / time				17-JUL-2013 15:00	17-JUL-2013 15:00	17-JUL-2013 15:00	19-JUL-2013 15:00	19-JUL-2013 15:00
				EB1317604-016	EB1317604-017	EB1317604-018	EB1317604-019	EB1317604-020
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM) - Continued								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	<50	<50	<50	<50
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.03**	**0.03**	**0.03**	**0.04**	**0.04**
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	<10	**20**	**30**	**10**	**10**
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
Iron	7439-89-6	1.00	mg/kg	**59.1**	**19.1**	**12.7**	**111**	**60.2**
Manganese	7439-96-5	1.00	mg/kg	<1.00	<1.00	<1.00	**37.6**	**12.6**
Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	**110**	**140**	**170**	**350**	**260**
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**7680**	**8370**	**11900**	**10700**	**9940**
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	**0.2**	**0.1**	<0.1	**1.9**	**2.4**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**340**	**220**	**210**	**2660**	**1740**
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	**340**	**220**	**210**	**2660**	**1740**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**72**	**65**	**78**	**589**	**328**
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	<2	<2	<2	**5**	**3**
EP004: Organic Matter								
Organic Matter	----	0.5	%	**0.9**	**0.9**	**1.0**	**5.8**	**3.2**
Total Organic Carbon	----	0.5	%	**0.5**	**0.5**	**0.6**	**3.4**	**1.8**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1419227**	Page	: 1 of 46
Client	: **EMGA MITCHELL MCLENNAN**	Laboratory	: Environmental Division Sydney
Contact	: MR TIMOTHY ROHDE	Contact	: Client Services
Address	: 1/4 87 WICKHAM TERRACE SPRING HILL QLD 4000	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: trohde@emgamm.com	E-mail	: sydney@alsglobal.com
Telephone	: 07 3839 1800	Telephone	: +61-2-8784 8555
Facsimile	: 07 3839 1866	Facsimile	: +61-2-8784 8500
Project	: HUME	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 28-AUG-2014
Sampler	: NC	Issue Date	: 09-SEP-2014
Site	: ----		
		No. of samples received	: 110
Quote number	: BN/005/13 v2	No. of samples analysed	: 110

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

General Comments

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

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

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl (Method 15G1) is a more suitable method for the determination of exchange acidity (H+ + Al3+).**
- **ED092: Insufficient sample provided for ED092 analysis on sample 181 70-80.**
- **Ek067G: Spike failed for Total P due to matrix interferences(Confirmed by re-digestion and re-analysis)**

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	Position	Accreditation Category
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Dian Dao		Sydney Inorganics
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics
Pabi Subba	Senior Organic Chemist	Sydney Inorganics
Satishkumar Trivedi	2 IC Acid Sulfate Soils Supervisor	Brisbane Acid Sulphate Soils
Shobhna Chandra	Metals Coordinator	Sydney Inorganics

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	44 0-10	44 10-18	44 50-60	44 20-30	44 70-80
			Client sampling date / time	28-APR-2014 15:00	28-APR-2014 15:00	28-APR-2014 15:00	28-APR-2014 15:00	28-APR-2014 15:00
Compound	CAS Number	LOR	Unit	ES1419227-001	ES1419227-002	ES1419227-003	ES1419227-004	ES1419227-005
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.9	6.2	7.1	6.5	7.2
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	128	112	164	82	223
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	22.3	18.1	19.9	17.4	21.3
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	8.4	7.0	4.4	4.7	5.5
Exchangeable Magnesium	----	0.1	meq/100g	3.2	3.5	5.9	3.3	7.7
Exchangeable Potassium	----	0.1	meq/100g	0.2	0.1	<0.1	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	0.2	0.2	0.3	0.2	0.4
Cation Exchange Capacity	----	0.1	meq/100g	11.8	10.8	10.7	8.3	13.8
ED022: Acid Extractable Pottasium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	<100	<100	<100	<100	<100
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	<50	<50	<50	<50
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.04	0.03	0.02	0.03	0.02
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	40	50	140	50	200
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	1.6	1.0	0.5	0.5	0.4
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
Iron	7439-89-6	1.00	mg/kg	88.9	64.8	10.6	20.2	12.9
Manganese	7439-96-5	1.00	mg/kg	74.1	69.0	<1.00	42.9	<1.00
Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	290	260	380	260	400
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	7530	7750	13900	8300	14100
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	56.1	38.1	1.4	14.5	2.9

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	44 0-10	44 10-18	44 50-60	44 20-30	44 70-80
			Client sampling date / time	28-APR-2014 15:00	28-APR-2014 15:00	28-APR-2014 15:00	28-APR-2014 15:00	28-APR-2014 15:00
Compound	CAS Number	LOR	Unit	ES1419227-001	ES1419227-002	ES1419227-003	ES1419227-004	ES1419227-005
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**2490**	**1960**	**410**	**940**	**390**
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	**2550**	**2000**	**410**	**950**	**390**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**408**	**346**	**139**	**234**	**181**
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	**16**	**15**	<2	<2	<2
EP004: Organic Matter								
Organic Matter	----	0.5	%	**5.5**	**3.5**	**0.5**	**2.0**	<0.5
Total Organic Carbon	----	0.5	%	**3.2**	**2.0**	<0.5	**1.2**	<0.5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	502 0-10	502 10-20	502 20-30	502 50-60	502 70-80
			Client sampling date / time	30-APR-2014 15:00	30-APR-2014 15:00	30-APR-2014 15:00	30-APR-2014 15:00	30-APR-2014 15:00
Compound	CAS Number	LOR	Unit	ES1419227-006	ES1419227-007	ES1419227-008	ES1419227-009	ES1419227-010
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	4.8	4.5	4.4	4.2	4.1
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	77	41	21	31	16
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	13.9	13.7	12.8	13.2	10.9
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	3.8	3.0	2.1	1.0	0.4
Exchangeable Magnesium	----	0.1	meq/100g	1.1	0.7	0.4	1.2	1.6
Exchangeable Potassium	----	0.1	meq/100g	0.2	0.1	<0.1	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	5.2	3.8	2.7	2.3	2.2
ED022: Acid Extractable Pottasium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	100	<100	<100	<100	<100
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	<50	<50	210	80
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.04	0.03	0.03	0.02	0.02
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	10	<10	<10	<10	<10
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	1.0	0.9	0.8	0.8	0.7
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	1.35	1.04	1.02	<1.00	<1.00
Iron	7439-89-6	1.00	mg/kg	87.8	54.8	38.1	9.16	8.52
Manganese	7439-96-5	1.00	mg/kg	124	73.4	65.0	14.0	9.03
Zinc	7440-66-6	1.00	mg/kg	1.02	<1.00	<1.00	<1.00	<1.00
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	400	350	300	390	390
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	8240	8350	8200	11000	11000
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	30.6	15.9	6.9	1.1	1.5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	502 0-10	502 10-20	502 20-30	502 50-60	502 70-80
			Client sampling date / time	30-APR-2014 15:00	30-APR-2014 15:00	30-APR-2014 15:00	30-APR-2014 15:00	30-APR-2014 15:00
Compound	CAS Number	LOR	Unit	ES1419227-006	ES1419227-007	ES1419227-008	ES1419227-009	ES1419227-010
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**1930**	**1820**	**1100**	**420**	**410**
EK062: Total Nitrogen as N (TKN + NOx)								
^ **Total Nitrogen as N**	----	20	mg/kg	**1960**	**1840**	**1110**	**420**	**410**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**444**	**420**	**285**	**226**	**256**
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	**11**	**6**	**6**	<2	<2
EP004: Organic Matter								
Organic Matter	----	0.5	%	**4.2**	**2.9**	**2.0**	<0.5	<0.5
Total Organic Carbon	----	0.5	%	**2.4**	**1.7**	**1.2**	<0.5	<0.5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

			Client sample ID	HC267 4-10	HC267 10-20	HC267 23-30	HC267 40-50	HC267 70-80
			Client sampling date / time	16-SEP-2013 15:00	16-SEP-2013 15:00	16-SEP-2013 15:00	16-SEP-2013 15:00	16-SEP-2013 15:00
Compound	CAS Number	LOR	Unit	ES1419227-011	ES1419227-012	ES1419227-013	ES1419227-014	ES1419227-015
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	3.8	3.9	4.1	4.3	4.7
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	62	35	25	13	12
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	7.6	6.4	6.5	4.4	5.2
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	0.9	0.3	0.3	0.1	<0.1
Exchangeable Magnesium	----	0.1	meq/100g	0.4	0.3	0.4	0.7	1.2
Exchangeable Potassium	----	0.1	meq/100g	0.1	<0.1	<0.1	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	1.4	0.6	0.7	0.9	1.2
ED022: Acid Extractable Pottasium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	<100	<100	<100	<100	<100
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	<50	<50	<50	110
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.02	0.02	<0.01	0.02
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	30	20	20	10	<10
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	0.9	0.7	0.6	0.5	0.4
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
Iron	7439-89-6	1.00	mg/kg	145	135	146	15.2	5.02
Manganese	7439-96-5	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	<1.00	1.91	<1.00
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	210	200	180	180	220
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	8690	10200	10600	10800	10800
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	14.8	11.1	8.9	3.2	0.8

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	**HC267 4-10**	**HC267 10-20**	**HC267 23-30**	**HC267 40-50**	**HC267 70-80**
			Client sampling date / time	16-SEP-2013 15:00	16-SEP-2013 15:00	16-SEP-2013 15:00	16-SEP-2013 15:00	16-SEP-2013 15:00
Compound	CAS Number	LOR	Unit	**ES1419227-011**	**ES1419227-012**	**ES1419227-013**	**ES1419227-014**	**ES1419227-015**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**820**	**520**	**360**	**200**	**110**
EK062: Total Nitrogen as N (TKN + NOx)								
^ **Total Nitrogen as N**	----	20	mg/kg	**830**	**530**	**370**	**200**	**110**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**96**	**73**	**76**	**65**	**64**
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	<2	<2	<2	<2	<2
EP004: Organic Matter								
Organic Matter	----	0.5	%	**3.0**	**2.4**	**1.3**	**0.8**	<0.5
Total Organic Carbon	----	0.5	%	**1.7**	**1.4**	**0.8**	<0.5	<0.5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	HC32 0-10	HC32 10-20	HC32 20-30	HC32 42-52	HC404 0-10
			Client sampling date / time	26-FEB-2014 15:00	26-FEB-2014 15:00	26-FEB-2014 15:00	26-FEB-2014 15:00	25-FEB-2014 15:00
Compound	CAS Number	LOR	Unit	ES1419227-016	ES1419227-017	ES1419227-018	ES1419227-019	ES1419227-020
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	4.5	4.4	4.3	4.4	4.5
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	189	60	30	16	98
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	8.9	8.6	7.6	10.7	5.9
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	4.2	3.8	2.7	2.6	3.6
Exchangeable Magnesium	----	0.1	meq/100g	0.9	0.8	0.7	0.6	0.8
Exchangeable Potassium	----	0.1	meq/100g	0.6	0.4	0.2	0.2	0.3
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	5.6	5.0	3.6	3.5	4.7
ED022: Acid Extractable Pottasium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	300	200	<100	<100	100
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	<50	<50	240	<50
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.03	0.02	0.02	0.02	0.03
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	40	40	30	<10	20
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	1.4	1.0	0.7	0.4	1.2
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
Iron	7439-89-6	1.00	mg/kg	115	151	25.2	5.49	88.0
Manganese	7439-96-5	1.00	mg/kg	5.26	<1.00	<1.00	<1.00	11.5
Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	790	500	430	420	460
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	15700	15000	17400	19900	10200
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	67.8	19.6	4.4	1.7	34.5

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	HC32 0-10	HC32 10-20	HC32 20-30	HC32 42-52	HC404 0-10
			Client sampling date / time	26-FEB-2014 15:00	26-FEB-2014 15:00	26-FEB-2014 15:00	26-FEB-2014 15:00	25-FEB-2014 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES1419227-016**	**ES1419227-017**	**ES1419227-018**	**ES1419227-019**	**ES1419227-020**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**2310**	**1420**	**960**	**300**	**1810**
EK062: Total Nitrogen as N (TKN + NOx)								
^ **Total Nitrogen as N**	----	20	mg/kg	**2380**	**1440**	**960**	**300**	**1840**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**354**	**261**	**167**	**127**	**226**
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	**14**	**2**	<2	<2	**7**
EP004: Organic Matter								
Organic Matter	----	0.5	%	**5.0**	**3.2**	**2.0**	**1.2**	**3.6**
Total Organic Carbon	----	0.5	%	**2.9**	**1.9**	**1.1**	**0.7**	**2.1**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	**HC404 12-20**	**HC404 20-30**	**HC404 50-60**	**HC404 70-80**	**HC472 0-10**
			Client sampling date / time	25-FEB-2014 15:00	25-FEB-2014 15:00	25-FEB-2014 15:00	25-FEB-2014 15:00	14-SEP-2013 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES1419227-021**	**ES1419227-022**	**ES1419227-023**	**ES1419227-024**	**ES1419227-025**
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**4.6**	**4.6**	**4.3**	**4.2**	**4.0**
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**58**	**33**	**32**	**38**	**479**
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	**5.8**	**6.0**	**9.1**	**11.5**	**20.4**
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	**3.4**	**2.9**	**1.1**	<0.1	**3.0**
Exchangeable Magnesium	----	0.1	meq/100g	**0.6**	**0.5**	**1.1**	**2.6**	**0.5**
Exchangeable Potassium	----	0.1	meq/100g	**0.1**	<0.1	<0.1	<0.1	**0.1**
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	**4.2**	**3.5**	**2.2**	**2.8**	**3.6**
ED022: Acid Extractable Pottasium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	<100	<100	<100	<100	<100
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	<50	**120**	**60**	<50
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.02**	**0.02**	**0.02**	**0.02**	**0.03**
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	**20**	**20**	**10**	**40**	**20**
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	**0.8**	**0.6**	**0.5**	**0.5**	**1.2**
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
Iron	7439-89-6	1.00	mg/kg	**74.6**	**27.7**	**6.37**	**5.90**	**117**
Manganese	7439-96-5	1.00	mg/kg	**1.36**	<1.00	<1.00	<1.00	**29.7**
Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	**7.10**
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	**340**	**320**	**510**	**760**	**410**
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**10300**	**10900**	**16300**	**23200**	**8070**
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	**20.9**	**10.6**	**12.2**	**6.8**	**333**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	HC404 12-20	HC404 20-30	HC404 50-60	HC404 70-80	HC472 0-10
			Client sampling date / time	25-FEB-2014 15:00	25-FEB-2014 15:00	25-FEB-2014 15:00	25-FEB-2014 15:00	14-SEP-2013 15:00
Compound	CAS Number	LOR	Unit	ES1419227-021	ES1419227-022	ES1419227-023	ES1419227-024	ES1419227-025
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	1120	810	280	260	2680
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	1140	820	290	270	3010
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	172	154	142	142	479
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	6	<2	<2	<2	46
EP004: Organic Matter								
Organic Matter	----	0.5	%	2.6	1.4	<0.5	<0.5	7.1
Total Organic Carbon	----	0.5	%	1.5	0.8	<0.5	<0.5	4.1

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	HC472 15-25	HC472 30-40	HC472 50-60	HC481 0-10	HC481 10-20
Client sampling date / time				14-SEP-2013 15:00	14-SEP-2013 15:00	14-SEP-2013 15:00	12-SEP-2013 15:00	12-SEP-2013 15:00
				ES1419227-026	ES1419227-027	ES1419227-028	ES1419227-029	ES1419227-030
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	4.3	3.8	4.0	4.2	4.1
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	29	16	12	162	46
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	10.4	14.4	16.3	6.8	4.8
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	0.7	0.7	0.2	2.9	1.2
Exchangeable Magnesium	----	0.1	meq/100g	0.2	0.6	0.7	0.7	0.4
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	<0.1	0.5	0.2
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	0.9	1.4	1.0	4.1	1.9
ED022: Acid Extractable Pottasium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	<100	<100	<100	200	100
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	<50	60	<50	<50
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.02	0.02	0.03	0.03
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	<10	<10	<10	10	10
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	0.7	3.3	1.6	2.0	1.0
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
Iron	7439-89-6	1.00	mg/kg	21.6	6.93	6.74	261	138
Manganese	7439-96-5	1.00	mg/kg	<1.00	<1.00	<1.00	65.4	19.8
Zinc	7440-66-6	1.00	mg/kg	<1.00	1.57	1.13	4.25	1.27
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	320	440	480	630	460
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	9440	15100	20300	10800	13700
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	12.9	5.0	2.1	57.9	12.5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Compound	CAS Number	LOR	Unit	HC472 15-25	HC472 30-40	HC472 50-60	HC481 0-10	HC481 10-20
Client sampling date / time				14-SEP-2013 15:00	14-SEP-2013 15:00	14-SEP-2013 15:00	12-SEP-2013 15:00	12-SEP-2013 15:00
				ES1419227-026	ES1419227-027	ES1419227-028	ES1419227-029	ES1419227-030
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	390	420	380	2870	1010
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	400	420	380	2930	1020
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	142	185	238	567	328
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	5	<2	11	74	<2
EP004: Organic Matter								
Organic Matter	----	0.5	%	0.9	0.6	0.6	8.0	2.3
Total Organic Carbon	----	0.5	%	0.5	<0.5	<0.5	4.7	1.4

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	HC481 25-30	HC481 50-57	HC481 60-70	HC481 70-80	133 0-10
			Client sampling date / time	12-SEP-2013 15:00	12-SEP-2013 15:00	12-SEP-2013 15:00	12-SEP-2013 15:00	30-APR-2014 15:00
Compound	CAS Number	LOR	Unit	ES1419227-031	ES1419227-032	ES1419227-033	ES1419227-034	ES1419227-035
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	4.2	4.1	4.2	4.1	4.6
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	25	44	38	34	72
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	7.7	18.8	17.8	14.2	17.0
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	1.6	1.5	1.1	0.8	4.9
Exchangeable Magnesium	----	0.1	meq/100g	0.7	1.6	1.6	1.6	1.4
Exchangeable Potassium	----	0.1	meq/100g	0.2	0.4	0.4	0.4	0.2
Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.1	0.1	0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	2.6	3.6	3.3	3.0	6.5
ED022: Acid Extractable Pottasium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	100	200	200	200	<100
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	180	250	120	<50
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.02	0.02	0.02	0.03
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	20	<10	<10	10	20
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	1.2	1.7	0.8	0.8	1.3
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
Iron	7439-89-6	1.00	mg/kg	41.3	7.13	3.04	6.40	89.4
Manganese	7439-96-5	1.00	mg/kg	6.46	<1.00	<1.00	<1.00	144
Zinc	7440-66-6	1.00	mg/kg	<1.00	1.03	<1.00	2.54	<1.00
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	490	830	790	670	620
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	18400	28500	25500	18700	8440
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	2.4	4.7	2.8	2.8	26.5

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	HC481 25-30	HC481 50-57	HC481 60-70	HC481 70-80	133 0-10
Client sampling date / time				12-SEP-2013 15:00	12-SEP-2013 15:00	12-SEP-2013 15:00	12-SEP-2013 15:00	30-APR-2014 15:00
				ES1419227-031	ES1419227-032	ES1419227-033	ES1419227-034	ES1419227-035
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	630	530	380	380	2440
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	630	530	380	380	2470
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	264	210	160	159	452
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	23	<2	<2	<2	10
EP004: Organic Matter								
Organic Matter	----	0.5	%	1.1	0.7	<0.5	<0.5	5.0
Total Organic Carbon	----	0.5	%	0.6	<0.5	<0.5	<0.5	2.9

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	133 20-30	133 30-40	133 50-60	133 70-80	524 0-10
			Client sampling date / time	30-APR-2014 15:00	30-APR-2014 15:00	30-APR-2014 15:00	30-APR-2014 15:00	29-APR-2014 15:00
Compound	CAS Number	LOR	Unit	ES1419227-036	ES1419227-037	ES1419227-038	ES1419227-039	ES1419227-040
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	4.6	4.4	4.2	4.3	4.6
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	36	24	18	12	384
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	15.2	13.9	14.4	16.0	31.3
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	4.4	2.6	1.1	0.4	6.9
Exchangeable Magnesium	----	0.1	meq/100g	1.3	1.3	2.0	1.7	3.6
Exchangeable Potassium	----	0.1	meq/100g	0.1	0.1	0.1	0.1	0.4
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	5.8	4.1	3.3	2.4	11.0
ED022: Acid Extractable Pottasium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	<100	<100	<100	<100	200
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	<50	190	50	90
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.03	0.02	0.02	0.02	0.06
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	30	30	10	<10	60
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	0.9	0.8	0.5	0.6	2.1
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	1.72
Iron	7439-89-6	1.00	mg/kg	55.4	18.9	7.10	6.97	343
Manganese	7439-96-5	1.00	mg/kg	78.1	37.5	<1.00	<1.00	80.4
Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	4.00
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	510	520	610	680	660
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	7680	8780	11000	12000	11400
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	8.7	3.6	0.8	1.6	227

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	133 20-30	133 30-40	133 50-60	133 70-80	524 0-10
			Client sampling date / time	30-APR-2014 15:00	30-APR-2014 15:00	30-APR-2014 15:00	30-APR-2014 15:00	29-APR-2014 15:00
Compound	CAS Number	LOR	Unit	ES1419227-036	ES1419227-037	ES1419227-038	ES1419227-039	ES1419227-040
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**1240**	**770**	**510**	**490**	**3300**
EK062: Total Nitrogen as N (TKN + NOx)								
^ **Total Nitrogen as N**	----	20	mg/kg	**1250**	**770**	**510**	**490**	**3530**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**277**	**266**	**237**	**196**	**486**
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	**5**	<2	<2	**25**	**49**
EP004: Organic Matter								
Organic Matter	----	0.5	%	**3.2**	**1.1**	<0.5	**0.6**	**11.8**
Total Organic Carbon	----	0.5	%	**1.9**	**0.6**	<0.5	<0.5	**6.8**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	524 10-20	524 20-30	524 50-60	524 70-80	HC10 0-10
			Client sampling date / time	29-APR-2014 15:00	29-APR-2014 15:00	29-APR-2014 15:00	29-APR-2014 15:00	26-NOV-2013 15:00
Compound	CAS Number	LOR	Unit	ES1419227-041	ES1419227-042	ES1419227-043	ES1419227-044	ES1419227-045
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.0	5.3	5.0	5.1	3.7
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	88	56	50	115	223
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	16.8	17.8	19.4	18.9	17.2
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	5.4	5.2	3.1	3.4	2.2
Exchangeable Magnesium	----	0.1	meq/100g	3.6	3.9	5.5	6.4	1.7
Exchangeable Potassium	----	0.1	meq/100g	0.1	<0.1	0.1	0.1	0.3
Exchangeable Sodium	----	0.1	meq/100g	0.1	0.2	0.4	0.6	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	9.3	9.4	9.2	10.4	4.2
ED022: Acid Extractable Pottasium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	<100	<100	<100	<100	200
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	<50	<50	<50	<50
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.03	0.03	0.02	0.02	0.03
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	30	30	440	530	50
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	0.7	0.7	1.8	0.5	1.6
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	1.55	1.28	<1.00	1.10	<1.00
Iron	7439-89-6	1.00	mg/kg	186	148	202	169	285
Manganese	7439-96-5	1.00	mg/kg	80.0	62.4	<1.00	<1.00	31.4
Zinc	7440-66-6	1.00	mg/kg	1.48	1.11	<1.00	<1.00	1.94
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	440	430	450	460	360
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	9920	9640	13200	14000	8260
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	32.8	13.6	196	149	80.3

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	524 10-20	524 20-30	524 50-60	524 70-80	HC10 0-10
			Client sampling date / time	29-APR-2014 15:00	29-APR-2014 15:00	29-APR-2014 15:00	29-APR-2014 15:00	26-NOV-2013 15:00
Compound	CAS Number	LOR	Unit	ES1419227-041	ES1419227-042	ES1419227-043	ES1419227-044	ES1419227-045
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	1300	1400	700	860	2540
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	1330	1410	900	1010	2620
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	213	242	131	154	193
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	12	8	<2	<2	11
EP004: Organic Matter								
Organic Matter	----	0.5	%	3.5	3.4	1.8	1.9	8.7
Total Organic Carbon	----	0.5	%	2.0	2.0	1.0	1.1	5.0

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	HC10 10-20	HC10 20-30	HC10 50-60	HC10 73-80	HC238 0-10
Client sampling date / time				26-NOV-2013 15:00	26-NOV-2013 15:00	26-NOV-2013 15:00	26-NOV-2013 15:00	13-SEP-2013 15:00
				ES1419227-046	ES1419227-047	ES1419227-048	ES1419227-049	ES1419227-050
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	3.8	3.8	4.0	3.9	4.5
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	51	45	108	40	185
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	7.4	6.9	19.6	24.7	14.9
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	0.2	0.1	<0.1	<0.1	3.2
Exchangeable Magnesium	----	0.1	meq/100g	0.4	0.2	0.5	0.3	3.1
Exchangeable Potassium	----	0.1	meq/100g	0.1	<0.1	<0.1	<0.1	0.2
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	0.8	0.4	0.7	0.4	6.5
ED022: Acid Extractable Pottasium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	<100	<100	<100	<100	100
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	<50	<50	100	<50
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.02	0.03	0.03	0.03
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	30	30	100	20	20
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	0.6	0.7	0.6	0.5	1.4
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	1.91
Iron	7439-89-6	1.00	mg/kg	223	133	76.8	58.7	249
Manganese	7439-96-5	1.00	mg/kg	4.25	4.88	<1.00	<1.00	39.5
Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	2.30
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	150	100	180	160	680
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	6020	4940	15200	16800	11800
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	6.8	8.5	22.7	6.1	91.0

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	HC10 10-20	HC10 20-30	HC10 50-60	HC10 73-80	HC238 0-10
			Client sampling date / time	26-NOV-2013 15:00	26-NOV-2013 15:00	26-NOV-2013 15:00	26-NOV-2013 15:00	13-SEP-2013 15:00
Compound	CAS Number	LOR	Unit	ES1419227-046	ES1419227-047	ES1419227-048	ES1419227-049	ES1419227-050
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	1020	660	1490	1150	2320
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	1030	670	1510	1160	2410
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	106	79	175	170	329
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	<2	<2	<2	<2	13
EP004: Organic Matter								
Organic Matter	----	0.5	%	3.3	2.9	7.8	6.9	4.2
Total Organic Carbon	----	0.5	%	1.9	1.7	4.5	4.0	2.4

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	HC238 20-30	HC238 40-50	HC238 50-60	HC238 70-80	HC4 0-10
			Client sampling date / time	13-SEP-2013 15:00	13-SEP-2013 15:00	13-SEP-2013 15:00	13-AUG-2013 15:00	27-FEB-2014 15:00
Compound	CAS Number	LOR	Unit	ES1419227-051	ES1419227-052	ES1419227-053	ES1419227-054	ES1419227-055
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.1	5.1	4.9	4.8	5.1
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	26	26	23	21	237
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	17.4	15.2	15.0	19.6	16.9
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	2.7	2.4	0.8	1.3	10.6
Exchangeable Magnesium	----	0.1	meq/100g	4.0	3.8	2.0	3.7	9.2
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	0.2
Exchangeable Sodium	----	0.1	meq/100g	0.1	0.2	<0.1	0.3	0.5
Cation Exchange Capacity	----	0.1	meq/100g	6.9	6.5	3.0	5.4	20.5
ED022: Acid Extractable Pottasium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	<100	<100	<100	<100	<100
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	<50	<50	<50	<50
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.02	0.02	0.02	0.04
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	110	50	100	60	310
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	0.6	0.7	0.6	0.8	1.6
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	1.01	1.14	<1.00	<1.00	2.20
Iron	7439-89-6	1.00	mg/kg	47.3	104	81.7	29.2	252
Manganese	7439-96-5	1.00	mg/kg	62.6	78.8	<1.00	54.8	83.7
Zinc	7440-66-6	1.00	mg/kg	<1.00	1.05	<1.00	<1.00	2.48
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	520	480	360	580	980
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	13800	13400	10200	26300	25700
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	6.5	6.3	4.7	3.0	13.6

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	HC238 20-30	HC238 40-50	HC238 50-60	HC238 70-80	HC4 0-10
Client sampling date / time				13-SEP-2013 15:00	13-SEP-2013 15:00	13-SEP-2013 15:00	13-AUG-2013 15:00	27-FEB-2014 15:00
				ES1419227-051	ES1419227-052	ES1419227-053	ES1419227-054	ES1419227-055
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**670**	**890**	**400**	**560**	**3150**
EK062: Total Nitrogen as N (TKN + NOx)								
^ **Total Nitrogen as N**	----	20	mg/kg	**680**	**900**	**400**	**560**	**3160**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**222**	**199**	**104**	**230**	**460**
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	<2	<2	**2**	<2	**17**
EP004: Organic Matter								
Organic Matter	----	0.5	%	**1.1**	**1.6**	**0.7**	**0.7**	**5.6**
Total Organic Carbon	----	0.5	%	**0.6**	**1.0**	<0.5	<0.5	**3.2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	HC4 20-30	HC4 50-60	HC454 0-10	HC454 12-20	HC454 20-30
			Client sampling date / time	27-FEB-2014 15:00	27-FEB-2014 15:00	08-APR-2014 15:00	08-APR-2014 15:00	08-APR-2014 15:00
Compound	CAS Number	LOR	Unit	ES1419227-056	ES1419227-057	ES1419227-058	ES1419227-059	ES1419227-060
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.1	6.5	5.2	5.2	5.2
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	512	921	118	29	26
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	19.4	19.2	26.4	20.9	20.8
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	10.7	12.8	5.7	3.3	3.6
Exchangeable Magnesium	----	0.1	meq/100g	12.7	19.8	4.7	3.2	3.3
Exchangeable Potassium	----	0.1	meq/100g	0.3	0.2	0.3	0.1	0.1
Exchangeable Sodium	----	0.1	meq/100g	1.1	2.1	0.5	0.5	0.5
Cation Exchange Capacity	----	0.1	meq/100g	24.8	34.9	11.2	7.1	7.6
ED022: Acid Extractable Pottasium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	<100	<100	100	<100	<100
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	50	<50	<50	<50
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.03	0.02	0.03	0.02	0.02
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	880	1500	20	50	50
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	0.8	0.3	1.4	1.0	0.9
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	1.52	1.07	3.06	2.54	2.54
Iron	7439-89-6	1.00	mg/kg	287	29.0	193	94.3	106
Manganese	7439-96-5	1.00	mg/kg	<1.00	<1.00	123	125	138
Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	2.75	<1.00	<1.00
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	930	1040	490	360	400
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	32300	33800	10500	10600	11400
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	0.4	0.8	62.2	10.3	7.7

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	HC4 20-30	HC4 50-60	HC454 0-10	HC454 12-20	HC454 20-30
			Client sampling date / time	27-FEB-2014 15:00	27-FEB-2014 15:00	08-APR-2014 15:00	08-APR-2014 15:00	08-APR-2014 15:00
Compound	CAS Number	LOR	Unit	ES1419227-056	ES1419227-057	ES1419227-058	ES1419227-059	ES1419227-060
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	2000	790	2900	1760	1570
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	2000	790	2960	1770	1580
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	258	137	491	326	298
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	2	<2	9	3	<2
EP004: Organic Matter								
Organic Matter	----	0.5	%	3.0	1.5	5.3	2.4	2.5
Total Organic Carbon	----	0.5	%	1.7	0.8	3.1	1.4	1.4

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Client sample ID				HC454 50-60	HC454 70-80	HC92 0-10	HC92 12-20	HC92 20-30
Client sampling date / time				08-APR-2014 15:00	08-APR-2014 15:00	08-APR-2014 15:00	08-APR-2014 15:00	08-APR-2014 15:00
Compound	CAS Number	LOR	Unit	ES1419227-061	ES1419227-062	ES1419227-063	ES1419227-064	ES1419227-065
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	4.8	4.8	4.4	4.3	4.2
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	32	61	168	52	17
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	25.2	27.5	21.3	17.0	17.6
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	1.5	1.3	3.0	1.0	0.3
Exchangeable Magnesium	----	0.1	meq/100g	3.5	4.1	1.6	1.0	0.6
Exchangeable Potassium	----	0.1	meq/100g	0.1	0.1	0.2	0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	1.0	1.1	<0.1	0.5	0.2
Cation Exchange Capacity	----	0.1	meq/100g	6.1	6.7	4.8	2.6	1.2
ED022: Acid Extractable Pottasium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	<100	<100	<100	<100	<100
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	<50	<50	<50	<50
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.02	0.05	0.02	0.02
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	150	140	40	40	90
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	1.0	0.9	1.9	0.8	0.7
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	1.95	1.79	<1.00	<1.00	1.05
Iron	7439-89-6	1.00	mg/kg	101	58.4	688	431	88.8
Manganese	7439-96-5	1.00	mg/kg	21.5	17.9	2.15	<1.00	<1.00
Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	3.04	1.07	<1.00
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	500	570	270	180	190
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	23800	27600	5030	5630	8730
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	0.4	1.3	84.7	10.5	1.2

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	HC454 50-60	HC454 70-80	HC92 0-10	HC92 12-20	HC92 20-30
			Client sampling date / time	08-APR-2014 15:00	08-APR-2014 15:00	08-APR-2014 15:00	08-APR-2014 15:00	08-APR-2014 15:00
Compound	CAS Number	LOR	Unit	ES1419227-061	ES1419227-062	ES1419227-063	ES1419227-064	ES1419227-065
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**1540**	**1320**	**3580**	**1130**	**440**
EK062: Total Nitrogen as N (TKN + NOx)								
^ **Total Nitrogen as N**	----	20	mg/kg	**1540**	**1320**	**3660**	**1140**	**440**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**265**	**229**	**367**	**131**	**88**
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	<2	<2	**8**	<2	<2
EP004: Organic Matter								
Organic Matter	----	0.5	%	**2.6**	**1.5**	**7.8**	**3.1**	**0.9**
Total Organic Carbon	----	0.5	%	**1.5**	**0.9**	**4.5**	**1.8**	**0.5**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	HC92 40-50	HC92 70-80	HC126 0-10	HC126 12-20	HC126 20-30
			Client sampling date / time	08-APR-2014 15:00	08-APR-2014 15:00	26-NOV-2013 15:00	27-NOV-2013 15:00	26-NOV-2013 15:00
Compound	CAS Number	LOR	Unit	ES1419227-066	ES1419227-067	ES1419227-068	ES1419227-069	ES1419227-070
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	4.3	4.1	4.6	4.5	4.4
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	18	18	149	23	22
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	20.1	14.4	14.1	8.4	6.8
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	0.2	<0.1	2.7	1.0	0.6
Exchangeable Magnesium	----	0.1	meq/100g	1.0	0.7	1.3	0.8	0.6
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	0.2	0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	1.6	0.9	4.0	2.0	1.4
ED022: Acid Extractable Pottasium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	<100	<100	<100	<100	<100
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	<50	<50	<50	<50
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.03	0.05	0.03	0.02	0.02
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	50	10	10	<10	<10
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	1.0	0.7	0.8	0.5	0.5
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
Iron	7439-89-6	1.00	mg/kg	24.3	7.95	207	106	91.6
Manganese	7439-96-5	1.00	mg/kg	<1.00	<1.00	10.6	<1.00	<1.00
Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	380	220	200	150	160
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	12300	7520	10400	10100	11900
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	1.0	1.7	87.1	11.3	10.4

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	HC92 40-50	HC92 70-80	HC126 0-10	HC126 12-20	HC126 20-30
Client sampling date / time				08-APR-2014 15:00	08-APR-2014 15:00	26-NOV-2013 15:00	27-NOV-2013 15:00	26-NOV-2013 15:00
				ES1419227-066	**ES1419227-067**	**ES1419227-068**	**ES1419227-069**	**ES1419227-070**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**520**	**210**	**2450**	**1140**	**540**
EK062: Total Nitrogen as N (TKN + NOx)								
^ **Total Nitrogen as N**	----	20	mg/kg	**520**	**210**	**2540**	**1150**	**550**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**164**	**166**	**250**	**177**	**101**
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	<2	<2	**8**	**5**	**5**
EP004: Organic Matter								
Organic Matter	----	0.5	%	**0.7**	<0.5	**4.1**	**3.3**	**2.2**
Total Organic Carbon	----	0.5	%	<0.5	<0.5	**2.4**	**1.9**	**1.3**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	HC126 50-60	HC126 80-90	HC263 0-10	HC263 20-30	HC263 50-60
			Client sampling date / time	26-NOV-2013 15:00	26-NOV-2013 15:00	26-NOV-2013 15:00	26-NOV-2013 15:00	26-NOV-2013 15:00
Compound	CAS Number	LOR	Unit	ES1419227-071	ES1419227-072	ES1419227-073	ES1419227-074	ES1419227-075
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	4.4	4.4	4.2	4.4	4.4
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	20	12	59	22	9
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	8.1	4.9	8.2	8.7	7.6
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	0.2	<0.1	1.3	0.3	0.1
Exchangeable Magnesium	----	0.1	meq/100g	0.3	0.4	0.6	0.4	0.5
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	0.2	0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	0.6	0.5	2.2	0.9	0.7
ED022: Acid Extractable Pottasium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	<100	<100	<100	<100	<100
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	<50	<50	<50	80
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.02	0.02	0.02	0.02
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	<10	<10	10	<10	<10
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	0.5	0.4	0.9	0.7	0.5
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
Iron	7439-89-6	1.00	mg/kg	33.3	26.5	200	67.4	8.92
Manganese	7439-96-5	1.00	mg/kg	<1.00	<1.00	10.6	<1.00	<1.00
Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	170	140	290	240	230
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	14200	10400	13600	16800	14300
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	7.4	1.6	25.7	9.9	2.8

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

			Client sample ID	HC126 50-60	HC126 80-90	HC263 0-10	HC263 20-30	HC263 50-60
			Client sampling date / time	26-NOV-2013 15:00	26-NOV-2013 15:00	26-NOV-2013 15:00	26-NOV-2013 15:00	26-NOV-2013 15:00
Compound	CAS Number	LOR	Unit	ES1419227-071	ES1419227-072	ES1419227-073	ES1419227-074	ES1419227-075
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**540**	**230**	**810**	**730**	**230**
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	**550**	**230**	**840**	**740**	**230**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**123**	**101**	**108**	**149**	**117**
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	**4**	**12**	<2	<2	<2
EP004: Organic Matter								
Organic Matter	----	0.5	%	**1.5**	**0.6**	**3.6**	**1.5**	<0.5
Total Organic Carbon	----	0.5	%	**0.9**	<0.5	**2.1**	**0.9**	<0.5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	HC263 70-80	HC300 0-10	HC300 10-19	HC300 20-30	HC300 50-60
			Client sampling date / time	26-NOV-2013 15:00	28-NOV-2013 15:00	28-NOV-2013 15:00	28-NOV-2013 15:00	28-NOV-2013 15:00
Compound	CAS Number	LOR	Unit	ES1419227-076	ES1419227-077	ES1419227-078	ES1419227-079	ES1419227-080
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	7.4	4.3	4.6	4.4	4.1
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	9	78	24	31	13
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	6.6	5.2	3.4	4.7	4.9
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	<0.1	1.3	0.9	0.8	0.1
Exchangeable Magnesium	----	0.1	meq/100g	0.6	0.4	0.2	0.2	<0.1
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	0.7	1.8	1.2	1.1	0.2
ED022: Acid Extractable Pottasium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	<100	<100	<100	<100	<100
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	60	<50	<50	<50	<50
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	0.02	<0.01	0.02	<0.01
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	<10	<10	<10	10	<10
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	0.5	0.5	0.4	0.4	0.4
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
Iron	7439-89-6	1.00	mg/kg	8.23	49.0	48.0	97.7	25.6
Manganese	7439-96-5	1.00	mg/kg	<1.00	16.9	1.86	<1.00	<1.00
Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	280	60	60	80	150
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	14200	1500	2180	3520	7450
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	2.4	41.6	7.0	13.0	2.9

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	HC263 70-80	HC300 0-10	HC300 10-19	HC300 20-30	HC300 50-60
			Client sampling date / time	26-NOV-2013 15:00	28-NOV-2013 15:00	28-NOV-2013 15:00	28-NOV-2013 15:00	28-NOV-2013 15:00
Compound	CAS Number	LOR	Unit	ES1419227-076	ES1419227-077	ES1419227-078	ES1419227-079	ES1419227-080
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**170**	**310**	**260**	**270**	**140**
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	**170**	**350**	**270**	**280**	**140**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**110**	**39**	**39**	**54**	**55**
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	<2	<2	<2	<2	<2
EP004: Organic Matter								
Organic Matter	----	0.5	%	<0.5	**1.1**	**0.8**	**0.8**	<0.5
Total Organic Carbon	----	0.5	%	<0.5	**0.7**	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	HC300 70-80	HC73 0-6	HC73 10-20	HC73 20-30	HC73 55-60
			Client sampling date / time	28-NOV-2013 15:00	26-NOV-2013 15:00	26-NOV-2013 15:00	26-NOV-2013 15:00	26-NOV-2013 15:00
Compound	CAS Number	LOR	Unit	ES1419227-081	ES1419227-082	ES1419227-083	ES1419227-084	ES1419227-085
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	4.4	4.0	4.3	4.4	4.3
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	10	108	26	19	11
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	4.5	19.6	7.9	7.0	6.6
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	0.1	3.0	1.9	0.6	<0.1
Exchangeable Magnesium	----	0.1	meq/100g	0.4	0.4	0.3	0.1	<0.1
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	0.6	3.5	2.3	0.8	0.2
ED022: Acid Extractable Pottasium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	<100	<100	<100	<100	<100
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	70	<50	<50	<50	80
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.02	0.02	0.02	0.02
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	<10	30	10	<10	<10
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	0.6	5.0	3.4	3.0	2.6
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
Iron	7439-89-6	1.00	mg/kg	7.42	133	57.4	22.1	13.6
Manganese	7439-96-5	1.00	mg/kg	<1.00	19.3	1.50	<1.00	<1.00
Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	220	130	90	80	80
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	9000	4890	5560	6820	7560
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	0.8	32.5	4.9	4.6	0.6

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Compound	CAS Number	LOR	Unit	HC300 70-80	HC73 0-6	HC73 10-20	HC73 20-30	HC73 55-60
Client sampling date / time				28-NOV-2013 15:00	26-NOV-2013 15:00	26-NOV-2013 15:00	26-NOV-2013 15:00	26-NOV-2013 15:00
				ES1419227-081	ES1419227-082	ES1419227-083	ES1419227-084	ES1419227-085
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	120	2000	1140	510	320
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	120	2030	1140	510	320
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	83	133	101	68	62
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	<2	6	<2	<2	<2
EP004: Organic Matter								
Organic Matter	----	0.5	%	<0.5	10.4	2.8	2.5	1.2
Total Organic Carbon	----	0.5	%	<0.5	6.0	1.6	1.4	0.7

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	HC73 70-80	HC83 0-10	HC83 10-19	HC83 20-30	HC83 35-45
Client sampling date / time				26-NOV-2013 15:00	27-NOV-2013 15:00	27-NOV-2013 15:00	27-NOV-2013 15:00	27-NOV-2013 15:00
				ES1419227-086	ES1419227-087	ES1419227-088	ES1419227-089	ES1419227-090
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	4.3	4.6	4.6	4.5	4.5
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	7	25	21	15	10
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	5.8	8.7	8.7	8.2	8.5
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	<0.1	0.9	0.2	0.1	<0.1
Exchangeable Magnesium	----	0.1	meq/100g	<0.1	1.1	0.6	0.6	1.4
Exchangeable Potassium	----	0.1	meq/100g	<0.1	0.3	0.2	0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.2	0.2	0.2	0.2
Cation Exchange Capacity	----	0.1	meq/100g	0.1	2.5	1.2	1.1	1.6
ED022: Acid Extractable Pottasium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	<100	100	<100	<100	<100
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	90	<50	<50	<50	<50
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.02	0.02	0.02	0.02
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	<10	20	20	30	20
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	2.3	2.8	2.4	2.2	1.9
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
Iron	7439-89-6	1.00	mg/kg	7.63	71.5	57.2	80.1	14.1
Manganese	7439-96-5	1.00	mg/kg	<1.00	2.93	<1.00	<1.00	<1.00
Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	80	310	210	160	160
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	7930	15800	12600	11900	12600
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	0.6	0.4	0.6	1.4	1.2

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	**HC73 70-80**	**HC83 0-10**	**HC83 10-19**	**HC83 20-30**	**HC83 35-45**
			Client sampling date / time	26-NOV-2013 15:00	27-NOV-2013 15:00	27-NOV-2013 15:00	27-NOV-2013 15:00	27-NOV-2013 15:00
Compound	CAS Number	LOR	Unit	**ES1419227-086**	**ES1419227-087**	**ES1419227-088**	**ES1419227-089**	**ES1419227-090**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**290**	**1180**	**780**	**480**	**280**
EK062: Total Nitrogen as N (TKN + NOx)								
^ **Total Nitrogen as N**	----	20	mg/kg	**290**	**1180**	**780**	**480**	**280**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**71**	**105**	**96**	**96**	**122**
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	<2	<2	<2	<2	<2
EP004: Organic Matter								
Organic Matter	----	0.5	%	**0.9**	**5.5**	**3.2**	**2.1**	**0.8**
Total Organic Carbon	----	0.5	%	**0.5**	**3.2**	**1.9**	**1.2**	<0.5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	HC83 60-70	HC264 0-6	HC264 7-17	181 0-10	181 10-20
			Client sampling date / time	27-NOV-2013 15:00	27-NOV-2013 15:00	27-NOV-2013 15:00	29-APR-2014 15:00	27-APR-2014 15:00
Compound	CAS Number	LOR	Unit	ES1419227-091	ES1419227-092	ES1419227-093	ES1419227-094	ES1419227-095
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	4.5	4.4	4.6	4.6	4.5
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	12	361	123	245	224
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	8.1	17.6	10.7	22.2	23.5
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	<0.1	11.1	3.0	6.9	6.6
Exchangeable Magnesium	----	0.1	meq/100g	1.1	4.0	1.2	2.8	2.5
Exchangeable Potassium	----	0.1	meq/100g	<0.1	1.0	0.6	0.6	0.6
Exchangeable Sodium	----	0.1	meq/100g	0.1	0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	1.3	16.3	4.9	10.4	9.8
ED022: Acid Extractable Pottasium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	<100	300	400	400	300
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	<50	<50	<50	<50
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	0.04	0.03	0.05	0.04
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	<10	40	30	<10	<10
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	1.8	3.4	2.0	2.4	2.3
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	1.71
Iron	7439-89-6	1.00	mg/kg	6.69	218	63.3	420	937
Manganese	7439-96-5	1.00	mg/kg	<1.00	154	16.8	39.5	50.7
Zinc	7440-66-6	1.00	mg/kg	<1.00	3.02	<1.00	3.86	6.61
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	140	810	540	840	780
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	8810	7900	8820	6860	7290
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	0.6	261	44.1	164	152

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

			Client sample ID	HC83 60-70	HC264 0-6	HC264 7-17	181 0-10	181 10-20
			Client sampling date / time	27-NOV-2013 15:00	27-NOV-2013 15:00	27-NOV-2013 15:00	29-APR-2014 15:00	27-APR-2014 15:00
Compound	CAS Number	LOR	Unit	ES1419227-091	ES1419227-092	ES1419227-093	ES1419227-094	ES1419227-095
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	140	4900	1950	5490	4900
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	140	5160	1990	5650	5050
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	138	396	401	783	736
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	<2	4	<2	25	16
EP004: Organic Matter								
Organic Matter	----	0.5	%	<0.5	12.4	7.7	8.4	8.4
Total Organic Carbon	----	0.5	%	<0.5	7.2	4.5	4.9	4.8

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	181 20-30	181 50-60	181 70-80	HC152 0-10	HC152 10-18
			Client sampling date / time	24-APR-2014 15:00	28-APR-2014 15:00	29-APR-2014 15:00	27-FEB-2014 15:00	27-FEB-2014 15:00
Compound	CAS Number	LOR	Unit	ES1419227-096	ES1419227-097	ES1419227-098	ES1419227-099	ES1419227-100
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	4.7	4.9	4.8	6.2	6.7
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	123	16	34	205	73
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	20.5	15.6	24.4	16.9	13.9
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	6.9	4.4	5.4	10.0	8.8
Exchangeable Magnesium	----	0.1	meq/100g	2.4	1.8	10.6	4.8	6.6
Exchangeable Potassium	----	0.1	meq/100g	0.6	0.2	0.5	0.2	0.2
Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.2	1.4	0.1	1.0
Cation Exchange Capacity	----	0.1	meq/100g	9.9	6.6	17.9	15.2	16.6
ED022: Acid Extractable Pottasium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	300	<100	<100	100	<100
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	<50	<50	70	<50
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.04	0.02	0.02	0.04	0.03
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	<10	<10	260	20	70
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	2.0	1.2	1.7	1.1	0.9
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	----	1.09	<1.00
Iron	7439-89-6	1.00	mg/kg	400	161	----	76.5	46.2
Manganese	7439-96-5	1.00	mg/kg	28.4	34.1	----	36.0	32.9
Zinc	7440-66-6	1.00	mg/kg	2.82	<1.00	----	1.62	<1.00
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	710	320	490	340	270
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	7910	7290	19500	7600	10200
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	71.9	1.2	5.8	77.5	5.1

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	181 20-30	181 50-60	181 70-80	HC152 0-10	HC152 10-18
			Client sampling date / time	24-APR-2014 15:00	28-APR-2014 15:00	29-APR-2014 15:00	27-FEB-2014 15:00	27-FEB-2014 15:00
Compound	CAS Number	LOR	Unit	ES1419227-096	ES1419227-097	ES1419227-098	ES1419227-099	ES1419227-100
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	3980	1240	890	2240	1520
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	4050	1240	900	2320	1520
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	588	419	278	395	261
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	15	2	<2	43	6
EP004: Organic Matter								
Organic Matter	----	0.5	%	7.4	2.3	1.8	4.7	2.9
Total Organic Carbon	----	0.5	%	4.3	1.3	1.0	2.7	1.7

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	HC152 20-30	HC152 50-60	HC278 0-10	HC278 10-20	HC278 30-40
Client sampling date / time				27-FEB-2014 15:00	27-FEB-2014 15:00	27-FEB-2014 15:00	27-FEB-2014 15:00	27-FEB-2014 15:00
				ES1419227-101	ES1419227-102	ES1419227-103	ES1419227-104	ES1419227-105
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	7.4	8.3	5.4	5.2	5.1
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	183	393	107	32	11
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	20.0	15.9	15.8	14.3	19.0
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	7.1	4.7	5.4	5.0	6.5
Exchangeable Magnesium	----	0.1	meq/100g	12.4	14.1	1.6	1.5	4.9
Exchangeable Potassium	----	0.1	meq/100g	0.2	0.1	0.2	0.2	0.3
Exchangeable Sodium	----	0.1	meq/100g	1.3	2.1	<0.1	0.2	0.4
Cation Exchange Capacity	----	0.1	meq/100g	21.0	21.0	7.3	6.9	12.0
ED022: Acid Extractable Pottasium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	<100	<100	100	<100	<100
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	90	<50	<50	<50
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.02	0.03	0.03	0.02
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	530	460	10	10	20
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	1.2	0.4	1.0	0.8	0.7
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	1.54	1.48	<1.00
Iron	7439-89-6	1.00	mg/kg	19.7	7.59	146	123	18.7
Manganese	7439-96-5	1.00	mg/kg	1.46	<1.00	51.8	37.9	<1.00
Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	1.06	<1.00	<1.00
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	570	490	410	370	740
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	22200	18900	9070	9540	22100
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	1.6	0.3	57.4	14.0	1.1

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

				Client sample ID	HC152 20-30	HC152 50-60	HC278 0-10	HC278 10-20	HC278 30-40
				Client sampling date / time	27-FEB-2014 15:00	27-FEB-2014 15:00	27-FEB-2014 15:00	27-FEB-2014 15:00	27-FEB-2014 15:00
Compound	CAS Number	LOR	Unit		ES1419227-101	ES1419227-102	ES1419227-103	ES1419227-104	ES1419227-105
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		1330	710	2270	1500	990
EK062: Total Nitrogen as N (TKN + NOx)									
^ Total Nitrogen as N	----	20	mg/kg		1330	710	2330	1510	990
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		195	123	458	343	197
EK080: Bicarbonate Extractable Phosphorus (Colwell)									
Bicarbonate Ext. P (Colwell)	----	2	mg/kg		<2	<2	8	3	<2
EP004: Organic Matter									
Organic Matter	----	0.5	%		1.9	0.9	4.6	2.8	1.2
Total Organic Carbon	----	0.5	%		1.1	0.5	2.7	1.6	0.7

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	HC278 50-60	HC278 70-80	HC414 0-10	HC414 10-20	HC414 22-32
Client sampling date / time				27-FEB-2014 15:00	27-FEB-2014 15:00	16-SEP-2013 15:00	16-SEP-2013 15:00	17-SEP-2013 15:00
				ES1419227-106	ES1419227-107	ES1419227-108	ES1419227-109	ES1419227-110
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.2	5.2	4.6	4.4	4.2
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	8	11	27	27	28
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	16.5	13.8	12.2	13.4	13.8
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	6.2	6.4	0.2	0.1	<0.1
Exchangeable Magnesium	----	0.1	meq/100g	5.6	6.0	0.2	0.1	<0.1
Exchangeable Potassium	----	0.1	meq/100g	0.3	0.3	0.1	0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	0.4	0.4	0.2	0.2	0.1
Cation Exchange Capacity	----	0.1	meq/100g	12.6	13.2	0.7	0.6	0.4
ED022: Acid Extractable Pottasium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	<100	<100	<100	<100	<100
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	<50	50	70	130
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.02	0.02	0.02	0.02
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	20	20	20	30	30
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	0.5	0.3	0.6	0.5	0.3
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
Iron	7439-89-6	1.00	mg/kg	5.61	5.90	101	47.3	52.3
Manganese	7439-96-5	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	650	540	180	150	120
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	16400	13600	13800	14100	13800
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	0.4	0.3	0.2	0.2	0.2

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	HC278 50-60	HC278 70-80	HC414 0-10	HC414 10-20	HC414 22-32
			Client sampling date / time	27-FEB-2014 15:00	27-FEB-2014 15:00	16-SEP-2013 15:00	16-SEP-2013 15:00	17-SEP-2013 15:00
Compound	CAS Number	LOR	Unit	ES1419227-106	ES1419227-107	ES1419227-108	ES1419227-109	ES1419227-110
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	560	480	1220	1270	750
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	560	480	1220	1270	750
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	148	147	105	113	108
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	<2	<2	<2	<2	<2
EP004: Organic Matter								
Organic Matter	----	0.5	%	0.7	<0.5	5.8	4.9	3.1
Total Organic Carbon	----	0.5	%	<0.5	<0.5	3.4	2.9	1.8

CERTIFICATE OF ANALYSIS

Work Order	: **EB1443988**	Page	: 1 of 10
Client	: **EMGA MITCHELL MCLENNAN**	Laboratory	: Environmental Division Brisbane
Contact	: MR TIMOTHY ROHDE	Contact	: Customer Services EB
Address	: 1/4 87 WICKHAM TERRACE SPRING HILL QLD 4000	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: trohde@emgamm.com	E-mail	: ALSEnviro.Brisbane@alsglobal.com
Telephone	: 07 3839 1800	Telephone	: +61-7-3243 7222
Facsimile	: 07 3839 1866	Facsimile	: +61-7-3243 7218
Project	: Hume	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 08-Oct-2014 14:05
C-O-C number	: ----	Date Analysis Commenced	: 10-Oct-2014
Sampler	: NEIL CUPPLES	Issue Date	: 17-Oct-2014 17:29
Site	: ----		
		No. of samples received	: 20
Quote number	: ----	No. of samples analysed	: 20

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

WORLD RECOGNISED ACCREDITATION

Signatories

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

Signatories	*Position*	*Accreditation Category*
Andrew Matheson	Senior Chemist	Brisbane Inorganics
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics
Satishkumar Trivedi	2 IC Acid Sulfate Soils Supervisor	Brisbane Acid Sulphate Soils

General Comments

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

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

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.

- **ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl (Method 15G1) is a more suitable method for the determination of exchange acidity (H+ + Al3+).**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	592 0-10	592 10-20	592 20-30	592 50-60	592 70-80
			Client sampling date / time	[26-Sep-2014]	[26-Sep-2014]	[26-Sep-2014]	[26-Sep-2014]	[26-Sep-2014]
Compound	CAS Number	LOR	Unit	EB1443988-001	EB1443988-002	EB1443988-003	EB1443988-004	EB1443988-005
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.2	5.7	6.6	6.6	5.4
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	59	65	17	26	41
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1	%	14.5	11.0	11.7	14.7	18.0
ED008: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	3.6	3.8	3.6	2.7	1.9
^ Exchangeable Magnesium	----	0.1	meq/100g	0.6	0.6	0.7	1.7	2.5
^ Exchangeable Potassium	----	0.1	meq/100g	0.3	0.2	0.3	0.2	0.1
^ Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
^ Cation Exchange Capacity	----	0.1	meq/100g	4.5	4.6	4.6	4.6	4.5
ED022 : Acid Extractable Potassium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	16700	11100	13700	6800	4700
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	<50	<50	80	590
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.03	0.02	0.02	<0.01	0.03
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	10	<10	<10	<10	<10
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	0.6	0.6	0.8	0.4	0.5
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
Iron	7439-89-6	1	mg/kg	132	84.2	16.1	5.69	17.1
Manganese	7439-96-5	1	mg/kg	68.7	38.6	41.6	1.00	<1.00
Zinc	7440-66-6	1	mg/kg	2.32	<1.00	<1.00	<1.00	<1.00
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	380	300	410	400	420
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	6010	6660	10300	13500	15400
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	20.8	9.9	2.0	0.5	0.4
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	592 0-10	592 10-20	592 20-30	592 50-60	592 70-80
			Client sampling date / time	[26-Sep-2014]	[26-Sep-2014]	[26-Sep-2014]	[26-Sep-2014]	[26-Sep-2014]
Compound	CAS Number	LOR	Unit	EB1443988-001	EB1443988-002	EB1443988-003	EB1443988-004	EB1443988-005
				Result	Result	Result	Result	Result
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser - Continued								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**850**	**560**	<20	**150**	<20
EK062: Total Nitrogen as N (TKN + NOx)								
^ **Total Nitrogen as N**	----	20	mg/kg	**870**	**570**	<20	**150**	<20
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**25**	**105**	**10**	**115**	**13**
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	**6**	**4**	<2	**2**	<2
EP004: Organic Matter								
Organic Matter	----	0.5	%	**0.9**	**0.6**	**1.3**	**2.8**	**0.8**
Total Organic Carbon	----	0.5	%	**0.5**	<0.5	**0.7**	**1.6**	<0.5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	594 0-10	594 12-20	594 25-35	594 50-60	594 70-80
			Client sampling date / time	[26-Sep-2014]	[26-Sep-2014]	[26-Sep-2014]	[26-Sep-2014]	[26-Sep-2014]
Compound	CAS Number	LOR	Unit	EB1443988-006	EB1443988-007	EB1443988-008	EB1443988-009	EB1443988-010
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	6.0	6.2	6.4	6.8	6.7
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	33	20	16	42	53
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1	%	14.7	10.8	11.6	14.7	17.3
ED008: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	3.9	2.6	3.1	3.8	3.1
^ Exchangeable Magnesium	----	0.1	meq/100g	0.9	0.5	0.7	1.8	3.5
^ Exchangeable Potassium	----	0.1	meq/100g	0.4	0.2	0.2	<0.1	<0.1
^ Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
^ Cation Exchange Capacity	----	0.1	meq/100g	5.2	3.3	3.9	5.7	6.8
ED022 : Acid Extractable Potassium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	22500	14000	7100	2600	2600
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	<50	<50	50	170
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.03	0.02	0.02	0.02	0.02
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	<10	<10	<10	20	20
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	0.7	0.5	0.5	0.4	0.4
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
Iron	7439-89-6	1	mg/kg	121	70.9	12.8	7.82	8.25
Manganese	7439-96-5	1	mg/kg	35.6	12.7	3.09	<1.00	<1.00
Zinc	7440-66-6	1	mg/kg	1.84	<1.00	<1.00	<1.00	<1.00
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	400	290	260	300	380
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	4290	4210	8040	13700	17000
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	27.4	4.9	0.8	1.2	0.6
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	594 0-10	594 12-20	594 25-35	594 50-60	594 70-80
			Client sampling date / time	[26-Sep-2014]	[26-Sep-2014]	[26-Sep-2014]	[26-Sep-2014]	[26-Sep-2014]
Compound	CAS Number	LOR	Unit	EB1443988-006	EB1443988-007	EB1443988-008	EB1443988-009	EB1443988-010
				Result	Result	Result	Result	Result
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser - Continued								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	1280	610	270	80	110
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	1310	610	270	80	110
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	268	135	94	80	121
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	8	5	<2	<2	12
EP004: Organic Matter								
Organic Matter	----	0.5	%	4.4	2.5	1.3	0.6	<0.5
Total Organic Carbon	----	0.5	%	2.5	1.4	0.7	<0.5	<0.5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)	Client sample ID			595 0-10	595 10-20	595 20-30	595 50-60	595 70-80
	Client sampling date / time			[26-Sep-2014]	[26-Sep-2014]	[26-Sep-2014]	[26-Sep-2014]	[26-Sep-2014]
Compound	CAS Number	LOR	Unit	EB1443988-011	EB1443988-012	EB1443988-013	EB1443988-014	EB1443988-015
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.7	6.0	6.4	6.5	6.5
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	34	24	16	21	29
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1	%	16.2	13.7	13.6	16.7	18.3
ED008: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	3.7	3.4	3.0	3.4	3.1
^ Exchangeable Magnesium	----	0.1	meq/100g	0.7	0.6	0.7	1.2	2.0
^ Exchangeable Potassium	----	0.1	meq/100g	0.4	0.3	0.3	0.1	<0.1
^ Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
^ Cation Exchange Capacity	----	0.1	meq/100g	4.8	4.3	4.0	4.7	5.2
ED022 : Acid Extractable Potassium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	19000	16600	17100	3700	3000
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	<50	<50	70	120
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.02	0.02	0.02	<0.01
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	10	<10	<10	<10	<10
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	0.6	0.6	0.7	0.4	0.2
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
Iron	7439-89-6	1	mg/kg	117	56.8	14.5	5.90	7.06
Manganese	7439-96-5	1	mg/kg	39.8	30.3	21.3	<1.00	<1.00
Zinc	7440-66-6	1	mg/kg	1.42	<1.00	<1.00	<1.00	<1.00
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	450	440	420	310	340
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	6020	7220	8430	11300	13000
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	11.3	12.8	2.2	0.5	0.3
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	595 0-10	595 10-20	595 20-30	595 50-60	595 70-80
			Client sampling date / time	[26-Sep-2014]	[26-Sep-2014]	[26-Sep-2014]	[26-Sep-2014]	[26-Sep-2014]
Compound	CAS Number	LOR	Unit	EB1443988-011	EB1443988-012	EB1443988-013	EB1443988-014	EB1443988-015
				Result	Result	Result	Result	Result
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser - Continued								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**1090**	**800**	<20	**160**	**150**
EK062: Total Nitrogen as N (TKN + NOx)								
^ **Total Nitrogen as N**	----	20	mg/kg	**1100**	**810**	<20	**160**	**150**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**160**	**141**	**10**	**142**	**112**
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	<2	**9**	<2	<2	<2
EP004: Organic Matter								
Organic Matter	----	0.5	%	<0.5	**4.4**	**3.9**	**1.6**	**0.9**
Total Organic Carbon	----	0.5	%	<0.5	**2.5**	**2.3**	**0.9**	**0.5**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**596 0-10**	**596 10-20**	**596 23-33**	**596 50-57**	**596 70-80**
			Client sampling date / time	[26-Sep-2014]	[26-Sep-2014]	[26-Sep-2014]	[26-Sep-2014]	[26-Sep-2014]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1443988-016**	**EB1443988-017**	**EB1443988-018**	**EB1443988-019**	**EB1443988-020**
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**5.9**	**6.2**	**6.7**	**6.2**	**5.5**
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**33**	**37**	**20**	**30**	**33**
EA055: Moisture Content								
^ **Moisture Content (dried @ 103°C)**	----	1	%	**13.0**	**12.7**	**12.5**	**16.0**	**16.1**
ED008: Exchangeable Cations								
^ **Exchangeable Calcium**	----	0.1	meq/100g	**3.4**	**3.4**	**3.6**	**2.6**	**1.9**
^ **Exchangeable Magnesium**	----	0.1	meq/100g	**0.6**	**0.6**	**0.6**	**2.0**	**2.2**
^ **Exchangeable Potassium**	----	0.1	meq/100g	**0.2**	**0.1**	<0.1	<0.1	<0.1
^ **Exchangeable Sodium**	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
^ **Cation Exchange Capacity**	----	0.1	meq/100g	**4.2**	**4.1**	**4.3**	**4.7**	**4.2**
ED022 : Acid Extractable Potassium (Skene)								
Acid Extractable K (Skene)	----	100	mg/kg	**10200**	**6300**	**3500**	**2000**	**2000**
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	<50	<50	**170**	**350**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.02**	**0.02**	**0.02**	**0.02**	**0.03**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	<10	**10**	<10	<10	<10
ED091 : Calcium Chloride Extractable Boron								
Boron	7440-42-8	0.2	mg/kg	**0.5**	**0.4**	**0.4**	**0.4**	**0.4**
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
Iron	7439-89-6	1	mg/kg	**66.5**	**39.5**	**14.0**	**9.01**	**8.15**
Manganese	7439-96-5	1	mg/kg	**29.9**	**22.5**	**10.8**	<1.00	<1.00
Zinc	7440-66-6	1	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
ED093T: Total Major Cations								
Potassium	7440-09-7	50	mg/kg	**260**	**190**	**170**	**250**	**250**
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**4780**	**5260**	**6880**	**12700**	**13500**
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	**14.6**	**8.8**	**2.7**	**0.2**	**0.3**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	596 0-10	596 10-20	596 23-33	596 50-57	596 70-80
			Client sampling date / time	[26-Sep-2014]	[26-Sep-2014]	[26-Sep-2014]	[26-Sep-2014]	[26-Sep-2014]
Compound	CAS Number	LOR	Unit	EB1443988-016	EB1443988-017	EB1443988-018	EB1443988-019	EB1443988-020
				Result	Result	Result	Result	Result
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser - Continued								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**950**	**500**	**360**	**130**	**180**
EK062: Total Nitrogen as N (TKN + NOx)								
^ **Total Nitrogen as N**	----	20	mg/kg	**960**	**510**	**360**	**130**	**180**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**151**	**111**	**94**	**104**	**105**
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	**6**	**12**	**4**	**4**	<2
EP004: Organic Matter								
Organic Matter	----	0.5	%	**1.0**	**3.5**	**2.2**	**1.9**	**1.0**
Total Organic Carbon	----	0.5	%	**0.6**	**2.0**	**1.2**	**1.1**	**0.6**

Appendix F

BSAL site verification assessment criteria and methods

Table F.1 describes the BSAL verification assessment criteria and methods used for analysis of the application area.

Table F.1 BSAL site verification assessment criteria and methods used

Assessment item	Reference in Interim Protocol	Assessment criteria	Assessment method
Reliable water source			
Within area mapped using Bureau of Meteorology (BoM) data as having 350 millimetres (mm) and above rainfall 9 out of 10 years?	Page 4	The site is within the mapped area.	Project area overlaid on the New South Wales (NSW) Office of Water (NOW) (2013a) assessment layer.
Overlying a groundwater source declared by NOW as highly productive groundwater?	Page 4	The site is within the mapped area.	Project area overlaid on the NOW (2013b) assessment layer.
Within the area mapped by NOW as being within 150 metres (m) of a highly reliable surface water supply?	Page 4	The site is within the mapped area.	Project area overlaid on the NOW (2013c) assessment layer.
Soils and landscape verification			
1. Is slope less than or equal (≤) to 10%?	Page 21	Slope ≤ 10%.	Site observations made using a hand held clinometer. GIS analysis of slope using a digital elevation model (DEM) created from light detection and ranging (LIDAR) data.
2. Is there less than (<) 30% rock outcrop?	Page 22	Less than 30% rock outcrop.	Presence of outcropping bedrock was recorded in the field as an average density within a 10 m radius surrounding the core hole. Visual assessment recorded on a soil and land information system (SALIS) data card using the method described by McDonald et al. (2009).
3. Does ≤20% of area have unattached rock fragments greater than (>) 60 mm in diameter?	Page 22	Less than or equal to 20% of the area has unattached rock fragments >60 mm in diameter.	Unattached surface rock fragments with an average maximum dimension larger than 60 mm were recorded in the field as an average density within a 10 m radius surrounding the core hole. Visual assessment recorded on a SALIS data card using the method described by McDonald et al. (2009).
4. Does ≤ 50% of the area have gilgais >500 mm deep?	Pages 22 and 23	Gilgais with depression depth (vertical interval) greater than 500 mm cover ≤ 50% of site.	Initial visual assessment for presence. None noted.
5. Is slope <5%?	Page 21	Slope <5%.	Site observations made using a hand held clinometer. GIS analysis of slope using a DEM created from LIDAR data.
6. Are there nil rock outcrops?	Page 22	No rock outcrops.	Presence of outcropping bedrock was recorded in the field as an average density within a 10 m radius surrounding the core hole. Visual assessment recorded on a SALIS data card using the method described by McDonald et al. (2009).

Table F.1 BSAL site verification assessment criteria and methods used

Assessment item	Reference in Interim Protocol	Assessment criteria	Assessment method
7(a). Does soil have moderate fertility?	Page 23 and Page 28, Appendix 2, Table 6	Fertility ranking of moderate.	Fertility ranking initially assigned to each soil type using the Interim Protocol, Appendix 2, Table 6, which is a ranking of inherent soil fertility based on the Australian soil classification (ASC) (Isbell 2002). This table is an adaptation of Table 8.2 in Murphy et al. (2007) and correlates the ASC with the approximate equivalent Great Soil Groups (Stace et al. 1968). Additional analysis of agricultural fertility characteristics were made with reference to Table 8.2 in Murphy et al. (2007). This analysis was based on laboratory analysis results for samples collected in the soil survey. Soil fertility was categorised based on a combination of pH, electrical conductivity (EC), chloride (Cl), plant available water capacity (PAWC), macronutrients, micronutrients, cation exchange capacity (CEC), exchangeable sodium percentage (ESP) and organic carbon. This analysis was made using the agricultural industry benchmarks of Baker and Eldershaw 1993, DERM 2011 and Peverill, Sparrow and Reuter 1999.
7(b). Does soil have moderately high or high fertility?	Page 23 and Page 28, Appendix 2, Table 6	Fertility ranking of moderately high or high.	Fertility ranking initially assigned to each soil type using the Interim Protocol, Appendix 2, Table 6, which is a ranking of inherent soil fertility based on the ASC (Isbell 2002). This table is an adaptation of Table 8.2 in Murphy et al. (2007) and correlates the ASC with the approximate equivalent Great Soil Groups (Stace et al. 1968). Additional analysis of agricultural fertility characteristics were made with reference to Table 8.2 in Murphy et al. (2007). This analysis was based on laboratory analysis results for samples collected in the soil survey. Soil fertility was categorised based on a combination of pH, EC, Cl, PAWC, macronutrients, micronutrients, CEC, ESP and organic carbon. This analysis was made using the agricultural industry benchmarks of Baker and Eldershaw 1993, DERM 2011 and Peverill, Sparrow and Reuter 1999.
8. Is effective rooting depth to a physical barrier greater than or equal to (≥) 750 mm?	Pages 25 and 26	Rooting depth to a physical barrier ≥750 mm?	A visual assessment was made during the field inspection (and recorded on a SALIS data card) for presence of compacted layers and/or pans as defined by McDonald and Isbell (2009) pp 192-195. These comprise gravelly/rocky layers that include both coarse fragments (defined in McDonald et al. (2009) pp 139-143) and segregations (defined in McDonald and Isbell (2009) pp 195-198). That is, soil horizons >100 mm thick containing >20% (volume) of coarse fragments and/or segregations >60 mm in diameter.
9. Is soil drainage better than poor?	Pages 23 and 24.	Soil drainage better than poor.	Soil drainage rankings are defined in McDonald and Isbell (2009) and were recorded in the field on a SALIS data card.
10. Does the pH range from 5 to 8.9 if measured in water or 4.5 to 8.1 if measured in calcium chloride, within the upper 600 mm of soil profile?	Page 24	pH between 5 and 8.9, measured in water, within the uppermost 600 mm of the soil profile.	pH was measured by laboratory analysis in a 1:5 soil:water suspension, in accordance with method 4A1 in Rayment and Lyons (2011).

Table F.1 BSAL site verification assessment criteria and methods used

Assessment item	Reference in Interim Protocol	Assessment criteria	Assessment method
11. Is salinity (ECe) ≤4 deciSiemens (dS)/m or are chlorides <800 milligrams per kilogram (mg/kg) when gypsum is present, within the uppermost 600 mm of the soil profile?	Page 25	Salinity (ECe) ≤4dS/m or chlorides <800 mg/kg when gypsum is present, within the uppermost 600 mm of the soil profile.	Two methods of measuring soil salinity were used: • electrical conductivity of a 1:5 soil:water suspension (EC1:5), measured in dS/m (Method 3A1, Rayment & Lyons 2011); and • concentration of soluble chloride (Cl) in a 1:5 soil:water suspension, measured in mg/kg (Method 5A2, Rayment & Lyons 2011). EC 1:5 was converted to electrical conductivity in a saturated extract (ECe) by using a conversion factor dependent on the field texture of the soil. The conversion factor was based on Slavich and Petterson (1993).
12. Is effective rooting depth to a chemical barrier ≥750 mm?	Pages 25 and 26	pH (1:5 soil:water) is between 5.0 and-8.9 ECe <4dS/m (or chlorides <800mg/kg when gypsum is present) ESP <15 Ca:Mg ratio >0.1	Measured in laboratory analysis.
Minimum area			
Contiguous area is ≥20 hectares (ha).	Page 27	A contiguous area equal to or exceeding 20 ha.	GIS analysis of the soil polygon or subject landform feature.

Appendix G

Detailed BSAL site verification assessments

Table G.1 BSAL verification assessments for detailed sites

Criteria	Site number and ASC		
	15 - Acidic-Mottled Dystrophic Grey Kandosol	32 - Acidic Dystrophic Brown Kandosol	44 - Bleached Mesotrophic Yellow Kandosol
Reliable water source - Only 1 POSITIVE RESULT required			
Within the area mapped using Bureau of Meteorology (BoM) data as having 350 mm and above rainfall 9 out of 10 years?	Within the mapped area	Within the mapped area	Within the mapped area
Overlying a groundwater source declared by NSW Office of Water (NOW) as highly productive groundwater?	Within the Nepean Groundwater Source	Within the Nepean Groundwater Source	Within the Nepean Groundwater Source
Within the area mapped by NOW as being within 150 m of a highly reliable surface water supply?	Project area within 150 m of many sources	Project area within 150 m of many sources	Project area within 150 m of many sources
Soils and landscape verification - All POSITIVE RESULTS required			
Is the slope ≤10%	3%	3%	9%
Is there <30% rock outcrop?	0%	0%	0%
Does ≤20% of area have unattached rock fragments >60 mm diameter?	0%	0%	0%
Does ≤50% of area have gilgais >500 mm deep?	0%	0%	0%
Only 1 POSITIVE RESULT required			
Is slope between 5% and 10%? And does soil have moderately high or high fertility?	3% Slope + Mod. low fert.	3% Slope + Mod. low fert.	9% Slope + Mod. low fert.
Is slope <5%? And are there SOME rock outcrops? And does soil have moderately high or high fertility?	3% Slope + 0% Outcrops + Mod. low fert.	3% Slope + 0% Outcrops + Mod. low fert.	9% Slope + 0% Outcrops + Mod. low fert.
Is slope <5%? And are there NIL rock outcrops? And does soil have moderate fertility?	3% Slope + 0% Outcrops + Mod. low fert.	3% Slope + 0% Outcrops + Mod. low fert.	9% Slope + 0% Outcrops + Mod. low fert.
All POSITIVE RESULTS required			
Is effective rooting depth to a physical barrier ≥750 mm?	Barrier at 500 mm (<20% coarse frags)	Barrier at 550 mm (rock)	No barrier ≤750 mm
Is soil drainage better than poor?	Imperfect	Moderately well	Imperfect
Is pH_{water} 5-8.9 within the upper 600 mm?	5.1-5.4	4.5-4.4	5.9-7.2
Is salinity within the upper 600 mm (ECe) ≤4 dS/m or chloride <800 mg/kg when gypsum is present?	0.09-0.13ECe + Cl <10-30	0.99-0.12 ECe + Cl <10-40	1.15-0.65 ECe + Cl 40-200
Is effective rooting depth to a chemical barrier ≥750 mm?	Barrier at 150 mm (ESP 29%)	Barrier at 0 mm (pH 4.5)	No barrier ≤750 mm
Minimum area - All POSITIVE RESULTS required			
Does the biophysical resource have a contiguous area of ≥20 ha?	>20 ha	>20 ha	>20 ha
Is the site BSAL?	NOT BSAL	NOT BSAL	NOT BSAL
Comments on pass failure criteria	Failed fertility, physical barrier and chemical barrier criteria	Failed fertility, physical barrier, pH and chemical barrier criteria	Failed fertility criteria

Table G.1 BSAL verification assessments for detailed sites

Criteria	Site number and ASC		
	133 - Acidic-Mottled Dystrophic Yellow Kandosol	183 - Palic-Acidic Paralithic Leptic Tenosol	267 - Acidic-Sodic Dystrophic Yellow Kandosol
Reliable water source - Only 1 POSITIVE RESULT required			
Within the area mapped using BoM data as having 350 mm and above rainfall 9 out of 10 years?	Within the mapped area	Within the mapped area	Within the mapped area
Overlying a groundwater source declared by NOW as highly productive groundwater?	Within the Nepean Groundwater Source	Within the Nepean Groundwater Source	Within the Nepean Groundwater Source
Within the area mapped by NOW as being within 150 m of a highly reliable surface water supply?	Project area within 150 m of many sources	Project area within 150 m of many sources	Project area within 150 m of many sources
Soils and landscape verification - All POSITIVE RESULTS required			
Is the slope ≤10%	14%	3%	1%
Is there <30% rock outcrop?	0%	0%	0%
Does ≤20%of area have unattached rock fragments >60 mm diameter?	0%	0%	0%
Does ≤50%of area have gilgais >500 mm deep?	0%	0%	0%
Only 1 POSITIVE RESULT required			
Is slope between 5% and 10%? And does soil have moderately high or high fertility?	14% Slope + Mod. low fert.	3% Slope + Mod. low fert.	1% Slope + Mod. low fert.
Is slope <5%? And are there SOME rock outcrops? And does soil have moderately high or high fertility?	14% Slope + 0% Outcrops + Mod. low fert.	3% Slope + 0% Outcrops + Mod. low fert.	1% Slope + 0% Outcrops + Mod. low fert.
Is slope <5%? And are there NIL rock outcrops? And does soil have moderate fertility?	14% Slope + 0% Outcrops + Mod. low fert.	3% Slope + 0% Outcrops + Mod. low fert.	1% Slope + 0% Outcrops + Mod. low fert.
All POSITIVE RESULTS required			
Is effective rooting depth to a physical barrier ≥750 mm?	No barrier ≤750 mm	Barrier at 550 mm (rock)	No barrier ≤750 mm
Is soil drainage better than poor?	Imperfect	Moderately well	Poorly
Is pH_{water} 5-8.9 within the upper 600mm?	4.6-4.3	5.4-5.6	3.8-4.2
Is salinity within the upper 600 mm (ECe) ≤4 dS/m or chloride <800 mg/kg when gypsum is present?	0.69-0.08 ECe + Cl <10-40	0.14-0.12 ECe + Cl 10-10	0.39-0.13 ECe + Cl 10-30
Is effective rooting depth to a chemical barrier ≥750 mm?	Barrier at 0 mm (pH 4.6)	No barrier ≤750 mm	Barrier at 100 mm (ESP 16%, pH 3.8)
Minimum area - All POSITIVE RESULTS required			
Does the biophysical resource have a contiguous area of ≥20 ha?	>20 ha	>20 ha	>20 ha
Is the site BSAL?	NOT BSAL	NOT BSAL	NOT BSAL
Comments on pass failure criteria	Failed slope, fertility, pH and chemical barrier criteria	Failed fertility and physical barrier criteria	Failed fertility, drainage, pH and chemical barrier criteria

Table G.1 BSAL verification assessments for detailed sites

Criteria	Site number and ASC		
	388 - Bleached-Mottled Dystrophic Yellow Kandosol	404 - Acidic-Mottled Dystrophic Brown Kandosol	472 - Acidic-Sodic Dystrophic Yellow Kandosol
Reliable water source - Only 1 POSITIVE RESULT required			
Within the area mapped using BoM data as having 350 mm and above rainfall 9 out of 10 years?	Within the mapped area	Within the mapped area	Within the mapped area
Overlying a groundwater source declared by NOW as highly productive groundwater?	Within the Nepean Groundwater Source	Within the Nepean Groundwater Source	Within the Nepean Groundwater Source
Within the area mapped by NOW as being within 150 m of a highly reliable surface water supply?	Project area within 150 m of many sources	Project area within 150 m of many sources	Project area within 150 m of many sources
Soils and landscape verification - All POSITIVE RESULTS required			
Is the slope ≤10%	7%	3%	4%
Is there <30% rock outcrop?	0%	0%	0%
Does ≤20%of area have unattached rock fragments >60 mm diameter?	0%	0%	2-10%
Does ≤50%of area have gilgais >500 mm deep?	0%	0%	0%
Only 1 POSITIVE RESULT required			
Is slope between 5% and 10%? And does soil have moderately high or high fertility?	7% Slope + Mod. low fert.	3% Slope + Mod. low fert.	4% Slope + Mod. low fert.
Is slope <5%? And are there SOME rock outcrops? And does soil have moderately high or high fertility?	7% Slope + 0% Outcrops + Mod. low fert.	3% Slope + 0% Outcrops + Mod. low fert.	4% Slope + 0% Outcrops + Mod. low fert.
Is slope <5%? And are there NIL rock outcrops? And does soil have moderate fertility?	7% Slope + 0% Outcrops + Mod. low fert.	3% Slope + 0% Outcrops + Mod. low fert.	4% Slope + 0% Outcrops + Mod. low fert.
All POSITIVE RESULTS required			
Is effective rooting depth to a physical barrier ≥750 mm?	No barrier ≤750 mm	No barrier ≤750 mm	Barrier at 110 mm (20-50% coarse frags)
Is soil drainage better than poor?	Imperfect	Imperfect	Imperfect
Is pH_{water} 5-8.9 within the upper 600mm?	5.1-6.1	4.6-4.2	4.3-3.8
Is salinity within the upper 600 mm (ECe) ≤4 dS/m or chloride <800 mg/kg when gypsum is present?	0.20-0.67ECe + Cl 27-170	0.95-0.24 ECe + Cl 20-10	4.6-0.08 ECe + Cl 20-<10
Is effective rooting depth to a chemical barrier ≥750 mm?	No barrier ≤750 mm	Barrier at 0 mm (pH 4.6)	Barrier at 0 mm (pH 4.3 + 4.6 ECe)
Minimum area - All POSITIVE RESULTS required			
Does the biophysical resource have a contiguous area of ≥20 ha?	>20 ha	>20 ha	>20 ha
Is the site BSAL?	NOT BSAL	NOT BSAL	NOT BSAL
Comments on pass failure criteria	Failed fertility criteria	Failed fertility, pH and chemical barrier criteria	Failed fertility, physical boundary, pH, salinity and chemical barrier criteria

Table G.1 BSAL verification assessments for detailed sites

Criteria	Site number and ASC		
	481 - Acidic-Mottled Dystrophic Yellow Kandosol	502 - Mottled Dystrophic Yellow Kandosol	592 - Haplic Dystrophic Red Kandosol
Reliable water source - Only 1 POSITIVE RESULT required			
Within the area mapped using BoM data as having 350 mm and above rainfall 9 out of 10 years?	Within the mapped area	Within the mapped area	Within the mapped area
Overlying a groundwater source declared by NOW as highly productive groundwater?	Within the Nepean Groundwater Source	Within the Nepean Groundwater Source	Within the Nepean Groundwater Source
Within the area mapped by NOW as being within 150 m of a highly reliable surface water supply?	Project area within 150 m of many sources	Project area within 150 m of many sources	Project area within 150 m of many sources
Soils and landscape verification - All POSITIVE RESULTS required			
Is the slope ≤10%	7%	8%	1%
Is there <30% rock outcrop?	0%	0%	0%
Does ≤20%of area have unattached rock fragments >60 mm diameter?	0%	0%	0%
Does ≤50%of area have gilgais >500 mm deep?	0%	0%	0%
Only 1 POSITIVE RESULT required			
Is slope between 5% and 10%? And does soil have moderately high or high fertility?	7% Slope + Mod. low fert.	8% Slope + Mod. low fert.	1% Slope + Mod. low fert.
Is slope <5%? And are there SOME rock outcrops? And does soil have moderately high or high fertility?	7% Slope + 0% Outcrops + Mod. low fert.	8% Slope + 0% Outcrops + Mod. low fert.	1% Slope + 0% Outcrops + Mod. low fert.
Is slope <5%? And are there NIL rock outcrops? And does soil have moderate fertility?	7% Slope + 0% Outcrops + Mod. low fert.	8% Slope + 0% Outcrops + Mod. low fert.	1% Slope + 0% Outcrops + Mod. low fert.
All POSITIVE RESULTS required			
Is effective rooting depth to a physical barrier ≥750 mm?	No barrier ≤750 mm	Barrier at 350 mm (20-50% coarse frags)	No barrier ≤750 mm
Is soil drainage better than poor?	Imperfect	Moderately well	Moderately well
Is pH_{water} 5-8.9 within the upper 600mm?	4.2-4.1	4.8-4.2	5.2-6.6
Is salinity within the upper 600 mm (ECe) ≤4 dS/m or chloride <800 mg/kg when gypsum is present?	1.56-0.18 ECe + Cl 20-<10	0.74-0.16 ECe + Cl 10-<10	0.55-0.19ECe + Cl 10-<10
Is effective rooting depth to a chemical barrier ≥750 mm?	Barrier at 0 mm (pH 4.2)	Barrier at 0 mm (pH 4.8)	No barrier ≤750 mm
Minimum area - All POSITIVE RESULTS required			
Does the biophysical resource have a contiguous area of ≥20 ha?	>20 ha	>20 ha	<20 ha (3.6 ha)
Is the site BSAL?	NOT BSAL	NOT BSAL	NOT BSAL
Comments on pass failure criteria	Failed fertility, pH and chemical barrier criteria	Failed fertility, physical boundary, pH and chemical barrier criteria	Failed fertility and area criteria

Table G.1 BSAL verification assessments for detailed sites

Criteria	Site number and ASC		
	594 - Mottled Dystrophic Yellow Kandosol	595 - Haplic Dystrophic Red Kandosol	596 - Mottled Dystrophic Yellow Kandosol
Reliable water source - Only 1 POSITIVE RESULT required			
Within the area mapped using BoM data as having 350 mm and above rainfall 9 out of 10 years?	Within the mapped area	Within the mapped area	Within the mapped area
Overlying a groundwater source declared by NOW as highly productive groundwater?	Within the Nepean Groundwater Source	Within the Nepean Groundwater Source	Within the Nepean Groundwater Source
Within the area mapped by NOW as being within 150 m of a highly reliable surface water supply?	Project area within 150 m of many sources	Project area within 150 m of many sources	Project area within 150 m of many sources
Soils and landscape verification - All POSITIVE RESULTS required			
Is the slope ≤10%	3%	4%	3%
Is there <30% rock outcrop?	0%	0%	0%
Does ≤20%of area have unattached rock fragments >60 mm diameter?	0%	0%	0%
Does ≤50%of area have gilgais >500 mm deep?	0%	0%	0%
Only 1 POSITIVE RESULT required			
Is slope between 5% and 10%? And does soil have moderately high or high fertility?	3% Slope + Mod. low fert.	4% Slope + Mod. low fert.	3% Slope + Mod. low fert.
Is slope <5%? And are there SOME rock outcrops? And does soil have moderately high or high fertility?	3% Slope + 0% Outcrops + Mod. low fert.	4% Slope + 0% Outcrops + Mod. low fert.	3% Slope + 0% Outcrops + Mod. low fert.
Is slope <5%? And are there NIL rock outcrops? And does soil have moderate fertility?	3% Slope + 0% Outcrops + Mod. low fert.	4% Slope + 0% Outcrops + Mod. low fert.	3% Slope + 0% Outcrops + Mod. low fert.
All POSITIVE RESULTS required			
Is effective rooting depth to a physical barrier ≥750 mm?	No barrier ≤750 mm	No barrier ≤750 mm	No barrier ≤750 mm
Is soil drainage better than poor?	Imperfectly	Moderately well	Moderately well
Is pH_{water} 5-8.9 within the upper 600mm?	6.0-6.8	5.7-6.5	5.9-6.2
Is salinity within the upper 600 mm (ECe) ≤4 dS/m or chloride <800 mg/kg when gypsum is present?	0.31-0.30ECe + Cl <10-20	0.27-0.12ECe + Cl 10-<10	0.28-0.21ECe + Cl 10-<10
Is effective rooting depth to a chemical barrier ≥750 mm?	No barrier ≤750 mm	No barrier ≤750 mm	No barrier ≤750 mm
Minimum area - All POSITIVE RESULTS required			
Does the biophysical resource have a contiguous area of ≥20 ha?	>20 ha	<20 ha (3.6 ha)	>20 ha
Is the site BSAL?	NOT BSAL	NOT BSAL	NOT BSAL
Comments on pass failure criteria	Failed fertility criteria	Failed fertility and area criteria	Failed fertility criteria

Table G.1 BSAL verification assessments for detailed sites

Criteria	Site number and ASC		
	73 - Palic-Acidic Paralithic Leptic Tenosol	83 - Palic-Acidic Paralithic Leptic Tenosol	126 - Palic-Acidic Paralithic Leptic Tenosol
Reliable water source - Only 1 POSITIVE RESULT required			
Within the area mapped using BoM data as having 350 mm and above rainfall 9 out of 10 years?	Within the mapped area	Within the mapped area	Within the mapped area
Overlying a groundwater source declared by NOW as highly productive groundwater?	Within the Nepean Groundwater Source	Within the Nepean Groundwater Source	Within the Nepean Groundwater Source
Within the area mapped by NOW as being within 150 m of a highly reliable surface water supply?	Project area within 150 m of many sources	Project area within 150 m of many sources	Project area within 150 m of many sources
Soils and landscape verification - All POSITIVE RESULTS required			
Is the slope ≤10%	14%	6%	20%
Is there <30% rock outcrop?	0%	0%	0%
Does ≤20%of area have unattached rock fragments >60 mm diameter?	0%	2-10%	0-2%
Does ≤50%of area have gilgais >500 mm deep?	0%	0%	0%
Only 1 POSITIVE RESULT required			
Is slope between 5% and 10%? And does soil have moderately high or high fertility?	14% Slope + Low fert.	6% Slope + Low fert.	20% Slope + Low fert.
Is slope <5%? And are there SOME rock outcrops? And does soil have moderately high or high fertility?	14% Slope + 0% Outcrops + Low fert.	6% Slope + 0% Outcrops + Low fert.	20% Slope + 0% Outcrops + Low fert.
Is slope <5%? And are there NIL rock outcrops? And does soil have moderate fertility?	14% Slope + 0% Outcrops + Low fert.	6% Slope + 0% Outcrops + Low fert.	20% Slope + 0% Outcrops + Low fert.
All POSITIVE RESULTS required			
Is effective rooting depth to a physical barrier ≥750 mm?	No barrier ≤750 mm	No barrier ≤750 mm	No barrier ≤750 mm
Is soil drainage better than poor?	Rapidly	Rapidly	Rapidly
Is pH_{water} 5-8.9 within the upper 600mm?	4.0-4.4	4.6-4.5	4.6-4.4
Is salinity within the upper 600 mm (ECe) ≤4 dS/m or chloride <800 mg/kg when gypsum is present?	0.14-2.16 ECe + Cl <10-30	0.43-0.17 ECe + Cl <10-30	2.5-0.34 ECe + Cl <10-30
Is effective rooting depth to a chemical barrier ≥750 mm?	Barrier at 0 mm (pH 4.0)	Barrier at 0 mm (pH 4.6)	Barrier at 0 mm (pH 4.6)
Minimum area - All POSITIVE RESULTS required			
Does the biophysical resource have a contiguous area of ≥20 ha?	>20 ha	>20 ha	>20 ha
Is the site BSAL?	NOT BSAL	NOT BSAL	NOT BSAL
Comments on pass failure criteria	Failed slope, fertility, pH and chemical barrier criteria	Failed fertility, pH and chemical barrier criteria	Failed slope, fertility, pH and chemical barrier criteria

Table G.1 BSAL verification assessments for detailed sites

Criteria	Site number and ASC		
	263 - Palic-Acidic Paralithic Leptic Tenosol	287 - Palic-Acidic Paralithic Leptic Tenosol	300 - Palic-Acidic Paralithic Leptic Tenosol
Reliable water source - Only 1 POSITIVE RESULT required			
Within the area mapped using BoM data as having 350 mm and above rainfall 9 out of 10 years?	Within the mapped area	Within the mapped area	Within the mapped area
Overlying a groundwater source declared by NOW as highly productive groundwater?	Within the Nepean Groundwater Source	Within the Nepean Groundwater Source	Within the Nepean Groundwater Source
Within the area mapped by NOW as being within 150 m of a highly reliable surface water supply?	Project area within 150 m of many sources	Project area within 150 m of many sources	Project area within 150 m of many sources
Soils and landscape verification - All POSITIVE RESULTS required			
Is the slope ≤10%	3%	9%	6%
Is there <30% rock outcrop?	0%	0%	0%
Does ≤20%of area have unattached rock fragments >60 mm diameter?	0%	0-2%	0%
Does ≤50%of area have gilgais >500 mm deep?	0%	0%	0%
Only 1 POSITIVE RESULT required			
Is slope between 5% and 10%? And does soil have moderately high or high fertility?	3% Slope + Low fert.	9% Slope + Low fert.	6% Slope + Low fert.
Is slope <5%? And are there SOME rock outcrops? And does soil have moderately high or high fertility?	3% Slope + 0% Outcrops + Low fert.	9% Slope + 0% Outcrops + Low fert.	6% Slope + 0% Outcrops + Low fert.
Is slope <5%? And are there NIL rock outcrops? And does soil have moderate fertility?	3% Slope + 0% Outcrops + Low fert.	9% Slope + 0% Outcrops + Low fert.	6% Slope + 0% Outcrops + Low fert.
All POSITIVE RESULTS required			
Is effective rooting depth to a physical barrier ≥750 mm?	No barrier ≤750 mm	No barrier ≤750 mm	No barrier ≤750 mm
Is soil drainage better than poor?	Rapidly	Well	Rapidly
Is pH_{water} 5-8.9 within the upper 600mm?	4.2-4.4	5.6-5.2	4.3-4.5
Is salinity within the upper 600 mm (ECe) ≤4 dS/m or chloride <800 mg/kg when gypsum is present?	0.55-0.08 ECe + Cl <10-10	0.12-0.09 ECe + Cl <10	0.23-1.17 ECe + Cl <10-10
Is effective rooting depth to a chemical barrier ≥750 mm?	Barrier at 0 mm (pH 4.2)	Barrier at 10 mm (ESP 33)	Barrier at 0 mm (pH 4.3)
Minimum area - All POSITIVE RESULTS required			
Does the biophysical resource have a contiguous area of ≥20 ha?	>20 ha	>20 ha	>20 ha
Is the site BSAL?	NOT BSAL	NOT BSAL	NOT BSAL
Comments on pass failure criteria	Failed fertility, pH and chemical barrier criteria	Failed fertility and chemical barrier criteria	Failed fertility, pH and chemical barrier criteria

Table G.1 BSAL verification assessments for detailed sites

Criteria	Site number and ASC		
	4 - Acidic-Sodic Dermosolic Redoxic Hydrosol	10 - Acidic-Sodic Tenosolic Oxyaquic Hydrosol	92 - Acidic-Sodic Kandosolic Redoxic Hydrosol
Reliable water source - Only 1 POSITIVE RESULT required			
Within the area mapped using BoM data as having 350 mm and above rainfall 9 out of 10 years?	Within the mapped area	Within the mapped area	Within the mapped area
Overlying a groundwater source declared by NOW as highly productive groundwater?	Within the Nepean Groundwater Source	Within the Nepean Groundwater Source	Within the Nepean Groundwater Source
Within the area mapped by NOW as being within 150 m of a highly reliable surface water supply?	Project area within 150 m of many sources	Project area within 150 m of many sources	Project area within 150 m of many sources
Soils and landscape verification - All POSITIVE RESULTS required			
Is the slope ≤10%	1%	2%	1%
Is there <30% rock outcrop?	0%	0%	0%
Does ≤20%of area have unattached rock fragments >60 mm diameter?	0%	0%	0%
Does ≤50%of area have gilgais >500 mm deep?	0%	0%	0%
Only 1 POSITIVE RESULT required			
Is slope between 5% and 10%? And does soil have moderately high or high fertility?	1% Slope + Mod. low fert.	2% Slope + Mod. low fert	1% Slope + Mod. low fert
Is slope <5%? And are there SOME rock outcrops? And does soil have moderately high or high fertility?	1% Slope + 0% Outcrops + Mod. low fert	2% Slope + 0% Outcrops + Mod. low fert	1% Slope + 0% Outcrops + Mod. low fert
Is slope <5%? And are there NIL rock outcrops? And does soil have moderate fertility?	1% Slope + 0% Outcrops + Mod. low fert	2% Slope + 0% Outcrops + Mod. low fert	1% Slope + 0% Outcrops + Mod. low fert
All POSITIVE RESULTS required			
Is effective rooting depth to a physical barrier ≥750 mm?	No barrier ≤750 mm	No barrier ≤750 mm	No barrier ≤750 mm
Is soil drainage better than poor?	Poorly	Well	Poorly
Is pH_{water} 5-8.9 within the upper 600mm?	5.1-5.6	3.7-4.0	4.4-42
Is salinity within the upper 600 mm (ECe) ≤4 dS/m or chloride <800 mg/kg when gypsum is present?	1.60-5.5 ECe + Cl 310-1500	4.46-0.90 ECe + Cl 20-100	1.62-0.12 ECe + Cl 40-90
Is effective rooting depth to a chemical barrier ≥750 mm?	Barrier at 200 mm (Cl 880) + 500 mm (ECe 5.5)	Barrier at 0 mm (pH 3.7)	Barrier at 0 mm (pH 4.4)
Minimum area - All POSITIVE RESULTS required			
Does the biophysical resource have a contiguous area of ≥20 ha?	>20 ha	>20 ha	>20 ha
Is the site BSAL?	NOT BSAL	NOT BSAL	NOT BSAL
Comments on pass failure criteria	Failed fertility, drainage, salinity and chemical barrier criteria	Failed fertility, pH and chemical barrier criteria	Failed fertility, drainage, pH and chemical barrier criteria

Table G.1 BSAL verification assessments for detailed sites

Criteria	Site number and ASC		
	238 - Acidic-Sodic Kandosolic Redoxic Hydrosol	454 - Acidic-Sodic Kandosolic Redoxic Hydrosol	524 - Acidic-Sodic Kandosolic Redoxic Hydrosol
Reliable water source - Only 1 POSITIVE RESULT required			
Within the area mapped using BoM data as having 350 mm and above rainfall 9 out of 10 years?	Within the mapped area	Within the mapped area	Within the mapped area
Overlying a groundwater source declared by NOW as highly productive groundwater?	Within the Nepean Groundwater Source	Within the Nepean Groundwater Source	Within the Nepean Groundwater Source
Within the area mapped by NOW as being within 150 m of a highly reliable surface water supply?	Project area within 150 m of many sources	Project area within 150 m of many sources	Project area within 150 m of many sources
Soils and landscape verification - All POSITIVE RESULTS required			
Is the slope ≤10%	2%	1%	1%
Is there <30% rock outcrop?	0%	0%	0%
Does ≤20%of area have unattached rock fragments >60 mm diameter?	0%	0%	0%
Does ≤50%of area have gilgais >500 mm deep?	0%	0%	0%
Only 1 POSITIVE RESULT required			
Is slope between 5% and 10%? And does soil have moderately high or high fertility?	2% Slope + Mod. low fert	1% Slope + Mod. low fert	1% Slope + Mod. low fert
Is slope <5%? And are there SOME rock outcrops? And does soil have moderately high or high fertility?	2% Slope + 0% Outcrops + Mod. low fert	1% Slope + 0% Outcrops + Mod. low fert	1% Slope + 0% Outcrops + Mod. low fert
Is slope <5%? And are there NIL rock outcrops? And does soil have moderate fertility?	2% Slope + 0% Outcrops + Mod. low fert	1% Slope + 0% Outcrops + Mod. low fert	1% Slope + 0% Outcrops + Mod. low fert
All POSITIVE RESULTS required			
Is effective rooting depth to a physical barrier ≥750 mm?	Barrier at 650 mm (20-50% coarse frags)	No barrier ≤750 mm	No barrier ≤750 mm
Is soil drainage better than poor?	Poorly	Imperfectly	Poorly
Is pH_{water} 5-8.9 within the upper 600mm?	4.5-5.1	5.2-4.8	4.6-5.3
Is salinity within the upper 600 mm (ECe) ≤4 dS/m or chloride <800 mg/kg when gypsum is present?	1.39-0.17 ECe + Cl 20-110	0.88-0.196ECe + Cl 20-150	2.88-0.31 ECe + Cl 30-440
Is effective rooting depth to a chemical barrier ≥750 mm?	Barrier at 0 mm (pH 4.5)	No barrier ≤750 mm	Barrier at 0 mm (pH 4.6)
Minimum area - All POSITIVE RESULTS required			
Does the biophysical resource have a contiguous area of ≥20 ha?	>20 ha	>20 ha	>20 ha
Is the site BSAL?	NOT BSAL	NOT BSAL	NOT BSAL
Comments on pass failure criteria	Failed fertility, drainage, pH, physical barrier and chemical barrier criteria	Failed fertility and pH criteria	Failed fertility, drainage and pH and chemical barrier criteria

Table G.1 BSAL verification assessments for detailed sites

Criteria	Site number and ASC		
	264 - Acidic Lithic Leptic Rudosol	414 - Acidic Lithic Leptic Rudosol	474 - Acidic Lithic Leptic Rudosol
Reliable water source - Only 1 POSITIVE RESULT required			
Within the area mapped using BoM data as having 350 mm and above rainfall 9 out of 10 years?	Within the mapped area	Within the mapped area	Within the mapped area
Overlying a groundwater source declared by NOW as highly productive groundwater?	Within the Nepean Groundwater Source	Within the Nepean Groundwater Source	Within the Nepean Groundwater Source
Within the area mapped by NOW as being within 150 m of a highly reliable surface water supply?	Project area within 150 m of many sources	Project area within 150 m of many sources	Project area within 150 m of many sources
Soils and landscape verification - All POSITIVE RESULTS required			
Is the slope ≤10%	51%	22%	18%
Is there <30% rock outcrop?	2-10%	50-100%	2-10%
Does ≤20%of area have unattached rock fragments >60 mm diameter?	20-50% of 60-200 mm	20-50% of 60-200 mm	2-10% of 200-600 mm + 2-10% of >600 mm
Does ≤50%of area have gilgais >500 mm deep?	0%	0%	0%
Only 1 POSITIVE RESULT required			
Is slope between 5% and 10%? And does soil have moderately high or high fertility?	51% Slope + Low fert.	22% Slope + Low fert.	18% Slope + Low fert.
Is slope <5%? And are there SOME rock outcrops? And does soil have moderately high or high fertility?	51% Slope + 2-10% Outcrops + Low fert.	22% Slope + 50-100% Outcrops + Low fert.	18% Slope + 2-10% Outcrops + Low fert.
Is slope <5%? And are there NIL rock outcrops? And does soil have moderate fertility?	51% Slope + 2-10% Outcrops + Low fert.	22% Slope + 50-100% Outcrops + Low fert.	18% Slope + 2-10% Outcrops + Low fert.
All POSITIVE RESULTS required			
Is effective rooting depth to a physical barrier ≥750 mm?	Barrier at 170 mm (rock)	Barrier at 320 mm (rock)	Barrier at 100 mm (rock)
Is soil drainage better than poor?	Well	Rapidly	Rapidly
Is pH_{water} 5-8.9 within the upper 600mm?	4.4-4.6	4.6-4.2	5.3-5.8
Is salinity within the upper 600 mm (ECe) ≤4 dS/m or chloride <800 mg/kg when gypsum is present?	7.22-2.46ECe + Cl 40-30	0.46-0.24 ECe + Cl 20-30	0.21-0.44 ECe + Cl 30-40
Is effective rooting depth to a chemical barrier ≥750 mm?	Barrier at 0 mm (ECe 7.22, pH 4.4)	Barrier at 0 mm (pH 4.6)	No barrier ≤750 mm
Minimum area - All POSITIVE RESULTS required			
Does the biophysical resource have a contiguous area of ≥20 ha?	>20 ha	>20 ha	>20 ha
Is the site BSAL?	NOT BSAL	NOT BSAL	NOT BSAL
Comments on pass failure criteria	Failed slope, surface rock, fertility, physical barrier, pH, salinity and chemical barrier criteria	Failed slope, surface rock, fertility, physical barrier, pH and chemical barrier criteria	Failed slope, fertility and physical barrier criteria

Table G.1 BSAL verification assessments for detailed sites

Criteria	Site number and ASC		
	152 - Mottled-Sodic Eutrophic Grey Dermosol	181 - Acidic-Sodic Eutrophic Brown Dermosol	278 - Acidic- Mottled Mesotrophic Grey Dermosol
Reliable water source - Only 1 POSITIVE RESULT required			
Within the area mapped using BoM data as having 350 mm and above rainfall 9 out of 10 years?	Within the mapped area	Within the mapped area	Within the mapped area
Overlying a groundwater source declared by NOW as highly productive groundwater?	Within the Nepean Groundwater Source	Within the Nepean Groundwater Source	Within the Nepean Groundwater Source
Within the area mapped by NOW as being within 150 m of a highly reliable surface water supply?	Project area within 150 m of many sources	Project area within 150 m of many sources	Project area within 150 m of many sources
Soils and landscape verification - All POSITIVE RESULTS required			
Is the slope ≤10%	3%	5%	2%
Is there <30% rock outcrop?	0-2%	0%	0%
Does ≤20%of area have unattached rock fragments >60 mm diameter?	0%	0%	0%
Does ≤50%of area have gilgais >500 mm deep?	0%	0%	0%
Only 1 POSITIVE RESULT required			
Is slope between 5% and 10%? And does soil have moderately high or high fertility?	3% Slope + Mod. fert	5% Slope + Mod. fert	2% Slope + Mod. fert
Is slope <5%? And are there SOME rock outcrops? And does soil have moderately high or high fertility?	3% Slope + 0-2% Outcrops + Mod. fert	5% Slope + 0% Outcrops + Mod. fert	2% Slope + 0% Outcrops + Mod. fert
Is slope <5%? And are there NIL rock outcrops? And does soil have moderate fertility?	3% Slope + 0-2% Outcrops + Mod. fert	5% Slope + 0% Outcrops + Mod. fert	2% Slope + 0% Outcrops + Mod. fert
All POSITIVE RESULTS required			
Is effective rooting depth to a physical barrier ≥750 mm?	Barrier at 600 mm (rock)	No barrier ≤750 mm	No barrier ≤750 mm
Is soil drainage better than poor?	Poorly	Poorly	Poorly
Is pH_{water} 5-8.9 within the upper 600mm?	6.4-8.3	4.6-4.9	5.1-5.3
Is salinity within the upper 600 mm (ECe) ≤4 dS/m or chloride <800 mg/kg when gypsum is present?	1.64-2.4 ECe + Cl 20-530	2.4-0.13 ECe + Cl <10-260	0.05-0.56 ECe + Cl 10-20
Is effective rooting depth to a chemical barrier ≥750 mm?	No barrier ≤750 mm	Barrier at 0 mm (pH 4.6)	No barrier ≤750 mm
Minimum area - All POSITIVE RESULTS required			
Does the biophysical resource have a contiguous area of ≥20 ha?	8.6 ha	15.6 ha	1.25 ha
Is the site BSAL?	NOT BSAL	NOT BSAL	NOT BSAL
Comments on pass failure criteria	Failed fertility, physical barrier, drainage and area criteria	Failed fertility, drainage, pH, chemical barrier and area criteria	Failed drainage and area criteria

Appendix H

Copy of SVC notification advertisement

POSITIONS VACANT

Beechwood
your family home

FRAMING and FIXOUT CARPENTERS, PAINTERS and BRICKLAYERS

Beechwood Homes South Coast require sub-contractors for the Southern Highlands area.Must have own insurance, safe work method statement, white card and licence.

Please email your resume to

receptionsth@beechwoodhomes.com.au

POSITIONS VACANT

OXLEY FRAME AND TRUSS

have a position vacant for a Heavy-Combination licensed Semi Driver to work locally delivering roof trusses and wall frames as well as yard duties.. Must be competent and preferably licensed to operate a crane and forklift.

Above award wages offered and conditions apply. Resumes should be sent attention to:

The Manager,
Oxley Frame & Truss,
PO Box 786,
BOWRAL NSW 2576

FURNITURE REMOVAL DRIVER

• Must have MR Licence.
• Experience preferred but not essential

Please call Will
0420 413 052

JUNIOR SALESPERSON

Long established business requires a Junior Salesperson for a permanent full time position.

Phone: 48721211

A & S KITCHENS

Cabinet Maker/Wood Machinest
Required for quality Kitchen
Manufacturer in Bowral.
Top wages for the right person.
Must have experience & references.
Apply to A & S Kitchens
4861 1453
ALSO Factory hand required

Sub -Contractor's Needed

Patio Installers/Carpenters/Builders
Spanline South Coast
are looking for experienced
patio/carport/glass room installers
with suitable licences, vehicle and tools.
Continuous or casual work in
The Highlands Area
For further information please call
Spanline South Coast on
ph 02 4421 4733

PUBLIC NOTICES

PUBLIC NOTICE OF INTENTION TO LODGE AN APPLICATION FOR A SITE VERIFICATION CERTIFICATE UNDER CLAUSE 17C OF THE STATE ENVIRONMENTAL PLANNING POLICY (MINING, PETROLEUM PRODUCTION AND EXTRACTIVE INDUSTRIES) 2007

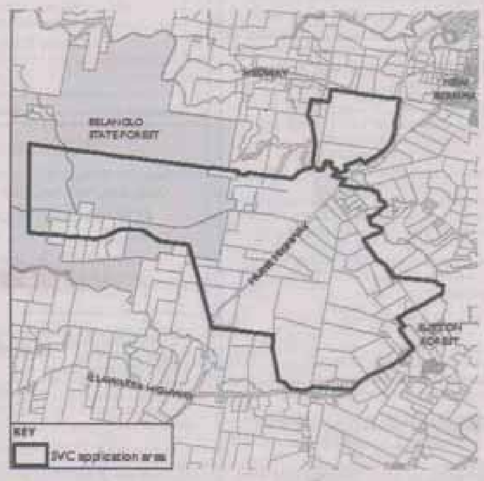
Within 30 days of today's date, Hume Coal Pty Limited (Hume Coal) (ABN 90 070 017 784) intends to apply to the NSW Department of Planning and Environment for a Site Verification Certificate for the Hume Coal Project (the project), in accordance with Clause 17C of State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007.

The proposed project involves development and operation of an underground coal mine and associated mine infrastructure, including facilities to handle, process, wash and transport coal. It is proposed that the mine will be built and operated over a minimum period of approximately 22 years, followed by around two years of closure and rehabilitation activities. It will use low impact mining methods and employ around 300 personnel at peak production.

SITE DESCRIPTION:

The application for a Site Verification Certificate is being made for land within and north of exploration authorisation 349 (A349), approximately 100 km south-west of Sydney and 3 km west of Moss Vale in the Wingecarribee local government area. A349 was originally granted in 1985 and is now held by Hume Coal. Underground mining will be restricted to A349, while surface facilities will be developed within and north of A349. The application area is shown below. It comprises all of the land within the boundary shown, including the following Lot/DPs and some Crown land parcels which do not have an assigned legal description.

3/1188; 4/1188; 5/1188; 1/2553; 16/2715; 17/2715; 3/11147; 7/11147; 8/11147; 1/56241; 1/88227; 1/112008; 1/124496; 1/130301; 1/160149; 1/160150; 1/162755; 2/213223; 2/214236; 2/217937; 3/244195; 4/244195; 5/244195; 1/249175; 6/250743; 7/250743; 1/250746; 7/250746; 8/250746; 10/262736; 11/262736; 19/262737; 20/262737; 21/262737; 22/262737; 23/262737; 29/262737; 29/262738; 30/262738; 31/262738; A/382162; B/382162; 1/549837; 1/556488; 1/605156; 2/605156; 11/703936; 7/703937; 10/705789; 12/705789; 17/705790; 18/705790; 20/705790; 21/705790; 1/711048; 2/711048; 3/711048; 4/711048; 5/711048; 1/718830; 1/744544; 2/746773; 1/751251; 2/751251; 3/751251; 31/751251; 32/751251; 33/751251; 37/751251; 47/751251; 48/751251; 60/751251; 62/751251; 64/751251; 65/751251; 66/751251; 71/751251; 87/751251; 88/751251; 97/751251; 98/751251; 100/751251; 101/751251; 102/751251; 105/751251; 108/751251; 113/751251; 114/751251; 117/751251; 172/751251; 173/751251; 174/751251; 1/780173; 1/783660; 6/806772; 7/806772; 2/806934; 3/806934; 2/819179; 4/826337; 6/829835; 200/839314; 1/860654; 2/860654; 4/872238; 7/874965; 2/875422; 8/883697; 1/995642; 12/1004339; 1/1008476; 1/1009075; 2/1009075; 1/1028147; 1/1029524; 2/1029524; 9/1040207; 10/1040207; 601/1041158; 11/1044116; 1/1046976; 1/1093425; 2/1093425; 1/1118652; 2/1118652; 671/1118901; 672/1118901; 2/1138694; 11/1154387; 12/1154387; 7141/1203892



APPLICANT DETAILS:

Hume Coal Pty Limited • Unit 7-8, Clarence House, 9 Clarence Street, Moss Vale NSW 2577

Ph: +61 2 4868 1233 • www.humecoal.com.au

FURTHER INFORMATION:

Once lodged the Site Verification Certificate application will be available online at www.humecoal.com.au

A Development Application for the project will be submitted to the Minister for Planning in 2016, under Part 4, Division 4.1 of the NSW *Environmental Planning and Assessment Act 1979*. It will be accompanied by an Environmental Impact Statement (EIS) describing the project in detail, along with its potential environmental, social and economic effects and the proposed environmental safeguards. The EIS will be prepared in accordance with relevant guidelines, policies and assessment requirements issued by the NSW Department of Planning and Environment. It will be made publicly available for review and comment.

Should you have any questions regarding this notice, please contact Hume Coal on 02 4868 1233 or info@humecoal.com.au. Alternatively, visit our community office at Shop 7, 256 Argyle Street, Moss Vale NSW or our project office at Unit 7-8, Clarence House, 9 Clarence Street, Moss Vale.

Project Office

7/8 Clarence House
9 Clarence Street
Moss Vale NSW 2577
Ph: +61 2 4869 8200
E: info@humecoal.com.au

Mailing Address

Hume Coal Pty Limited
PO Box 1226
Moss Vale NSW 2577

Appendix B

Land and soil capability assessment

Land and Soil Capability Assessment Report

Decision Tables
Hume Coal Project Area

Prepared for Hume Coal | 23 June 2016

Land and Soil Capability Assessment Report

Decision Tables

Hume Coal Project Area

Prepared for Hume Coal | 23 June 2016

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Land and Soil Capability Assessment Report

FINAL

Report J12055RP1 | Prepared for Hume Coal | 23 June 2016

Prepared by	**Celeste Ellice**	Approved by	**Timothy Rohde**
Position	Senior Environmental Scientist	Position	Associate - Land capability and rehabilitation services manager
Signature	M.C. Ellice	Signature	T. Rohde
Date	23 June 2016	Date	23 June 2016

Document Control

Version	Date	Prepared by	Reviewed by
V0_draft	16/09/2015	K Drapala	T Rohde
V1	4/03/2016	C. Ellice	T Rohde
V2	23/06/2016	C. Ellice	T Rohde

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1 Introduction

This report is focused on meeting the requirements of *The land and soil capability assessment scheme* (OEH 2012). The land and soil capability assessment scheme (OEH 2012) outlines the process to assess the limitations of land-use based on the biophysical characteristics of the land. It should be noted that the tables enclosed within this report are either directly replicated or adapted from OEH 2012.

The land and soil capability (LSC) classes present on a property are determined at the farm scale for each soil management unit (SMU). This is done using the information collected during the field survey and supplemented with information gathered during the desktop assessment. Table 1.1 outlines the information required to make an assessment of land and soil capability classes and their definitions (OEH 2012). Table 1.2 provides definitions of the land and soil capability classes.

Table 1.1 Data requirements for determining LSC classes (OEH 2012)

	Water erosion	Wind erosion	Soil structure decline	Soil acidification	Salinity	Water-logging	Shallow soils and rock	Mass movement
NSW Division	✓							
Sand dune or mobile sand body	✓							
Slope %	✓							✓
Scree or talus slope								✓
Footslope or drainage plain receiving high run-on	✓							
Gully erosion or sodic dispersible subsoils	✓							
Annual rainfall		✓		✓				✓
Wind erosive power		✓						
Exposure to wind		✓						
Surface soil texture		✓	✓	✓				
Surface soil texture modifier			✓					
Great Soil Group				✓				
pH of surface soil				✓				
Surface soil modifier				✓				
Parent material				✓				
Recharge potential of landscape					✓			
Discharge potential of landscape					✓			
Salt store of landscape					✓			
Waterlogging duration						✓		
Return period of waterlogging						✓		
Rocky outcrop							✓	
Soil depth							✓	
Presence of existing mass movement								✓

Table 1.2 Land and soil capability classes - general definitions (EOH 2012)

LSC class	General definition
Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation)	
1	**Extremely high capability land**: Land has no limitations. No special land management practices required. Land capable of all rural land uses and land management practices.
2	**Very high capability land**: Land has slight limitations. These can be managed by readily available, easily implemented management practices. Land is capable of most land uses and land management practices, including intensive cropping with cultivation.
3	**High capability land**: Land has moderate limitations and is capable of sustaining high-impact land uses, such as cropping with cultivation, using more intensive, readily available and widely accepted management practices. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation.
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)	
4	**Moderate capability land**: Land has moderate to high limitations for high-impact land uses. Will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment and technology.
5	**Moderate–low capability land**: Land has high limitations for high-impact land uses. Will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation.
Land capable for a limited set of land uses (grazing, forestry and nature conservation	
6	**Low capability land**: Land has very high limitations for high-impact land uses. Land use restricted to low-impact land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environmental degradation.
Land generally incapable of agricultural land use (selective forestry and nature conservation)	
7	**Very low capability land**: Land has severe limitations that restrict most land uses and generally cannot be overcome. On-site and off-site impacts of land management practices can be extremely severe if limitations not managed. There should be minimal disturbance of native vegetation.
8	**Extremely low capability land**: Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation. There should be no disturbance of native vegetation.

2 New South Wales land divisions

The land and soil capability assessment scheme (OEH 2012) applies different criteria to properties depending on their location in New South Wales (NSW). Under The Crown Lands Act of 1884 NSW was divided into the three land division zones of Western, Central and Eastern. The first step in the assessment process is to determine which zone the property exists in. This can be determined by locating the property on the map in Figure 2.1.

Figure 2.1 Map of NSW land divisions

This can accurately be achieved through examination of the 1907 Map of New South Wales. Table 2.1 provides the result of looking up the project on the 1907 map.

Table 2.1 NSW Land Division of the project

	Division
Hume Coal Project	Eastern Division

Source: http://www.nla.gov.au/apps/cdview/?pi=nla.map-rm2795-sd

3 Assessment of water erosion LSC classes

Table 3.1 outlines the assessment table for determining water erosion LSC classes. Assessment has been based on the criteria applicable to the Eastern Land Division. Table 3.2 outlines the results table for water erosion LSC classes for each of the detailed sites in the project area.

Table 3.1 Water erosion LSC class assessment table (OEH 2012)

NSW division	Slope class (%) for each LSC class							
	Class 1	Class 2	Class 3	Class 4[1]	Class 5[2]	Class 6	Class 7	Class 8
Eastern and Central divisions	<1	1 to <3	3 to <10 or 1 to <3 with slopes >500m length	10 to <20	10 to <20	20 to <33	33 to <50	>50
Western division[3]	<1	1 to <3 or <1 for hardsetting red soils	1 to 3	3 to 5	3 to 5	5 to 33	33 to 50	>50

Notes: 1.No gully erosion or sodic/dispersible soils are present.
2. Gully erosion and/or sodic/dispersible soils are present.
3. Western CMA provided advice on slope classes.

Table 3.2 Water erosion LSC classes for the SMUs within the project area

Site ID	Slope (%)[1]	Slope class (%)[1]	Water Erosion LSC class
Dermosol			
124	5.	3 to <10%	3
152	3.	3 to <10%	3
181	5.	3 to <10%	3
278	2.	1 to<3%	2
620	12.	10 to <20%	4
632	9.	3 to <10%	3
Hydrosol			
4	1.	1 to<3%	2
10	2.	1 to<3%	2
92	1.	1 to<3%	2
111	1.	1 to<3%	2
238	2.	1 to<3%	2
454	1.	1 to<3%	2
524	1.	1 to<3%	2
611	2.	1 to<3%	2
697	4.	3 to <10%	3
Kandosol			
7	7.	3 to <10%	3
15	3.	3 to <10%	3
16	4.	3 to <10%	3
17	30.	20 to <33%	6

Table 3.2 Water erosion LSC classes for the SMUs within the project area

Site ID	Slope (%)[1]	Slope class (%)[1]	Water Erosion LSC class
22	2.	1 to<3%	2
28	10.	10 to <20%	4
32	3.	3 to <10%	3
34	5.	3 to <10%	3
44	9.	3 to <10%	3
45	12.	10 to <20%	4
47	5.	3 to <10%	3
48	5.	3 to <10%	3
55	4.	3 to <10%	3
70	3.	3 to <10%	3
87	3.	3 to <10%	3
99	8.	3 to <10%	3
110	14.	10 to <20%	4
116	2.	1 to<3%	2
120	2.	1 to<3%	2
133	14.	10 to <20%	4
135	3.	3 to <10%	3
137	7.	3 to <10%	3
138	25.	20 to <33%	6
145	8.	3 to <10%	3
146	1.	1 to<3%	2
149	2.	1 to<3%	2
151	3.	3 to <10%	3
153	15.	10 to <20%	4
155	2.	1 to<3%	2
160	1.	1 to<3%	2
168	2.	1 to<3%	2
170	7.	3 to <10%	3
175	6.	3 to <10%	3
186	1.	1 to<3%	2
187	5.	3 to <10%	3
188	4.	3 to <10%	3
195	9.	3 to <10%	3
202	4.	3 to <10%	3
209	6.	3 to <10%	3
211	2.	1 to<3%	2
213	23.	20 to <33%	6
220	10.	10 to <20%	4
230	5.	3 to <10%	3
232	6.	3 to <10%	3
235	10.	10 to <20%	4
236	6.	3 to <10%	3
240	5.	3 to <10%	3

Table 3.2 Water erosion LSC classes for the SMUs within the project area

Site ID	Slope (%)[1]	Slope class (%)[1]	Water Erosion LSC class
248	1.	1 to<3%	2
251	6.	3 to <10%	3
255	24.	20 to <33%	6
258	4.	3 to <10%	3
260	4.	3 to <10%	3
267	1.	1 to<3%	2
269	8.	3 to <10%	3
274	8.	3 to <10%	3
279	3.	3 to <10%	3
281	6.	3 to <10%	3
282	3.	3 to <10%	3
283	5.	3 to <10%	3
290	6.	3 to <10%	3
297	2.	1 to<3%	2
298	4.	3 to <10%	3
308	3.	3 to <10%	3
310	3.	3 to <10%	3
328	8.	3 to <10%	3
337	8.	3 to <10%	3
339	23.	20 to <33%	6
342	1.	1 to<3%	2
356	1.	1 to<3%	2
360	10.	10 to <20%	4
361	5.	3 to <10%	3
363	3.	3 to <10%	3
365	4.	3 to <10%	3
366	7.	3 to <10%	3
373	9.	3 to <10%	3
374	4.	3 to <10%	3
388	7.	3 to <10%	3
391	4.	3 to <10%	3
396	4.	3 to <10%	3
404	3.	3 to <10%	3
406	6.	3 to <10%	3
417	3.	3 to <10%	3
419	3.	3 to <10%	3
421	4.	3 to <10%	3
423	0.5	<1%	1
426	2.	1 to<3%	2
429	3.	3 to <10%	3
435	4.	3 to <10%	3
437	3.	3 to <10%	3
449	7.	3 to <10%	3

Table 3.2 Water erosion LSC classes for the SMUs within the project area

Site ID	Slope (%)[1]	Slope class (%)[1]	Water Erosion LSC class
451	2.	1 to<3%	2
459	10.	10 to <20%	4
468	3.	3 to <10%	3
472	4.	3 to <10%	3
473	10.	10 to <20%	4
481	7.	3 to <10%	3
486	4.	3 to <10%	3
488	11.	10 to <20%	4
489	7.	3 to <10%	3
499	12.	10 to <20%	4
500	5.	3 to <10%	3
502	8.	3 to <10%	3
505	9.	3 to <10%	3
508	11.	10 to <20%	4
510	2.	1 to<3%	2
511	6.	3 to <10%	3
512	11.	10 to <20%	4
528	12.	10 to <20%	4
535	4.	3 to <10%	3
536	4.	3 to <10%	3
537	3.	3 to <10%	3
539	12.	10 to <20%	4
544	4.	3 to <10%	3
545	2.	1 to<3%	2
550	6.	3 to <10%	3
592	1.	1 to<3%	2
594	3.	3 to <10%	3
595	4.	3 to <10%	3
596	3.	3 to <10%	3
601	2.	1 to<3%	2
602	2.	1 to<3%	2
603	8.	3 to <10%	3
606	2.	1 to<3%	2
607	1.	1 to<3%	2
610	2.	1 to<3%	2
612	8.	3 to <10%	3
613	1.	1 to<3%	2
614	10.	10 to <20%	4
615	4.	3 to <10%	3
616	5.	3 to <10%	3
617	3.	3 to <10%	3
618	1.	1 to<3%	2
619	15.	10 to <20%	4

Table 3.2 Water erosion LSC classes for the SMUs within the project area

Site ID	Slope (%)[1]	Slope class (%)[1]	Water Erosion LSC class
621	5.	3 to <10%	3
622	2.	1 to<3%	2
623	9.	3 to <10%	3
624	5.	3 to <10%	3
625	5.	3 to <10%	3
626	10.	10 to <20%	4
627	6.	3 to <10%	3
628	6.	3 to <10%	3
629	12.	10 to <20%	4
630	4.	3 to <10%	3
631	3.	3 to <10%	3
633	2.	1 to<3%	2
670	5.	3 to <10%	3
671	2.	1 to<3%	2
672	3.	3 to <10%	3
681	2.	1 to<3%	2
682	9.	3 to <10%	3
683	2.	1 to<3%	2
684	8.	3 to <10%	3
686	8.	3 to <10%	3
687	4.	3 to <10%	3
688	4.	3 to <10%	3
690	5.	3 to <10%	3
691	3.	3 to <10%	3
692	52.	>50%	8
698	6.	3 to <10%	3
699	5.	3 to <10%	3
700	4.	3 to <10%	3
701	3.	3 to <10%	3
702	8.	3 to <10%	3
703	6.	3 to <10%	3
704	2.	1 to<3%	2
Rudosol			
38	8.	3 to <10%	3
49	2.	1 to<3%	2
100	8.	3 to <10%	3
113	5.	3 to <10%	3
117	2.	1 to<3%	2
148	3.	3 to <10%	3
159	10.	10 to <20%	4
178	9.	3 to <10%	3
189	12.	10 to <20%	4
204	4.	3 to <10%	3

Table 3.2 Water erosion LSC classes for the SMUs within the project area

Site ID	Slope (%)[1]	Slope class (%)[1]	Water Erosion LSC class
259	4.	3 to <10%	3
264	51.	>50%	8
312	1.	1 to<3%	2
350	5.	3 to <10%	3
352	22.	20 to <33%	6
357	4.	3 to <10%	3
393	5.	3 to <10%	3
403	19.	10 to <20%	4
411	47.	33 to <50%	7
414	22.	20 to <33%	6
438	17.	10 to <20%	4
465	12.	10 to <20%	4
474	18.	10 to <20%	4
490	32.	20 to <33%	6
521	27.	20 to <33%	6
525	33.	33 to <50%	7
609	27.	20 to <33%	6
Tenosol			
26	4.	3 to <10%	3
29	2.	1 to<3%	2
73	14.	10 to <20%	4
83	6.	3 to <10%	3
90	1.	1 to<3%	2
112	1.	1 to<3%	2
119	11.	10 to <20%	4
126	3.	3 to <10%	3
128	14.	10 to <20%	4
157	8.	3 to <10%	3
174	4.	3 to <10%	3
183	3.	3 to <10%	3
196	9.	3 to <10%	3
201	6.	3 to <10%	3
224	8.	3 to <10%	3
229	4.	3 to <10%	3
234	2.	1 to<3%	2
239	10.	10 to <20%	4
263	20.	20 to <33%	6
287	9.	3 to <10%	3
300	6.	3 to <10%	3
307	3.	3 to <10%	3
327	2.	1 to<3%	2
364	3.	3 to <10%	3
376	4.	3 to <10%	3

Table 3.2 Water erosion LSC classes for the SMUs within the project area

Site ID	Slope (%)[1]	Slope class (%)[1]	Water Erosion LSC class
379	8.	3 to <10%	3
467	4.	3 to <10%	3
513	7.	3 to <10%	3
522	13.	10 to <20%	4
523	10.	10 to <20%	4
532	7.	3 to <10%	3
600	2.	1 to<3%	2
604	4.	3 to <10%	3
605	4.	3 to <10%	3
608	2.	1 to<3%	2
685	5.	3 to <10%	3
689	6.	3 to <10%	3

4 Assessment of wind erosion LSC classes

The wind erosion LSC class requires the assessment of four hazards:

1. wind erodibility class of surface soil;
2. wind erosion power;
3. exposure to wind; and
4. average yearly rainfall.

4.1 Wind erodibility hazard

Table 4.1 outlines the assessment figure for determining wind erodibility hazard

Table 4.1 Wind erodibility hazard of surface soils (OEH 2012)

Wind erodibility class of surface soil	Surface soil texture
Low	Loams, clay loams or clays (all with >13% clay)
Moderate	Fine sandy loams or sandy loams (all with 6–13% clay); also includes organic peats
High	Loamy sands or loose sands (all with <6% clay).

4.2 Exposure to Wind

Table 4.2 outlines the assessment figure for determining exposure to wind

Table 4.2 Exposure to wind (OEH 2012)

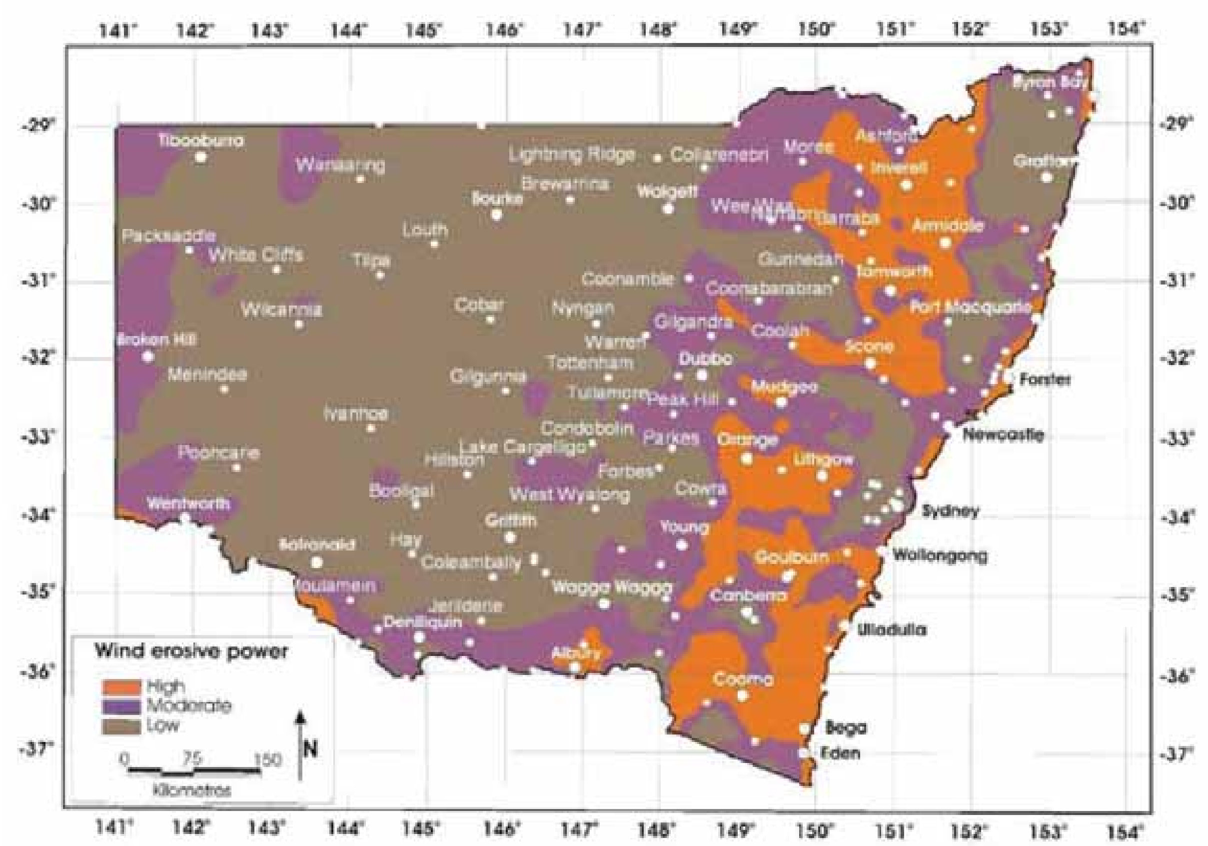
Exposure to wind class of surface soil	Site exposure to prevailing winds
Low	Sheltered locations in valleys or in the lee of hills
Moderate	Intermediate situations – not low or high exposure locations
High	Hilltops, cols or saddles, open plains or exposed coastal locations

4.3 Average yearly Rainfall

Average yearly rainfall for the project area is 970mm. http://www.bom.gov.au/climate/data/ (June 2015).

4.4 Wind erosion power

Figure 4.1 outlines the assessment figure for determining wind erosion power



Source: NSW Department of Trade and Investment (undated).

Figure 4.1 Wind erosive power (NSW Department of Trade and Investment in OEH 2012)

4.5 Wind erosion LSC classes

Table 4.3 outlines the assessment table for determining wind erosion LSC classes. The Hume Coal Project location falls in the High scale for wind erosive power (from Figure 4.1) and the annual average rainfall is 961mm. The following Table 4.3 has been shaded for the sections that do not apply to the site based on wind erosive power and average annual rainfall. Table 4.4 outlines the results table for wind erosion LSC classes.

Table 4.3 Wind erosion LSC class assessment table (OEH 2012)

Wind erodibility class of surface soil	Wind erosive power	Exposure to wind	Average annual rainfall (mm)			
			>500	300–500	200 to <300	<200
Low	Low	Low	1	2	3	6
		Moderate	1	2	3	6
		High	2	3	4	7
	Moderate	Low	1	2	3	6
		Moderate	2	3	4	6
		High	3	4	5	7
	High	Low	2	3	4	6
		Moderate	3	4	5	7
		High	4	5	6	7
Moderate	Low	.	2	3	4	7
		Moderate	3	4	5	7
		High	4	5	6	8
	Moderate	Low	2	3	4	6
		Moderate	3	4	5	7
		High	4	5	6	8
	High	Low	3	4	5	7
		Moderate	4	5	6	8
		High	5	6	7	8
High	Low	Low	3	4	5	7
		Moderate	4	5	6	8
		High	5	6	7	8
	Moderate	Low	4	5	6	8
		Moderate	5	6	7	8
		High	6	7	8	8
	High	Low	5	6	7	8
		Moderate	6	7	8	8
		High	7 (8*)	8	8	8

*Note: * Mobile sand bodies such as coastal beaches, foredunes and blowouts are Class 8.*

Table 4.4 Wind erosion LSC classes for the SMUs within the project area

Site ID	Surface soil texture	Wind erodibility class	Landform element	Site morphology	Local relief	Exposure to wind	Wind Erosion LSC class
Dermosol							
124	silty clay loam	Low	hillslope	mid-slope	very low (9-30 m)	Moderate	3
152	silty clay loam	Low	footslope	lower slope	very low (9-30 m)	Low	2
181	silty loam	Moderate	hillcrest	upper slope	low (30-90 m)	Moderate	4
278	silty clay loam	Low	hillslope	lower slope	very low (9-30 m)	Low	2
620	clay loam	Low	hillslope	mid-slope	very low (9-30 m)	Moderate	3
632	clay	Low	hillcrest	crest	very low (9-30 m)	Moderate	3
Hydrosol							
4	clay	Low	drainage depression	open depression	extremely low (< 9m)	Low	2
10	loamy sand	High	bank	open depression	low (30-90 m)	Low	5
92	silty loam	Moderate	drainage depression	open depression	extremely low (< 9m)	Low	3
111	silty clay loam	Low	valley flat	flat	extremely low (< 9m)	Low	2
238	clay	Low	drainage depression	open depression	very low (9-30 m)	Low	2
454	clay	Low	drainage depression	open depression	extremely low (< 9m)	Low	2
524	clay	Low	drainage depression	open depression	extremely low (< 9m)	Low	2
611	silty clay loam	Low	hillslope	upper slope	very low (9-30 m)	Moderate	3
697	sandy loam	Moderate	hillslope	mid-slope	very low (9-30 m)	Moderate	4
Kandosol							
7	silty clay loam	Low	hillslope	lower slope	low (30-90 m)	Low	2
15	sandy clay loam	Low	hillslope	lower slope	very low (9-30 m)	Low	2
16	silty clay loam	Low	hillslope	lower slope	extremely low (< 9m)	Low	2
17	silty clay loam	Low	hillslope	ridge		High	4
22	clay	Low	footslope	lower slope		Low	2
28	clay loam	Low	hillslope	upper slope	low (30-90 m)	Moderate	3
32	silty clay loam	Low	hillslope	upper slope	extremely low (< 9m)	Moderate	3
34	sandy clay loam	Low	hillslope	upper slope		High	4
44	clay loam	Low	hillslope	mid-slope	very low (9-30 m)	Moderate	3
45	silty clay loam	Low	hillslope	mid-slope	very low (9-30 m)	Moderate	3
47	silty clay loam	Low	hillslope	mid-slope	very low (9-30 m)	Moderate	3
48	silty loam	Moderate	hillslope	upper slope	extremely low (< 9m)	Moderate	4
55	silty clay loam	Low	hillslope	lower slope		Low	2
70	silty loam	Moderate	hillslope	mid-slope		Moderate	4
87	silty loam	Moderate	hillslope	lower slope	low (30-90 m)	Moderate	4

Table 4.4 Wind erosion LSC classes for the SMUs within the project area

Site ID	Surface soil texture	Wind erodibility class	Landform element	Site morphology	Local relief	Exposure to wind	Wind Erosion LSC class
99	silty clay loam	Low	hillslope	mid-slope		Moderate	3
110	silty clay loam	Low	hillslope	lower slope		Low	2
116	sandy loam	Moderate	hillslope	mid-slope	very low (9-30 m)	Moderate	4
120	clayey sand	Moderate	hillslope	upper slope	very low (9-30 m)	Moderate	4
133	silty loam	Moderate	hillslope	mid-slope	low (30-90 m)	Moderate	4
135	sandy clay loam	Low	hillslope	mid-slope		Moderate	3
137	silty loam	Moderate	hillslope	upper slope	very low (9-30 m)	Moderate	4
138	silty clay loam	Low	hillslope	mid-slope	low (30-90 m)	Moderate	3
145	clay loam sandy	Low	hillslope	upper slope	very low (9-30 m)	Moderate	3
146	silty clay loam	Low	hillslope	lower slope	extremely low (< 9m)	Low	2
149	silty clay loam	Low	hillslope	lower slope	extremely low (< 9m)	Low	2
151	clay loam	Low	hillslope	mid-slope	very low (9-30 m)	Moderate	3
153	silty clay loam	Low	hillslope	upper slope	low (30-90 m)	Moderate	3
155	silty loam	Moderate	hillslope	lower slope	extremely low (< 9m)	Low	3
160	sandy clay loam	Low	hillslope	mid-slope	extremely low (< 9m)	Low	2
168	silty clay loam	Low	hillslope	mid-slope		Moderate	3
170	silty clay loam	Low	hillslope	upper slope	very low (9-30 m)	Moderate	3
175	silty clay loam	Low	hillslope	mid-slope	very low (9-30 m)	Moderate	3
186	silty loam	Moderate	hillcrest	crest	low (30-90 m)	Moderate	4
187	silty clay loam	Low	hillslope	mid-slope	very low (9-30 m)	Moderate	3
188	silty clay loam	Low	drainage depression	mid-slope	very low (9-30 m)	Moderate	3
195	silty clay loam	Low	hillslope	lower slope		Low	2
202	silty loam	Moderate	hillslope	lower slope	low (30-90 m)	Low	3
209	silty clay loam	Low	footslope	lower slope	very low (9-30 m)	Low	2
211	silty loam	Moderate	hillslope	mid-slope		Moderate	4
213	silty loam	Moderate	hillslope	mid-slope	low (30-90 m)	Moderate	4
220	silty clay loam	Low	hillslope	mid-slope	very low (9-30 m)	Moderate	3
230	clay loam	Low	hillslope	upper slope	low (30-90 m)	Moderate	3
232	silty clay loam	Low	hillslope	lower slope		Low	2
235	silty loam	Moderate		mid-slope	low (30-90 m)	Moderate	4
236	clay loam	Low	hillslope	mid-slope	low (30-90 m)	Moderate	3
240	silty clay loam	Low	hillslope	upper slope	low (30-90 m)	High	4
248	silty clay loam	Low	hillslope	mid-slope		Moderate	3
251	clay loam sandy	Low	hillslope	lower slope	very low (9-30 m)	Low	2
255	silty loam	Moderate	hillslope	upper slope	very low (9-30 m)	Moderate	4
258	silty clay loam	Low	hillslope	mid-slope	extremely low (< 9m)	Low	2

Table 4.4 Wind erosion LSC classes for the SMUs within the project area

Site ID	Surface soil texture	Wind erodibility class	Landform element	Site morphology	Local relief	Exposure to wind	Wind Erosion LSC class
260	silty loam	Moderate	hillslope	lower slope		Low	3
267	silty clay loam	Low	hillcrest	crest	low (30-90 m)	High	4
269	silty loam	Moderate	hillslope	mid-slope	low (30-90 m)	Moderate	4
274	silty clay loam	Low	hillslope	lower slope	very low (9-30 m)	Low	2
279	clay loam sandy	Low	hillslope	lower slope	very low (9-30 m)	Low	2
281	silty clay loam	Low	hillslope	mid-slope	very low (9-30 m)	Moderate	3
282	loamy sand	High	hillslope	mid-slope	very low (9-30 m)	Moderate	6
283	silty clay loam	Low	hillslope	lower slope	low (30-90 m)	Low	2
290	silty loam	Moderate	hillslope	lower slope	very low (9-30 m)	Low	3
297	silty clay loam	Low	hillslope	open depression	extremely low (< 9m)	Low	2
298	silty loam	Moderate	hillslope	lower slope	extremely low (< 9m)	Low	3
308	sandy clay loam	Low	footslope	lower slope	low (30-90 m)	Low	2
310	clay loam	Low	hillslope	mid-slope		Moderate	3
328	sandy clay loam	Low	footslope	mid-slope		Low	2
337	silty loam	Moderate	hillslope	upper slope	very low (9-30 m)	Moderate	4
339	silty clay loam	Low	hillslope	lower slope		Low	2
342	silty loam	Moderate	hillcrest	crest	low (30-90 m)	Moderate	4
356	clay loam sandy	Low	hillcrest	crest		High	4
360	silty clay loam	Low	hillslope	lower slope	low (30-90 m)	Low	2
361	silty clay loam	Low	hillslope	lower slope	low (30-90 m)	Low	2
363	silty loam	Moderate	hillslope	mid-slope	low (30-90 m)	Moderate	4
365	sandy clay loam	Low	hillcrest	lower slope	extremely low (< 9m)	Low	2
366	silty clay loam	Low	hillslope	mid-slope	low (30-90 m)	Moderate	3
373	silty clay loam	Low	hillslope	lower slope	very low (9-30 m)	Low	2
374	silty clay loam	Low	hillslope	lower slope	extremely low (< 9m)	Low	2
388	silty clay loam	Low	hillslope	lower slope	very low (9-30 m)	Low	2
391	silty clay loam	Low	hillslope	upper slope	very low (9-30 m)	Moderate	3
396	silty clay loam	Low	hillslope	mid-slope	very low (9-30 m)	Moderate	3
404	silty loam	Moderate	hillcrest	mid-slope	very low (9-30 m)	Moderate	4
406	sandy clay loam	Low	footslope	lower slope		Low	2
417	silty loam	Moderate	hillslope	lower slope	extremely low (< 9m)	Low	3
419	clay loam	Low	hillslope	lower slope	very low (9-30 m)	Low	2
421	silty clay loam	Low	hillslope	mid-slope	very low (9-30 m)	Moderate	3
423	clay	Low	footslope	lower slope		Low	2
426	silty clay loam	Low	hillcrest	crest	low (30-90 m)	High	4
429	silty clay loam	Low	hillslope	mid-slope	very low (9-30 m)	Moderate	3
435	silty clay loam	Low	hillslope	upper slope	very low (9-30 m)	Moderate	3

Table 4.4 Wind erosion LSC classes for the SMUs within the project area

Site ID	Surface soil texture	Wind erodibility class	Landform element	Site morphology	Local relief	Exposure to wind	Wind Erosion LSC class
437	sandy clay loam	Low	footslope	lower slope	extremely low (< 9m)	Low	2
449	clay loam	Low	hillslope	upper slope	very low (9-30 m)	Moderate	3
451	silty clay loam	Low	hillcrest	crest	extremely low (< 9m)	Moderate	3
459	silty loam	Moderate	hillslope	lower slope	very low (9-30 m)	Low	3
468	clay loam	Low	footslope	lower slope	low (30-90 m)	Low	2
472	silty loam	Moderate	hillslope	upper slope	very low (9-30 m)	Moderate	4
473	sandy clay loam	Low	hillslope	mid-slope	very low (9-30 m)	Moderate	3
481	silty loam	Moderate	hillslope	upper slope	low (30-90 m)	Moderate	4
486	silty loam	Moderate	hillslope	ridge		High	5
488	silty loam	Moderate	hillslope	lower slope	very low (9-30 m)	Low	3
489	silty clay loam	Low	hillslope	upper slope	very low (9-30 m)	Moderate	3
499	clay loam	Low	hillslope	mid-slope	low (30-90 m)	Moderate	3
500	silty loam	Moderate	footslope	lower slope	very low (9-30 m)	Low	3
502	silty loam	Moderate	footslope	upper slope	low (30-90 m)	Low	3
505	clay loam sandy	Low	hillslope	mid-slope	very low (9-30 m)	Moderate	3
508	clay loam	Low	hillslope	mid-slope	low (30-90 m)	Moderate	3
510	silty loam	Moderate	hillcrest	ridge	very low (9-30 m)	Moderate	4
511	silty loam	Moderate	hillslope	lower slope		Low	3
512	clay loam	Low	hillslope	lower slope	low (30-90 m)	Low	2
528	silty clay loam	Low	hillslope	lower slope	low (30-90 m)	Low	2
535	silty clay loam	Low	hillslope	mid-slope	very low (9-30 m)	Moderate	3
536	silty clay loam	Low	hillslope	ridge	extremely low (< 9m)	Moderate	3
537	silty loam	Moderate	hillslope	mid-slope	very low (9-30 m)	Moderate	4
539	silty loam	Moderate	hillslope	mid-slope	very low (9-30 m)	Moderate	4
544	silty clay loam	Low	hillcrest	upper slope	low (30-90 m)	Moderate	3
545	clay loam	Low	hillslope	upper slope	low (30-90 m)	Moderate	3
550	sandy clay loam	Low	hillslope	upper slope	very low (9-30 m)	Moderate	3
592	silty clay loam	Low	hillslope	hillock	very low (9-30 m)	Moderate	3
594	clay loam sandy	Low	hillslope	mid-slope	extremely low (< 9m)	Low	2
595	silty clay loam	Low	hillslope	hillock	very low (9-30 m)	Moderate	3
596	clay loam sandy	Low	hillslope	hillock	very low (9-30 m)	Moderate	3
601	sandy clay loam	Low	hillslope	upper slope	extremely low (< 9m)	Moderate	3
602	clay loam sandy	Low	hillslope	mid-slope		Moderate	3
603	silty loam	Moderate	hillslope	mid-slope	very low (9-30 m)	Moderate	4
606	clay loam sandy	Low	hillslope	mid-slope		Moderate	3
607	clay loam sandy	Low	hillslope	ridge		High	4
610	silty clay loam	Low	hillcrest	mid-slope	very low (9-30 m)	Moderate	3

Table 4.4 Wind erosion LSC classes for the SMUs within the project area

Site ID	Surface soil texture	Wind erodibility class	Landform element	Site morphology	Local relief	Exposure to wind	Wind Erosion LSC class
612	silty clay loam	Low	hillslope	upper slope	very low (9-30 m)	Moderate	3
613	clay loam	Low	hillcrest	crest	extremely low (< 9m)	Moderate	3
614	clay	Low	hillslope	upper slope	very low (9-30 m)	Moderate	3
615	sandy clay loam	Low	hillslope	upper slope	low (30-90 m)	Moderate	3
616	silty loam	Moderate	hillslope	upper slope	very low (9-30 m)	Low	4
617	clay	Low	hillslope	mid-slope	very low (9-30 m)	Moderate	3
618	silty clay loam	Low	hillcrest	upper slope		High	4
619	clay loam sandy	Low	hillslope	mid-slope	low (30-90 m)	Moderate	3
621	silty clay loam	Low	hillslope	lower slope	very low (9-30 m)	Low	2
622	silty clay loam	Low	hillcrest	mid-slope	extremely low (< 9m)	Low	2
623	silty clay loam	Low	hillslope	lower slope	low (30-90 m)	Low	2
624	silty clay loam	Low	hillslope	ridge	low (30-90 m)	High	4
625	silty clay loam	Low	hillcrest	crest	low (30-90 m)	High	4
626	silty clay loam	Low	hillslope	upper slope		High	4
627	silty loam	Moderate	hillslope	upper slope	low (30-90 m)	Moderate	4
628	silty clay loam	Low	hillslope	lower slope	low (30-90 m)	Low	2
629	clay	Low	hillslope	mid-slope	very low (9-30 m)	Moderate	3
630	clay	Low	hillslope	lower slope	low (30-90 m)	Low	2
631	clay	Low	hillcrest	mid-slope	very low (9-30 m)	Moderate	3
633	silty clay loam	Low	hillslope	lower slope	very low (9-30 m)	Low	2
670	sandy loam	Moderate	hillcrest	crest		High	5
671	sandy clay loam	Low	drainage depression	open depression		Low	2
672	silty loam	Moderate	hillcrest	hillock		High	5
681	clayey sand	High	hillslope	mid-slope		Low	5
682	clayey sand	High	hillcrest	crest		Low	5
683	sandy loam	Moderate	hillslope	simple slope		Moderate	4
684	sandy loam	Moderate	drainage depression	open depression		Low	3
686	sandy loam	Moderate	hillcrest	crest		High	5
687	sandy loam	Moderate	hillslope	upper slope		Moderate	4
688	sandy clay loam	Low	hillcrest	hillock		Moderate	3
690	sandy clay loam	Low	hillslope	mid-slope		Low	2
691	sandy clay loam	Low	hillslope	upper slope		Moderate	3
692	sandy clay loam	Low	drainage depression	open depression		Low	2

Table 4.4 Wind erosion LSC classes for the SMUs within the project area

Site ID	Surface soil texture	Wind erodibility class	Landform element	Site morphology	Local relief	Exposure to wind	Wind Erosion LSC class
698	sandy clay loam	Low	drainage depression	open depression		Low	2
699	sandy clay loam	Low	hillslope	mid-slope		Moderate	3
700	sandy clay loam	Low	hillcrest	upper slope		High	4
701	sandy clay loam	Low	hillslope	hillock		High	4
702	clay loam sandy	Low	hillslope	hillock		Moderate	3
703	sandy clay loam	Low	hillcrest	hillock		Moderate	3
704	sandy clay loam	Low	hillslope	mid-slope		Moderate	3
Rudosol							
38	sandy clay loam	Low	hillslope	ridge	low (30-90 m)	High	4
49	loamy sand	High	hillcrest	ridge		High	7
100	loam	Low	hillcrest	mid-slope	low (30-90 m)	Moderate	3
113	sandy loam	Moderate	hillslope	mid-slope		Low	3
117	clayey sand	Moderate	hillslope	mid-slope	extremely low (< 9m)	Low	3
148	sandy loam	Moderate	hillslope	lower slope	very low (9-30 m)	Low	3
159	silty loam	Moderate	bank	mid-slope	extremely low (< 9m)	Low	3
178	loamy sand	High	hillslope	upper slope	low (30-90 m)	Moderate	6
189	loamy sand	High	hillcrest	mid-slope	low (30-90 m)	Moderate	6
204	loamy sand	High	hillslope	mid-slope	extremely low (< 9m)	Low	5
259	silty loam	Moderate	hillslope	mid-slope	very low (9-30 m)	Moderate	4
264	loamy sand	High	hillslope	lower slope	high (90-300 m)	Low	5
312	loamy sand	High	hillcrest	ridge	extremely low (< 9m)	Moderate	6
350	silty clay loam	Low	hillslope	mid-slope		Moderate	3
352	loamy sand	High	hillslope	upper slope	low (30-90 m)	Moderate	6
357	silty loam	Moderate	hillslope	mid-slope		Moderate	4
393	clay loam	Low	hillslope	crest	extremely low (< 9m)	Moderate	3
403	loamy sand	High	hillslope	upper slope	high (90-300 m)	Moderate	6
411	loamy sand	High	hillslope	mid-slope	low (30-90 m)	Moderate	6
414	clayey sand	High	scarp	ridge	low (30-90 m)	High	7
438	sandy clay loam	Low	hillslope	mid-slope		Moderate	3
465	loamy sand	High	hillslope	mid-slope	very low (9-30 m)	Moderate	6
474	sandy loam	Moderate	hillslope	upper slope	low (30-90 m)	Moderate	4
490	sand	High	hillslope	upper slope	low (30-90 m)	Moderate	6
521	clayey sand	Moderate	hillslope	mid-slope	low (30-90 m)	Moderate	4
525	loamy sand	High	hillslope	upper slope	low (30-90 m)	Moderate	6
609	clayey sand	Moderate	hillslope	mid-slope	very low (9-30 m)	Moderate	4

Table 4.4 Wind erosion LSC classes for the SMUs within the project area

Site ID	Surface soil texture	Wind erodibility class	Landform element	Site morphology	Local relief	Exposure to wind	Wind Erosion LSC class
Tenosol							
26	silty loam	Moderate	hillslope	mid-slope		Moderate	4
29	clayey sand	High	hillslope	ridge	extremely low (< 9m)	Low	5
73	loamy sand	High	hillslope	lower slope	low (30-90 m)	Low	5
83	clayey sand	High	hillslope	ridge	low (30-90 m)	Moderate	6
90	clayey sand	High	footslope	ridge	very low (9-30 m)	Low	5
112	clayey sand	High	scroll	crest		Low	5
119	silty loam	Moderate	hillslope	lower slope	very low (9-30 m)	Low	3
126	clayey sand	High	gully	open depression	very low (9-30 m)	Low	5
128	clay loam	Low	hillslope	mid-slope	low (30-90 m)	Moderate	3
157	sandy loam	Moderate	hillslope	mid-slope		Low	3
174	silty loam	Moderate		upper slope	low (30-90 m)	Moderate	4
183	silty clay loam	Low	hillcrest	ridge	extremely low (< 9m)	Moderate	3
196	loam	Low	footslope	mid-slope	low (30-90 m)	Moderate	3
201	clayey sand	Moderate	hillslope	upper slope	very low (9-30 m)	Moderate	4
224	loam	Low	hillslope	lower slope	extremely low (< 9m)	Low	2
229	loamy sand	High	hillslope	open depression	very low (9-30 m)	Low	5
234	loamy sand	High	drainage depression	open depression	very low (9-30 m)	Low	5
239	silty loam	Moderate	hillslope	upper slope	low (30-90 m)	Moderate	4
263	sandy clay loam	Low	hillslope	mid-slope	low (30-90 m)	Moderate	3
287	sandy loam	Moderate	hillslope	upper slope	very low (9-30 m)	Moderate	4
300	sand	High	hillslope	mid-slope	very low (9-30 m)	Moderate	6
307	sandy clay loam	Low	hillslope	upper slope	very low (9-30 m)	Moderate	3
327	silty loam	Moderate	hillslope	lower slope	extremely low (< 9m)	Low	3
364	loamy sand	High	hillslope	mid-slope	very low (9-30 m)	Low	5
376	silty loam	Moderate	hillslope	mid-slope	very low (9-30 m)	Moderate	4
379	clayey sand	High	hillslope	ridge		Moderate	6
467	loamy sand	High	hillslope	mid-slope	extremely low (< 9m)	Moderate	6
513	silty loam	Moderate	hillslope	mid-slope	low (30-90 m)	Moderate	4
522	loamy sand	High	hillslope	mid-slope	very low (9-30 m)	Moderate	6
523	sandy loam	Moderate	hillslope	upper slope		Moderate	4
532	clayey sand	Moderate	hillslope	upper slope	very low (9-30 m)	Moderate	4
600	loamy sand	High	hillcrest	mid-slope	very low (9-30 m)	Moderate	6
604	sandy loam	Moderate	hillslope	mid-slope		Low	3

Table 4.4 Wind erosion LSC classes for the SMUs within the project area

Site ID	Surface soil texture	Wind erodibility class	Landform element	Site morphology	Local relief	Exposure to wind	Wind Erosion LSC class
605	clayey sand	Moderate	hillslope	upper slope	very low (9-30 m)	Moderate	4
608	sandy clay loam	Low	hillslope	upper slope	low (30-90 m)	Moderate	3
685	sandy clay loam	Low	hillslope	upper slope		High	4
689	sandy loam	Moderate	hillslope	mid-slope		Moderate	4

Notes: *1.Type any additional notes or Sources.*

2. Or simply delete these lines of text if not required.

3. Climate data from nearest the site, Moss Vale (Hoskins Street) Bureau of Meteorology weather station, site number 068045.

5 Assessment of soil structural decline LSC classes

Table 5.1 outlines the assessment table for determining soil structural decline LSC classes. Table 5.2 provides further information on the surface soil properties of clays to be used in collaboration with Table 5.1. Table 5.3 outlines the results table for soil structural decline LSC classes.

Table 5.1 Soil structural decline LSC class assessment table (OEH 2012)

Field texture (surface soils)	Modifier	Outcome - surface soil type	LCS class
Loose sand	Nil	Loose sand	1
Sandy loam	Nil	Fragile light textured surface soil	3
Fine sandy loam	Normal	Fragile light textured soil	3
	High levels of silt and very fine sand (>60%)	Fragile light textured soil – very hardsetting	4
Loam	Normal	Fragile medium textured soil	3
	Friable/ferric[1]	Friable medium textured soils – includes dark, friable loam soils	1
	High levels of silt and very fine sand	Fragile medium textured soil – very hardsetting	4
	Mildly sodic	Mildly sodic loam surface soil	4
	Moderately sodic	Moderately sodic loam surface soil	6
Clay loam	Normal	Fragile medium textured soil	3
	Friable/ferric[1]	Friable clay loam surface soil – includes dark, friable clay loam soils	1
	High levels of silt and very fine sand (>60%)	Fragile medium textured soil – very hardsetting	4
	Mildly sodic	Mildly sodic clay loam surface soil	4
	Moderately sodic	Moderately sodic clay loam surface soil	6
Clay	Friable/ferric[1]	Friable clay surface soil	2
	Strongly self-mulching	Strongly self-mulching surface soil	1
	Weakly self-mulching	Weakly self-mulching surface soil	3
	Mildly sodic	Mildly sodic/coarsely structured clay surface soil	4
	Moderately sodic	Moderately sodic/coarsely structured clay surface soil	6
	Strongly sodic	Strongly sodic surface soil	7
Highly organic soils	Mineral soils with high organic matter[2]	Mineral soils with high organic matter	-[2]
	Organosol/peat soils[3]	Organic/peat soils	7

Notes: *1. The occurrence of friable or ferric surface soils is associated with (a) basaltic or basic parent materials and soils of the Ferrosols groups in the Australian Soil Classification or the Krasnozems and Euchrozem Great Soil Groups, and (b) the dark loam surface soils of the Chernozems and Prairie Soils on alluvial flats.*
2. Loosely defined here as soils with over 8% organic carbon. These soils revert to the LSC class determined by the mineral component of the soils.
3. Organosols have organic material layers over 0.4 m thick with minimum organic carbon of 12% if sands or 18% if clays (Isbell 2002).

Table 5.2 Guidelines for evaluating some surface soil properties of clays

Sodicity/size of soil structural units	Character of surface soil
Very low exchangeable sodium (<3%), high exchangeable calcium, strongly swelling clays (smectitic) as in Vertosols (GSG Black Earths) Peds/aggregates 2–5 mm in an air dry condition	Strongly self-mulching surface soil
Low exchangeable sodium (3–5%), moderate exchangeable calcium, moderately swelling clays (illitic, interstratified, kaolinitic) as in many Dermosols and fertile Chromosols (GSG, Krasnozems, Euchrozems and others) Peds/aggregates 5–10 mm in an air dry condition	Weakly self-mulching surface soil
Moderate levels of exchangeable sodium (5–8%), often moderately low exchangeable calcium relative to exchangeable magnesium (ratio <2:1) Peds/aggregates 10–20 mm in an air dry condition	Mildly sodic surface soils
High levels of exchangeable sodium (8–15%), often low exchangeable calcium relative to exchangeable magnesium (ratio <1:1) Peds/aggregates 20–50 mm in an air dry condition	Moderately sodic surface soils
Very high levels of exchangeable sodium (>15%), often very low exchangeable calcium relative to exchangeable magnesium (ratio <0.5:1) Peds/aggregates >50 mm in an air dry condition	Strongly sodic surface soils

Table 5.3 Soil structural decline LSC classes for the SMU's within the project area

Site ID	Field texture (surface soils)	Modifier	Outcome - surface soil type	Soil structural decline LSC class
Dermosol				
124	silty clay loam	Normal	Fragile medium textured soil	3
152	silty clay loam	Normal	Fragile medium textured soil	3
181	silty loam	Normal	Fragile medium textured soil	3
278	silty clay loam	Normal	Fragile medium textured soil	3
620	clay loam	Normal	Fragile medium textured soil	3
632	clay	Weakly self-mulching	Weakly self-mulching surface soil	3
Hydrosol				
4	clay	Weakly self-mulching	Weakly self-mulching surface soil	3
10	loamy sand	Normal	Fragile medium textured soil	3
92	silty loam	Normal	Fragile medium textured soil	3
111	silty clay loam	Normal	Fragile medium textured soil	3
238	clay	Weakly self-mulching	Weakly self-mulching surface soil	3
454	clay	Weakly self-mulching	Weakly self-mulching surface soil	3
524	clay	Weakly self-mulching	Weakly self-mulching surface soil	3
611	silty clay loam	Normal	Fragile medium textured soil	3
697	sandy loam	Nil	Fragile light textured surface soil	3
Kandosol				
7	silty clay loam	Normal	Fragile medium textured soil	3
15	sandy clay loam	Normal	Fragile medium textured soil	3
16	silty clay loam	Normal	Fragile medium textured soil	3
17	silty clay loam	Normal	Fragile medium textured soil	3
22	clay	Weakly self-mulching	Weakly self-mulching surface soil	3
28	clay loam	Normal	Fragile medium textured soil	3

Table 5.3 Soil structural decline LSC classes for the SMU's within the project area

Site ID	Field texture (surface soils)	Modifier	Outcome - surface soil type	Soil structural decline LSC class
32	silty clay loam	Normal	Fragile medium textured soil	3
34	sandy clay loam	Normal	Fragile medium textured soil	3
44	clay loam	Normal	Fragile medium textured soil	3
45	silty clay loam	Normal	Fragile medium textured soil	3
47	silty clay loam	Normal	Fragile medium textured soil	3
48	silty loam	Normal	Fragile medium textured soil	3
55	silty clay loam	Normal	Fragile medium textured soil	3
70	silty loam	Normal	Fragile medium textured soil	3
87	silty loam	Normal	Fragile medium textured soil	3
99	silty clay loam	Normal	Fragile medium textured soil	3
110	silty clay loam	Normal	Fragile medium textured soil	3
116	sandy loam	Nil	Fragile light textured surface soil	3
120	clayey sand	Normal	Fragile medium textured soil	3
133	silty loam	Normal	Fragile medium textured soil	3
135	sandy clay loam	Normal	Fragile medium textured soil	3
137	silty loam	Normal	Fragile medium textured soil	3
138	silty clay loam	Normal	Fragile medium textured soil	3
145	clay loam sandy	Normal	Fragile medium textured soil	3
146	silty clay loam	Normal	Fragile medium textured soil	3
149	silty clay loam	Normal	Fragile medium textured soil	3
151	clay loam	Normal	Fragile medium textured soil	3
153	silty clay loam	Normal	Fragile medium textured soil	3
155	silty loam	Normal	Fragile medium textured soil	3
160	sandy clay loam	Normal	Fragile medium textured soil	3
168	silty clay loam	Normal	Fragile medium textured soil	3
170	silty clay loam	Normal	Fragile medium textured soil	3
175	silty clay loam	Normal	Fragile medium textured soil	3
186	silty loam	Normal	Fragile medium textured soil	3
187	silty clay loam	Normal	Fragile medium textured soil	3
188	silty clay loam	Normal	Fragile medium textured soil	3
195	silty clay loam	Normal	Fragile medium textured soil	3
202	silty loam	Normal	Fragile medium textured soil	3
209	silty clay loam	Normal	Fragile medium textured soil	3
211	silty loam	Normal	Fragile medium textured soil	3
213	silty loam	Normal	Fragile medium textured soil	3
220	silty clay loam	Normal	Fragile medium textured soil	3
230	clay loam	Normal	Fragile medium textured soil	3
232	silty clay loam	Normal	Fragile medium textured soil	3
235	silty loam	Normal	Fragile medium textured soil	3
236	clay loam	Normal	Fragile medium textured soil	3
240	silty clay loam	Normal	Fragile medium textured soil	3
248	silty clay loam	Normal	Fragile medium textured soil	3

Table 5.3 Soil structural decline LSC classes for the SMU's within the project area

Site ID	Field texture (surface soils)	Modifier	Outcome - surface soil type	Soil structural decline LSC class
251	clay loam sandy	Normal	Fragile medium textured soil	3
255	silty loam	Normal	Fragile medium textured soil	3
258	silty clay loam	Normal	Fragile medium textured soil	3
260	silty loam	Normal	Fragile medium textured soil	3
267	silty clay loam	Normal	Fragile medium textured soil	3
269	silty loam	Normal	Fragile medium textured soil	3
274	silty clay loam	Normal	Fragile medium textured soil	3
279	clay loam sandy	Normal	Fragile medium textured soil	3
281	silty clay loam	Normal	Fragile medium textured soil	3
282	loamy sand	Normal	Fragile medium textured soil	3
283	silty clay loam	Normal	Fragile medium textured soil	3
290	silty loam	Normal	Fragile medium textured soil	3
297	silty clay loam	Normal	Fragile medium textured soil	3
298	silty loam	Normal	Fragile medium textured soil	3
308	sandy clay loam	Normal	Fragile medium textured soil	3
310	clay loam	Normal	Fragile medium textured soil	3
328	sandy clay loam	Normal	Fragile medium textured soil	3
337	silty loam	Normal	Fragile medium textured soil	3
339	silty clay loam	Normal	Fragile medium textured soil	3
342	silty loam	Normal	Fragile medium textured soil	3
356	clay loam sandy	Normal	Fragile medium textured soil	3
360	silty clay loam	Normal	Fragile medium textured soil	3
361	silty clay loam	Normal	Fragile medium textured soil	3
363	silty loam	Normal	Fragile medium textured soil	3
365	sandy clay loam	Normal	Fragile medium textured soil	3
366	silty clay loam	Normal	Fragile medium textured soil	3
373	silty clay loam	Normal	Fragile medium textured soil	3
374	silty clay loam	Normal	Fragile medium textured soil	3
388	silty clay loam	Normal	Fragile medium textured soil	3
391	silty clay loam	Normal	Fragile medium textured soil	3
396	silty clay loam	Normal	Fragile medium textured soil	3
404	silty loam	Normal	Fragile medium textured soil	3
406	sandy clay loam	Normal	Fragile medium textured soil	3
417	silty loam	Normal	Fragile medium textured soil	3
419	clay loam	Normal	Fragile medium textured soil	3
421	silty clay loam	Normal	Fragile medium textured soil	3
423	clay	Weakly self-mulching	Weakly self-mulching surface soil	3
426	silty clay loam	Normal	Fragile medium textured soil	3
429	silty clay loam	Normal	Fragile medium textured soil	3
435	silty clay loam	Normal	Fragile medium textured soil	3
437	sandy clay loam	Normal	Fragile medium textured soil	3
449	clay loam	Normal	Fragile medium textured soil	3

Table 5.3 Soil structural decline LSC classes for the SMU's within the project area

Site ID	Field texture (surface soils)	Modifier	Outcome - surface soil type	Soil structural decline LSC class
451	silty clay loam	Normal	Fragile medium textured soil	3
459	silty loam	Normal	Fragile medium textured soil	3
468	clay loam	Normal	Fragile medium textured soil	3
472	silty loam	Normal	Fragile medium textured soil	3
473	sandy clay loam	Normal	Fragile medium textured soil	3
481	silty loam	Normal	Fragile medium textured soil	3
486	silty loam	Normal	Fragile medium textured soil	3
488	silty loam	Normal	Fragile medium textured soil	3
489	silty clay loam	Normal	Fragile medium textured soil	3
499	clay loam	Normal	Fragile medium textured soil	3
500	silty loam	Normal	Fragile medium textured soil	3
502	silty loam	Normal	Fragile medium textured soil	3
505	clay loam sandy	Normal	Fragile medium textured soil	3
508	clay loam	Normal	Fragile medium textured soil	3
510	silty loam	Normal	Fragile medium textured soil	3
511	silty loam	Normal	Fragile medium textured soil	3
512	clay loam	Normal	Fragile medium textured soil	3
528	silty clay loam	Normal	Fragile medium textured soil	3
535	silty clay loam	Normal	Fragile medium textured soil	3
536	silty clay loam	Normal	Fragile medium textured soil	3
537	silty loam	Normal	Fragile medium textured soil	3
539	silty loam	Normal	Fragile medium textured soil	3
544	silty clay loam	Normal	Fragile medium textured soil	3
545	clay loam	Normal	Fragile medium textured soil	3
550	sandy clay loam	Normal	Fragile medium textured soil	3
592	silty clay loam	Normal	Fragile medium textured soil	3
594	clay loam sandy	Normal	Fragile medium textured soil	3
595	silty clay loam	Normal	Fragile medium textured soil	3
596	clay loam sandy	Normal	Fragile medium textured soil	3
601	sandy clay loam	Normal	Fragile medium textured soil	3
602	clay loam sandy	Normal	Fragile medium textured soil	3
603	silty loam	Normal	Fragile medium textured soil	3
606	clay loam sandy	Normal	Fragile medium textured soil	3
607	clay loam sandy	Normal	Fragile medium textured soil	3
610	silty clay loam	Normal	Fragile medium textured soil	3
612	silty clay loam	Normal	Fragile medium textured soil	3
613	clay loam	Normal	Fragile medium textured soil	3
614	clay	Weakly self-mulching	Weakly self-mulching surface soil	3
615	sandy clay loam	Normal	Fragile medium textured soil	3
616	silty loam	Normal	Fragile medium textured soil	3
617	clay	Weakly self-mulching	Weakly self-mulching surface soil	3
618	silty clay loam	Normal	Fragile medium textured soil	3

Table 5.3 Soil structural decline LSC classes for the SMU's within the project area

Site ID	Field texture (surface soils)	Modifier	Outcome - surface soil type	Soil structural decline LSC class
619	clay loam sandy	Normal	Fragile medium textured soil	3
621	silty clay loam	Normal	Fragile medium textured soil	3
622	silty clay loam	Normal	Fragile medium textured soil	3
623	silty clay loam	Normal	Fragile medium textured soil	3
624	silty clay loam	Normal	Fragile medium textured soil	3
625	silty clay loam	Normal	Fragile medium textured soil	3
626	silty clay loam	Normal	Fragile medium textured soil	3
627	silty loam	Normal	Fragile medium textured soil	3
628	silty clay loam	Normal	Fragile medium textured soil	3
629	clay	Weakly self-mulching	Weakly self-mulching surface soil	3
630	clay	Weakly self-mulching	Weakly self-mulching surface soil	3
631	clay	Weakly self-mulching	Weakly self-mulching surface soil	3
633	silty clay loam	Normal	Fragile medium textured soil	3
670	sandy loam	Nil	Fragile light textured surface soil	3
671	sandy clay loam	Normal	Fragile medium textured soil	3
672	silty loam	Normal	Fragile medium textured soil	3
681	clayey sand	Normal	Fragile medium textured soil	3
682	clayey sand	Normal	Fragile medium textured soil	3
683	sandy loam	Nil	Fragile light textured surface soil	3
684	sandy loam	Nil	Fragile light textured surface soil	3
686	sandy loam	Nil	Fragile light textured surface soil	3
687	sandy loam	Nil	Fragile light textured surface soil	3
688	sandy clay loam	Normal	Fragile medium textured soil	3
690	sandy clay loam	Normal	Fragile medium textured soil	3
691	sandy clay loam	Normal	Fragile medium textured soil	3
692	sandy clay loam	Normal	Fragile medium textured soil	3
698	sandy clay loam	Normal	Fragile medium textured soil	3
699	sandy clay loam	Normal	Fragile medium textured soil	3
700	sandy clay loam	Normal	Fragile medium textured soil	3
701	sandy clay loam	Normal	Fragile medium textured soil	3
702	clay loam sandy	Normal	Fragile medium textured soil	3
703	sandy clay loam	Normal	Fragile medium textured soil	3
704	sandy clay loam	Normal	Fragile medium textured soil	3
Rudosol				
38	sandy clay loam	Normal	Fragile medium textured soil	3
49	loamy sand	Normal	Fragile medium textured soil	3
100	loam	Normal	Fragile medium textured soil	3
113	sandy loam	Nil	Fragile light textured surface soil	3
117	clayey sand	Normal	Fragile medium textured soil	3
148	sandy loam	Nil	Fragile light textured surface soil	3
159	silty loam	Normal	Fragile medium textured soil	3
178	loamy sand	Normal	Fragile medium textured soil	3

Table 5.3 Soil structural decline LSC classes for the SMU's within the project area

Site ID	Field texture (surface soils)	Modifier	Outcome - surface soil type	Soil structural decline LSC class
189	loamy sand	Normal	Fragile medium textured soil	3
204	loamy sand	Normal	Fragile medium textured soil	3
259	silty loam	Normal	Fragile medium textured soil	3
264	loamy sand	Normal	Fragile medium textured soil	3
312	loamy sand	Normal	Fragile medium textured soil	3
350	silty clay loam	Normal	Fragile medium textured soil	3
352	loamy sand	Normal	Fragile medium textured soil	3
357	silty loam	Normal	Fragile medium textured soil	3
393	clay loam	Normal	Fragile medium textured soil	3
403	loamy sand	Normal	Fragile medium textured soil	3
411	loamy sand	Normal	Fragile medium textured soil	3
414	clayey sand	Normal	Fragile medium textured soil	3
438	sandy clay loam	Normal	Fragile medium textured soil	3
465	loamy sand	Normal	Fragile medium textured soil	3
474	sandy loam	Nil	Fragile light textured surface soil	3
490	sand	Nil	Loose sand	1
521	clayey sand	Normal	Fragile medium textured soil	3
525	loamy sand	Normal	Fragile medium textured soil	3
609	clayey sand	Normal	Fragile medium textured soil	3
Tenosol				
26	silty loam	Normal	Fragile medium textured soil	3
29	clayey sand	Normal	Fragile medium textured soil	3
73	loamy sand	Normal	Fragile medium textured soil	3
83	clayey sand	Normal	Fragile medium textured soil	3
90	clayey sand	Normal	Fragile medium textured soil	3
112	clayey sand	Normal	Fragile medium textured soil	3
119	silty loam	Normal	Fragile medium textured soil	3
126	clayey sand	Normal	Fragile medium textured soil	3
128	clay loam	Normal	Fragile medium textured soil	3
157	sandy loam	Nil	Fragile light textured surface soil	3
174	silty loam	Normal	Fragile medium textured soil	3
183	silty clay loam	Normal	Fragile medium textured soil	3
196	loam	Normal	Fragile medium textured soil	3
201	clayey sand	Normal	Fragile medium textured soil	3
224	loam	Normal	Fragile medium textured soil	3
229	loamy sand	Normal	Fragile medium textured soil	3
234	loamy sand	Normal	Fragile medium textured soil	3
239	silty loam	Normal	Fragile medium textured soil	3
263	sandy clay loam	Normal	Fragile medium textured soil	3
287	sandy loam	Nil	Fragile light textured surface soil	3
300	sand	Nil	Loose sand	1
307	sandy clay loam	Normal	Fragile medium textured soil	3

Table 5.3 Soil structural decline LSC classes for the SMU's within the project area

Site ID	Field texture (surface soils)	Modifier	Outcome - surface soil type	Soil structural decline LSC class
327	silty loam	Normal	Fragile medium textured soil	3
364	loamy sand	Normal	Fragile medium textured soil	3
376	silty loam	Normal	Fragile medium textured soil	3
379	clayey sand	Normal	Fragile medium textured soil	3
467	loamy sand	Normal	Fragile medium textured soil	3
513	silty loam	Normal	Fragile medium textured soil	3
522	loamy sand	Normal	Fragile medium textured soil	3
523	sandy loam	Nil	Fragile light textured surface soil	3
532	clayey sand	Normal	Fragile medium textured soil	3
600	loamy sand	Normal	Fragile medium textured soil	3
604	sandy loam	Nil	Fragile light textured surface soil	3
605	clayey sand	Normal	Fragile medium textured soil	3
608	sandy clay loam	Normal	Fragile medium textured soil	3
685	sandy clay loam	Normal	Fragile medium textured soil	3
689	sandy loam	Nil	Fragile light textured surface soil	3

6 Assessment of soil acidification LSC classes

Soil acidification is determined through a combination of buffering capacity of the soil surface, mean annual rainfall and pH of the natural soil surface. Buffering capacity of the soil surface can be determined through three different processes: the Great Soil Group, the surface soil texture or the geology of the area. For the Berrima Rail Project the surface soil texture was used (Table 6.1). Table 6.2 is the assessment table that uses the buffering capacity information to determine the LSC class. The mean annual rainfall is 961mm, so the sections of the table that are not relevant to the site rainfall have been shaded in grey. Table 6.3 outlines the results table for soil acidification LSC classes.

Table 6.1 Estimating buffering capacity of the soil surface by surface soil texture (OEH 2012)

Surface soil texture	Buffering capacity of surface soil
Sands and sandy loams – no calcium carbonate	VL
Sands and sandy loams – with calcium carbonate	M
Fine sandy loams – no calcium carbonate	L
Fine sandy loams – with calcium carbonate	M
Loams and clay loams – no calcium carbonate	M
Loams and clay loams – with calcium carbonate	H
Dark loams and clay loams (e.g. topsoils in Chernozems and Prairie Soils)	H
Clays – no calcium carbonate	H
Clays – with calcium carbonate	VH
Clays – with high shrink–swell	VH

The following textures described in the field survey were not specifically listed in Table 6.1, so the buffering capacity was assumed by using the equivalent clay percentages (as per the standard soil texture triangle).

Buffering capacity – Moderate:

- Silty clay loam
- Sandy clay loam
- Silty loam
- Clay loam sandy

Buffering capacity – Low:

- Loamy sand
- Clayey sand

Some of the sites did not have pH data, so a land class has been assigned using the surface soil texture and a pH of 5.5-6.7 (water) which represents the most neutral pH range measured for the project area. Therefore these land classes are likely to be a lower capability class, but would not be a higher capability class. These classes have been indicated with an *.

Table 6.2 Soil acidification LSC class assessment table (OEH 2012)

Texture/ buffering capacity	pH of the natural surface soil				
	<4.0 (CaCl2) <4.7 (water)	4.0–4.7 (CaCl2) 4.7–5.5 (water)	4.7–6.0 (CaCl2) 5.5–6.7 (water)	6.0–7.5 (CaCl2) 6.7–8.0 (water)	>7.5 (CaCl2) >8.0 (water)
Mean annual rainfall <550 mm					
Very low	6*	5	4	3	n/a
Low	5	5	3	3	n/a
Moderate	5	4	3	2	1
High	4	3	2	1	1
Very high	n/a	n/a	1	1	1
Mean annual rainfall 550–700 mm					
Very low	6*	5	5	4	n/a
Low	5	5	4	3	n/a
Moderate	5	4	3	3	1
High	n/a	n/a	2	2	1
Very high	n/a	n/a	1	1	1
Mean annual rainfall 700–900 mm					
Very low	6*	5	5	4	n/a
Low	6*	5	4	4	n/a
Moderate	5	4	3	3	2
High	n/a	n/a	2	2	1
Very high	n/a	n/a	2	1	1
Mean annual rainfall >900 mm or irrigation					
Very low	6*	5	5*	4	n/a
Low	6*	4	4	3*	n/a
Moderate	5	4	3	3	2
High	5	3	2	2	1
Very high	5	3	2	1	1

Notes: *1. Based on natural pH status, buffering capacity and climate.*

** These lands usually have very low fertility.*

Table 6.3 Soil acidification LSC classes for the SMUs within the project area

Site ID	Surface soil texture	Buffering capacity of surface soil	pH of the natural surface soil	Soil acidification LSC class[1]
Dermosol				
124	silty clay loam	Moderate		3*
152	silty clay loam	Moderate	6.7	3
181	silty loam	Moderate	4.5	5
278	silty clay loam	Moderate	5.4	4
620	clay loam	Moderate		3*
632	clay	High	5.2	3

Table 6.3 Soil acidification LSC classes for the SMUs within the project area

Site ID	Surface soil texture	Buffering capacity of surface soil	pH of the natural surface soil	Soil acidification LSC class[1]
Hydrosol				
4	clay	High	5.1	3
10	loamy sand	Low	3.7	6
92	silty loam	Moderate	4.4	5
111	silty clay loam	Moderate	4.8	4
238	clay	High	4.5	5
454	clay	High	5.2	3
524	clay	High	4.6	5
611	silty clay loam	Moderate		3*
697	sandy loam	Very Low	6.6	5
Kandosol				
7	silty clay loam	Moderate	6.5	3
15	sandy clay loam	Moderate	5.1	4
16	silty clay loam	Moderate		3*
17	silty clay loam	Moderate	5.5	3
22	clay	High		2*
28	clay loam	Moderate		3*
32	silty clay loam	Moderate	4.5	5
34	sandy clay loam	Moderate		3*
44	clay loam	Moderate	5.5	4
45	silty clay loam	Moderate		3*
47	silty clay loam	Moderate	5.1	4
48	silty loam	Moderate		3*
55	silty clay loam	Moderate		3*
70	silty loam	Moderate		3*
87	silty loam	Moderate		3*
99	silty clay loam	Moderate		3*
110	silty clay loam	Moderate		3*
116	sandy loam	Very Low		5*
120	clayey sand	Low		4*
133	silty loam	Moderate	4.6	5
135	sandy clay loam	Moderate		3*
137	silty loam	Moderate		3*
138	silty clay loam	Moderate		3*
145	clay loam sandy	Moderate	5.3	4
146	silty clay loam	Moderate	4.8	4
149	silty clay loam	Moderate		3*
151	clay loam	Moderate		3*
153	silty clay loam	Moderate		3*
155	silty loam	Moderate		3*
160	sandy clay loam	Moderate	3.7	5
168	silty clay loam	Moderate		3*

Table 6.3 Soil acidification LSC classes for the SMUs within the project area

Site ID	Surface soil texture	Buffering capacity of surface soil	pH of the natural surface soil	Soil acidification LSC class[1]
170	silty clay loam	Moderate	5.1	4
175	silty clay loam	Moderate		3*
186	silty loam	Moderate		3*
187	silty clay loam	Moderate		3*
188	silty clay loam	Moderate		3*
195	silty clay loam	Moderate	5.2	4
202	silty loam	Moderate		3*
209	silty clay loam	Moderate	5.6	3
211	silty loam	Moderate		3*
213	silty loam	Moderate		3*
220	silty clay loam	Moderate	5.2	4
230	clay loam	Moderate		3*
232	silty clay loam	Moderate		3*
235	silty loam	Moderate		3*
236	clay loam	Moderate		3*
240	silty clay loam	Moderate		3*
248	silty clay loam	Moderate		3*
251	clay loam sandy	Moderate		3*
255	silty loam	Moderate		3*
258	silty clay loam	Moderate		3*
260	silty loam	Moderate	5.7	3
267	silty clay loam	Moderate	3.9	5
269	silty loam	Moderate		3*
274	silty clay loam	Moderate	5.5	3
279	clay loam sandy	Moderate	4.8	4
281	silty clay loam	Moderate	4.8	4
282	loamy sand	Low	3.4	6
283	silty clay loam	Moderate	4.9	4
290	silty loam	Moderate	4.9	4
297	silty clay loam	Moderate		3*
298	silty loam	Moderate		3*
308	sandy clay loam	Moderate		3*
310	clay loam	Moderate		3*
328	sandy clay loam	Moderate		3*
337	silty loam	Moderate	4.9	4
339	silty clay loam	Moderate		3*
342	silty loam	Moderate		3*
356	clay loam sandy	Moderate	4.2	5
360	silty clay loam	Moderate		3*
361	silty clay loam	Moderate		3*
363	silty loam	Moderate		3*
365	sandy clay loam	Moderate		3*

Table 6.3 Soil acidification LSC classes for the SMUs within the project area

Site ID	Surface soil texture	Buffering capacity of surface soil	pH of the natural surface soil	Soil acidification LSC class[1]
366	silty clay loam	Moderate	4.7	4
373	silty clay loam	Moderate		3*
374	silty clay loam	Moderate		3*
388	silty clay loam	Moderate	6.1	3
391	silty clay loam	Moderate		3*
396	silty clay loam	Moderate		3*
404	silty loam	Moderate	4.5	5
406	sandy clay loam	Moderate		3*
417	silty loam	Moderate		3*
419	clay loam	Moderate		3*
421	silty clay loam	Moderate		3*
423	clay	High		2*
426	silty clay loam	Moderate	5.6	3
429	silty clay loam	Moderate		3*
435	silty clay loam	Moderate		3*
437	sandy clay loam	Moderate		3*
449	clay loam	Moderate		3*
451	silty clay loam	Moderate		3*
459	silty loam	Moderate		3*
468	clay loam	Moderate	4.5	5
472	silty loam	Moderate	4.3	5
473	sandy clay loam	Moderate	5.2	4
481	silty loam	Moderate	4.2	5
486	silty loam	Moderate	5.1	4
488	silty loam	Moderate	5.	4
489	silty clay loam	Moderate	5.2	4
499	clay loam	Moderate	5.2	4
500	silty loam	Moderate	4.7	4
502	silty loam	Moderate	4.8	4
505	clay loam sandy	Moderate		3*
508	clay loam	Moderate	5.	4
510	silty loam	Moderate	5.5	3
511	silty loam	Moderate		3*
512	clay loam	Moderate	5.1	4
528	silty clay loam	Moderate		3*
535	silty clay loam	Moderate		3*
536	silty clay loam	Moderate		3*
537	silty loam	Moderate		3*
539	silty loam	Moderate		3*
544	silty clay loam	Moderate		3*
545	clay loam	Moderate		3*
550	sandy clay loam	Moderate		3*

Table 6.3 Soil acidification LSC classes for the SMUs within the project area

Site ID	Surface soil texture	Buffering capacity of surface soil	pH of the natural surface soil	Soil acidification LSC class[1]
592	silty clay loam	Moderate	5.2	4
594	clay loam sandy	Moderate	6	3
595	silty clay loam	Moderate	5.7	3
596	clay loam sandy	Moderate	5.9	3
601	sandy clay loam	Moderate		3*
602	clay loam sandy	Moderate		3*
603	silty loam	Moderate		3*
606	clay loam sandy	Moderate		3*
607	clay loam sandy	Moderate		3*
610	silty clay loam	Moderate	4.9	4
612	silty clay loam	Moderate		3*
613	clay loam	Moderate		3*
614	clay	High		2*
615	sandy clay loam	Moderate		3*
616	silty loam	Moderate		3*
617	clay	High		2*
618	silty clay loam	Moderate		3*
619	clay loam sandy	Moderate	4.1	5
621	silty clay loam	Moderate		3*
622	silty clay loam	Moderate		3*
623	silty clay loam	Moderate		3*
624	silty clay loam	Moderate		3*
625	silty clay loam	Moderate		3*
626	silty clay loam	Moderate		3*
627	silty loam	Moderate		3*
628	silty clay loam	Moderate		3*
629	clay	High		2*
630	clay	High		2*
631	clay	High		2*
633	silty clay loam	Moderate		3*
670	sandy loam	Very Low	6.1	5
671	sandy clay loam	Moderate	6.1	3
672	silty loam	Moderate		3*
681	clayey sand	Low	5.3	4
682	clayey sand	Low		4*
683	sandy loam	Very Low		5*
684	sandy loam	Very Low		5*
686	sandy loam	Very Low	5.2	5
687	sandy loam	Very Low	4.5	6
688	sandy clay loam	Moderate	4.2	5
690	sandy clay loam	Moderate	4.1	5
691	sandy clay loam	Moderate	4.2	5

Table 6.3 Soil acidification LSC classes for the SMUs within the project area

Site ID	Surface soil texture	Buffering capacity of surface soil	pH of the natural surface soil	Soil acidification LSC class[1]
692	sandy clay loam	Moderate	5.2	4
698	sandy clay loam	Moderate	5.6	3
699	sandy clay loam	Moderate	5.2	4
700	sandy clay loam	Moderate		3*
701	sandy clay loam	Moderate		3*
702	clay loam sandy	Moderate	4.2	5
703	sandy clay loam	Moderate	4.9	4
704	sandy clay loam	Moderate		3*
Rudosol				
38	sandy clay loam	Moderate		3*
49	loamy sand	Low		4*
100	loam	Moderate		3*
113	sandy loam	Very Low		5*
117	clayey sand	Low		4*
148	sandy loam	Very Low		5*
159	silty loam	Moderate		3*
178	loamy sand	Low		4*
189	loamy sand	Low		4*
204	loamy sand	Low		4*
259	silty loam	Moderate		3*
264	loamy sand	Low	4.6	6
312	loamy sand	Low		4*
350	silty clay loam	Moderate		3*
352	loamy sand	Low	4.8	4
357	silty loam	Moderate		3*
393	clay loam	Moderate		3*
403	loamy sand	Low	5.3	4
411	loamy sand	Low		4*
414	clayey sand	Low	4.6	6
438	sandy clay loam	Moderate		3*
465	loamy sand	Low		4*
474	sandy loam	Very Low	5.8	5
490	sand	Very Low		5*
521	clayey sand	Low		4*
525	loamy sand	Low		4*
609	clayey sand	Low		4*
Tenosol				
26	silty loam	Moderate		3*
29	clayey sand	Low		5*
73	loamy sand	Low	4	6
83	clayey sand	Low	4.6	6
90	clayey sand	Low		4*

Table 6.3 Soil acidification LSC classes for the SMUs within the project area

Site ID	Surface soil texture	Buffering capacity of surface soil	pH of the natural surface soil	Soil acidification LSC class[1]
112	clayey sand	Low		4*
119	silty loam	Moderate		3*
126	clayey sand	Low	4.6	6
128	clay loam	Moderate	5.	4
157	sandy loam	Very Low		5*
174	silty loam	Moderate		3*
183	silty clay loam	Moderate	5.4	4
196	loam	Moderate	4.7	4
201	clayey sand	Low		4*
224	loam	Moderate		3*
229	loamy sand	Low		4*
234	loamy sand	Low		4*
239	silty loam	Moderate		3*
263	sandy clay loam	Moderate	4.2	5
287	sandy loam	Very Low	5.6	5
300	sand	Very Low	4.6	6
307	sandy clay loam	Moderate		3*
327	silty loam	Moderate		3*
364	loamy sand	Low	5.1	4
376	silty loam	Moderate		3*
379	clayey sand	Low		4*
467	loamy sand	Low		4*
513	silty loam	Moderate	5.2	4
522	loamy sand	Low		4*
523	sandy loam	Very Low		5*
532	clayey sand	Low		4*
600	loamy sand	Low		4*
604	sandy loam	Very Low		5*
605	clayey sand	Low		4*
608	sandy clay loam	Moderate		3*
685	sandy clay loam	Moderate	4.2	5
689	sandy loam	Very Low	5.1	5

7 Assessment of salinity LSC classes

Salinity hazard is determined as a result of recharge potential, discharge potential and salt store. Table 7.1 and Figure 7.1 Table 7.1 summarises the supporting information for decision making, while Table 7.2 is the assessment table for salinity LSC classes. Table 7.3 outlines the results table for salinity LSC classes.

Table 7.1 A summary of salinity LSC notes from OEH 2012

Factor	Notes	Example	Information Source
Recharge potential	Recharge potential is the potential for water from rainfall, irrigation or streams to infiltrate past the plant root zone into the underlying groundwater system. This can occur over a whole landscape, or a component of the landscape, where water readily infiltrates soil, sediment or rock. Typically recharge areas have permeable, shallow and/or stony soils and fractured and/or weathered rock.	Recharge potential is highest where there is high rainfall relative to evaporation, low leaf area and plant water use, low water-holding capacity, and high permeability of the soils, regolith and rocks. Under natural conditions it relates to the climate, land use and hydrological characteristics of the catchment. It is exacerbated by land-use practices that disturb the vegetation cover or soil surface.	The value assigned for recharge potential is a qualitative assessment based on aerial photography, field observation and/or available literature, in particular soil landscape maps and reports.
Discharge potential	Discharge potential is the potential for groundwater to flow from the saturated zone to the land surface. It is a function of position in the landscape, depth to water table, groundwater pressure, soil type, substrate permeability and evapotranspiration. Discharge may occur as leakage to streams, evaporation from shallow water tables, or as springs and wet areas where water tables intersect the land surface or where narrow breaks occur in low permeability layers above confined aquifers.	Discharge potential is highest when recharge rates are greater than the amount of water that leaves the groundwater system through base flow and evapotranspiration. Typical discharge areas are low in the landscape and have high water tables, or higher in the landscape if sub-surface barriers impede groundwater flow.	The value assigned for discharge potential is a qualitative assessment based on aerial photography, field observation and/or available literature, in particular soil landscape maps and reports.
Salt store	**Salt stores** are high for many soils, regolith materials and rock types. This will depend on weathering characteristics, geological structures, rock and soil type, depth of the various materials and salt flux.	It is possible to have areas of low salt store and still have a salinity hazard due to evaporative concentration of salts at the soil surface. Conversely, areas of high salt store can have a lower hazard due to low rainfall. For example, in areas of low rainfall and low slope, salinity hazard can be low.	Figure 7.1 provides a broad indication of salt stores throughout NSW. This map is generalised and local information should be used where available.

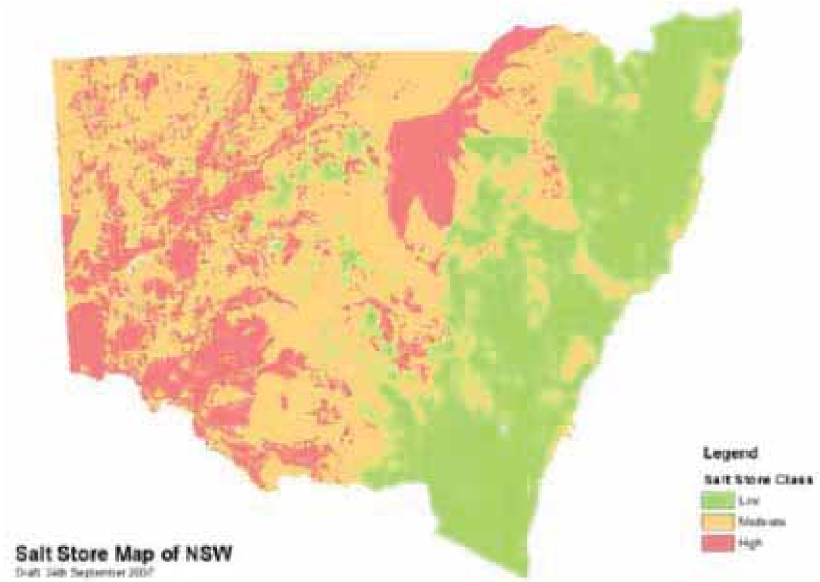


Figure 7.1 Salt store map of NSW (OEH 2012)

The site is located in a low salt store region, so the parts of Table 7.2 that pertain to high and medium salt store have been shaded as they are not relevant.

Table 7.2 Salinity LSC class assessment table (OEH 2012)

Recharge potential	Discharge potential	Salt store	LSC class
Low	Low	Low	1
		Moderate	3
		High	4
	Moderate	Low	1
		Moderate	4
		High	4
	High	Low	1
		Moderate	4
		High	5
Moderate	Low	Low	1
		Moderate	3
		High	4
	Moderate	Low	2
		Moderate	5
		High	6
	High	Low	1 (3) *
		Moderate	6
		High	6

Table 7.2 Salinity LSC class assessment table (OEH 2012)

Recharge potential	Discharge potential	Salt store	LSC class
High	Low	Low	1
		Moderate	4
		High	5
	Moderate	Low	3 (2) *
		Moderate	4
		High	7
	High	Low	2 (3) *
		Moderate	6
		High	7

*Note: * The values in brackets are more accurate and should be used in preference to the original*

Table 7.3 Salinity LSC classes for the SMUs within the project area

Site ID	Recharge Potential	Discharge Potential	Salt store	Salinity LSC class
Dermosol				
124	low	low	low	1
152	low	low	low	1
181	low	low	low	1
278	low	low	low	1
620	high	low	low	1
632	low	low	low	1
Hydrosol				
4	low	low	low	1
10	low	low	low	1
92	low	low	low	1
111	low	low	low	1
238	low	low	low	1
454	low	low	low	1
524	low	low	low	1
611	low	low	low	1
697	low	low	low	1
Kandosol				
7	low	low	low	1
15	low	low	low	1
16	low	low	low	1
17	low	low	low	1
22	low	low	low	1
28	low	low	low	1
32	moderate	low	low	1
34	low	low	low	1
44	low	low	low	1
45	low	low	low	1
47	low	low	low	1

Table 7.3 Salinity LSC classes for the SMUs within the project area

Site ID	Recharge Potential	Discharge Potential	Salt store	Salinity LSC class
48	low	low	low	1
55	low	low	low	1
70	moderate	low	low	1
87	moderate	low	low	1
99	low	low	low	1
110	moderate	low	low	1
116	high	low	low	1
120	high	low	low	1
133	low	low	low	1
135	low	low	low	1
137	low	low	low	1
138	low	low	low	1
145	moderate	low	low	1
146	low	low	low	1
149	low	low	low	1
151	moderate	low	low	1
153	moderate	low	low	1
155	low	low	low	1
160	low	low	low	1
168	low	low	low	1
170	low	low	low	1
175	low	low	low	1
186	moderate	low	low	1
187	low	low	low	1
188	low	low	low	1
195	low	low	low	1
202	low	low	low	1
209	moderate	low	low	1
211	moderate	low	low	1
213	moderate	low	low	1
220	moderate	low	low	1
230	low	low	low	1
232	low	low	low	1
235	moderate	low	low	1
236	low	low	low	1
240	moderate	low	low	1
248	low	low	low	1
251	moderate	low	low	1
255	high	low	low	1
258	low	low	low	1
260	moderate	low	low	1
267	low	low	low	1

Table 7.3 Salinity LSC classes for the SMUs within the project area

Site ID	Recharge Potential	Discharge Potential	Salt store	Salinity LSC class
269	low	low	low	1
274	low	low	low	1
279	low	low	low	1
281	low	low	low	1
282	low	low	low	1
283	low	low	low	1
290	low	low	low	1
297	low	low	low	1
298	low	low	low	1
308	low	low	low	1
310	low	low	low	1
328	moderate	low	low	1
337	low	low	low	1
339	low	low	low	1
342	low	low	low	1
356	moderate	low	low	1
360	low	low	low	1
361	low	low	low	1
363	low	low	low	1
365	low	low	low	1
366	low	low	low	1
373	low	low	low	1
374	low	low	low	1
388	low	moderate	low	1
391	low	low	low	1
396	moderate	low	low	1
404	moderate	low	low	1
406	low	low	low	1
417	moderate	low	low	1
419	low	low	low	1
421	low	low	low	1
423	low	low	low	1
426	moderate	low	low	1
429	low	low	low	1
435	low	low	low	1
437	low	low	low	1
449	low	low	low	1
451	low	low	low	1
459	low	moderate	low	1
468	low	low	low	1
472	low	low	low	1
473	low	low	low	1
481	low	low	low	1

Table 7.3 Salinity LSC classes for the SMUs within the project area

Site ID	Recharge Potential	Discharge Potential	Salt store	Salinity LSC class
486	low	low	low	1
488	low	low	low	1
489	moderate	low	low	1
499	low	low	low	1
500	low	low	low	1
502	moderate	low	low	1
505	low	low	low	1
508	low	low	low	1
510	low	low	low	1
511	low	low	low	1
512	low	low	low	1
528	low	low	low	1
535	moderate	low	low	1
536	high	low	low	1
537	moderate	low	low	1
539	moderate	low	low	1
544	moderate	low	low	1
545	moderate	low	low	1
550	low	low	low	1
592	moderate	low	low	1
594	low	low	low	1
595	moderate	low	low	1
596	low	low	low	1
601	low	low	low	1
602	low	low	low	1
603	low	low	low	1
606	low	low	low	1
607	low	low	low	1
610	low	low	low	1
612	low	low	low	1
613	moderate	low	low	1
614	low	low	low	1
615	moderate	low	low	1
616	moderate	low	low	1
617	low	low	low	1
618	low	low	low	1
619	low	low	low	1
621	low	low	low	1
622	low	low	low	1
623	low	low	low	1
624	low	low	low	1
625	low	low	low	1
626	low	low	low	1

Table 7.3 Salinity LSC classes for the SMUs within the project area

Site ID	Recharge Potential	Discharge Potential	Salt store	Salinity LSC class
627	low	low	low	1
628	low	low	low	1
629	low	low	low	1
630	low	low	low	1
631	low	low	low	1
633	low	low	low	1
670	low	low	low	1
671	low	low	low	1
672	low	low	low	1
681	low	low	low	1
682	low	low	low	1
683	low	low	low	1
684	low	low	low	1
686	low	low	low	1
687	low	low	low	1
688	low	low	low	1
690	low	low	low	1
691	low	low	low	1
692	low	low	low	1
698	low	low	low	1
699	low	low	low	1
700	low	low	low	1
701	low	low	low	1
702	low	low	low	1
703	low	low	low	1
704	low	low	low	1
Rudosol				
38	high	low	low	1
49	high	low	low	1
100	high	low	low	1
113	high	low	low	1
117	high	low	low	1
148	high	low	low	1
159	high	low	low	1
178	high	low	low	1
189	high	low	low	1
204	high	low	low	1
259	high	low	low	1
264	high	low	low	1
312	high	low	low	1
350	moderate	low	low	1
352	high	low	low	1
357	high	low	low	1

Table 7.3 Salinity LSC classes for the SMUs within the project area

Site ID	Recharge Potential	Discharge Potential	Salt store	Salinity LSC class
393	high	low	low	1
403	high	low	low	1
411	high	low	low	1
414	high	low	low	1
438	high	low	low	1
465	high	low	low	1
474	high	low	low	1
490	high	low	low	1
521	high	low	low	1
525	high	low	low	1
609	high	low	low	1
Tenosol				
26	high	low	low	1
29	high	low	low	1
73	high	low	low	1
83	high	low	low	1
90	high	low	low	1
112	high	low	low	1
119	high	low	low	1
126	high	low	low	1
128	high	low	low	1
157	high	low	low	1
174	high	low	low	1
183	moderate	low	low	1
196	high	low	low	1
201	high	low	low	1
224	high	low	low	1
229	high	low	low	1
234	high	low	low	1
239	high	low	low	1
263	high	low	low	1
287	high	low	low	1
300	high	low	low	1
307	high	low	low	1
327	moderate	low	low	1
364	low	low	low	1
376	moderate	low	low	1
379	high	low	low	1
467	high	low	low	1
513	high	low	low	1
522	high	low	low	1
523	high	low	low	1
532	high	low	low	1

Table 7.3 Salinity LSC classes for the SMUs within the project area

Site ID	Recharge Potential	Discharge Potential	Salt store	Salinity LSC class
600	high	low	low	1
604	high	low	low	1
605	high	low	low	1
608	moderate	low	low	1
685	low	low	low	1
689	low	low	low	1

Notes: 1.Information sources were Salis data cards, lab data, BOM

8 Assessment of waterlogging LSC classes

Table 8.1 outlines the assessment table for determining waterlogging LSC classes and Table 8.2 provides the results.

The typical waterlogging duration was not known, but the presence of mottling was used to distinguish the degree of waterlogging. Soil profiles which were logged as "imperfectly drained" with 20-50% mottles in the B horizon were classed as 4 (i.e. waterlogged every 2-3 years for 2-3 months duration). Soils which were logged as Hydrosols were assumed to be LSC class 6, but soils that were logged as poorly drained but were not classified as Hydrosol were assumed to be LSC class 5.

Table 8.1 Waterlogging LSC class assessment table (OEH 2012)

Typical waterlogging duration (months)	Return period	Typical soil drainage*	LSC class**
0	every year	rapidly drained and well drained	1
0–0.25	every year	moderately well drained	2
0.25–2	every year	imperfectly drained	3
2–3	every 2 to 3 years	imperfectly drained	4
2–3	every year	imperfectly drained	5
>3	every year	poorly drained	6
Almost permanently	every year	very poorly drained	8

*Notes: * NCST (2009, p.202–4)*

*** Based on slope position, climate and length of time soils are wet.*

Table 8.2 Waterlogging LSC classes for the SMUs within the project area

Site ID	Typical soil drainage	Waterlogging LSC class
Dermosol		
124	imperfectly drained	3
152	Imperfectly drained (20-50% mottles)	4
181	Poorly drained	5
278	Poorly drained	5
620	well drained	1
632	moderately well drained	2
Hydrosol		
4	Poorly drained (Hydrosol)	6
10	Poorly drained (Hydrosol)	6
92	Poorly drained (Hydrosol)	6
111	Poorly drained (Hydrosol)	6
238	Poorly drained (Hydrosol)	6
454	Poorly drained (Hydrosol)	6
524	Poorly drained (Hydrosol)	6
611	Poorly drained (Hydrosol)	6
697	Poorly drained (Hydrosol)	6

Table 8.2 Waterlogging LSC classes for the SMUs within the project area

Site ID	Typical soil drainage	Waterlogging LSC class
Kandosol		
7	Imperfectly drained (20-50% mottles)	4
15	Imperfectly drained (20-50% mottles)	4
16	imperfectly drained	3
17	Imperfectly drained (20-50% mottles)	4
22	Poorly drained	5
28	Poorly drained	5
32	moderately well drained	2
34	Imperfectly drained (20-50% mottles)	4
44	Imperfectly drained (20-50% mottles)	4
45	imperfectly drained	3
47	Imperfectly drained (20-50% mottles)	4
48	Imperfectly drained (20-50% mottles)	4
55	Imperfectly drained (20-50% mottles)	4
70	moderately well drained	2
87	moderately well drained	2
99	Imperfectly drained (20-50% mottles)	4
110	moderately well drained	2
116	well drained	1
120	well drained	1
133	Imperfectly drained (20-50% mottles)	4
135	imperfectly drained	3
137	imperfectly drained	3
138	Imperfectly drained (20-50% mottles)	4
145	moderately well drained	2
146	Imperfectly drained (20-50% mottles)	4
149	Imperfectly drained (20-50% mottles)	4
151	moderately well drained	2
153	moderately well drained	2
155	imperfectly drained	3
160	imperfectly drained	3
168	moderately well drained	2
170	Imperfectly drained (20-50% mottles)	4
175	imperfectly drained	3
186	moderately well drained	2
187	Imperfectly drained (20-50% mottles)	4
188	Imperfectly drained (20-50% mottles)	4
195	imperfectly drained	3
202	Imperfectly drained (20-50% mottles)	4
209	moderately well drained	2
211	moderately well drained	2
213	moderately well drained	2
220	moderately well drained	2

Table 8.2 Waterlogging LSC classes for the SMUs within the project area

Site ID	Typical soil drainage	Waterlogging LSC class
230	Imperfectly drained (20-50% mottles)	4
232	Imperfectly drained (20-50% mottles)	4
235	moderately well drained	2
236	Imperfectly drained (20-50% mottles)	4
240	moderately well drained	2
248	moderately well drained	2
251	moderately well drained	2
255	well drained	1
258	imperfectly drained	3
260	moderately well drained	2
267	Poorly drained	5
269	imperfectly drained	3
274	Imperfectly drained (20-50% mottles)	4
279	Imperfectly drained (20-50% mottles)	4
281	Imperfectly drained (20-50% mottles)	4
282	imperfectly drained	3
283	imperfectly drained	3
290	imperfectly drained	3
297	Imperfectly drained (20-50% mottles)	4
298	Poorly drained	5
308	Poorly drained	5
310	imperfectly drained	3
328	moderately well drained	2
337	Imperfectly drained (20-50% mottles)	4
339	Imperfectly drained (20-50% mottles)	4
342	Imperfectly drained (20-50% mottles)	4
356	moderately well drained	2
360	imperfectly drained	3
361	Imperfectly drained (20-50% mottles)	4
363	imperfectly drained	3
365	imperfectly drained	3
366	Imperfectly drained (20-50% mottles)	4
373	Poorly drained	5
374	Imperfectly drained (20-50% mottles)	4
388	Imperfectly drained (20-50% mottles)	4
391	imperfectly drained	3
396	moderately well drained	2
404	moderately well drained	2
406	imperfectly drained	3
417	moderately well drained	2
419	Imperfectly drained (20-50% mottles)	4
421	imperfectly drained	3
423	imperfectly drained	3

Table 8.2 Waterlogging LSC classes for the SMUs within the project area

Site ID	Typical soil drainage	Waterlogging LSC class
426	moderately well drained	2
429	imperfectly drained	3
435	Imperfectly drained (20-50% mottles)	4
437	Imperfectly drained (20-50% mottles)	4
449	Imperfectly drained (20-50% mottles)	4
451	imperfectly drained	3
459	Imperfectly drained (20-50% mottles)	4
468	Poorly drained	5
472	imperfectly drained	3
473	Imperfectly drained (20-50% mottles)	4
481	imperfectly drained	3
486	Imperfectly drained (20-50% mottles)	4
488	imperfectly drained	3
489	moderately well drained	2
499	Imperfectly drained (20-50% mottles)	4
500	Imperfectly drained (20-50% mottles)	4
502	moderately well drained	2
505	imperfectly drained	3
508	Imperfectly drained (20-50% mottles)	4
510	imperfectly drained	3
511	Imperfectly drained (20-50% mottles)	4
512	imperfectly drained	3
528	Imperfectly drained (20-50% mottles)	4
535	moderately well drained	2
536	well drained	1
537	moderately well drained	2
539	moderately well drained	2
544	moderately well drained	2
545	moderately well drained	2
550	Poorly drained	5
592	moderately well drained	2
594	imperfectly drained	3
595	moderately well drained	2
596	imperfectly drained	3
601	imperfectly drained	3
602	imperfectly drained	3
603	Imperfectly drained (20-50% mottles)	4
606	Imperfectly drained (20-50% mottles)	4
607	Poorly drained	5
610	imperfectly drained	3
612	moderately well drained	2
613	moderately well drained	2
614	imperfectly drained	3

Table 8.2 Waterlogging LSC classes for the SMUs within the project area

Site ID	Typical soil drainage	Waterlogging LSC class
615	moderately well drained	2
616	moderately well drained	2
617	Poorly drained	5
618	Imperfectly drained (20-50% mottles)	4
619	Poorly drained	5
621	imperfectly drained	3
622	moderately well drained	2
623	imperfectly drained	3
624	Imperfectly drained (20-50% mottles)	4
625	Imperfectly drained (20-50% mottles)	4
626	imperfectly drained	3
627	Poorly drained	5
628	Imperfectly drained (20-50% mottles)	4
629	moderately well drained	2
630	Poorly drained	5
631	Poorly drained	5
633	imperfectly drained	3
670	Poorly drained	5
671	Imperfectly drained (20-50% mottles)	4
672	Poorly drained	5
681	Poorly drained	5
682	Poorly drained	5
683	Poorly drained	5
684	Poorly drained	5
686	Poorly drained	5
687	Poorly drained	5
688	Poorly drained	5
690	Poorly drained	5
691	Poorly drained	5
692	Poorly drained	5
698	Poorly drained	5
699	imperfectly drained	3
700	imperfectly drained	3
701	imperfectly drained	3
702	imperfectly drained	3
703	Imperfectly drained (20-50% mottles)	4
704	imperfectly drained	3
Rudosol		
38	well drained	1
49	well drained	1
100	well drained	1
113	well drained	1
117	well drained	1

Table 8.2 Waterlogging LSC classes for the SMUs within the project area

Site ID	Typical soil drainage	Waterlogging LSC class
148	well drained	1
159	well drained	1
178	well drained	1
189	well drained	1
204	well drained	1
259	well drained	1
264	well drained	1
312	well drained	1
350	moderately well drained	2
352	well drained	1
357	well drained	1
393	well drained	1
403	well drained	1
411	well drained	1
414	well drained	1
438	well drained	1
465	well drained	1
474	well drained	1
490	well drained	1
521	well drained	1
525	well drained	1
609	well drained	1
Tenosol		
26	well drained	1
29	moderately well drained	2
73	well drained	1
83	well drained	1
90	well drained	1
112	well drained	1
119	well drained	1
126	well drained	1
128	well drained	1
157	well drained	1
174	well drained	1
183	moderately well drained	2
196	well drained	1
201	moderately well drained	2
224	well drained	1
229	well drained	1
234	well drained	1
239	well drained	1
263	well drained	1
287	well drained	1

Table 8.2 Waterlogging LSC classes for the SMUs within the project area

Site ID	Typical soil drainage	Waterlogging LSC class
300	well drained	1
307	well drained	1
327	moderately well drained	2
364	imperfectly drained	3
376	moderately well drained	2
379	well drained	1
467	well drained	1
513	well drained	1
522	well drained	1
523	well drained	1
532	well drained	1
600	well drained	1
604	well drained	1
605	well drained	1
608	moderately well drained	2
685	Poorly drained	5
689	Poorly drained	5

9 Assessment of shallow soils and rockiness LSC classes

Table 9.1 outlines the assessment table for determining shallow soils and rockiness LSC classes and Table 9.2 provides the results.

Table 9.1 Shallow soils and rockiness LSC class assessment table (OEH 2012)

Rocky outcrop (% coverage)*	Soil depth (cm)	LSC class**
Nil	>100	1
<30 (localised*)	>100	2
	75– <100	3
	50– <75	4
	25– <50	6
	0– <25	7
30–50 (widespread*)	>100	4
	75–100	5
	25–75	6
	<25	7
50–70 (widespread*)	>100	6
	50–100	6
	25– <50	7
	<25	7
>70	n/a	8

Notes: ** Rock outcrop limitation from soil landscape report.*

*** Based on rocky outcrop and soil depth.*

Table 9.2 Shallow soils and rockiness LSC classes for each soil type

Site ID	Rocky outcrop (% coverage)	Soil depth (cm)	Soil depth category (cm)	Shallow soils and rockiness LSC class
Dermosol				
124	Nil	0.55	50-<75cm	4
152	Nil	0.6	50-<75cm	4
181	Nil	0.8	75-<100cm	3
278	Nil	0.8	75-<100cm	3
620	Nil	0.09	<25cm	7
632	Nil	0.69	50-<75cm	4
Hydrosol				
4	Nil	0.6	50-<75cm	4
10	Nil	0.9	75-<100cm	3
92	Nil	0.8	75-<100cm	3
111	Nil	0.8	75-<100cm	3
238	Nil	0.8	75-<100cm	3
454	Nil	0.8	75-<100cm	3
524	Nil	0.8	75-<100cm	3

Table 9.2 Shallow soils and rockiness LSC classes for each soil type

Site ID	Rocky outcrop (% coverage)	Soil depth (cm)	Soil depth category (cm)	Shallow soils and rockiness LSC class
611	Nil	0.76	75-<100cm	3
697	Nil	0.74	50-<75cm	4
Kandosol				
7	Nil	0.64	50-<75cm	4
15	Nil	0.6	50-<75cm	4
16	Nil	0.8	75-<100cm	3
17		0.8	75-<100cm	3
22	Nil	0.7	50-<75cm	4
28	Nil	0.8	75-<100cm	3
32	Nil	0.54	50-<75cm	4
34		0.8	75-<100cm	3
44	Nil	0.8	75-<100cm	3
45	Nil	0.8	75-<100cm	3
47	Nil	0.88	75-<100cm	3
48	Nil	0.49	25-<50cm	6
55		0.83	75-<100cm	3
70		0.37	25-<50cm	6
87	Nil	0.8	75-<100cm	3
99		0.8	75-<100cm	3
110		0.8	75-<100cm	3
116	Nil	0.8	75-<100cm	3
120	Nil	0.8	75-<100cm	3
133	Nil	0.8	75-<100cm	3
135		0.55	50-<75cm	4
137	Nil	0.8	75-<100cm	3
138	Nil	0.68	50-<75cm	4
145	Nil	0.7	50-<75cm	4
146	Nil	0.8	75-<100cm	3
149	Nil	0.8	75-<100cm	3
151	Nil	0.55	50-<75cm	4
153	Nil	0.57	50-<75cm	4
155	Nil	0.66	50-<75cm	4
160	Nil	0.8	75-<100cm	3
168		0.76	75-<100cm	3
170	Nil	0.8	75-<100cm	3
175	Nil	0.5	50-<75cm	4
186	Nil	0.8	75-<100cm	3
187	Nil	0.69	50-<75cm	4
188	< 2%	0.56	50-<75cm	4
195	Nil	0.8	75-<100cm	3
202	Nil	0.8	75-<100cm	3
209	Nil	0.68	75-<100cm	4

Table 9.2 Shallow soils and rockiness LSC classes for each soil type

Site ID	Rocky outcrop (% coverage)	Soil depth (cm)	Soil depth category (cm)	Shallow soils and rockiness LSC class
211		0.34	25-<50cm	6
213	Nil	0.28	25-<50cm	6
220	Nil	0.88	75-<100cm	3
230	Nil	0.8	75-<100cm	3
232		0.8	75-<100cm	3
235	Nil	0.45	25-<50cm	6
236	Nil	0.61	50-<75cm	4
240	Nil	0.75	75-<100cm	3
248		0.67	50-<75cm	4
251	Nil	0.18	<25cm	7
255	Nil	0.27	25-<50cm	6
258	Nil	0.6	50-<75cm	4
260	Nil	0.73	50-<75cm	4
267	Nil	0.8	75-<100cm	3
269	Nil	0.4	25-<50cm	6
274	Nil	0.8	75-<100cm	3
279	Nil	0.8	75-<100cm	3
281	Nil	0.8	75-<100cm	3
282	Nil	0.8	75-<100cm	3
283	Nil	0.8	75-<100cm	3
290	Nil	0.61	50-<75cm	4
297	Nil	0.4	25-<50cm	6
298	Nil	0.8	75-<100cm	3
308	Nil	0.8	75-<100cm	3
310		0.7	50-<75cm	4
328		0.8	75-<100cm	3
337	Nil	0.8	75-<100cm	3
339		0.74	50-<75cm	4
342	Nil	0.8	75-<100cm	3
356	Nil	0.63	50-<75cm	4
360	Nil	0.24	<25cm	7
361	Nil	0.6	50-<75cm	4
363	Nil	0.55	50-<75cm	4
365	Nil	0.4	25-<50cm	6
366	Nil	0.4	25-<50cm	6
373	Nil	0.8	75-<100cm	3
374	Nil	0.8	75-<100cm	3
388	Nil	0.8	75-<100cm	3
391	Nil	0.8	75-<100cm	3
396	Nil	0.35	25-<50cm	6
404	Nil	0.8	75-<100cm	3
406		0.8	75-<100cm	3

Table 9.2 Shallow soils and rockiness LSC classes for each soil type

Site ID	Rocky outcrop (% coverage)	Soil depth (cm)	Soil depth category (cm)	Shallow soils and rockiness LSC class
417	Nil	0.43	25-<50cm	6
419	Nil	0.66	50-<75cm	4
421	Nil	0.5	50-<75cm	4
423		0.8	75-<100cm	3
426	Nil	0.4	25-<50cm	6
429	Nil	0.56	50-<75cm	4
435	Nil	0.8	75-<100cm	3
437	Nil	0.68	50-<75cm	4
449	Nil	0.8	75-<100cm	3
451	Nil	0.47	25-<50cm	6
459	Nil	0.8	75-<100cm	3
468	Nil	0.8	75-<100cm	3
472	Nil	0.63	50-<75cm	4
473	Nil	0.73	50-<75cm	4
481	Nil	0.8	75-<100cm	3
486		0.48	25-<50cm	6
488	Nil	0.8	75-<100cm	3
489	Nil	0.67	50-<75cm	4
499	Nil	0.8	75-<100cm	3
500	Nil	0.6	50-<75cm	4
502	Nil	0.8	75-<100cm	3
505	Nil	0.45	25-<50cm	6
508	Nil	0.75	75-<100cm	3
510	Nil	0.49	25-<50cm	6
511		0.78	75-<100cm	3
512	Nil	0.8	75-<100cm	3
528	Nil	0.8	75-<100cm	3
535	Nil	0.65	50-<75cm	4
536	Nil	0.4	25-<50cm	6
537	Nil	0.4	25-<50cm	6
539	Nil	0.53	50-<75cm	4
544	< 2%	0.5	50-<75cm	4
545	Nil	0.6	50-<75cm	4
550	Nil	0.8	75-<100cm	3
592	Nil	0.8	75-<100cm	3
594	Nil	0.8	75-<100cm	3
595	Nil	0.8	75-<100cm	3
596	Nil	0.8	75-<100cm	3
601	Nil	0.62	50-<75cm	4
602	Nil	0.65	50-<75cm	4
603	Nil	0.8	75-<100cm	3
606	Nil	0.7	50-<75cm	4

Table 9.2 Shallow soils and rockiness LSC classes for each soil type

Site ID	Rocky outcrop (% coverage)	Soil depth (cm)	Soil depth category (cm)	Shallow soils and rockiness LSC class
607	Nil	0.58	50-<75cm	4
610	Nil	0.8	75-<100cm	3
612	Nil	0.33	25-<50cm	6
613	Nil	0.24	<25cm	7
614	Nil	0.38	25-<50cm	6
615	Nil	0.4	25-<50cm	6
616	Nil	0.8	75-<100cm	3
617	Nil	0.84	75-<100cm	3
618	Nil	0.57	50-<75cm	4
619	Nil	0.82	75-<100cm	3
621	Nil	0.66	50-<75cm	4
622	Nil	0.82	75-<100cm	3
623	Nil	0.8	75-<100cm	3
624	Nil	0.75	75-<100cm	3
625	Nil	0.87	75-<100cm	3
626	Nil	0.42	25-<50cm	6
627	Nil	0.67	50-<75cm	4
628	Nil	0.9	75-<100cm	3
629	Nil	0.32	25-<50cm	6
630	Nil	0.71	50-<75cm	4
631	Nil	0.84	75-<100cm	3
633	Nil	0.59	50-<75cm	4
670	Nil	0.57	50-<75cm	4
671	Nil	0.83	75-<100cm	3
672	Nil	0.14	<25cm	7
681	Nil	0.79	75-<100cm	3
682	Nil	0.9	75-<100cm	3
683	Nil	0.67	50-<75cm	4
684	Nil	0.48	25-<50cm	6
686	Nil	0.89	75-<100cm	3
687	Nil	0.63	50-<75cm	4
688	Nil	0.42	25-<50cm	6
690	Nil	0.68	50-<75cm	4
691	Nil	0.73	50-<75cm	4
692	Nil	0.98	75-<100cm	3
698	Nil	0.85	75-<100cm	3
699	Nil	0.75	75-<100cm	3
700	Nil	0.73	50-<75cm	4
701		0.68	50-<75cm	4
702	Nil	0.74	50-<75cm	4
703	>20 - 30%	0.73	50-<75cm	4
704	<2%	0.14	25-<50cm	7

Table 9.2 Shallow soils and rockiness LSC classes for each soil type

Site ID	Rocky outcrop (% coverage)	Soil depth (cm)	Soil depth category (cm)	Shallow soils and rockiness LSC class
Rudosol				
38	10% - 20%	0.15	<25cm	7
49	2% - 10%	0.18	<25cm	7
100	Nil	0.3	25-<50cm	6
113		0.35	25-<50cm	6
117	Nil	0.45	25-<50cm	6
148	Nil	0.32	25-<50cm	6
159	Nil	0.18	<25cm	7
178	20% - 50%	0.04	<25 cm	7
189	Nil	0.5	50-<75cm	4
204	Nil	0.16	<25cm	7
259	Nil	0.3	25-<50cm	6
264	2% - 10%	0.17	<25cm	7
312	Nil	0.2	<25cm	7
350		0.36	25-<50cm	6
352	2% - 10%	0.19	<25cm	7
357		0.36	25-<50cm	6
393	Nil	0.28	25-<50cm	6
403	10% - 20%	0.32	25-<50cm	6
411	> 50%	0.15	<25cm	7
414	> 50%	0.32	25-<50cm	7
438	2% - 10%	0.12	<25cm	7
465	Nil	0.2	<25cm	7
474	2% - 10%	0.1	<25cm	7
490	2% - 10%	0.33	25-<50cm	6
521	20% - 50%	0.12	<25 cm	7
525	< 2%	0.16	<25cm	7
609	20% - 50%	0.12	<25 cm	7
Tenosol				
26		0.4	25-<50cm	6
29	Nil	0.8	75-<100cm	3
73	Nil	0.85	75-<100cm	3
83	Nil	0.85	75-<100cm	3
90	Nil	0.8	75-<100cm	3
112		0.74	50-<75cm	4
119	< 2%	0.28	25-<50cm	6
126	Nil	0.89	75-<100cm	3
128	Nil	0.18	<25cm	7
157		0.8	75-<100cm	3
174	Nil	0.29	25-<50cm	6
183	Nil	0.22	<25cm	7
196	Nil	0.8	75-<100cm	3

Table 9.2 Shallow soils and rockiness LSC classes for each soil type

Site ID	Rocky outcrop (% coverage)	Soil depth (cm)	Soil depth category (cm)	Shallow soils and rockiness LSC class
201	< 2%	0.42	25-<50cm	6
224	Nil	0.3	25-<50cm	6
229	Nil	0.21	<25cm	7
234		0.62	50-<75cm	4
239	Nil	0.34	25-<50cm	6
263	Nil	0.85	75-<100cm	3
287	Nil	0.8	75-<100cm	3
300	Nil	0.8	75-<100cm	3
307	Nil	0.42	25-<50cm	6
327	Nil	0.45	25-<50cm	6
364	Nil	0.8	75-<100cm	3
376	Nil	0.35	25-<50cm	6
379		0.55	50-<75cm	4
467	Nil	0.8	75-<100cm	3
513	Nil	0.32	25-<50cm	6
522	< 2%	0.15	<25cm	7
523		0.66	50-<75cm	4
532	Nil	0.8	75-<100cm	3
600	Nil	0.4	25-<50cm	6
604	Nil	0.52	50-<75cm	4
605	Nil	0.58	50-<75cm	4
608	Nil	0.39	25-<50cm	6
685	Nil	0.15	<25cm	7
689	Nil	0.36	25-<50cm	6

10 Assessment of mass movement LSC classes

Table 10.1 outlines the assessment table for determining mass movement LSC classes. The mean annual rainfall for the nearest weather station (Mossvale) is 961mm, so therefore is in the over 500mm category on the table. Table 10.2 provides the results.

Table 10.1 Mass movement LSC class assessment table (OEH 2012)

Mean annual rainfall (mm)	Mass movement present	Slope class (%)	LSC class
<500	No	n/a	1
	Yes	n/a	8
>500	No	n/a	1
	Yes	<20	6
		>20–50	7
		50 or any scree or talus slope	8

Note that scree or talus slopes go automatically into Class 8.

Table 10.2 Mass movement LSC classes for the SMUs within the project area

Site ID	Mass movement present	Slope class (%)	Mass movement LSC class
Dermosol			
124	No	n/a	1
152	No	n/a	1
181	No	n/a	1
278	No	n/a	1
620	No	n/a	1
632	No	n/a	1
Hydrosol			
4	No	n/a	1
10	No	n/a	1
92	No	n/a	1
111	No	n/a	1
238	No	n/a	1
454	No	n/a	1
524	No	n/a	1
611	No	n/a	1
697	No	n/a	1
Kandosol			
7	No	n/a	1
15	No	n/a	1
16	No	n/a	1
17	No	n/a	1
22	No	n/a	1

Table 10.2 Mass movement LSC classes for the SMUs within the project area

Site ID	Mass movement present	Slope class (%)	Mass movement LSC class
28	No	n/a	1
32	No	n/a	1
34	No	n/a	1
44	No	n/a	1
45	No	n/a	1
47	No	n/a	1
48	No	n/a	1
55	No	n/a	1
70	No	n/a	1
87	No	n/a	1
99	No	n/a	1
110	No	n/a	1
116	No	n/a	1
120	No	n/a	1
133	No	n/a	1
135	No	n/a	1
137	No	n/a	1
138	No	n/a	1
145	No	n/a	1
146	No	n/a	1
149	No	n/a	1
151	No	n/a	1
153	No	n/a	1
155	No	n/a	1
160	No	n/a	1
168	No	n/a	1
170	No	n/a	1
175	No	n/a	1
186	No	n/a	1
187	No	n/a	1
188	No	n/a	1
195	No	n/a	1
202	No	n/a	1
209	No	n/a	1
211	No	n/a	1
213	No	n/a	1
220	No	n/a	1
230	No	n/a	1
232	No	n/a	1
235	No	n/a	1
236	No	n/a	1
240	No	n/a	1

Table 10.2 Mass movement LSC classes for the SMUs within the project area

Site ID	Mass movement present	Slope class (%)	Mass movement LSC class
248	No	n/a	1
251	No	n/a	1
255	No	n/a	1
258	No	n/a	1
260	No	n/a	1
267	No	n/a	1
269	No	n/a	1
274	No	n/a	1
279	No	n/a	1
281	No	n/a	1
282	No	n/a	1
283	No	n/a	1
290	No	n/a	1
297	No	n/a	1
298	No	n/a	1
308	No	n/a	1
310	No	n/a	1
328	No	n/a	1
337	No	n/a	1
339	No	n/a	1
342	No	n/a	1
356	No	n/a	1
360	No	n/a	1
361	No	n/a	1
363	No	n/a	1
365	No	n/a	1
366	No	n/a	1
373	No	n/a	1
374	No	n/a	1
388	No	n/a	1
391	No	n/a	1
396	No	n/a	1
404	No	n/a	1
406	No	n/a	1
417	No	n/a	1
419	No	n/a	1
421	No	n/a	1
423	No	n/a	1
426	No	n/a	1
429	No	n/a	1
435	No	n/a	1
437	No	n/a	1

Table 10.2 Mass movement LSC classes for the SMUs within the project area

Site ID	Mass movement present	Slope class (%)	Mass movement LSC class
449	No	n/a	1
451	No	n/a	1
459	No	n/a	1
468	No	n/a	1
472	No	n/a	1
473	No	n/a	1
481	No	n/a	1
486	No	n/a	1
488	No	n/a	1
489	No	n/a	1
499	No	n/a	1
500	No	n/a	1
502	No	n/a	1
505	No	n/a	1
508	No	n/a	1
510	No	n/a	1
511	No	n/a	1
512	No	n/a	1
528	No	n/a	1
535	No	n/a	1
536	No	n/a	1
537	No	n/a	1
539	No	n/a	1
544	No	n/a	1
545	No	n/a	1
550	No	n/a	1
592	No	n/a	1
594	No	n/a	1
595	No	n/a	1
596	No	n/a	1
601	No	n/a	1
602	No	n/a	1
603	No	n/a	1
606	No	n/a	1
607	No	n/a	1
610	No	n/a	1
612	No	n/a	1
613	No	n/a	1
614	No	n/a	1
615	No	n/a	1
616	No	n/a	1
617	No	n/a	1

Table 10.2 Mass movement LSC classes for the SMUs within the project area

Site ID	Mass movement present	Slope class (%)	Mass movement LSC class
618	No	n/a	1
619	No	n/a	1
621	No	n/a	1
622	No	n/a	1
623	No	n/a	1
624	No	n/a	1
625	No	n/a	1
626	No	n/a	1
627	No	n/a	1
628	No	n/a	1
629	No	n/a	1
630	No	n/a	1
631	No	n/a	1
633	No	n/a	1
670	No	n/a	1
671	No	n/a	1
672	No	n/a	1
681	No	n/a	1
682	No	n/a	1
683	No	n/a	1
684	No	n/a	1
686	No	n/a	1
687	No	n/a	1
688	No	n/a	1
690	No	n/a	1
691	No	n/a	1
692	No	n/a	1
698	No	n/a	1
699	No	n/a	1
700	No	n/a	1
701	No	n/a	1
702	No	n/a	1
703	No	n/a	1
704	No	n/a	1
Rudosol			
38	No	n/a	1
49	No	n/a	1
100	No	n/a	1
113	No	n/a	1
117	No	n/a	1
148	No	n/a	1
159	No	n/a	1

Table 10.2 Mass movement LSC classes for the SMUs within the project area

Site ID	Mass movement present	Slope class (%)	Mass movement LSC class
178	No	n/a	1
189	No	n/a	1
204	No	n/a	1
259	No	n/a	1
264	No	n/a	1
312	No	n/a	1
350	No	n/a	1
352	No	n/a	1
357	No	n/a	1
393	No	n/a	1
403	No	n/a	1
411	No	n/a	1
414	No	n/a	1
438	No	n/a	1
465	No	n/a	1
474	No	n/a	1
490	No	n/a	1
521	No	n/a	1
525	No	n/a	1
609	No	n/a	1
Tenosol			
26	No	n/a	1
29	No	n/a	1
73	No	n/a	1
83	No	n/a	1
90	No	n/a	1
112	No	n/a	1
119	No	n/a	1
126	No	n/a	1
128	No	n/a	1
157	No	n/a	1
174	No	n/a	1
183	No	n/a	1
196	No	n/a	1
201	No	n/a	1
224	No	n/a	1
229	No	n/a	1
234	No	n/a	1
239	No	n/a	1
263	No	n/a	1
287	No	n/a	1
300	No	n/a	1

Table 10.2 Mass movement LSC classes for the SMUs within the project area

Site ID	Mass movement present	Slope class (%)	Mass movement LSC class
307	No	n/a	1
327	No	n/a	1
364	No	n/a	1
376	No	n/a	1
379	No	n/a	1
467	No	n/a	1
513	No	n/a	1
522	No	n/a	1
523	No	n/a	1
532	No	n/a	1
600	No	n/a	1
604	No	n/a	1
605	No	n/a	1
608	No	n/a	1
685	No	n/a	1
689	No	n/a	1

11 Assessment of LSC classes for soil management units

Data for the assessment was sourced from field survey observations, desktop analysis and soil laboratory analysis. There was pH data for 90 of the 244 sites assessed for LSC. The sites with no pH data were assigned a pH range which represented the median pH of the sites with pH data (soil acidification classes indicated with an asterisk*). The soil acidification class for the soils with no pH data were classed as 2, 3, 4 or 5, based on soil texture, and would be higher if the pH was lower than average. However, only eight of these sites (with no pH data) which had a soil acidification class of 2 or 3, had an overall LSC classification that was Class 3. Only three sites which had a soil acidification class of 4, had an overall LSC classification that was Class 4. All of the other 143 sites with no pH data had an overall LSC class that was higher (than the soil acidification class) due to other limiting factors such as steep slopes, waterlogging or soil shallowness. The results for each site that was assessed are presented in Table 11.1.

A map has been produced that shows the spatial distribution of the LSC classes (Figure 11.1)

Table 11.1 Summary of LSC classes across the project area

SMUs	Water Erosion LSC class	Wind Erosion LSC class	Soil structural decline LSC class	Soil acidification LSC class	Salinity LSC class	Waterlogging LSC class	Shallow soils and rockiness LSC class	Mass movement LSC class	SMULSC class
Dermosol									
124	3	3	3	3*	1	3	4	1	4
152	3	2	3	3	1	4	4	1	4
181	3	4	3	5	1	5	3	1	5
278	2	2	3	4	1	5	3	1	5
620	4	3	3	3*	1	1	7	1	7
632	3	3	3	3	1	2	4	1	4
Hydrosol									
4	2	2	3	3	1	6	4	1	6
10	2	5	3	6	1	6	3	1	6
92	2	3	3	5	1	6	3	1	6
111	2	2	3	4	1	6	3	1	6
238	2	2	3	5	1	6	3	1	6
454	2	2	3	3	1	6	3	1	6
524	2	2	3	5	1	6	3	1	6
611	2	3	3	3*	1	6	3	1	6
697	3	4	3	5	1	6	4	1	6
Kandosol									
7	3	2	3	3	1	4	4	1	4
15	3	2	3	4	1	4	4	1	4
16	3	2	3	3*	1	3	3	1	3
17	6	4	3	3	1	4	3	1	6
22	2	2	3	2*	1	5	4	1	5
28	4	3	3	3*	1	5	3	1	5
32	3	3	3	5	1	2	4	1	5
34	3	4	3	3*	1	4	3	1	4

Table 11.1 Summary of LSC classes across the project area

SMUs	Water Erosion LSC class	Wind Erosion LSC class	Soil structural decline LSC class	Soil acidification LSC class	Salinity LSC class	Waterlogging LSC class	Shallow soils and rockiness LSC class	Mass movement LSC class	SMULSC class
44	3	3	3	4	1	4	3	1	4
45	4	3	3	3*	1	3	3	1	4
47	3	3	3	4	1	4	3	1	4
48	3	4	3	3*	1	4	6	1	6
55	3	2	3	3*	1	4	3	1	4
70	3	4	3	3*	1	2	6	1	6
87	3	4	3	3*	1	2	3	1	4
99	3	3	3	3*	1	4	3	1	4
110	4	2	3	3*	1	2	3	1	4
116	2	4	3	5*	1	1	3	1	5
120	2	4	3	4*	1	1	3	1	4
133	4	4	3	5	1	4	3	1	5
135	3	3	3	3*	1	3	4	1	4
137	3	4	3	3*	1	3	3	1	4
138	6	3	3	3*	1	4	4	1	6
145	3	3	3	4	1	2	4	1	4
146	2	2	3	4	1	4	3	1	4
149	2	2	3	3*	1	4	3	1	4
151	3	3	3	3*	1	2	4	1	4
153	4	3	3	3*	1	2	4	1	4
155	2	3	3	3*	1	3	4	1	4
160	2	2	3	5	1	3	3	1	5
168	2	3	3	3*	1	2	3	1	3
170	3	3	3	4	1	4	3	1	4
175	3	3	3	3*	1	3	4	1	4
186	2	4	3	3*	1	2	3	1	4
187	3	3	3	3*	1	4	4	1	4
188	3	3	3	3*	1	4	4	1	4
195	3	2	3	4	1	3	3	1	4
202	3	3	3	3*	1	4	3	1	4
209	3	2	3	3	1	2	4	1	3
211	2	4	3	3*	1	2	6	1	6
213	6	4	3	3*	1	2	6	1	6
220	4	3	3	4	1	2	3	1	4
230	3	3	3	3*	1	4	3	1	4
232	3	2	3	3*	1	4	3	1	4
235	4	4	3	3*	1	2	6	1	6
236	3	3	3	3*	1	4	4	1	4
240	3	3	3	3*	1	2	3	1	4
248	2	3	3	3*	1	2	4	1	4

Table 11.1 Summary of LSC classes across the project area

SMUs	Water Erosion LSC class	Wind Erosion LSC class	Soil structural decline LSC class	Soil acidification LSC class	Salinity LSC class	Waterlogging LSC class	Shallow soils and rockiness LSC class	Mass movement LSC class	SMULSC class
251	3	2	3	3*	1	2	7	1	7
255	6	4	3	3*	1	1	6	1	6
258	3	2	3	3*	1	3	4	1	4
260	3	3	3	3	1	2	4	1	4
267	2	4	3	5	1	5	3	1	5
269	3	4	3	3*	1	3	6	1	6
274	3	2	3	3	1	4	3	1	4
279	3	2	3	4	1	4	3	1	4
281	3	3	3	4	1	4	3	1	4
282	3	6	3	6	1	3	3	1	6
283	3	2	3	4	1	3	3	1	4
290	3	3	3	4	1	3	4	1	4
297	2	2	3	3*	1	4	6	1	6
298	3	3	3	3*	1	5	3	1	5
308	3	2	3	3*	1	5	3	1	5
310	3	3	3	3*	1	3	4	1	4
328	3	2	3	3*	1	2	3	1	3
337	3	4	3	4	1	4	3	1	4
339	6	2	3	3*	1	4	4	1	6
342	2	4	3	3*	1	4	3	1	4
356	2	4	3	5	1	2	4	1	5
360	4	2	3	3*	1	3	7	1	7
361	3	2	3	3*	1	4	4	1	4
363	3	4	3	3*	1	3	4	1	4
365	3	2	3	3*	1	3	6	1	6
366	3	3	3	4	1	4	6	1	6
373	3	2	3	3*	1	5	3	1	5
374	3	2	3	3*	1	4	3	1	4
388	3	2	3	3	1	4	3	1	4
391	3	3	3	3*	1	3	3	1	6
396	3	3	3	3*	1	2	6	1	6
404	3	4	3	5	1	2	3	1	5
406	3	2	3	3*	1	3	3	1	3
417	3	3	3	3*	1	2	6	1	6
419	3	2	3	3*	1	4	4	1	4
421	3	3	3	3*	1	3	4	1	4
423	1	2	3	2*	1	3	3	1	3
426	2	4	3	3	1	2	6	1	6
429	3	3	3	3*	1	3	4	1	4
435	3	3	3	3*	1	4	3	1	4

Table 11.1 Summary of LSC classes across the project area

SMUs	Water Erosion LSC class	Wind Erosion LSC class	Soil structural decline LSC class	Soil acidification LSC class	Salinity LSC class	Waterlogging LSC class	Shallow soils and rockiness LSC class	Mass movement LSC class	SMULSC class
437	3	2	3	3*	1	4	4	1	4
449	3	3	3	3*	1	4	3	1	4
451	2	3	3	3*	1	3	6	1	6
459	4	3	3	3*	1	4	3	1	4
468	3	2	3	5	1	5	3	1	5
472	3	4	3	5	1	3	4	1	5
473	4	3	3	4	1	4	4	1	4
481	3	4	3	5	1	3	3	1	5
486	3	5	3	4	1	4	6	1	6
488	4	3	3	4	1	3	3	1	4
489	3	3	3	4	1	2	4	1	4
499	4	3	3	4	1	4	3	1	4
500	3	3	3	4	1	4	4	1	4
502	3	3	3	4	1	2	3	1	4
505	3	3	3	3*	1	3	6	1	6
508	4	3	3	4	1	4	3	1	4
510	2	4	3	3	1	3	6	1	6
511	3	3	3	3*	1	4	3	1	4
512	4	2	3	4	1	3	3	1	4
528	4	2	3	3*	1	4	3	1	4
535	3	3	3	3*	1	2	4	1	4
536	3	3	3	3*	1	1	6	1	6
537	3	4	3	3*	1	2	6	1	6
539	4	4	3	3*	1	2	4	1	4
544	3	3	3	3*	1	2	4	1	4
545	2	3	3	3*	1	2	4	1	4
550	3	3	3	3*	1	5	3	1	5
592	2	3	3	4	1	2	3	1	4
594	3	2	3	3	1	3	3	1	3
595	3	3	3	3	1	2	3	1	3
596	3	3	3	3	1	3	3	1	3
601	2	3	3	3*	1	3	4	1	4
602	2	3	3	3*	1	3	4	1	4
603	3	4	3	3*	1	4	3	1	4
606	2	3	3	3*	1	4	4	1	4
607	2	4	3	3*	1	5	4	1	5
610	2	3	3	4	1	3	3	1	4
612	3	3	3	3*	1	2	6	1	6
613	2	3	3	3*	1	2	7	1	7
614	4	3	3	2*	1	3	6	1	6

Table 11.1 Summary of LSC classes across the project area

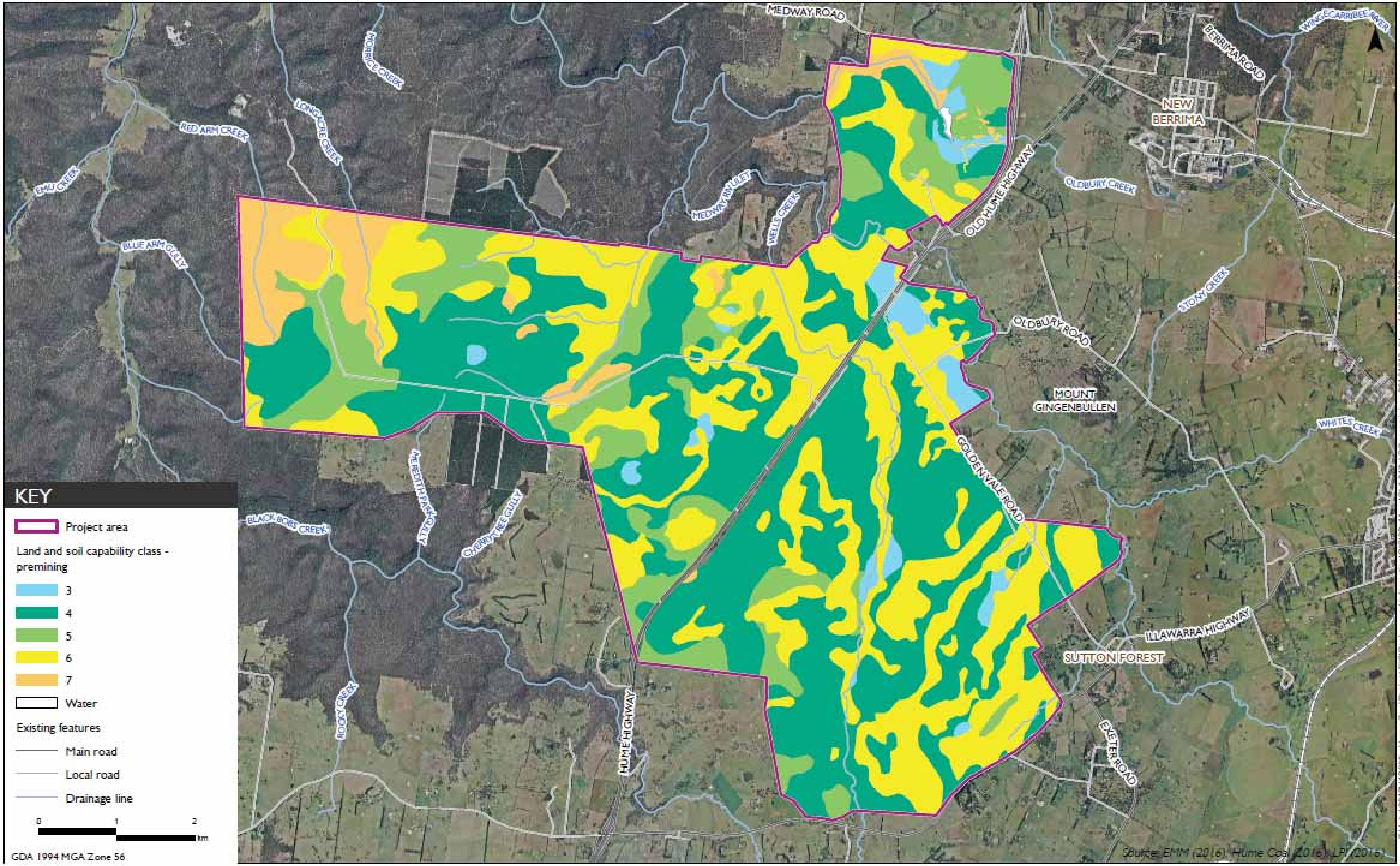
SMUs	Water Erosion LSC class	Wind Erosion LSC class	Soil structural decline LSC class	Soil acidification LSC class	Salinity LSC class	Waterlogging LSC class	Shallow soils and rockiness LSC class	Mass movement LSC class	SMULSC class
615	3	3	3	3*	1	2	6	1	6
616	3	3	3	3*	1	2	3	1	3
617	3	3	3	2*	1	5	3	1	5
618	2	4	3	3*	1	4	4	1	4
619	4	3	3	5	1	5	3	1	5
621	3	2	3	3*	1	3	4	1	4
622	2	2	3	3*	1	2	3	1	3
623	3	2	3	3*	1	3	3	1	3
624	3	4	3	3*	1	4	3	1	4
625	3	4	3	3*	1	4	3	1	4
626	4	4	3	3*	1	3	6	1	6
627	3	4	3	3*	1	5	4	1	5
628	3	2	3	3*	1	4	3	1	4
629	4	3	3	2*	1	2	6	1	6
630	3	2	3	2*	1	5	4	1	5
631	3	3	3	2*	1	5	3	1	5
633	2	2	3	3*	1	3	4	1	4
670	3	5	3	5	1	5	4	1	5
671	2	2	3	3	1	4	3	1	4
672	3	5	3	3*	1	5	7	1	7
681	2	5	3	4	1	5	3	1	5
682	3	5	3	4*	1	5	3	1	5
683	2	4	3	5*	1	5	4	1	5
684	3	3	3	5*	1	5	6	1	6
686	3	5	3	5	1	5	3	1	5
687	3	4	3	6	1	5	4	1	6
688	3	3	3	5	1	5	6	1	6
690	3	2	3	5	1	5	4	1	5
691	3	3	3	5	1	5	4	1	5
692	8	2	3	4	1	5	3	1	8
698	3	2	3	3	1	5	3	1	5
699	3	3	3	4	1	3	3	1	4
700	3	4	3	3*	1	3	4	1	4
701	3	4	3	3*	1	3	4	1	4
702	3	3	3	5	1	3	4	1	5
703	3	3	3	4	1	4	4	1	4
704	2	3	3	3*	1	3	7	1	7
Rudosol									
38	3	4	3	3*	1	1	7	1	7
49	2	7	3	4*	1	1	7	1	7

Table 11.1 Summary of LSC classes across the project area

SMUs	Water Erosion LSC class	Wind Erosion LSC class	Soil structural decline LSC class	Soil acidification LSC class	Salinity LSC class	Waterlogging LSC class	Shallow soils and rockiness LSC class	Mass movement LSC class	SMULSC class
100	3	3	3	3*	1	1	6	1	6
113	3	3	3	5*	1	1	6	1	6
117	2	3	3	4*	1	1	6	1	6
148	3	3	3	5*	1	1	6	1	6
159	4	3	3	3*	1	1	7	1	7
178	3	6	3	4*	1	1	7	1	7
189	4	6	3	4*	1	1	4	1	6
204	3	5	3	4*	1	1	7	1	7
259	3	4	3	3*	1	1	6	1	6
264	8	5	3	6	1	1	7	1	8
312	2	6	3	4*	1	1	7	1	7
350	3	3	3	3*	1	2	6	1	6
352	6	6	3	4	1	1	7	1	7
357	3	4	3	3*	1	1	6	1	6
393	3	3	3	3*	1	1	6	1	6
403	4	6	3	4	1	1	6	1	6
411	7	6	3	4*	1	1	7	1	7
414	6	7	3	6	1	1	7	1	7
438	4	3	3	3*	1	1	7	1	7
465	4	6	3	4*	1	1	7	1	7
474	4	4	3	5	1	1	7	1	7
490	6	6	1	5*	1	1	6	1	6
521	6	4	3	4*	1	1	7	1	7
525	7	6	3	4*	1	1	7	1	7
609	6	4	3	4*	1	1	7	1	7
Tenosol									
26	3	4	3	3*	1	1	6	1	6
29	2	5	3	5*	1	2	3	1	5
73	4	5	3	6	1	1	3	1	6
83	3	6	3	6	1	1	3	1	6
90	2	5	3	4*	1	1	3	1	5
112	2	5	3	4*	1	1	4	1	5
119	4	3	3	3*	1	1	6	1	6
126	3	5	3	6	1	1	3	1	6
128	4	3	3	4	1	1	7	1	7
157	3	3	3	5*	1	1	3	1	5
174	3	4	3	3*	1	1	6	1	6
183	3	3	3	4	1	2	7	1	7
196	3	3	3	4	1	1	3	1	4
201	3	4	3	4*	1	2	6	1	6

Table 11.1 Summary of LSC classes across the project area

SMUs	Water Erosion LSC class	Wind Erosion LSC class	Soil structural decline LSC class	Soil acidification LSC class	Salinity LSC class	Waterlogging LSC class	Shallow soils and rockiness LSC class	Mass movement LSC class	SMULSC class
224	3	2	3	3*	1	1	6	1	6
229	3	5	3	4*	1	1	7	1	7
234	2	5	3	4*	1	1	4	1	5
239	4	4	3	3*	1	1	6	1	6
263	6	3	3	5	1	1	3	1	6
287	3	4	3	5	1	1	3	1	5
300	3	6	1	6	1	1	3	1	6
307	3	3	3	3*	1	1	6	1	6
327	2	3	3	3*	1	2	6	1	6
364	3	5	3	4	1	3	3	1	5
376	3	4	3	3*	1	2	6	1	6
379	3	6	3	4*	1	1	4	1	6
467	3	6	3	4*	1	1	3	1	6
513	3	4	3	4	1	1	6	1	6
522	4	6	3	4*	1	1	7	1	7
523	4	4	3	5*	1	1	4	1	5
532	3	4	3	4*	1	1	3	1	4
600	2	6	3	4*	1	1	6	1	6
604	3	3	3	5*	1	1	4	1	5
605	3	4	3	4*	1	1	4	1	4
608	2	3	3	3*	1	2	6	1	6
685	3	4	3	5	1	5	7	1	7
689	3	4	3	5	1	5	6	1	6



Land and soil capability class - pre-mining (EMM mapping)

Hume Coal Project

12 Conclusion

12.1 Relationship between soil type and LSC classes

The Kandosol and Dermosol soils have generally been classified as Class 4 or 5. These soils are therefore capable of cropping with restricted cultivation, pasture cropping and grazing. The sites which were Class 5 were either poorly drained or slightly acidic. Some sites were classified as Class 6 due to shallow soil depths. Eleven of the Kandosol soil sites were Class 3, however incomplete data for surface pH means eight of these sites are conservatively classified (without soil pH) and may be Class 4 or 5.

The Hydrosols have been classified as Class 6, based on being waterlogged for several months of the year.

The Rudosols have been generally classified as Class 6 or 7, based on the rockiness and/or shallowness of the soils. Therefore the Rudosols are generally suitable for forestry or nature conservation, with some limited areas that may be able to support grazing (Class 6). These soils are limited to the steep slopes associated with sandstone surface geology most commonly found within Belanglo State Forest. Within the project area, common land uses on this soil type are low intensity grazing on native pastures and forestry.

The Tenosols have been generally classified as Class 5, 6 or 7, based on a low surface soil pH, shallow soils, or sites subject to wind erosion. Therefore the Tenosols are generally suited to either grazing, forestry or nature conservation. They are most commonly found within and immediately surrounding the Belanglo State Forest, and land use on this soil type is typically for native and pine forestry.

12.2 Distribution of LSC classes

The LSC assessment has mapped 58% of the project area as moderate (Class 4 – 44%) to moderate-low (Class 5 – 14%) capability land. This means that the land has moderate to high limitations for high – impact land uses, which will restrict cropping, high intensity grazing and horticulture (OEH 2012). These limitations can only be managed with the implementation of suitable soil conservation measures.

32% of the project area is mapped as low capability (Class 6) – suitable for a limited set of land uses such as grazing, forestry and nature conservation. Very low capability land is mapped across 6% of the project area, suitable for selective forestry and nature conservation.

High capability land is mapped on 3% of the project area. None of the individual areas mapped as Class 3 are greater than 20 ha. OEH state that 20 ha is the minimum area required for commercial food production and therefore, use this as a requirement for defining BSAL in the interim protocol (DP&E 2015).

Table 12.1 shows the number of hectares of each land class in the project area.

Table 12.1 Land and soil capability classes in the project area

Class	Capability	Land in the project area	Hectares (ha)	%
Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation)				
1	Extremely high	None	0	
2	Very high	None	0	
3	High	Kandosols (areas restricted in size)	144	3%
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)				
4	Moderate	Kandosols, Dermosols	2221	44%
5	Moderate–low	Poorly drained Kandosols, slightly acidic Tenosols and Kandosols, imperfectly drained Dermosols	704	14%
Land capable for a limited set of land uses (grazing, forestry and nature conservation)				
6	Low	Hydrosols, Acidic Tenososls Soils with steep slopes or shallow soils	1641	32%
Land generally incapable of agricultural land use (selective forestry and nature conservation)				
7	Very low	Shallow soils (mostly Rudosols and Tenosols)	300	6%
8	Extremely low	Very steep ground (>50%).		
	None	Waterbody, Hume Highway, etc	41	1%

Notes: 1.modified description from OEH 2012.

References

Australian Bureau of Meteorology http://www.bom.gov.au/climate/data/ (visited 02 June 2015)

Department of Environment and Heritage (2012) *Land and soil capability assessment scheme.* NSW government.

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