9 GEOLOGY, MINERAL RESOURCES, OVERBURDEN AND SOILS

9.1 INTRODUCTION

The information presented in this chapter builds on the EIS, Volume 1, Chapter 9 Geology Mineral Resources, Overburden and Soils and should be read in conjunction with the EIS chapter.

Chapter 6 Project Operations of the Supplementary EIS provides further details on refinements/modifications to the Project.

Further detailed information is located in an addendum to the EIS technical report relating to the Supplementary EIS, presented in STR 9-1-SV1.5 Addendum to Geology, Mineral Resources, Overburden and Soils Technical Report. Further detailed information on the potential for cattle grazing during and following mining is provided in Technical Report STR22-1-SV1.5 Economic Evaluation of Agricultural Production under Mining Lease.

9.2 METHODOLOGY OF ASSESSMENT

9.2.4 LAND SUITABILITY ASSESSMENT

A number of different land evaluation systems exist for assessing the quality of agricultural land. More common systems include the land suitability assessment, land capability assessment and land classification for strategic planning.

The *Guidelines for Agricultural Land Evaluation in Queensland* (Department of Primary Industries 1994), recommend different land evaluation systems for different assessment purposes, as follows:

- land capability classification is recommended where evaluation of a wide range of agricultural land uses is required. Land capability classification allocates land to capability classes based on the severity of land limitations for general agricultural use (for example slope, flooding or erosion rate), and assigns land to a hierarchy of eight land uses, Class 1 being suitable for all agricultural and pastoral uses, and Class 8 being land unsuitable for either cultivation or grazing.
- land suitability classification is recommended for studies where more specific information at a medium or large scale is required. Land suitability classification evaluates land attributes based on specified land uses (e.g. rain-fed cropping), and rates land into one of five classes for specified land uses, Class 1 being suitable with negligible limitations, and Class 5 being unsuitable with severe limitations.
- land classification for strategic planning is recommended for strategic planning use in Queensland. This method allocates land into four broad agricultural categories: arable, limited arable, pastoral and non-agricultural.

Land classification for strategic planning is the land evaluation system used in the Taroom Shire Planning Scheme.

The EIS used the land suitability classification as this methodology was specified in the Wandoan Coal Project Terms of Reference, and is the recommended methodology under the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* (Department of Mines and Energy 1995).

However, information from the Department of Environment and Resource Management (DERM) indicated that some land suitability criteria in Appendix 2 of the Land Suitability Guidelines (Department of Mines and Energy 1995) require modification for use in Central Queensland for dry land cropping. These criteria relate to nutrient availability and water erosion. In Central Queensland, alkaline near-surface soils do not appear to impact on crop nutrient availability (A Biggs, per coms, 27 February 2009). As such, the pre-mining land suitability has been reassessed with revised 'nutrient deficiency' and 'water erosion' criteria. Further details of the assessment are presented in the addendum to the technical report STR9-1-SV1.5.

Also, in response to submissions on the EIS, an assessment of existing and future cattle grazing potential of the MLA areas has now been conducted based on the framework included in Queensland Primary Industries and Fisheries (now Department of Employment, Economic Development and Innovation) (DEEDI) 'Stocktake' program. The study also assessed the economic impact of the grazing potential during operation and post-mining, and is discussed in Chapter 22 Economics.

9.2.5 LAND SUITABILTY ASSESSMENT DURING MINE OPERATIONS

Taking into account submissions from DERM and Project refinements/modifications, a new assessment has been conducted for the Supplementary EIS assessing the land suitability classification of land potentially available for agricultural use during mine operation. Land suitability, in essence, does not consider land use, only potential land uses. However, for the purpose of assessing the impacts on agriculture during mine operation, land in which agriculture will not be able to be conducted due to mine operations has been considered 'unavailable' for the land suitability assessment.

The land suitability classes were assessed for indicative 'snapshot' scenarios in Years 5, 10, 20 and 30. In preparing the assessment, buffer areas around mine infrastructure were assigned to represent areas in which agriculture is excluded. These buffers are indicative estimates only, for the purpose of this assessment, and may not be the actual buffers implemented. The buffers and assumptions made in conducting this assessment are:

- areas not impacted by mine operations will retain their pre-mining land suitability class
- land will be unavailable in the vicinity of mine infrastructure area, including areas between the mine infrastructure area and Austinvale Pit, Austinvale North Pit, Woleebee , Leichhardt Pit, and Frank West Pit, as these pits develop
- land will be unavailable for a 1 km buffer around active mining faces. This accounts for the 600 m exclusion zone for blasting, as well as an additional distance to allow for fencing relocations (i.e. stock fences will only be relocated periodically)
- land will be unavailable for a 100 m buffer around haul roads, mine access roads, the rail spur, conveyors, levees, in-pit dumps, creek diversions and other mine infrastructure. It should be noted that these distances have been assigned for operational purposes, not safety purposes
- land suitability classes for rehabilitated land will be assigned based on section 9.5.6 of this chapter
- rehabilitated land will be considered in the land suitability assessment when rehabilitation areas reach 200 ha. Areas smaller than 200 ha are considered economically non-viable for cattle grazing (an area of 200 ha would run about 50-60 steers which would justify putting in watering points and fencing). Although not strictly land suitability related, this minimal area allowance provides for a conservative and realistic assessment of land potentially available for agricultural use.

9.2.6 AGRICULTURAL (GRAZING) PRODUCTION ASSESSMENT

An assessment of the impact of the cattle production levels over the life of the mine was carried out as a component of the Supplementary EIS. Cropping was excluded from this assessment on the basis that the main land use in the MLA area is grazing. However, it is recognised that some cropping does occur for feedlots and cattle fodder. An economic assessment on the impacts to cattle grazing is provided in Chapter 22 Economics.

This assessment was based in the Supplementary EIS Mine Plan.

Current production levels

Current production levels within the MLA areas were assessed by a combination of field visits, and use of satellite imagery and published soils data.

DEEDI's Stocktake package was used to assess the land condition, long-term carrying capacity and calculate short term forage budgets. Differing from the Land Suitability Classification used in the EIS, the Stocktake package describes '*grazing land condition is the capacity of grazing land to produce useful forage…a measure of how well the grazing ecosystem is functioning*'. The Stocktake package assesses the landscapes ability to utilise rainfall and convert that moisture into useable dry matter. These assessments can be converted into kilogram of dry matter of pasture available for animal production on a yearly basis. These numbers are then used as a basis to predict the number of stock that can be run on the pasture.

The Stocktake package separates land type and land condition and for each land type it ranks the land condition which is essentially an assessment of the landscapes ability to produce forage.

Land was classified into four land types, labelled Type A, B, C and D, correlating with the soil association in Chapter 9 of the EIS. The existing conditions of land within the MLA areas was also assessed under Stocktake, being Condition A, B, C and D, roughly correlating with cattle grazing land suitability Class 1, 2, 3 and 4 respectively.

Production levels on rehabilitated mined land

Likely production on rehabilitated land was established from a review of existing grazing trials conducted on projects in Central Queensland that were funded by the Australian Coal Association Research Program (ACARP) and undertaken by scientists from the University of Queensland, Centre for Mined Land Rehabilitation, as discussed in Technical Report STR22-1-SV1.5. The data from these projects is from trials that have similar pasture systems to the MLA areas of the Wandoan Coal Project.

The ACARP projects suggested that rehabilitated pastures have comparable performance to unmined land in the same area. Weight gain per head on rehabilitated land is therefore likely to be similar to unmined land, with an equivalent carrying capacity resulting in an equivalent economic value. Weight gain aspects have not been covered in this Chapter, but are assessed in Technical Report STR22-1-SV1.5.

This grazing trial data was then used to establish suitable parameters for grazing on rehabilitated land to assess likely carrying capacity via the Stocktake package.

Assessment of mine scenarios

Three scenarios were assessed in relation to the impact of mining on the agricultural productivity of the MLA areas. The three scenarios were:

- Scenario 1: Agricultural production without the mine. This scenario represents the likely agricultural productivity if the mine does not occur.
- Scenario 2: Agricultural production with the mine, without decommissioning. This scenario represents the likely agricultural productivity if mining is extended and continues beyond the current 30 years approval period, such that the site is not fully rehabilitated and decommissioned at the end of Year 30.
- Scenario 3: Agricultural production with the mine, with decommissioning. This scenario represents the likely agricultural productivity if mining ceases after Year 30, and the site is then fully rehabilitated and decommissioned.

An assessment of indicative areas available for cattle grazing during the mine operation was conducted for indicative 'snapshot' scenarios on Year 5, 10, 20 and 30, as well as the final landform for Scenario 3.

In preparing the assessment, buffer areas around mine infrastructure were assigned. These buffers are indicative estimates only, for this purpose of this assessment, and may not be the actual buffers implemented. The buffers and assumptions made in conducting this assessment are:

- buffers are the same as used for land suitability in section 9.2.6 above
- grazing of rehabilitated land will be conducted at the following carrying capacity:
  - 0-12 months – zero carrying capacity
  - 12-24 months – 25% of district average carrying capacity
  - 24-48 months – 50% of district average carrying capacity
  - >48 months – 100% of district average carrying capacity.

The outcome of this assessment is outlined in sections 9.5 and 9.6 of this chapter.

9.3 EXISTING ENVIRONMENT

9.3.4 MINERAL RESOURCES

A new search of DEEDI's Interactive Resource and Tenure online maps (http://www.dme.qld.gov.au/mines/tenure_maps.cfm, accessed on 19 June 2009) was conducted for the Project area, as shown in Figure 9-6a-SV1.3 and Figure 9-6b-SV1.3. This search identified no changes to petroleum leases (PL), exploration permits for coal (EPC), mineral development licences (MDL) or mining leases relative to the EIS.

The following changes to exploration permits for petroleum (EPP) have occurred since the EIS:

- EPP867 (application) held by Paillard Energy Pty Ltd was deemed unsuccessful
- EPP869 (application) held by Bow Energy Resources Ltd was deemed unsuccessful
- EPP870 (application) held by Pure Energy Resources Limited was deemed unsuccessful.

Although not in the Project area, it is relevant to note that a number of mining lease applications in the wider Wandoan region have been lodged with the mining registrar since the preparation of the EIS. These mining leases are:

- ML50247 (application), Woori South Mining Lease, held by Surat Coal Pty Limited near Guluguba
- ML50248 (application), Woori North Mining Lease, held by Surat Coal Pty Limited near Guluguba
- ML50254 (application), held by Taroom Coal Proprietary Limited to the west of the Wandoan Coal Project.

These mining leases are being proposed by different proponents, and are not related to the Wandoan Coal Project.

9.3.7 LAND SUITABILITY AND AGRICULTURAL LANDS

Land suitability

The pre-mining land suitability classes for dry land cropping have been reassessed with the revised criteria as described in section 9.2.4. The revised land suitability distribution is shown in Figure 9-9-SV1.3.

The revised mapping classified the majority of the site at Class 3 for cropping, with upper slopes that are occupied by Kinnoul soil, being classified as Class 4, due to shallow soil depth limiting pore water holding capacity and erosion potential. The EIS classification mapping indicated a large portion of Class 4 land over the site.

As stated in the EIS, Chapter 9 Geology, Mineral Resources, Overburden and Soils, section 9.3.7, small portions of land on the upper floodplains can be considered Class 2 for dry land cropping. Due to the limited extent of these areas, they have not been included on the mapping. The revised land suitability assessment has not changed this finding.

This distribution of agricultural land under the land suitability criteria differs to the good quality agricultural land (GQAL) distribution under the Taroom Planning Scheme (Taroom Shire Council 2006), and discussion on the reasoning for the different distribution is contained below. In amending the land suitability classification, it should be noted that Western Downs Regional Council, the body responsible for GQAL classification in the Project area, did not comment of the land suitability class distribution as presented in the EIS in its submission.

Good Quality Agricultural Land

Section 6.1 of the *Planning Guidelines: The identification of Good Quality Agricultural Land* (DPI/ DHLGP 1993), states “where a development proposal affects an area identified as good quality agricultural land on the strategic plan or other data source, regardless of whether the land is currently cultivated, a detailed assessment of the agricultural quality of the land is usually necessary”. The land suitability assessment was conducted to address this requirement, as well as requirements of the Terms of Reference.

To support the findings of the assessment conducted for the Supplementary EIS, the land suitability classification of the Supplementary EIS study has been compared with the GQAL rating under the Taroom Planning Scheme (Taroom Shire Council 2006), and two studies into the land suitability/capability undertaken by the Department of Primary Industries (DPI) in 1985 (Foster 1985, and Grey and Macnish 1985), and a PhD Thesis related to soils conducted in the Austinvale and Woleebee areas (Slater 1986), in Table 9-1.

The two DPI studies were shire-wide, nominally mapped at a 1:250,000 scale. Foster (1985) was conducted as a desktop assessment, and Grey and Macnish (1985) sampled one test pit per 7,500 ha, but focussing on agricultural areas. The studies undertaken for the EIS were conducted only for the MLA areas at a higher resolution scale of one test pit per 600 ha, plus additional observations and the findings of previous reports. The studies undertaken for the EIS were conducted by soil specialists as part of the Project.

Table 9-1: Comparison of land classes assigned in the EIS and other resources

Study	Methodology of study	Land Class – Brigalow Uplands LRA (undulating land)	Land Class – Poplar Box Alluvia LRA (alluvial plains)
Department of Primary Industries, Evaluation of Agricultural Land in Taroom Shire (Foster 1985)	Conducted at a shire-wide scale at 1:250,000, based on previous studies. Land suitability class assigned based on Land Resource Areas.	Class A2 (long term cropping with moderate limitations)	Class B1 (Occasional cropping, better suited to grazing)
Taroom Shire Planning Scheme GQAL mapping (Taroom Shire Council 2006)	Based on Foster 1985 mapping (as above).	Agricultural Land Class A (cropping land)	Agricultural Land Class B (marginal cropping land)
Department of Primary Industries, Land Management Field Manual Wandoan District (Grey and Macnish 1985)	Conducted at a shire-wide scale with soil mapping at 1:250,000, but more detailed than Foster 1985. One test pit per 7,500 ha Land Capability Classes assigned based on soil units.	Capability Class 3 (moderate limitations to cropping) for: ▪ Cheshire ▪ Rolleston ▪ Downfall. Capability Class 4 (primarily pastoral, occasional careful cropping) for: ▪ Kinnoul Combination of Capability Class 3 and 4 for: ▪ Teviot ▪ Retro.	Capability Class 3 (moderate limitations to cropping) for: ▪ Juandah
Edaphic Properties of Soil and Overburden from a Potential Coal Mine near Wandoan, Queensland (Slater 1986).	Conducted in the vicinity of the Austinvale and Woleebee coal deposits. The Austinvale area was mapped at 1:25,000 and the Woleebee area at 1:50,000. One test pit per 265 ha, plus 40 soil core sites and additional observations. Land Capability Classes assigned based on soil units.	Combination of Capability Class 2 and 3 (minor limitations to cropping and moderate limitations to cropping) for: ▪ Teviot ▪ Rolleston ▪ Downfall ▪ Cheshire. Capability Class 4 (primarily pastoral, occasional careful cropping) for: ▪ Retro	Capability Class 3 (moderate limitations to cropping) for: ▪ Wolleebee ▪ Juandah.

Study	Methodology of study	Land Class – Brigalow Uplands LRA (undulating land)	Land Class – Poplar Box Alluvia LRA (alluvial plains)
The Supplementary EIS Land Suitability Classes	Based on the findings of the EIS assessment, and revised following discussion with DERM. One test pit per 600 ha, plus additional observations Land suitability class assigned based on soil type, topography and slope, flooding etc.	Suitability Class 3 for cropping (moderate limitations) for: ▪ Teviot ▪ Cheshire ▪ Rolleston ▪ Downfall Suitability Class 4 for cropping (marginal land) for: ▪ Kinnoul All Suitability Class 2 for beef cattle grazing (minor limitations)	Suitability Class 3 for cropping (moderate limitations) for: ▪ Juandah ▪ Wolleebee ▪ Retro. All Suitability Class 2 for beef cattle grazing (minor limitations)
The original EIS land suitability classes	Based on the findings of the EIS assessment. One test pit per 600 ha, plus additional observations Land suitability class assigned based on soil type, topography and slope, flooding etc.	Suitability Class 3 for cropping (moderate limitations) for: ▪ Teviot Suitability Class 4 for cropping (marginal land) for: ▪ Cheshire ▪ Kinnoul ▪ Downfall ▪ Rolleston All Suitability Class 2 for beef cattle grazing (minor limitations)	Suitability Class 3 for cropping (moderate limitations) for: ▪ Juandah ▪ Wolleebee ▪ Retro. All Suitability Class 2 for beef cattle grazing (minor limitations)

9.3.9 AGRICULTURAL PRODUCTION

Land type

The MLA areas fall into four main Land types, correlating with the soil associations defined in the EIS, Volume 1, Chapter 9 Geology, Mineral Resources, Overburden and Soils and shown in Figure 9-8-V1.3 of the EIS. The approximate areas of each land type are shown in Table 9-2.

Table 9-2: Land types with the MLA areas

Land type Classification	Description	Area (Ha)	Proportion of MLA areas (%)
A	Brigalow upland non-cracking clays	12,691	39
B	Brigalow upland cracking clays	13,007	40
C	Poplar box alluvia uniform soil	4,136	13
D	Poplar box alluvia texture contrast soil	2,348	8
Totals		32,182	100

Land condition

Based on the field assessment and review of existing information as detailed in Technical Report STR 22-1-SV1.5, 90% of the land was classed as being in Condition B of the DEEDI's Stocktake package classification, which roughly correlates with Land Suitability Class 2 for beef cattle grazing, and supports the finding of Volume 1, Chapter 9 of the EIS. The remaining land was a combination of Condition A and Condition C.

Due to the high portion of land in Condition B, all land within the MLA areas was assumed in Condition B for the purpose of this agricultural production assessment.

Carrying capacity

The MLA areas were assessed in relation to their grazing capacity as detailed in Technical Report STR22-1-SV1.5 Economic Evaluation of Agricultural Production under Mining Lease. Based on a land Condition B under the DEEDI Stocktake package classification, the MLA areas have been calculated to have an annual equivalent grazing capacity of 2.8 ha/head, which equates to approximately 11,657 head of cattle on the MLA areas.

Carrying capacities based on different land condition assumptions are provided in the STR22-1-SV1.5 Economic Evaluation of Agricultural Production under Mining Lease. The economic implications of this carrying capacity are discussed in Chapter 22 Economics.

9.4 DESCRIPTION OF PROPOSED DEVELOPMENT

9.4.1 MLA AREAS

A description of proposed refinements to the mine development is provided in Chapter 6 Project Operations of this Supplementary EIS. Refinements that relate to the geology, soils, mineral resources, overburden and soils aspects of the Project are summarised in this section.

Due to feedback received on the EIS, the scheduling of mining in Frank Creek Pit has been deferred, and mining in Woleebee South Pit will no longer occur within the timeframe of this Project. A new pit, Wubagul Pit, in the southeast portion of the MLA areas has been designed and addressed in response to these mine plan changes. The mining methods for Wubagul Pit will generally be the same as for other mine pits.

As noted in EIS Volume 1, Chapter 9 Geology, Mineral Resources, Overburden and Soils, section 9.4.1, the Year 30 landform presented in the EIS was not a final landform, as mining is proposed to continue beyond Year 30 of the mine. Post mining land suitability areas presented in the EIS were based on the Year 30 landform, as opposed to the final landform, due to information available at the time of EIS preparation. In the Year 30 landform presented in the EIS, ramps and voids had not been rehabilitated.

A final landform has now been prepared, as presented in Figures 6-42-SV1.3 and 6-43-SV1.3. Typically, a single final void will remain after completion of mining for each pit. However, no final voids will remain for Austinvale, Austinvale North, Frank Creek, Leichhardt or Woleebee North and Woleebee Pits, as these pits are

to be used for tailing disposal and covered with approximately 20 m of overburden. Final void slope gradients will be up to 1(v):7(h), or 14.2% gradient. The upper surface of overburden stockpiles will be levelled out and shaped to provide a gently undulating landform.

In the EIS it was anticipated that the final landform would be similar to the existing topography, with around 5 m, and a maximum of 25 m increased elevation compared to the existing landform. Reassessment of the overburden bulking factor (that is, expansion in volume of overburden as it is excavated), and the revised tailings strategy have resulted in this increase in elevation being reassessed to being an average of 20 m above the existing landform, although some compaction and settling is likely to occur.

Proposed measures to be implemented to mitigate the impacts of the post-mining landform are discussed in section 9.6 of this Supplementary EIS.

9.5 POTENTIAL IMPACTS

The potential impacts relating to Wubagul Pit, and mine layout refinements since publication of the EIS are generally the same as discussed in the EIS Volume 1, Chapter 9 Geology, Mineral Resources, Overburden and Soils, sections 9.5. Additional information to the EIS is described below.

9.5.1 TOPOGRAPHY AND GEOMORPHOLOGY

An indicative final landform has been prepared for the Supplementary EIS and is presented in Figures 6-44-SV1.3 and 6-45-SV1.3.

As discussed in section 9.4.1, the final landform has a reduced number of final voids in the eastern portion of the MLA areas relative to the EIS, as a result of the revised tailings strategy. The final landform for these pits will be mounds an average of 20 m above the natural landform, as shown in Figures 6-44-SV1.3 and 6-45-SV1.3.

The creation of overburden stockpiles of higher elevation than included in the EIS, as discussed in section 9.4.1, has the potential to impact catchment size, slope erosion processes and geomorphologic aspects of the landscape. Discussion of these impacts and proposed mitigation measures are contained in Chapter 11 Water Supply and Management. Visual impacts of the overburden stockpiles are discussed in Chapter 19 Visual Amenity.

9.5.3 OVERBURDEN

Dispersion, slaking and erosion potential

The erosion potential of overburden was discussed in the EIS Volume 1, Chapter 9 Geology, Mineral Resources, Overburden and Soils, section 9.3.5. This included that clay rich, slake prone rocks are present throughout the overburden across the Project area, and that overburden material will readily disperse when left exposed on the soil surface or otherwise exposed to water. Section 9.3.5 also noted that the overburden has medium to high salinity.

Measures to mitigate against dispersion and salinity in overburden are covered in section 9.6.2 of the EIS, which includes that overburden will be capped with subsoil and topsoil, unless trials show certain types of overburden to be suitable for direct revegetation, and the use of less dispersive overburden as a capping material and testing of dispersion and slaking potential during stripping. Management of spoil, landform stability and water will consider the dispersive nature of the overburden in planning the handling of spoil, landform shaping, and the planning of rehabilitation.

Saline overburden material (e.g. siltstone and mudstone) will not be used as a subsoil media or placed within the rooting zone of plants unless vegetation trials show acceptable plant germination and establishment rates to allow successful revegetation.

As summarised above, based on the mitigation measures included in the EIS, processes will be in place to manage and remediate any erosion or salinity issues on-site and to prevent off-site problems. Further information on management of overburden, especially with regard to length of time of overburden exposure to air and water is contained in Chapters 11 and 25.

9.5.4 SOILS

The potential impacts relating to soils from the mine layout refinements are the same as discussed in the EIS Volume 1, Chapter 9 Geology, Mineral Resources, Overburden and Soils, section 9.5.2.

Erosion and salinity

The EIS Volume 1, Chapter 9 Geology, Mineral Resources, Overburden and Soils, section 9.5.4 illustrated some potential for erosion and salinity problems if not properly managed, and that soil salinity is not considered a high risk.

Based on the mitigation measures included in section 9.6.3 of the EIS, processes will be in place to suitably manage and remediate any erosion or salinity issues on-site and to prevent off-site problems. These measures include:

- minimising disturbance through the use of a 'permit to disturb' system requiring any clearing works to be authorised by mine site Environmental staff
- selective topsoil stripping and reuse based on soil properties
- installation of erosion and sediment control measures to minimise erosion and sediment released into waterways
- drainage design to minimise catchment area and erosion potential
- monitoring of revegetation works and monitoring for erosion
- prompt remediation of erosion.

9.5.5 SOIL CONSERVATION PLANS

Impacts to approved property conservation plans were addressed in EIS Volume 1, Chapter 9 Geology, Mineral Resources, Overburden and Soils, section 9.5.5. It is acknowledged in the EIS that soil conservation measures not covered under an approved Soil Conservation Plan are likely to be impacted by the gas supply pipeline. Measures to mitigate against impacts to existing soil conservation works are addressed in the EIS Volume 1, Chapter 9 Geology, Mineral Resources, Overburden and Soils, section 9.6.3.

9.5.6 LAND USE SUITABILITY

Post-mining land suitability in MLA areas

As noted in section 9.4.1, the Year 30 landform presented in the EIS was not a final landform, as mining is proposed to continue beyond Year 30 of the mine (under a new approval). The post-mining land suitability classes have been reassessed based on the post-mining landform, and supersedes the Year 30 landform presented in the EIS.

The Year 30 landform presented in the EIS included ramps and voids that had not been rehabilitated. The area of Class 5 land shown in the EIS Volume 1, Table 9-10 comprised these voids and ramps.

The land suitability classes of disturbed areas (e.g. rehabilitated pits) have generally been assigned based on the slope gradient, as non-slope related elements will be managed through spoil and topsoil handling, field trials and rehabilitation planning to ensure rehabilitated land is returned to the appropriate land suitability class.

While much of the rehabilitated overburden stockpiles are being returned to a slope gradient suitable for Class 3 cropping land (suitable land with moderate limitations), cropping as a post-mining land use of rehabilitated spoil is limited in Australia, and it has therefore been conservatively assumed that the land will be returned to Class 4 cropping land (marginally suitable land).

The slope gradient limitations of the post-mining land suitability classes, as well as other limitations, were provided in Table 6-3 of the EIS Volume 1 Chapter 9 Geology, Mineral Resources, Overburden and Soils technical report TR 9-1-V1.5. An extract of this table is provided in Table 9-3 below. Most soils on the disturbed area will be rehabilitated to the classification of non-sodic soils.

Table 9-3: Gradient limitations on post-mining land suitability classes

Limitation	Cropping			Beef cattle grazing		
	Class 3	Class 4	Class 5	Class 2	Class 3	Class 4
Water erosion	Slopes 1–3% on cracking clays or Slopes 2–4% on non-sodic rigid soils or Slopes 1–2% on sodic rigid soils	Slopes 3-5% on all cracking clays or Slopes 4–6% on non-sodic rigid soils or Slopes 2–3% on sodic rigid soils	Slopes >5% on all cracking clays or Slopes >6% on non-sodic rigid soils or slopes >3% on sodic rigid soils	Slopes 3–6% on cracking clays, or Slopes 3–12% on non-sodic rigid soils or Slopes 1-3% on sodic rigid soils	Slopes 6–9% on cracking clays, or Slopes 12–20% on non-sodic rigid soils or Slopes 3–6% on sodic rigid soils	Slopes 9-15% on cracking clays or Slopes 20-45% on non-sodic rigid soils or Slopes 6-12% on sodic rigid soils

Note: Soil type refers to top 10 cm of soil profile

As discussed in Chapter 9 of the EIS, land suitability is an assessment of what the land could potentially be used for, and does not imply use of land for a given purpose. Following from the impacts and mitigation section of Chapter 9 of the EIS, the final landform and further mine planning, the proposed post-mining land suitability classes for each landform have not fundamentally changed from the EIS, and are:

- undisturbed land will be returned to (or retained in) its pre-mining land suitability class
- land used for infrastructure components of the Project (roads, MIA, etc) will have limitations related to water availability, through compaction and breakdown of the subsoil structure. Where practicable this land will be returned to Class 3 cropping land or Class 2 grazing land, otherwise it will be returned to Class 4 cropping land or Class 3 grazing land
- spoil stockpiles will have limitations related to water availability, salinity, gradient, erosion and nutrient content. Flatter gradient sections of spoil stockpiles will be returned to Class 4 cropping land or Class 2 grazing land where practicable. Steeper gradient spoil slopes will be returned to Class 5 cropping land or Class 4 grazing land
- tailings will be disposed off in-pit, and covered with approximately 20 m of overburden. As such, no tailings dam sites are expected in the final landform
- final voids will be re-shaped to reduced gradients, and will have limitations similar to those listed for spoil stockpiles, and will be Class 4 for cattle grazing or Class 5 for cropping.

Reference in the EIS Volume 1, Chapter 9, section 9.6.6 to Class 5 cropping land and Class 4 grazing land on spoil piles and tailings dams was referring to ramps and adjacent final voids present in the Year 30 landform, with the classes assigned due to slope gradient restrictions. The Class 5 cropping land and Class 4 grazing land should have been referenced to final voids.

The land suitability classes of the final landform are presented in Figures 9-13-SV1.3 and 9-14-SV1.3.

As shown in Table 9-4, under the revised land suitability assessment 3,407 ha of land will likely be reduced from land suitability Class 2 to Class 4 for beef cattle grazing. This land comprises the rehabilitated final voids and ramps, as well as steeper sections of overburden stockpiles, and equates to approximately 10.5% of the MLA areas. The agricultural productivity and economic impact of this reduction in land class is discussed in Technical Report STR 22-1-SV1.5 Economic Evaluation of Agricultural Production under Mining Lease.

In terms of land suitability for dryland cropping, the Project will likely result in a reduction in Class 3 cropping land by 8,113 ha, and the introduction of 3,407 ha of Class 5 cropping land. The Class 5 land comprises the rehabilitated final voids and ramps, as well as steeper sections of overburden stockpiles.

Table 9-4: Pre- and post-mining land suitability areas

Land suitability class	Estimated area of land (ha)			
	Pre-mining dry land cropping	Post-mining dry land cropping	Pre-mining beef cattle grazing	Post-mining cattle grazing
2	0	0	32,191	28,784
3	26,335	18,222	0	0
4	5,856	10,562	0	3,407
5	0	3,407	0	0

Operational land suitability in the MLA areas

Mining and rehabilitation will be undertaken in a progressive nature. This means land not required for mining activities until later in the mine operations will still be suitable for agricultural purposes in earlier years of operation. Rehabilitated mined land will become suitable for agricultural purposes progressively later in mining operations.

An indicative estimate of land potentially available for agriculture during mine operations at Years 5, 10, 20 and 30, with the accompanying land suitability classification of these lands, are shown in Figures 9-15-SV1.3 to 9-22-SV1.3 and in Tables 9-5 and 9-6. The parameters and assumptions made in conducting this assessment are provided in section 9.2.5. It is important to note that these figures only show the potential for agricultural use, and that agricultural use will not necessarily occur in accordance with these figures. It must also be noted that the land will not necessarily be made available for agricultural use by pre-mine landowners.

During Year 5, mining operations are progressing on MLA 50230, with almost 9,000 ha of this land already unavailable for agriculture. Mining operations will have also commenced in Mud Creek Pit, and road, conveyor and other infrastructure will be located or will be under construction on MLA 50229 and MLA 50231. However, MLA 50229 and MLA 50231 largely retain their pre-mining land suitability class.

Rehabilitation works have commenced for the Austinvale Pits, Frank Creek Pit and Wubagul Pit. However this rehabilitation is generally small in area and is in close proximity to active mining operations and will not be available for agriculture.

During Year 10 the area of land unavailable on MLA 50230 and MLA 50231 has only slightly increased, while unavailable areas on MLA 50229 have increased significantly with mining in Summer Hill and Turkey Hill Pits. Rehabilitation is progressing on a number of pits in MLA 50230. However, these areas remain in close proximity to mine operations or land locked by haul roads, and as such are assumed not available for agriculture.

During Year 20 the area of land unavailable for agriculture has increased across the site with the progression of mining, with approximately 15,000 ha unavailable for agriculture. Rehabilitation has also been progressing, with large portions of the areas being disturbed by mine pits having been rehabilitated. In Year 20, rehabilitated land not in close proximity to mining infrastructure becomes ‘available’ at the Turkey Hill Pit and being relatively flat, has been classified Class 4 for cropping or Class 2 for cattle grazing.

During Year 30 mining has been completed in a number of pits, and rehabilitated land is available for agriculture, with flatter land being Class 4 for cropping or Class 2 for cattle grazing, and steeper slopes being Class 5 for cropping or Class 4 for cattle grazing. However, large areas of rehabilitated land on MLA 50230 are still classified as unavailable due to their proximity to or being land locked by haul roads and other mine infrastructure.

Table 9-5: Estimated operational land suitability areas for beef cattle grazing

Land suitability class	Estimated area of land (ha)				
	Pre-mining	Year 5	Year 10	Year 20	Year 30
2	32,191	23,275	20,220	16,722	18,682
3	0	0	0	0	0
4	0	0	0	233	1,812
5	0	0	0	0	0
Unavailable due to mine operation	0	8,916	11,971	15,236	11,697

Table 9-6: Estimated operational land suitability areas for dry land cropping

Land suitability class	Estimated area of land (ha)				
	Pre-mining	Year 5	Year 10	Year 20	Year 30
3	26,335	18,722	17,241	13,821	13,361
4	5,856	4,501	2,931	2,852	5,292
5	0	0	0	233	1,812
Unavailable due to mine operation	0	8,916	11,971	15,236	11,697

Post-mining good quality agricultural land

The Project aims to return the majority of land within the MLA areas to good quality agricultural land (GQAL) following mine closure.

The correlation between the land suitability classification and land classification for strategic planning, according to the *Guidelines for Agricultural Land Evaluation in Queensland* (Department of Primary Industries 1994) is presented in Table 9-7. Based on this table, most land within the post-mining landscape will be returned to the equivalent of Class A agricultural land, with steeper slopes being Class B to D agricultural land.

Under section 2 and Attachment 2 of '*The Planning Guidelines: The Identification of Good Quality Agricultural Land*' (Department of Primary Industries and Department of Housing, Local Government and Planning Queensland 1993), Class A, B and C agricultural land in the former Taroom Shire comprise GQAL. Most land within the MLA areas, with the exception of the 3,407 ha comprising final voids and ramps, will therefore be returned to GQAL.

Table 9-7: Correlation between land suitability classification and land classification for strategic planning

Land classification for strategic planning		Land suitability class for:		
Description	Class code	Most crops	Improved pastures	Native pastures
Arable land	A	1-3	1-3	1-3
Limitable arable land	B	4-5	1-3	1-3
Pastoral land	C	4-5	1-3	1-3
Non-agricultural land	D	4-5	4-5	4-5

Source: After Figure 5-1 of *Guidelines for Agricultural Land Evaluation in Queensland* (Department of Primary Industries 1994)

Gas supply pipeline

The gas supply pipeline is proposed to be buried, and no reduction in land suitability class is expected as a result. Once construction and site rehabilitation has been completed, existing agricultural land uses will generally be able to continue over the corridor, and minimal impacts to future pastoral business plans are expected. Limitations to the siting of infrastructure such as sheds or irrigation equipment, and to practices that require excavation or disturbance of the soil may result from installation of the gas supply pipeline.

However these limitations are expected to be minimal through continued consultation between WJV and landowners.

9.5.7 AGRICULTURAL PRODUCTION

Land type

As discussed in the EIS, Volume 1, Chapter 9 Geology, Mineral Resources, Overburden and Soils, section 9.6.3, the rehabilitated country will have a recreated soil profile that will not match any of the current soil types. Construction of the rehabilitation areas will be guided by the broad physical and chemical targets, set out in Volume 1, Chapter 9, Table 9-9 of the EIS, for the new soil profile.

Seventy five percent of the mined area comprises Land Type A (Brigalow Upland Non Cracking Clays), with most of the remaining area comprising Land Type B (Brigalow Upland Cracking Clays). For the purpose of this assessment, all rehabilitated pits and overburden dumps have been assumed to be returned to a profile of similar productivity to the existing Land Type B, which has a lower productivity level compared to Land Type A.

Unmined land will remain the same land type as existed pre-mining.

Land condition

Current scientific trial data from other mine rehabilitation sites supports the premise that rehabilitated land can have the same production level as unmined land when all critical elements are met, as discussed in Technical Report STR22.1-SV1.5.

In order to assign productive capacities to the above land forms in relation to the Stocktake model, the following parameters have been used:

- unmined land - Land condition 'B'
- land rehabilitated to Suitability Class 2 for cattle grazing - Land condition 'B'
- land rehabilitated to Suitability Class 3 for cattle grazing - Land condition 'B' with a 25% reduction in carrying capacity
- land rehabilitated to Suitability Class 4 for cattle grazing - Land condition 'D' (final voids are included in this category).

Carrying capacity

Scenario 1 Agricultural production without the mine

Scenario 1 is based on the scenario that the mine does not occur, and grazing continues over the MLA areas for the next 36 years. As discussed in section 9.3.9, under current conditions, the MLA areas have been assessed as being able to run an average of 11,657 head of cattle. An economic assessment of this carrying capacity is contained in Chapter 22 Economics.

As presented in Table 9-8, over the next 36 years the MLA areas without mining development, would be expected to carry an annualised equivalent total of 419,652 head of cattle.

Table 9-8: Summary of grazing production of the MLA areas without mining

	Units	
Land type	(A, B, C, D)	A, B, C, D
Land condition	(A, B, C, D)	B
Carrying capacity	(ha/head, annual equivalent)	2.8
Area assessed	(ha)	32,182
No of head/area	(head, annual equivalent)	11,657
No of head	(head/36 years)	419,652

Scenario 2 Agricultural production with the mine, without decommissioning

For this scenario the current production benchmark that has been established in the Table 9-8 will be used as the starting point in Year 1, and then as the mine develops areas of each land type that are affected by the physical mining will be altered in the evaluation, based on snapshots of Years 5, 10, 20 and 30.

Table 9-9 illustrates the break-up of the MLA areas in relation to the mining operations over the initial 30 year lease period. In this scenario, mining is proposed to continue beyond Year 30 (under a new approval). Areas that are available to be rehabilitated at Year 30, will take four years to reach full grazing capacity (end Year 34). To assist with uniformity and comparison of the three scenarios, total grazing production has been continued for another two years which brings the total assessment period to 36 years.

This assessment does not fully account for the progressive rehabilitation and release of land for agricultural production, but is based on static snapshots due to complexity in assessing rehabilitation between the snapshot years. However this assessment provides an indication of the agricultural production potential of the land during mine operations. An economic assessment of this carrying capacity is contained in Chapter 22 Economics.

Table 9-9: Summary of grazing production during mining without decommissioning

Year of operation	Land category	Average area per annum (ha)	Average carrying capacity per annum (head)	Number of years	No. of head
Year 1 to 4	Land Unaffected by mining	23,224	8,181	4	32,724
	Land affected by Mining	8,858	0		0
	Sub-Totals	32,182	8,181		32,724
Year 5 to 9	Land Unaffected by mining	23,224	8,181	5	40,905
	Land affected by Mining	8,958	0		0
	Sub-Totals	32,182	8,181		40,905
Year 10 to 19	Land Unaffected by mining	20,172	6,961	10	69,610
	Land affected by Mining	12,010	0		0
	Sub-Totals	32,182	6,961		69,610
Year 20 to 29	Land Unaffected by mining	16,087	5,690	10	56,900
	Land affected by Mining	15,277	0		0
	Land rehabilitated to Class 2	585	210	6*	1,260
	Land rehabilitated to Class 4 and above	233	23	6*	138
	Sub–Totals	32,182	5923		58,298
Year 30 to 34	Land Unaffected by mining	15,565	5,453	5	27,265
	Land affected by Mining	11,717	0		0
	Land rehabilitated to Class 2	2,503	898	1*	898
	Land rehabilitated to Class 4 and above	1,579	155	1*	155
	Land rehabilitated to Class 2 after year 20	585	210	5	1,050
	Land rehabilitated to Class 4 and above after year 20	233	23	5	115
	Sub-Totals	32,182	6739		29,483
Year 34 to 36	Land Unaffected by mining	15,565	5,453	2	10,906
	Land affected by Mining	11,717	0		0
	Land rehabilitated to Class 2	3,088	1,108	2	2,216

Year of operation	Land category	Average area per annum (ha)	Average carrying capacity per annum (head)	Number of years	No. of head
	Land rehabilitated to Class 4 and above	1,812	178	2	356
	Sub-Total	32,182	6739		13,478
Year 1 to 36	Total				244,498

* Note – These figures represent the number of years at full production for the area stated during this time period.

As shown in Table 9-9, in scenario 2 with mining continuing beyond Year 30 (under a new approval), the MLA areas are estimated at being able to carry a total of 244,498 head of cattle over the 36 years of assessment, compared to 419,652 head of cattle without mining. Scenario 2 will result in an estimate of 175,154 head of cattle, or 41%, reduction in production throughout the operational period of the mine.

Scenario 3 Agricultural production with the mine, with decommissioning

Scenario 3 proposes mining to cease at Year 30, and a final landform has been prepared to represent how the landscape would be rehabilitated. For the purposes of this assessment, the final landform has been assumed to represent Year 32 with return to full grazing production taking an additional 4 years, therefore this assessment is based on a 36 year grazing production period.

Again, this assessment does not fully account for the progressive rehabilitation and release of land for agricultural production as discussed in Scenario 2 above. An economic assessment of this carrying capacity is contained in Chapter 22 Economics.

Table 9-10: Summary of grazing production during mining with decommissioning

Year of operation	Land category	Average area per annum (ha)	Average carrying capacity per annum (head)	Number of years	No. of head
Year 1 to 4	Land Unaffected by mining	23,224	8,181	4	32,724
	Land affected by Mining	8,958	0	0	0
	Sub-Totals	32,182	8,181		32,724
Year 5 to 9	Land Unaffected by mining	23,224	8,181	5	40,905
	Land affected by Mining	8,958	0	0	0
	Sub-Totals	32,182	8,181		40,905
Year 10 to 19	Land Unaffected by mining	20,172	6,961	10	69,610
	Land affected by Mining	12,010	0	0	0
	Sub-Totals	32,182	6,961		69,610
Year 20 to 31	Land Unaffected by mining	16,087	5,690	12	68,280
	Land affected by Mining	15,277	0	0	0
	Land rehabilitated to Class 2	585	210	*8	1,680
	Land rehabilitated to Class 4 and above	233	23	*8	184
	Sub–Totals	32,182	5923		70,144
Year 32 to 36	Land Unaffected by mining	21,044	7,320	5	36,600
	Land affected by Mining	0	0	0	0
	Land rehabilitated to Class 2	7,149	2,565	*1	2,565
	Land rehabilitated to Class 4 and above	3,171	310	*1	310
	Land rehabilitated to Class 2 after year 20	585	210	5	1,050

Year of operation	Land category	Average area per annum (ha)	Average carrying capacity per annum (head)	Number of years	No. of head
	Land rehabilitated to Class 4 and above after year 20	233	23	5	115
	Sub-Totals	32,182	10,428		40,640
Year 1 to 36	Total				254,023

* Note – These figures represent the number of years at full production for the area stated during this time period.

As shown in Table 9-10, in scenario 3, with rehabilitation occurring at the conclusion of mining in Year 30, the MLA areas are estimated of being able to carry a total of 254,023 head of cattle over the 36 years of assessment, compared to 419,652 head of cattle without mining. Scenario 3 will result in an estimate of 165,629 head of cattle, or 39% reduction in production throughout the operational period of the mine.

Post mining carrying capacity

As shown in Table 9-11, the post-mining landscape is assessed as having a sustainable carrying capacity of approximately 10,428 head of cattle, compared to 11,657 head of cattle for the pre-mining landscape (refer Table 9-8). The post Project landform will therefore have a reduced capacity of approximately 1,229 head of cattle per annum or 11% reduced productivity. Discussion on the economic implications of these scenarios is covered in Chapter 22 Economics.

Table 9-11: Grazing production in the MLA area after mining is complete

	Units	Rehabilitated gentle slopes	Rehabilitated steeper slopes	Unmined land	Total
Land Type	(A, B, C, D)	B	B	A, B, C, D	
Land Condition	(A, B, C, D)	B	D	B	
Carrying Capacity	(ha/head, annual equivalent)	2.8	10.2	2.9	
Area Assessed	(ha)	7,734	3,404	21,044	32,184
No of head/Area	(head, annual equivalent)	2,775	333	7,320	10,428

9.6 MITIGATION MEASURES

9.6.1 TOPOGRAPHY

Changes in the Project relating to the final landform, pit layout refinements and an increase in overburden stockpile elevation have occurred since the EIS. However, the mitigation measures in relation to topography provided in the EIS remain applicable and have not changed from those provided in the EIS.

The indicative final landform is presented in Figures 6-44-SV1.3 and 6-45-SV1.3.

9.6.2 OVERBURDEN

Proposed measures to monitor for and manage any acid producing potential of overburden and interburden were covered in the EIS Volume 1, Chapter 9 Geology, Mineral Resources, Overburden and Soils, section 9.6.3. In this section it was discussed that there is a low to negligible risk of development of acid mine drainage from overburden and interburden. Additional to the measures included in the EIS, potential measures to monitor for and manage acid producing potential in rejects include the following:

- characterisation of tailings and coal rejects acid producing potential, based on tailings produced during bulk sample operations, prior to commencement of mining
- laboratory characterisation of selected samples of tailings material will be conducted during the tailings disposal process to confirm the acid generation potential. This characterisation will be in accordance with

the *Assessment and Management of Acid Drainage* (Department of Primary Industries 1995) and/or other relevant guidelines

- a characterisation program will be undertaken based on the finding of the bulk sample tailings analysis findings. It is expected that tailings characterisation will be undertaken at a minimum rate of 8 regularly spaced samples per 1,000,000 tonnes of tailings material
- records will be kept of tailings disposal to indicate locations and characteristics of tailings stored within the tailings storage facility
- where acid producing potential of tailings material indicates that the material is potentially acid forming, kinetic tests will be conducted to establish oxidation rates and potential reaction products and formulate suitable control strategies.

9.6.3 SOILS

Mitigation measures in relation to soil management provided in the EIS remain applicable and have not changed from those provided in the EIS. Additional measures and clarification of measures in the EIS are provided below.

Dispersion and erosion

Mitigation measures related to erosion and sediment control for the gas supply pipeline were discussed in the EIS Volume 1, Chapter 9 Geology, Mineral Resources, Overburden and Soils, section 9.6.3.

The following additional erosion and sediment control related mitigation measures will be applied to the gas supply pipeline:

- the pipeline route will be located away from the outlet end of any runoff control works or from constructed waterways related to agricultural soil conservation measures, where practicable. A review of aerial photography identifies that the majority of properties along the alignment have the potential to contain agricultural runoff control works in the vicinity of the pipeline route
- the final land surface will be designed to prevent the concentration of overland flow that may result in erosion either within the corridor or on adjacent land
- where the pipeline is not parallel to existing runoff control works, or where there is a potential to concentrate overland flow, the final landform design will be constructed as far as possible to ensure natural flow of runoff is not impeded or concentrated
- 'whoa boys' or similar measures will be constructed along the pipeline route to avoid concentration of runoff, where appropriate.

Topsoil reuse

As discussed in EIS Volume 1, Chapter 9 Geology, Mineral Resources, Overburden and Soils, section 9.6.3, the placement of topsoil will be based on consideration of the landscape position the topsoil was stripped from, with soils of the undulating topography (Brigalow uplands cracking clays and non-cracking clays), used on slopes and hilltops, and the alluvial soils (Juandah, Woleebee and Retro) used in lower slopes and areas where water accumulation may occur.

During rehabilitation, soil profiles will be created from the application of subsoil and topsoil, based on soil properties and stripping depth recommendations provided in Table 9-9 of the EIS and local knowledge. An indicative profile as shown in Figure 9-1. Selection of topsoil and subsoil will be based on suitable properties and depth for rehabilitation/long term soil success for a sustainable post mining land use, and will not be a re-creation of the pre-existing soil profiles (e.g. a Cheshire soil profile will not be recreated).

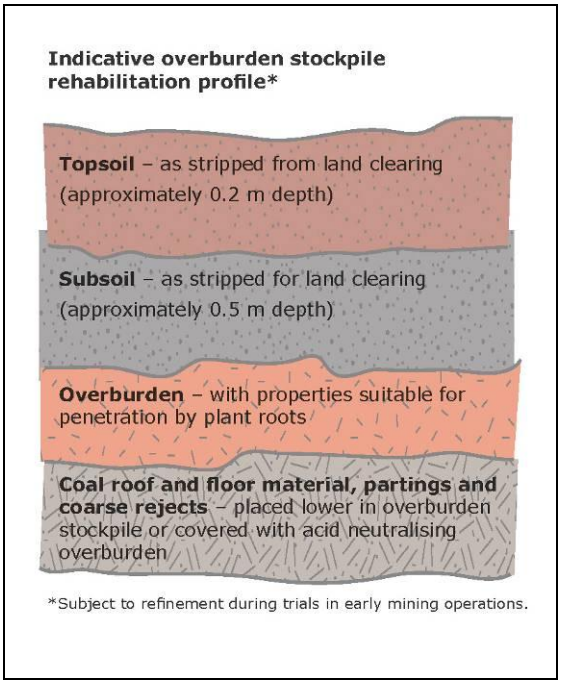

Figure 9-1: Indicative soil rehabilitation profile

Measures for managing the use, during rehabilitation, of soil with chemical and physical soil properties unfavourable for plant growth, including chlorine and sodium bulges, were discussed in the EIS Volume 1, Chapter 9 Geology, Mineral Resources, Overburden and Soils, section 9.6.3. These measures include recommended topsoil and subsoil stripping depths for each of the various soil types, based on the chemical and physical properties of the soils, as provided in Table 9-9 of section 9.6.3 of the EIS.

Stripping of topsoil will occur under a 'Permit to Disturb' procedure. This procedure will require assessment of soil units present prior to stripping, approval of topsoil stripping methods and areas by site environmental staff prior to commencement, and recording of topsoil stockpile locations. It is likely that some topsoil with unfavourable properties will be collected during stripping. However, the stockpiling and redistribution of this topsoil will mix poorer quality topsoil with other topsoil, diluting the unfavourable properties of the topsoil. Monitoring of rehabilitation will identify if rehabilitation at a given location is not succeeding, and ensure that further measures are implemented to enable successful rehabilitation.

A general key to identify where the different soil units occur within the Project area is provided in the EIS Volume 1 Chapter 9 Geology, Mineral Resources, Overburden and Soils technical report TR 9-1-V1.5, Figure 3-9.

In addition to the mitigation measures relating to reuse of topsoil presented in the EIS Volume 1, Chapter 9 Geology, Mineral Resources, Overburden and Soils, section 9.6.3, the following mitigation measures will also be applied to topsoil management where necessary to achieve rehabilitation objectives:

- trials will be conducted to establish the optimum soil organic matter content and carbon fractionation of the planting medium (e.g. topsoil), and method of application. Based on the results of the trials, planting medium will be treated to improve soil organic matter as a component of the topsoil application, where practicable
- trials will be conducted into biological methods of increasing nutrient levels in the planting medium (e.g. topsoil), such as the use of cattle manure. Based on the results of the trials, planting medium will be treated to improve soil nutrient content as a component of the topsoil application, where practicable.

The EIS Volume 1, Chapter 9 Geology, Mineral Resources, Overburden and Soils, section 9.6.3 discusses the use of fencing on newly topsoiled areas to exclude vehicle or stock access until a vegetation cover has established. In referring to 'stock', this means agricultural animals such as cattle. Native animals will also be excluded or discouraged where possible by fencing to prevent damage to the soil or vegetation.

Soil conservation plans

Mitigation measures to be applied to existing soil conservation works were provided in the EIS Volume 1, Chapter 9 Geology, Mineral Resources, Overburden and Soils, section 9.6.3. The WJV will retain and maintain existing agricultural soil conservation measures where they currently exist and are not required for mining activities, including in areas containing MLA associated infrastructure. Soil conservation works that are disturbed during works will be reinstated following construction or operational mining activities, excluding areas impacted by mine pits. These measures apply regardless of whether the property or soil conservation works are covered under a soil conservation plan.

Salinity from CSM water

As discussed in sections 9.5.4 and 11.6.2 of the EIS, CSM by-product water may be used as the water source for dust suppression on haul roads. Concerns were raised in submissions on the EIS regarding the long-term impact of soil salinity and sodium adsorption ratio (SAR) in relation to haul road dust suppression with CSM water. The likely properties of the CSM water were discussed in the EIS Volume 1, section 11.4.4.

A study applying CSM water to compacted material similar to that proposed to be used as haul road base has been conducted for the Project (Landloch 2009). Rainfall simulations were undertaken for compacted material with CSM water applied, finding high dilution of salts from the CSM water in rainfall runoff, and quick recovery of runoff water to salinity levels consistent with zero application of CSM water. Management strategies identified from the study include:

- if soils are characterised as sodic with a high clay content, gypsum may be applied to improve the soil structure
- construction of maintenance and table drains, including vegetating drains with ground cover where possible to reduce water flow velocity and decrease erosion potential.

Measures to limit the potential for impacts from the use of CSM water for dust suppression are provided in section 11.6.2 of this Supplementary EIS. Measures to protect against long-term soil impacts are:

- prior to commencement of using CSM water for dust suppression, further site-specific assessments will be undertaken using potential haul road construction material and CSM water for the Project if the haul road material differs to the material considered in the existing CSM Water application study. These assessments will relate to the following:
  - potential accumulation of precipitated salt at the road surface
  - potential for the precipitated salts to be dissolved by rainfall, and to move in runoff
  - the likely interactions between quality of runoff water with rainfall rate and volume.
- based on the findings of the site-specific assessments, periodic monitoring of salinity and sodicity during the operation of a haul road may be conducted, including the road drains and adjacent land. If monitoring suggests a build-up of high levels of salinity or SAR, suitable management measures will be investigated and implemented
- a large portion of the haul roads requiring dust suppression are associated with pit ramps. These ramps will be removed and buried as a component of decommissioning and rehabilitating mine pits
- measurements of soil salinity and sodicity prior to the decommissioning of a haul road will be conducted, including the road surface, drains, sediment ponds and adjacent land. Where required, material with high salinity or SAR will be excavated and removed, or otherwise remediated, during haul road rehabilitation.

9.6.5 POST MINING LAND USE

Changes in the Project relating to the final landform, tailings disposal strategy, further development of the mine plan and reassessment of the pre-mining land suitability classification has occurred since the EIS publication. As a result the post-mining land suitability classification and post-mining land use has been refined and slightly altered compared to the EIS. These measures are discussed below.

Land suitability

Measures to mitigate the operational and post-mining land suitability classification and land use impacts have been incorporated into the Project, as part of the Supplementary EIS. These measures, as already discussed in this chapter, include:

- mining and rehabilitation will be undertaken in a progressive nature. This means land not required for mining activities until later in the mine operations will be “suitable” for agricultural purposes in earlier

years of operation. Rehabilitated mined land will become suitable for agricultural purposes progressively later in mining operations

- undisturbed land will be returned to (or retained in) its pre-mining land suitability class
- land used for infrastructure components of the Project (roads, MIA, etc) will have limitations related to water availability (through compaction and breakdown of the subsoil structure). Where practicable this land will be returned to Class 3 cropping land or Class 2 grazing land, otherwise it will be returned to Class 4 cropping land or Class 3 grazing land
- spoil stockpiles will have limitations related to water availability, salinity, gradient, erosion and nutrient content. Flatter gradient sections of spoil stockpiles will be returned to Class 4 cropping land or Class 2 grazing land where practicable. Steeper gradient spoil slopes will be returned to Class 5 cropping land or Class 4 grazing land
- tailings will be disposed of in mined-out pits, and covered with approximately 20 m of overburden. As such, no unrehabilitated tailings dam sites are expected in the final landform
- final voids will be reshaped to reduced gradients, and will have limitations similar to those listed for spoil stockpiles, and will be Class 4 for cattle grazing or Class 5 for cropping.

Rehabilitation and plant growth potential of soil and overburden material specific to Wandoan has been assessed by Slater (1986), as discussed in the EIS Volume 1, Chapter 9 Geology, Mineral Resources, Overburden and Soils, section 9.5.4, and the technical report TR09, section 5.2.3. Further to the information provided in the EIS, Slater (1986) also conducted planting and growth trials in a greenhouse to assess potential nutrient limitations and application rates (including trace nutrients), dry matter yields, plant emergence and growth rates of buffel grass, wheat and siratro on various soil and overburden samples from the Wandoan area. These trials contributed to the recommendations in Chapter 9 of the EIS as to the use and limitations of soil and overburden in rehabilitation as a planting material.

As discussed in the EIS, field trials building on the findings of the greenhouse trials will be conducted to refine the rehabilitation practices for the Project.

Post-mining land use

Based on the EIS Volume 1, Chapter 9 Geology, Mineral Resources, Overburden and Soils, section 9.6.5, and updated information relating to the refined mine plan, post-mining land uses are proposed to be:

- undisturbed land is proposed to be used for beef cattle grazing or dry land cropping as existed prior to mining
- land used for infrastructure components of the Project (roads, MIA etc) are proposed to be retained for beneficial reuse where appropriate, or alternately rehabilitated for beef cattle grazing
- the top surface of spoil stockpiles are proposed to be used for beef cattle grazing, subject to the findings of cattle grazing trials in the early phases of the mine operations
- the side slopes of spoil stockpiles are proposed to be used for low density beef cattle grazing, or alternatively for nature conservation, subject to the findings of cattle grazing trials in the early phases of the mine operations
- final voids are proposed to be used for low density beef cattle grazing, or alternatively for nature conservation, subject to the findings of cattle grazing trials in the early phases of the mine operations
- investigations and trials into the potential for cropping on the top surface of rehabilitated spoil stockpiles and infrastructure areas are recommended be conducted during the life of the mine.

There is a potential high risk of rill and gully erosion from cropping land use on rehabilitated land, including from tillage and fallow periods exposing the soil to erosion. Post-mining, rehabilitated spoil is proposed to be rehabilitated to Class 4 for cropping. However, research and technological advances over the 30 year operations of the mine may mean that cropping becomes a viable land use during rehabilitation later in the life of the mine. It is recommended the WJV participates in research into the potential for cropping as a post-mining land use.

9.6.6 FINAL LANDFORM DESIGN

As discussed in sections 9.6.1 and 9.6.5 above, some slopes for the overburden stockpiles will be up to 15% slope (and therefore Class 5 for cropping or Class 4 for cattle grazing). The most important feature of the post-mining landform is that the landform is stable, safe and sustainable. In some locations, this will require steeper gradient slopes to reduce the catchment size, and therefore reduce the corresponding erosion potential. However, as discussed in this chapter, the Project is aiming to minimise the change to land

suitability classes. The detailed design of the final landform will consider the erosion potential of longer (flatter gradient) slopes, in combination with existing landscape features and gradients.

9.6.7 MINE REHABILITATION

As discussed in EIS Volume 1, Chapter 9 Geology, Mineral Resources, Overburden and Soils, section 9.6.7, rehabilitation indicators for the Project in relation to soil and overburden properties and final landform include, but are not limited to:

- slope angle, length and profile
- chemical properties of topsoil and growth medium within plant rooting depth (e.g. pH, salinity, sodicity, trace elements, nutrients)
- physical properties (e.g. depth of topsoil, water infiltration, slope gradient, crusting).

In addition to the parameters listed above, biological parameters such as soil micro-fauna or soil organic matter content may also be used as indicators. Rehabilitation indicators relating to the above parameters will be prepared for the Plan of Operations.

Mine rehabilitation and mitigation measures are discussed in Chapter 25 Rehabilitation and Decommissioning.

9.6.8 AGRICULTURAL PRODUCTION

Measures to mitigate the operational and post-mining land suitability classification and land use impacts have been incorporated into the design of the Project. These measures, as already discussed in this chapter, include:

- rehabilitation of landforms and soil profiles as per the EIS and Supplementary EIS
- subject to field trials, grazing of rehabilitated land be conducted at the following carrying capacity:
  - 0-12 months – zero carrying capacity
  - 12-24 months – 25% of district average carrying capacity
  - 24-48 months – 50% of district average carrying capacity
  - >48 months – 100% of district average carrying capacity.
- cattle grazing trials on rehabilitated land be managed by the WJV to ensure stocking rates and management practices leave the land in a sustainable condition for the post-mining land owner.

9.7 RESIDUAL IMPACTS

The reassessment to the pre-mining land suitability classification for dry land cropping and the provision of a final landform have not significantly altered the residual impacts of the Project compared to the EIS. However the post-mining landscape now has fewer final voids compared to the EIS.

As discussed in section 9.6.5, the final landform land suitability classes and land uses are expected as presented in Table 9-12:

Table 9-12: Post-mining land use

Mining activity	Post mining land use	Post mining land suitability class for dry land cropping	Post mining land suitability class for beef cattle grazing
Infrastructure including roads, MIA etc	Beef cattle grazing*	Class 3 and Class 4	Class 2 and Class 3
Low gradient overburden stockpiles	Beef cattle grazing*	Class 4	Class 2
Steeper gradient overburden stockpiles	Low density beef cattle grazing* or nature conservation	Class 5	Class 4
Final voids	Low density beef cattle grazing* or nature conservation	Class 5	Class 4

Note: * Subject to the findings of trials

Based on the assessment conducted for this Supplementary EIS, the Project will result in changes to land suitability classification in the MLA areas as presented in Table 9-13.

Table 9-13: Pre- and post-mining land suitability areas

Land suitability class	Estimated area of land (ha)			
	Pre-mining dry land cropping	Post-mining dry land cropping	Pre-mining beef cattle grazing	Post-mining cattle grazing
2	0	0	32,191	28,784
3	26,335	18,222	0	0
4	5,856	10,562	0	3,407
5	0	3,407	0	0

During operation there will be approximately 40% reduction in the agricultural productivity of the MLA areas, and post-mining the agricultural productivity potential will be reduced by approximately 11% per annum.

9.8 REFERENCES

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