Land Resources

4

4 Land Resources

4.1 Climate

This section describes rainfall patterns, humidity, air temperature, wind (speed and direction), stability class, mixing height and temperature inversions within the region of the project. Data has been sourced from the Bureau of Meteorology (BOM) climate statistics for the Moranbah Water Treatment Plant (MWTP) (Latitude: 21.99°S, Longitude: 148.03°E) (BOM, 2008), which is located in Moranbah, north of the project site and a meteorological station that was installed by BMA adjacent to the project site in December 2007 (on-site data).

The site-specific data are not sufficient to enable to project's air quality impacts to be modelled. To provide the additional climatic data required, meteorological models (Calmet and TAPM) have been used. The modelled data were used to generate hourly records of wind speed, wind direction and air temperature as the Moranbah site records provide only two readings per day. Additionally, the modelled data provide site-specific parameters that cannot be directly measured such as mixing height, stability class and temperature inversions. Details of the setup and application of these models are provided in the air quality section (Section 10.2.11). This dataset is referred to as modelled data generated from Calmet for 2007.

This section also provides an assessment of extreme events and the project's vulnerability to natural or induced hazards such as flooding, drought, storm events, bushfires and climate change. The potential impacts due to climatic factors are addressed in the soil, air quality, surface water, groundwater and noise and vibration sections of the EIS.

4.1.1 Rainfall Patterns

Monthly mean rainfall values for the period of record January 1972 to December 2007 are provided in Table 4.1. Table 4.1 indicates a mean annual rainfall of approximately 597 mm with approximately 43% of rainfall occurring in the summer (Dec, Jan, and Feb) months. Mean monthly evaporation rates at the MWTP for the period of record from January 1986 to December 2007 are listed in

Table 4.2. Both monthly and annual evaporation rates significantly exceed rainfall. The average annual evaporation is significantly higher (i.e. around four times) than the average annual rainfall.

Table 4.1 Moranbah Water Treatment Plant Rainfall Statistics (Jan 1972 – Dec 2007)

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean monthly rainfall (mm)	100.2	94.3	48.7	37.5	36.8	23	19	23.7	8.1	37.8	68.6	99.2	597.2

Table 4.2 Moranbah Water Treatment Plant Evaporation Rates (Jan 1986 – Dec 2007)

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean monthly evaporation (mm)	257.3	220.4	220.1	177	136.4	108	117.8	151.9	207.7	251	266.6	269.7	2,384

4.1.2 Air Temperature

Ambient air temperature data have been summarised for 2007, using the modelled data generated by Calmet. Hourly temperature records have been analysed by time of day, and are presented in **Figure 4.1**.

The average temperature for 2007 was 19.9°C. The maximum temperature was 34.5°C on 12 March at both 12 and 1 pm, and a minimum of 3.0 °C on 20 July at 7 am.

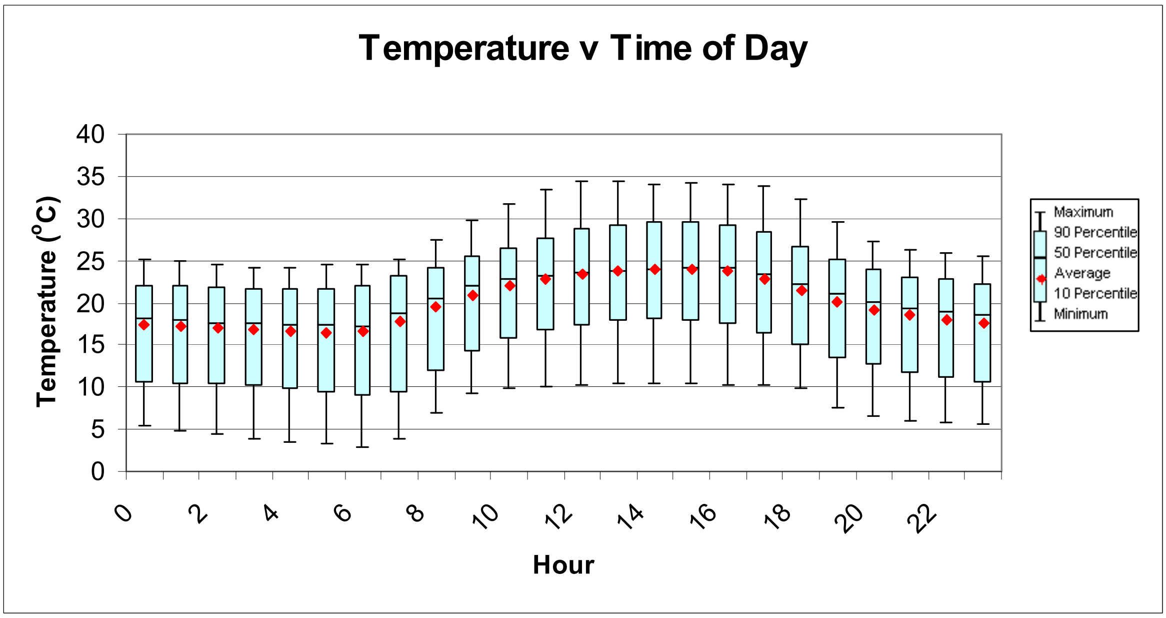


Figure 4.1 Temperature by time of day for Caval Ridge (Calmet 2007)

4.1.3 Humidity

Relative humidity data have been summarised for 2007, using the modelled data generated by Calmet. Hourly humidity records have been analysed by time of day, and are presented in Figure 4.2.

The average humidity for 2007 was 77%. The relative humidity reaches 100% frequently during the night, particularly in the early morning when ambient temperatures are lowest. The minimum relative humidity was 22% on 13 October.

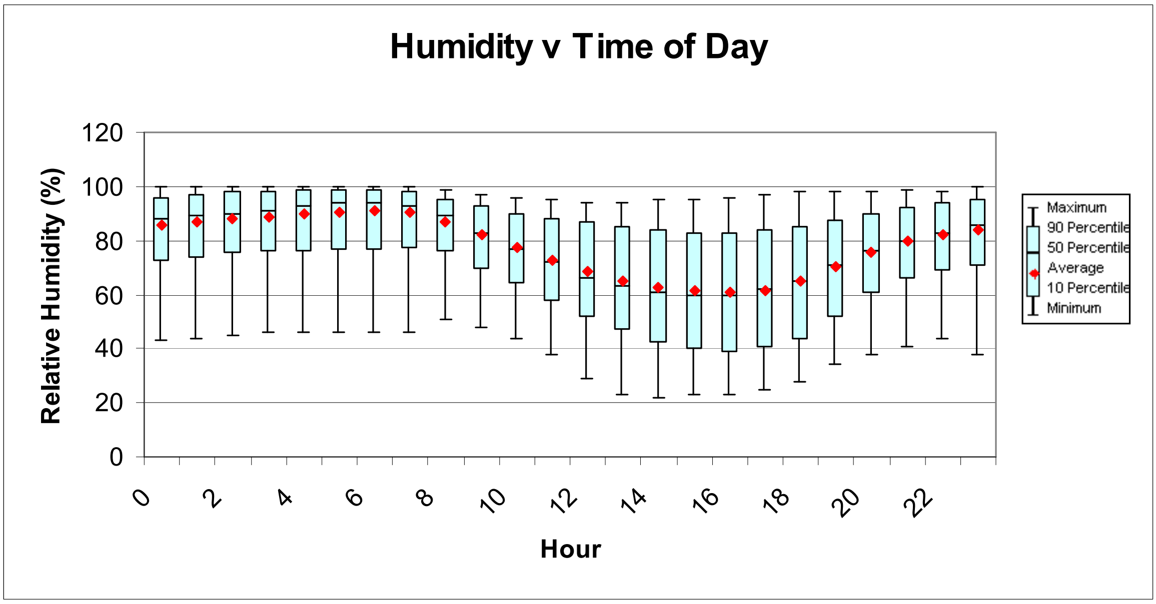


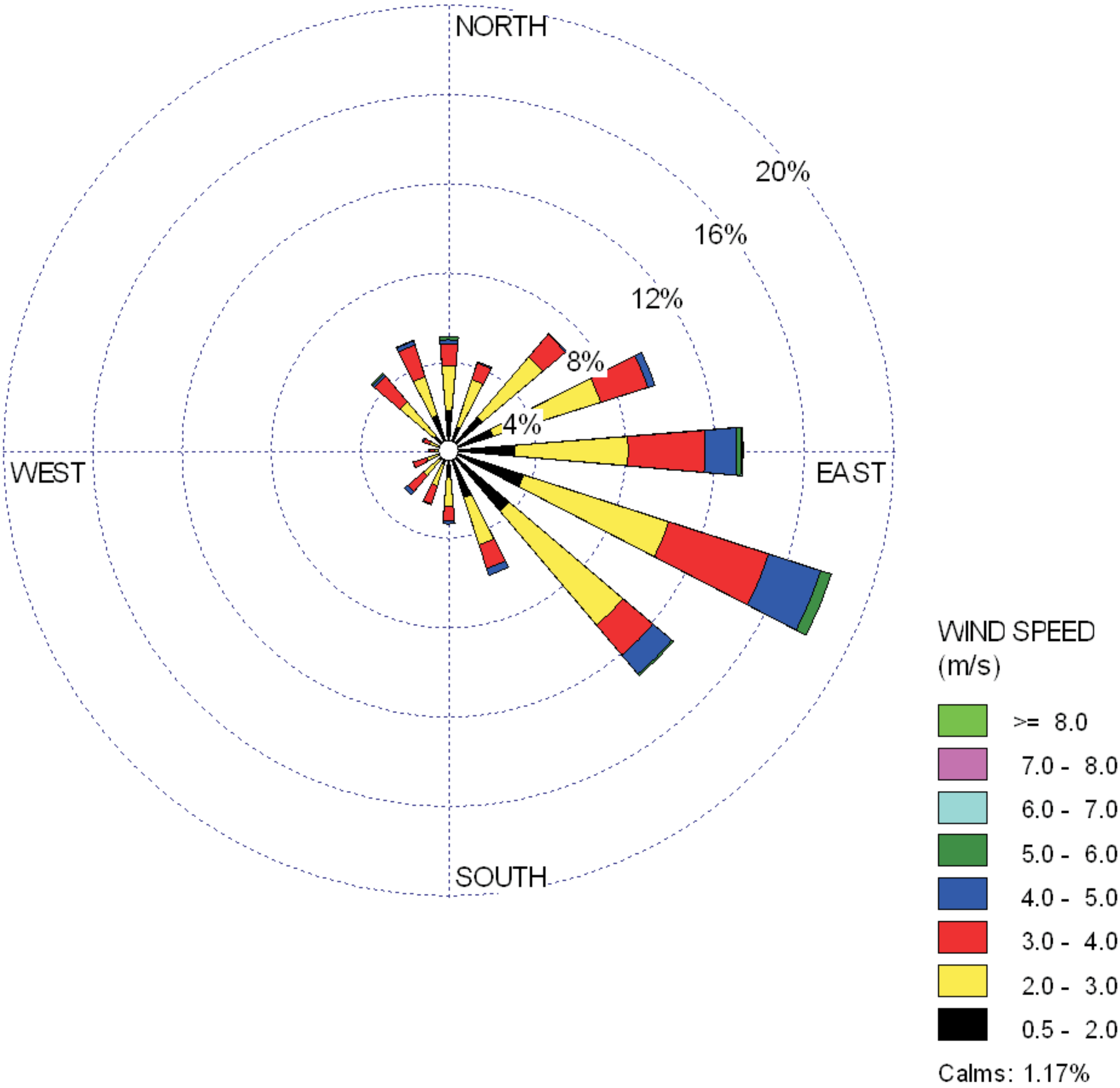
Figure 4.2 Relative Humidity by time of day for Caval Ridge (Calmet 2007)

4.1.4 Wind

On-site measurements of wind speed and wind direction are available from 18 December 2007 to 31 September 2008. Long-term measurements taken at Moranbah only present wind speed data that is measured twice per day, and thus does not give a representation of the wind patterns in the project site over the year or for specific seasons. These data are insufficient for use in dispersion modelling, as a complete year of data is required for wind speed, temperature, humidity, stability class and mixing height. Wind speed and wind direction data have been summarised for 2007, using the modelled data generated by Calmet. Wind roses that present the wind speed and direction data for all hours are shown in Figure 4.3.

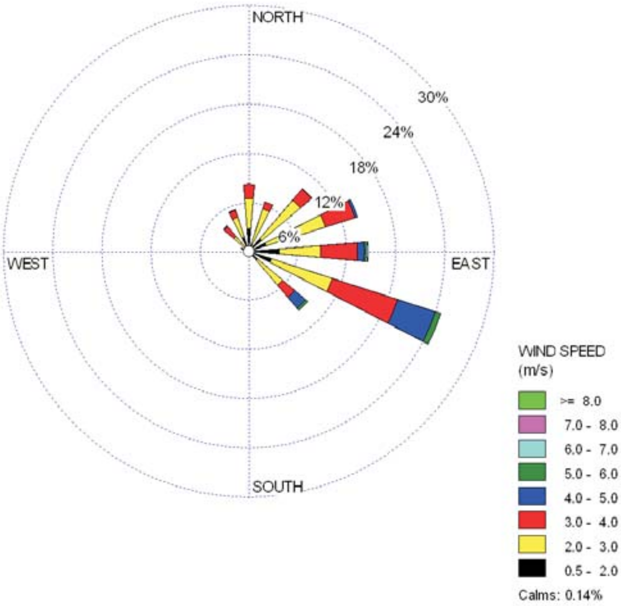
Typical winds at the project site are from the east-north-east through to the east-south-east sector. The wind speed reaches up to 7 m/s from the east, with an average over all hours of 2.5 m/s. The site is characterised by very infrequent winds from the western sector. Analysis of wind speed and direction data for each season in 2007 is shown as wind roses in Figure 4.4. The data show that maximum summer wind speeds were 7.0 m/s with a predominant east-south-easterly wind direction. Maximum autumn wind speeds were 5.8 m/s with a predominant east through to south-east wind direction. Winter wind direction tended to be from the east-south-east through to the south-south-east direction with a maximum wind speed of 5.4 m/s. Maximum wind speed in the Caval Ridge region in spring was 5.6 m/s, with the majority of winds from the north-east through to east sector, and also from the north-west.

The wind patterns through the day are presented in Figure 4.5. Early morning winds are characterised by low to moderate wind speeds, below 5 m/s, with wind directions mainly from the south-east. Mid-morning winds show increasing strength of up to 6 m/s after dawn, predominantly from the east-south-east direction. Winds in the afternoon are characterised by the east-north-east through to the east-south-east sector, with wind strengths of up to 7 m/s. These winds reflect the late afternoon arrival of the sea breeze from the east coast. Night-time winds show wind speeds of up to 6 m/s from the east-south-east direction, with lighter winds of up to 4 m/s that arise from the north through to the south-east direction and some light winds from other directions as well. These conditions reflect the decreasing influence of the sea breeze and the influence of low wind speeds that meander around terrain features under night time conditions.

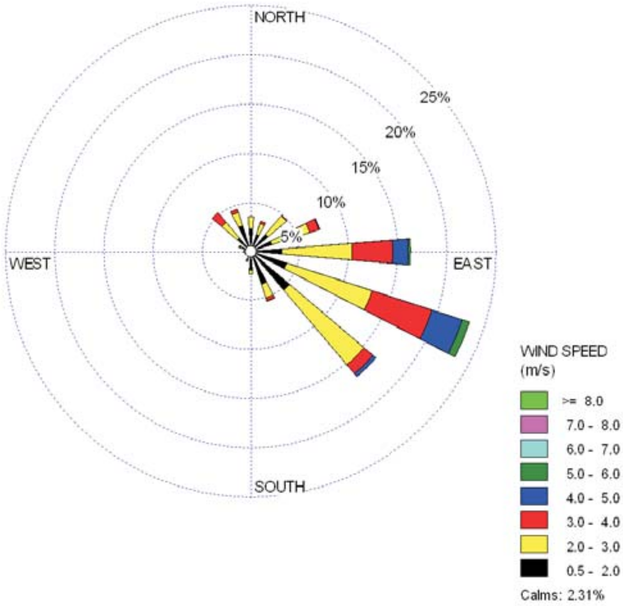


Source: Calmet Modelled Data for 2007

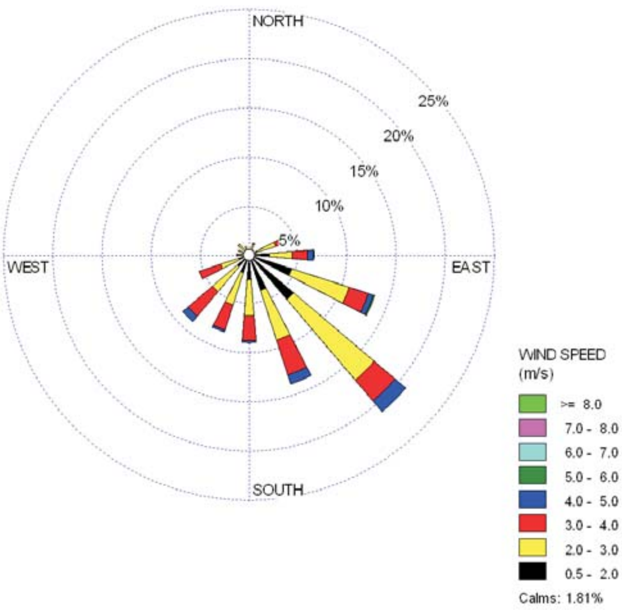
Client	Project	Title
BMA BHP Billiton Mitsubishi Alliance	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	WIND ROSE FOR ALL HOURS, 2007
URS	Drawn: VH · Approved: RS · Date: 08-05-2009 · Job No.: 4262 6158 · File No. 42626158-g-522.cdr	Figure: 4.3 · Rev. A · A4



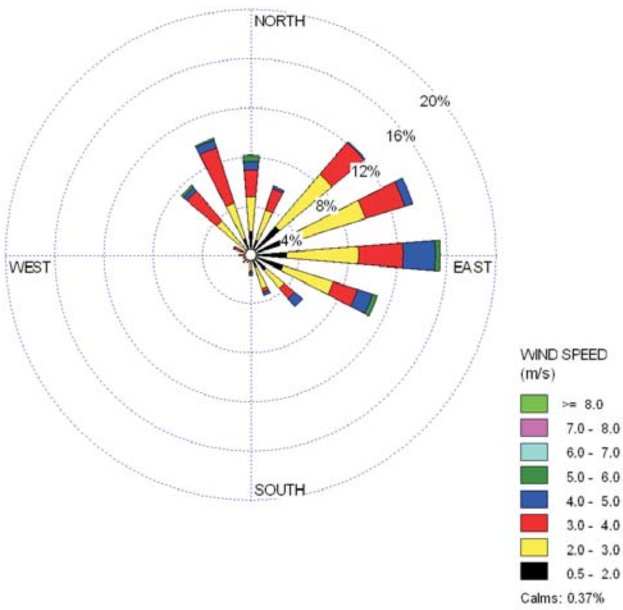
Summer Wind Rose



Autumn Wind Rose



Winter Wind Rose



Spring Wind Rose

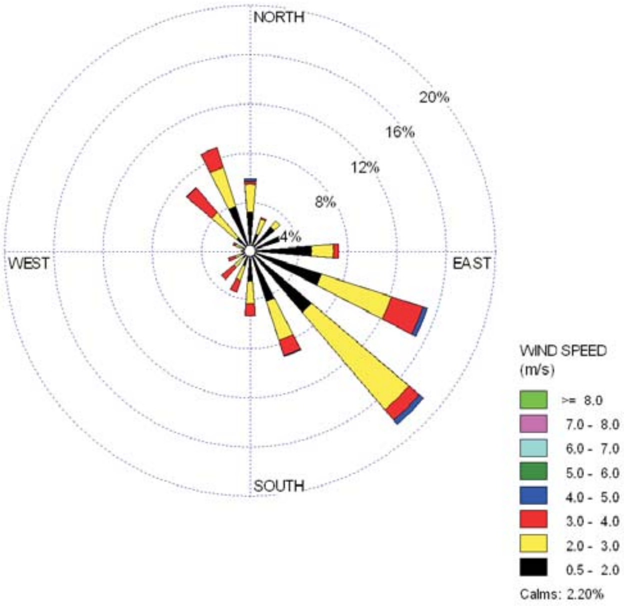
Source: Calmet Modelled Data for 2007

Client: BMA — BHP Billiton Mitsubishi Alliance; URS

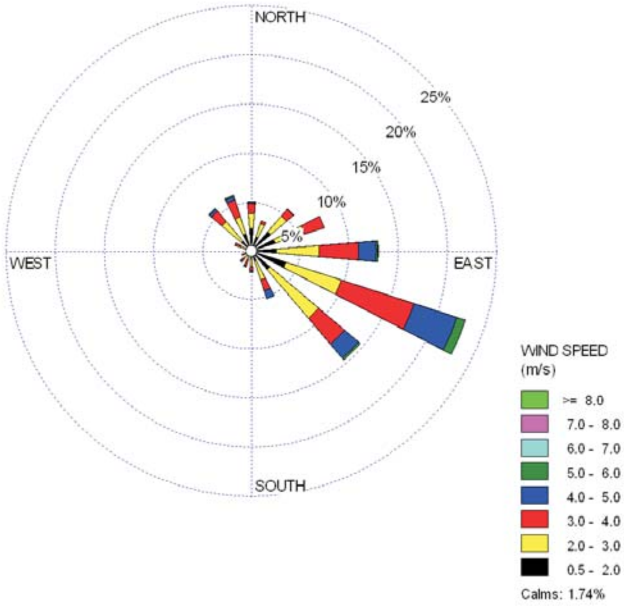
Project: CAVAL RIDGE PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Title: **WIND ROSE BY SEASON, 2007**

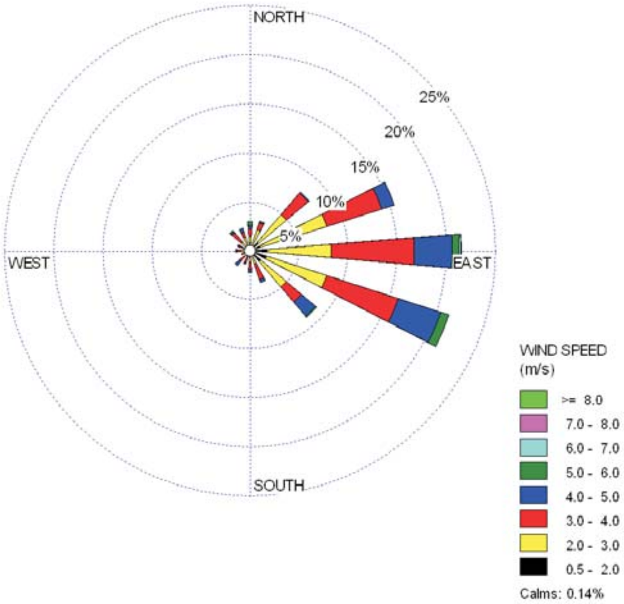
Drawn: VH	Approved: RS	Date: 08-05-2009	Figure: **4.4**
Job No.: **4262 6158**	File No. 42626158-g-523.cdr		Rev. A / A4



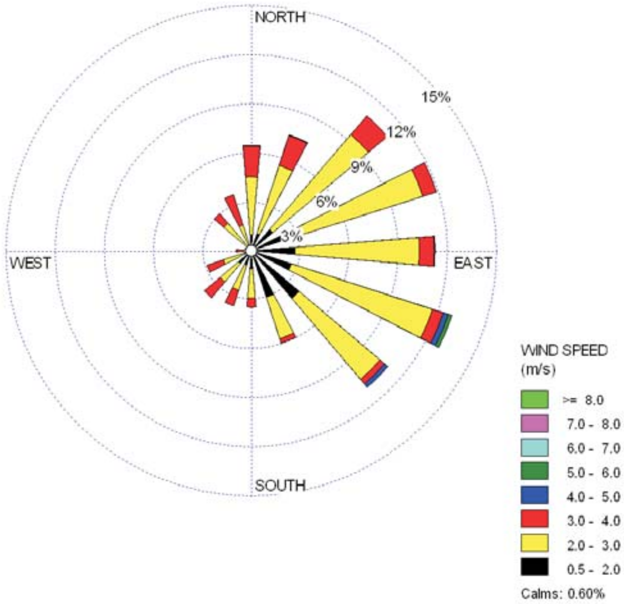
Midnight to 6am



6am to Midday



Midday to 6pm



6pm to Midnight

Source: Calmet Modelled Data for 2007

Client	Project	Title
BMA BHP Billiton Mitsubishi Alliance	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	**WIND ROSE BY TIME OF DAY, 2007**
URS	Drawn: VH / Approved: RS / Date: 08-05-2009 Job No.: **4262 6158** / File No. 42626158-g-517.cdr	Figure: **4.5** / Rev. A / A4

4.1.5 Stability Class

Stability of the atmosphere is determined by a combination of horizontal turbulence caused by the wind and vertical turbulence caused by the solar heating of the ground surface. Stability cannot be measured directly; instead it must be inferred from available surface data, either measured or model-generated data.

The Pasquill-Gifford scale defines stability on a scale from A to G, with stability class A being the least stable, occurring during strong daytime sun and stability class G being the most stable condition, occurring during low wind speeds at night. For any given wind speed the stability category may be characterised by two or three categories depending on the time of day and the amount of cloud present. In air quality models such as Calmet, the stability classes F and G are combined.

Stability class data for 2007 have been summarised using the modelled data generated by Calmet. This showed that for the project site stability class F (Figure 4.6) occurred most frequently (43.6%) in 2007, indicating that the dominant conditions were moderately to very stable, with very little lateral and vertical diffusion. Typically under class F stability, the wind direction tends to deviate by only a small amount, frequently resulting in poor dispersion conditions.

The frequency of strongly convective (unstable) conditions at the project site, represented by stability class A, is relatively low at 2.5% of hours in the year. This category requires strong sunlight and low wind speeds through the day, and is characterised by vertical movement of air. The low occurrence of these unstable conditions is typical of the inland areas of Queensland.

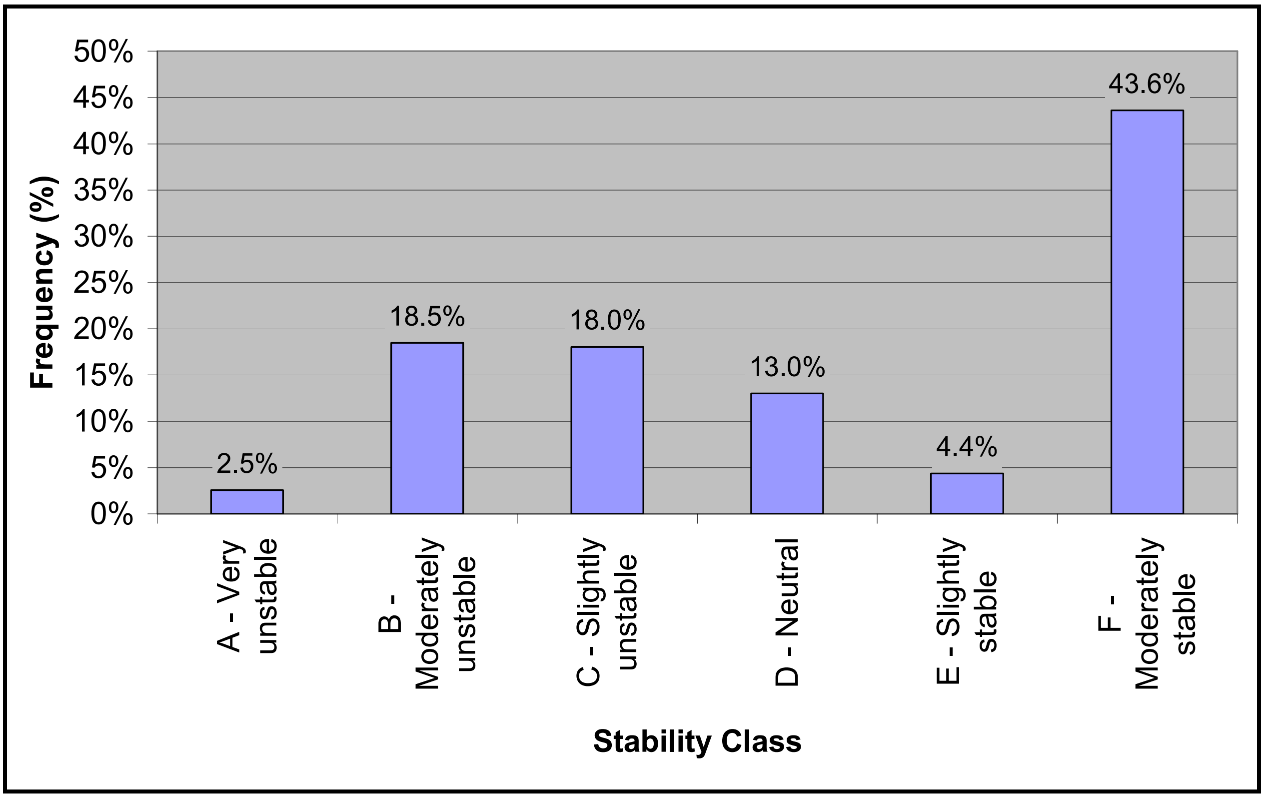


Figure 4.6 Frequency of Stability Class for Caval Ridge, 2007

4.1.6 Mixing Height

Mixing height quantifies the vertical height of mixing in the atmosphere and is a modelled parameter that is not able to be measured directly. Mixing height data have been summarised for 2007 using the modelled data generated by Calmet. Figure 4.7 represents the mixing height against time of day for Caval Ridge. The graph represents the typical growth of the boundary layer, whereby mixing height is generally lowest late at night/ early morning and highest during late afternoon (in this case 3:00 pm). The mixing height decreases in the afternoon, and particularly after sunset, due to the change from surface heating from the sun to a net heat loss overnight.

Average morning mixing heights range from 70 – 500 m above ground level and average afternoon mixing height ranges from 260 -1,370 m above ground level. Low mixing heights typically translate to stagnant air with low vertical motion, whilst high mixing heights allow vertical mixing and good dispersion of pollutants such as dust.

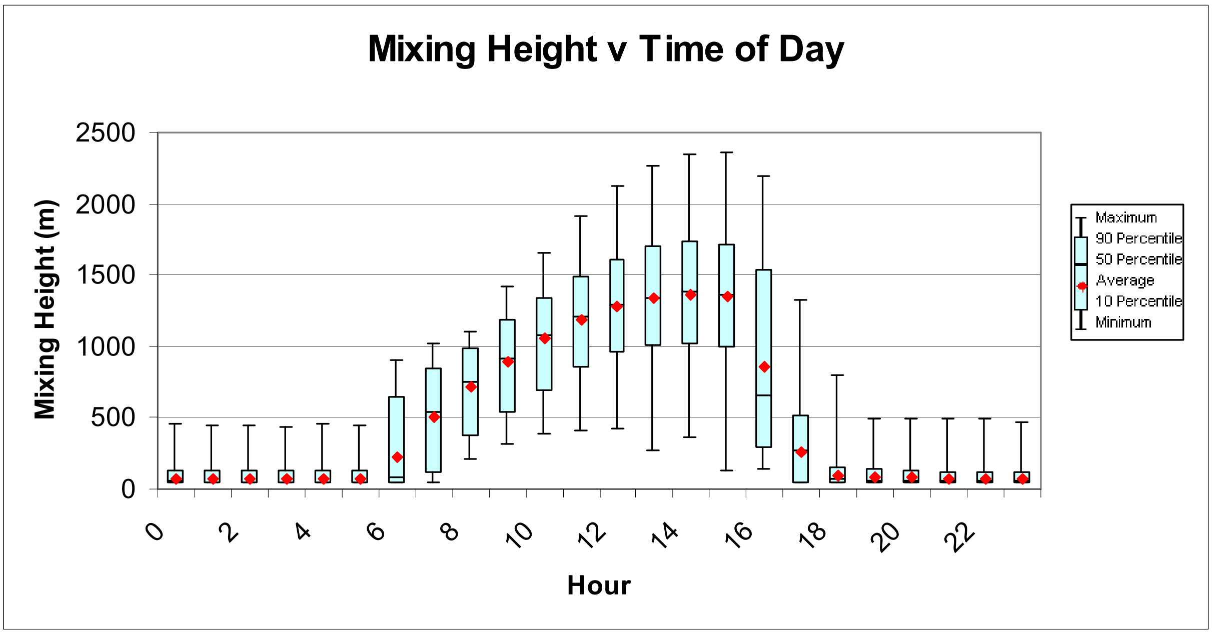


Figure 4.7 Mixing height by time of day for Caval Ridge, 2007

4.1.7 Temperature Inversions

Temperature inversions are an atmospheric condition that occurs when the normal temperature profile of the atmosphere changes from decreasing temperature with height (typically a reduction of $1^{o}C$ per 100 m for neutral conditions) to a state where temperature increases with height through the atmosphere. Temperature inversions often create the worst-case meteorological conditions for air dispersion and noise transmission, and thus are critical conditions for adverse impacts at nearby locations. The DERM's Planning for Noise Control guideline notes that temperature inversions create a significant noise impact warranting further assessment if they occur more than 30% of the time under the following conditions:

- Winter (June, July and August)
- Night-time period (1800 to 0700 hours)
- Temperature inversion strength of at least 3°C per 100 m plus a source-to-receiver drainage flow wind speed of 2 m/s.
- Moderate (F-class stability) inversions.

Temperature inversions are measured by simultaneous near-surface measurements at different heights, typically 10 and 50 m. No on-site temperature measurements are available for the Moranbah area to determine the frequency of temperature inversions. Consequently modelled temperature data for 2007 have been analysed at heights of 20 m to 300 m. The frequency of inversion conditions is 3% of the year at these heights, representing the conditions under which adverse noise impacts are most likely to cause nuisance due to reflection of sound waves.

4.1.8 Extremes of Climate

This section describes the project's vulnerability to natural hazards such as drought, floods, bushfires, storm events and climate change.

4.1.8.1 Drought

Recent periods of long term droughts (consecutive years of below average rainfall) in the central Queensland region include 1982 – 1983, 1991 – 1995 and 2001 – 2007. In addition to these historical drought periods, there is also evidence of longer periods where there is generally low rainfall (Figure 4.8). In these periods, not every year is dry, however the rainfall is below the long-term average.

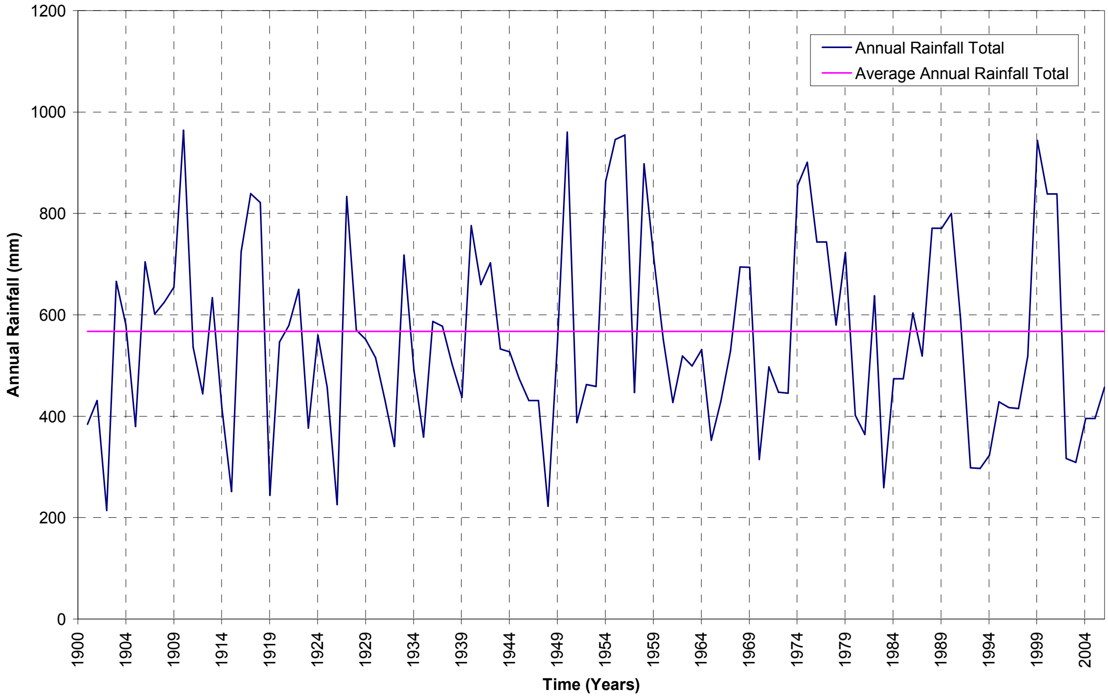


Figure 4.8 Annual Rainfall Totals (1900 – 2007) (NRW, 2008)

4.1.8.2 Flood

Flooding of the project site can be caused by localised flash flooding from intense thunderstorms or more widespread and longer-lived inundation resulting from heavy rain over the catchments. Most of the flooding occurs during the wet season (summer) in association with tropical cyclones or rain depressions. This was highlighted in the flooding assessment (Section 6.1.2.3) which found that the critical storm duration (i.e. the storm duration that produces the highest flood levels) was 6 hours.

In general, peak flood flows within the project site (existing, non-developed scenario) are contained within the creek channels up to the 1 in 100 annual exceedence probability (AEP) storm event. For the 1 in 100 AEP and larger storm events the flood waters extend onto the surrounding floodplains.

Horse Creek and Caval Creek diversions will be designed to convey storm events up to and including the 1 in 100 AEP within the diversion channel.

Further information on flooding characteristics within the project site is provided in Section 6.1.2.

4.1.8.3 Storm Events

The impacts of storm events on the capacity of wastewater containment systems (e.g. site bunding and stormwater management infrastructure) are addressed in Section 6.2.4 with regard to contamination of waterways.

4.1.8.4 Bushfires

The climate factors which exert most influence over bushfire weather are temperature, winds, and humidity (BOM, 2008). A combination of high temperature, high winds, and low humidity increases fire danger. In Queensland, spring (particularly late spring) brings a combination of these climate factors which constitute the fire season. During winter, the temperatures and rainfall are low. In summer, while the temperatures are at their hottest, the rainfall also increases reducing the risk of a significant fire. In the period between winter and summer, the fuel is very dry from the lack of rainfall during the winter months, and the temperatures increase.

The Rural Fire Service and Queensland Fire and Rescue Service have modelled the bushfire risk for Isaac Regional Council (RFS, 2008). The area surrounding Moranbah is primarily classified as having a medium to low bushfire risk, although there are areas within the region classified as having a high bushfire risk. This risk modelling examined factors of slope, aspect and vegetation.

4.1.9 Climate Change

The project's vulnerabilities to climate change have been addressed by conducting a risk assessment on the impacts of reduced rainfall, increased temperatures, increased rainfall intensity, increased storm severity, increased number of windy days, and increased risk of flooding. The methodology and results of this assessment are presented in Section 11.7. The proposed risk management strategies are also presented to allow the project to adapt to future climate change.

4.2 Topography and Geomorphology

The topography of the project site is generally flat to undulating. Elevation across the project site range from 220 m Australian height datum (AHD) to 274 m AHD, and surface slopes are typically <1% grading to east-north east towards the Isaac River which is the most prominent regional drainage feature. The existing topography is shown on Figure 4.9. The project site consists of the following geomorphological land zones of Cainozoic age (Figure 4.10):

- Alluvial plains and piedmont fans adjoining the Horse and Heyford Pits.
- Clay deposits under gently undulating plains within the Horse Pit area.
- Sand deposits on extensive flat or gently undulating plains adjoining the Heyford Pit.

- Igneous rocks, flood basalts forming extensive plains and occasional low scarps to the north of the Horse Pit.
- Duricrusts formed on a variety of rock types.

4.3 Geology

4.3.1 Regional Geology

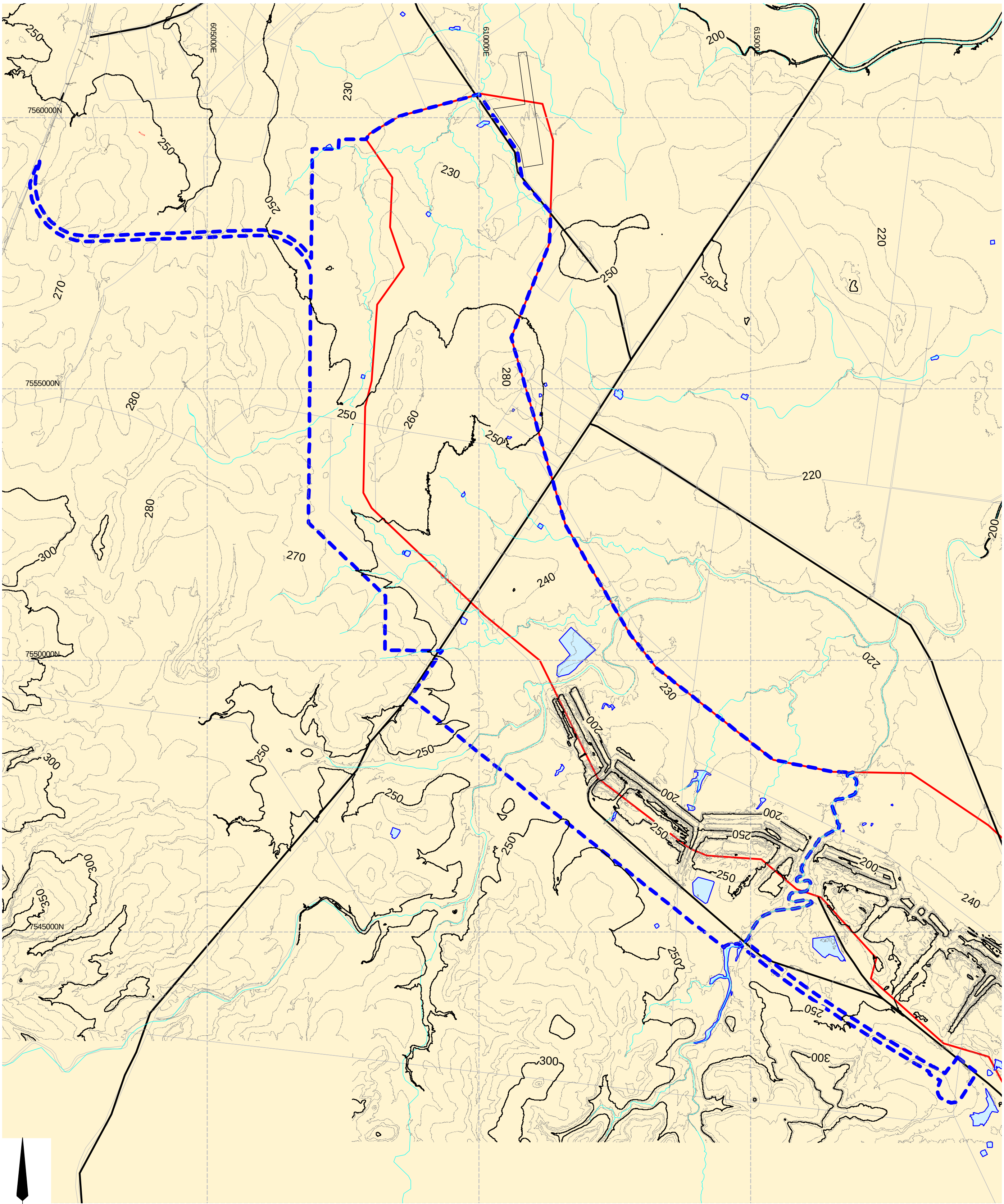
The Peak Downs Mine and continuous Caval Ridge Project area is situated on the relatively undisturbed western limb of the northern Bowen Basin, which is perched at the southern end of the Collinsville Shelf. Geological regions in the vicinity of the project site are shown in Figure 4.11. Economic coal seams occur in the terrestrial Moranbah Coal Measures which consist of 300 m depth of laterally changing sandstones, siltstones, mudstones, tuffaceous-claystones and coal. These coal seams were deposited on the eastern margin of the Collinsville Shelf, which provided a predominantly fluvial flood plain environment and is one of the structural elements of the Clermont Stable Block.

4.3.2 Specific project geological information

The economic coal seams of the Peak Downs operation and Caval Ridge Project areas occur mainly in the terrestrial Moranbah Coal Measures. Surface Tertiary alluvial along with surface Basalt flows in addition to weathering of the Permian sediments make up the variation in stratigraphy in the area. The target seams for the Caval Ridge Project are all seams in the lease above 30 cm thickness with primary targets of the Q seam - P seam zone, the Harrow Creek Seams and the Dysart Seams. Seam splitting is prevalent along the length of the lease making modelling complex, with a general trend to split to the north and also down dip. Seam naming in the region is based on the seam position around the P Tuff, a 1 to 2 m thick regional marker.

In descending stratigraphic order the seams are briefly described as follows:

- The S seam is the highest seam stratigraphically and is considered to be the basal seam of the Fort Cooper Coal Measures. It is 3 to 4m thick with high inherent ash and numerous claystone partings, and is modelled as S01. The R seam is 1 to 2 m thick and has a high inherent ash content and is modelled as R01. These two seams are rarely found in the lease and only at the eastern margins.
- The Q seam comprises several coal intervals modelled as Q01, Q02, Q03 with a cumulative thickness of 2 to 3.5m. Through much of the project area, the Q seam is un-split (Q01), splitting in the central part of the area into Q02 and Q03.
- The P seam is together as one seam in the south and splits to the north. One stringer splits low to attach near the H162. The 3 major P seam units are modelled as P02, P07 and P08 and are named due to the association with the P Tuff that is consistent through this part of the Bowen Basin. P07 and P08 splits are present in most of the Caval Ridge project, with unsplit P02 occurring near the P seam limit of oxidation (LOX) in the southern and central part of the Caval Ridge Project.



N

0 1.25 2.5km

Scale 1:100 000 (A4)

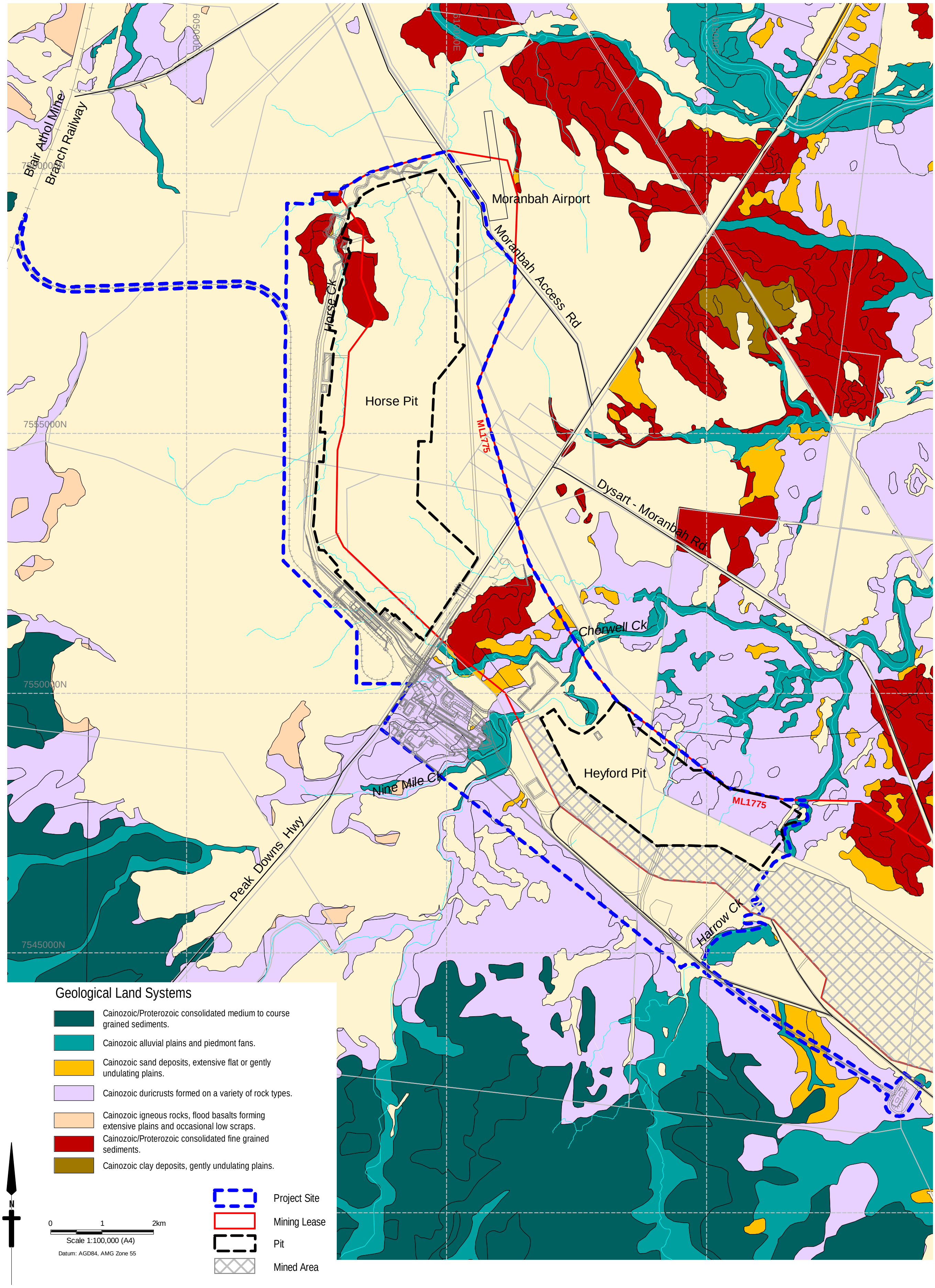
Datum: AGD84, Zone 55

Legend
Project Site
Mining Lease
Major Contour
Minor Contour (Interval 5m)

Source: DCDB Oct2008; 250th Geodata; Client Supplied Survey Data 2008

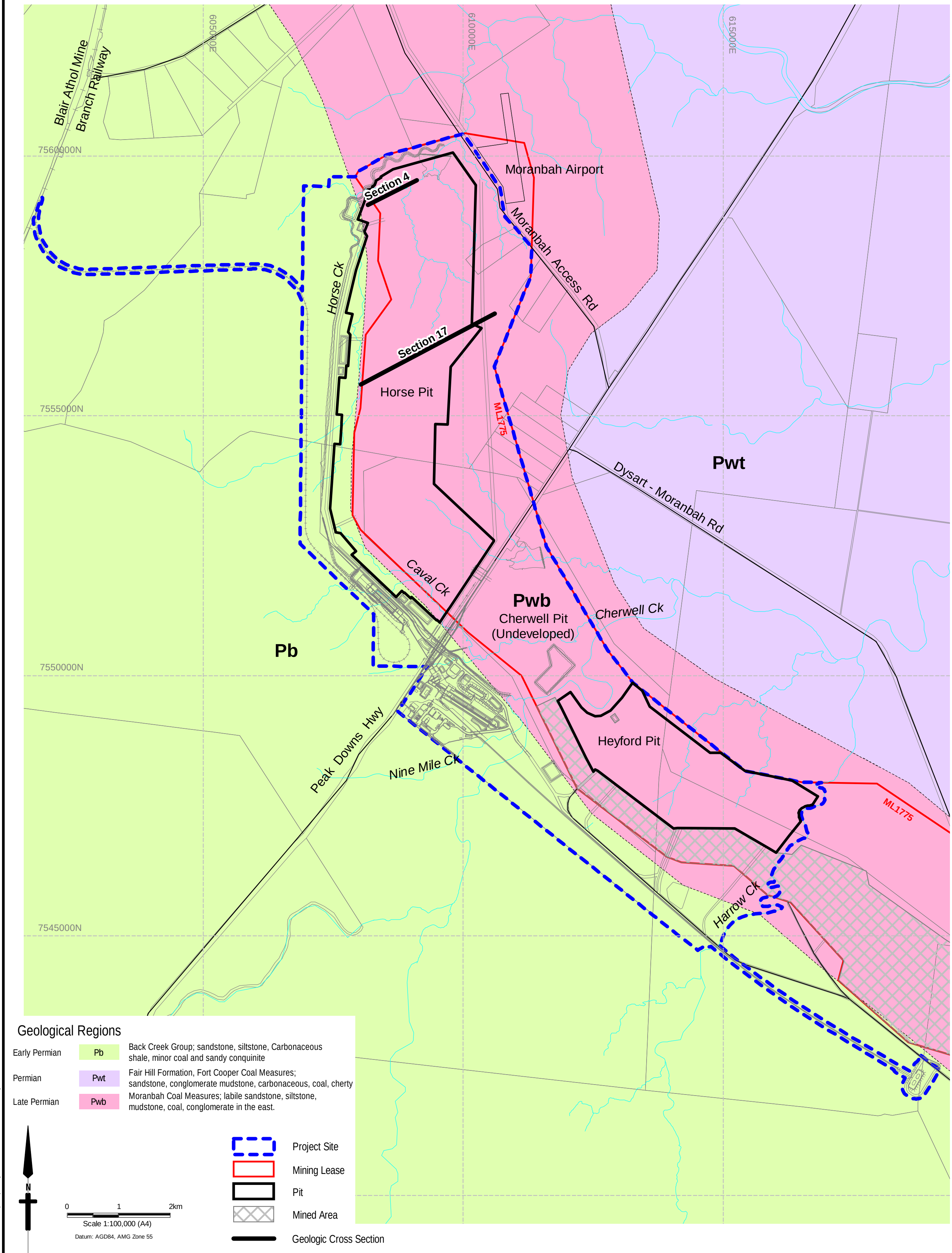
Client	Project	Title
BMA BHP Billiton Mitsubishi Alliance URS	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	**EXISTING TOPOGRAPHY**

Drawn: VH	Approved: RS	Date: 08-05-2009	Figure: **4.9**	Rev:A
Job No: **4262 6158**	File No: 42626158-g-513.wor			**A4**



Source: Qld EPA, RE Mapping Ver5, August 2008

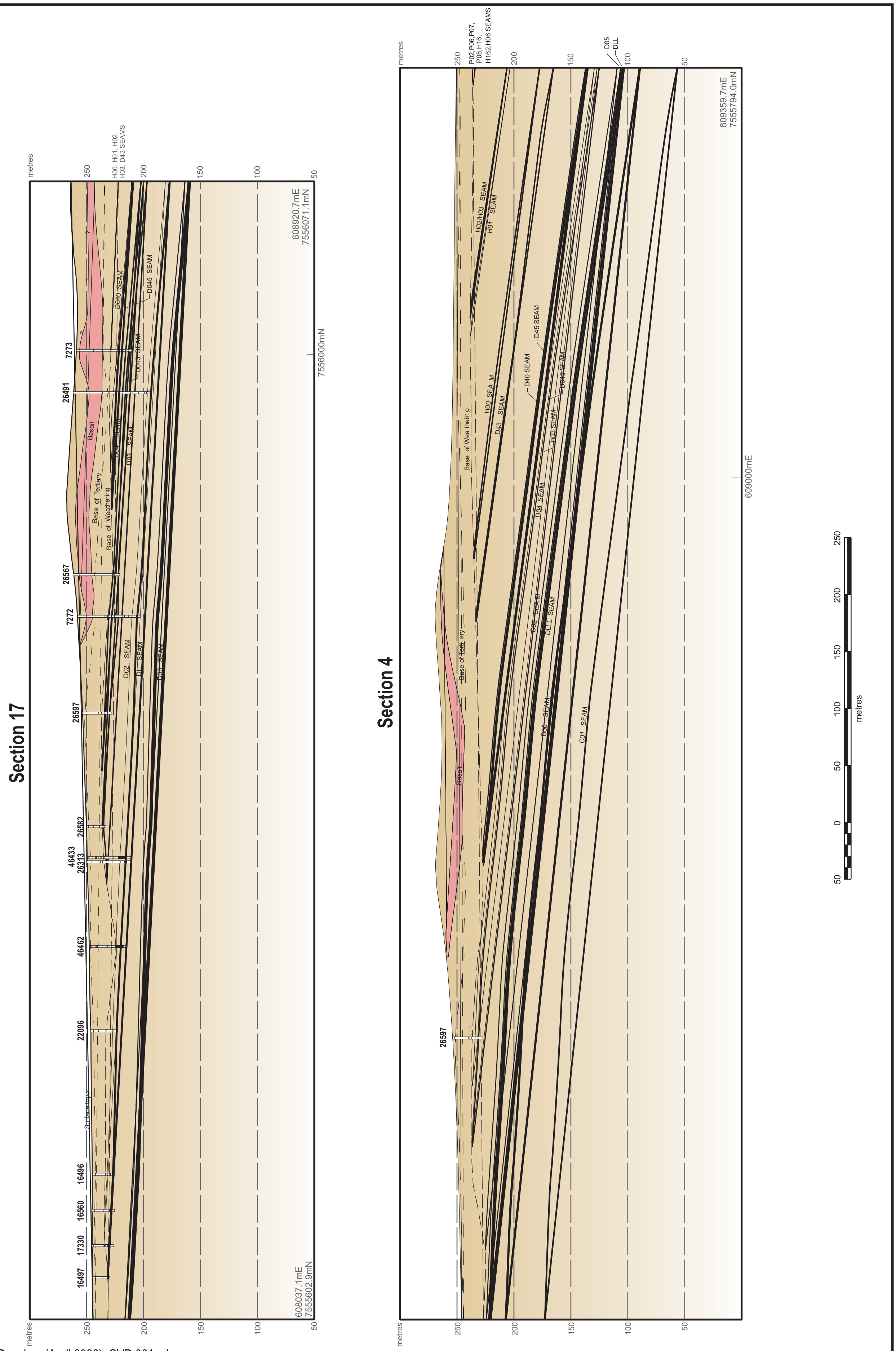
Client	Project	Title
BMA BHP Billiton Mitsubishi Alliance URS	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	**GEOLOGICAL LAND ZONES**
	Drawn: VH / Approved: RS / Date: 08-05-2009	Figure: **4.10** / Rev:B
	Job No: **4262 6158** / File No: 42626158-g-530b.wor	A4



Source: Qil Geological Mapping Data (2008)

Client	Project	Title
BMA BHP Billiton Mitsubishi Alliance URS	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	**GEOLOGY AND LOCATION OF GEOLOGIC CROSS SECTIONS**

Drawn: VH	Approved: RS	Date: 08-05-2009	Figure: **4.11**
Job No: **4262 6158**	File No: 42626158-g-529b.wor		Rev:B A4



Source: BMA Supplied Drawing (April 2008) CVP-001.cdr

Client	Project	Title
BMA BHP Billiton Mitsubishi Alliance	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	GEOLOGIC CROSS SECTIONS
URS	Drawn: VH / Approved: RS / Date: 08-05-2009 Job No.: 4262 6158 / File No. 42626158-g-612.cdr	Figure: 4.12 / Rev. A / A4

- The Harrow Creek group of seams is up to 12m thick and where fully coalesced is modelled as the H13 in the Harrow Pit in the centre of the Peak Downs Mine. From there it splits both to the north and south into a major separation as the Harrow Creek Upper, H16 and Lower, H15.
- Through most of the Caval Ridge Project area the Harrow Creek Upper sequence splits into the H161 and H162. The H161 always has a poor quality band at its base. This band, H06, is actually the upper ply of the Harrow Creek Lower sequence, which splits off the top of the Harrow Creek Lower and sits just beneath the Harrow Creek Uppers. As the Harrow Creek Lower seams develop to the north, six separate units split from the primary Harrow Creek Lower, which is modelled as H15. H08 and H00 split apart the H15, and then the H08 splits into H06 and H01. H00 occurs consistently through Caval Ridge Project area, with an average thickness of around 1.2m. At the northern extent of the current mining area and through into the Caval Ridge Project area, the H01 splits to H03 and H02. These splits merge back into the H01 (approx. 2.5-3m thick) in the northern part of the Caval Ridge Project.
- The Dysart Upper seam attains a maximum thickness of 3.5m where fully coalesced and is modelled as D47 but splits into multiple units at both ends of the lease. In the Caval Ridge Project area D47 splits to D43, D40 and D45. D43 and D40 shale out to the north D45 is identified through most of the Caval Ridge Project area, however it is often less than 0.3 m thick. None of these seams provide economic thicknesses except where their proximity to D04 enables it.
- The primary Dysart can be a single seam that reaches 5 m in thickness, and is then modelled as D05. North of Heyford Pit, it is divided quickly into 2 major splits over most of the project area. The D05 splits into D02 and D04 with further splitting off the bottom of the D04 forming the minor D03 seam. The D02 is generally stable but banding develops in some areas. The DL seam is a consistent 60 cm band that correlates under the D02 through most of the area. Two additional coaly bands sitting below the DL have been identified and modelled. These have been named the DLL (approx. 20 cm thick) and DLLL (10-20 cm thick).
- Two seams identified below the D02 have been named the D00 and C01 seams and a focus on their correlation from recent exploration programs has helped determine their extent. The D00 sits around 20 m below the D02 through much of the Caval Ridge Project area. It averages 1 m thick, but does thicken to 2.0 m in places. At this time, initial quality results indicate a high ash coal and poor yielding seam. C01 occurs 50-55 m below the D02 and is about 1 m thick. It has only been identified in a handful of drillholes. No quality data is currently available for the C01.

4.3.3 Geological structures within the area of disturbance

4.3.3.1 Regional

At the end of coal deposition in the late Triassic, the Bowen Basin was subject to significant tectonic compression from the eastern side with major thrust faulting creating the present commercial coal deposits. The regional dip in the area is 3-6 degrees though the northern extension of the Peak Downs Mine shows considerable deformation with strata dipping to 11 degrees and along strike flexures in excess of 10 degrees. Faulting and seam splitting is common, producing local steepening of the coal seam dips to over 20 degrees. The area has been influenced by several stages of structural deformation, including an extensional phase resulting in normal faulting and igneous intrusion in the form of sills and dykes, with a final late Cretaceous to early Tertiary compressional phase that resulted in thrusting and reversed re-activation of normal faults and a regional horizontal stress field.

4.3.3.2 Project Specific

Faults through the Northern and Southern Peak Downs models have been identified and modelled in 2005. Several major faults with throws up to 40 m have been identified in these areas. Faults in the Caval Ridge Project area were modelled. Most are high angle normal faults with 3 major trend directions:

- east-west – generally smaller scale nested faults, low deformation faults increasing in number to the south through Yura Pits (southern section of Peak Downs Mine). Likely compressional in nature.
- northeast – southwest – smallest of frequency but can have throws in excess of 25 m. The shallow northeast – southwest oriented folding or warping is thought to predate most faulting events.
- north-south – less frequent but largest structural impact across Peak Downs Mine.

The Caval Ridge Project area has an area of structural disturbance on the northern edge of the Cherwell Creek pit structures. The Cherwell Pit area is delineated by a series of large rolls that flex the seams from dips of 10 degrees in the south, through 30 degrees in the middle of the pit and back over a short distance to 8 degrees in the north as the Pit changes to the dragline operated Horse Pit. It should be noted that while Cherwell Pit (undeveloped) is identified in the geological description, this pit will not be developed as part of this project and any future development will be subject to the appropriate assessment and environmental approvals at that time.

4.3.4 Geological factors that may influence ground stability

The remains of Tertiary basalt flows overlay the Permian sequence in several places in minor occurrences that have generally weathered to clay profiles. An example of this is currently visible in the Heyford Pit highwall. The regional model is of generally 3 m flows intertwining to produce surface features with a mix of fresh and weathered basalt. The quarry to the north of the Moranbah airport shows the typical profile of these surface flows. An electro magnetic survey has been run over the Caval Ridge Project box cut area to attempt to delineate the Tertiary clay aureole from the original basalt flows. Further work is currently being finalised to filter this information and apply to the geological model of the area.

Minor faulting from the larger regional tectonic influences occurs in most pits within the Peak Downs Mine and throughout the seams in the Caval Ridge Project area. An area of critical disturbance and displacement is obvious in the Winchester Fault in Winchester Pit (Peak Downs Mine). Vertical displacement along faults ranges from several metres in the minor faults to the more serious impact of 36 m for the Winchester Fault. The coverage of drillholes in the Caval Ridge Project area would suggest that the likelihood of a regional scale fault is unlikely, however a seismic program will be run over the most disturbed area to attempt to define the disturbance better.

4.3.5 Geochemical information for the area to be mined

As part of the EIS process a geochemical characterisation and assessment of waste rock was completed for the project site (Section 5). The program focussed on acquiring representative samples of the main overburden, interburden and potential reject material types (sandstone, siltstone, carbonaceous siltstone and mudstone). Seventy four samples were collected and analysed from seven drillholes. The interburden and overburden were taken from chip samples associated with the exploration program of the time. Figure 5.1, shows the location of the holes that samples were collected from.

4.3.6 Summary of exploration process and results

Exploration has been intensively carried out in this area near Moranbah since the 1960's, The drilling by the Queensland government and the Utah Development Company resulted in the development of the Peak Downs Mine in 1972. A large geological database has been accumulated over the full extent of ML1775 with more than 9,000 exploration boreholes drilled since 1966 and 2,000 of these over the area north of the active Heyford Pit area.

Two exploration programs in the Caval Ridge Project area have completed 420 holes in the last four years centring on coal quality acquisition and the identification of lines of oxidation and structural anomalies for box cut risk minimisation.

The recent programs have delineated the resource to indicated status across the existing lease area and measured status over the initial boxcut area and payback period footprint. A large diameter bulk sample program was initiated to provide data for the design of a preparation plant. These holes are spaced 2 km apart along the length of the project area.

Geotechnical holes were drilled on the footwall of the proposed boxcut to quantify roof and floor strengths and better understand the relationship with basalt contacts, clays and the coal roof. Two typical cross sections are presented in Figure 4.11 and Figure 4.12 shows where the sections are taken from across the deposit.

4.3.7 Coal Analysis

Exploration core holes are planned at 500 m spacing to provide JORC qualified Measured Status data for coal Reserves and at 1,000 m spacing to calculate Indicated Resource volumes. Both slim core and large diameter core have been drilled at Peak Downs for analysis to predict raw and product quality parameters. Holes have been drilled to 300 m centres in areas of structural or coal quality complexity to provide more information for the mines coal-scheduling database.

When a core hole is planned the seam will initially be sampled as raw ply. The initial raw analysis is validated and assessed by a geologist who then provides instruction to the lab on washability analysis requirements for a working section. Generally at Peak Downs raw ply are initially analysed for raw ash, relative density, moisture holding capacity and inherent moisture. The sample is then crushed to –12.7 mm and the +0.5 mm sizing is washed at Floats 1.35, 1.40, 1.45, 1.50, 1.55, 1.60 and 1.80. A standard Peak Downs Froth analysis is completed on the –0.5 mm material. Then the cumulative Float 1.50 sample is combined with the 9.5% ash froth and analysis for proximate, ultimate, fluidity, dilatation, ash analysis, petrographics, crucible swell number (CSN), total sulphur and phosphorus is completed.

Core recoveries for coal seam intersections are deemed acceptable only where the core recovery, as measured against the geophysical logs, is 95% by volume or better. If the core recovery fails this, the intersection is re-drilled at the contractor's expense.

4.3.8 Metallurgical and Environmental Consideration

4.3.8.1 Coal Characterisation

Peak Downs is a single product, premium quality, hard coking coal that is derived from a blend of the Dysart and Harrow Creek seams. In the future, Harrow Creek seams will assume a larger proportion of the blend. The typical properties of the Peak Downs product are presented in Table 4.3.

The principal determining coal quality parameters in the Peak Downs area are phosphorous, volatile matter, total sulphur, fluidity and yield. Customers place particular emphasis on phosphorous specifications and pit blending is used as the major control to maintain uniform consistency of quality. The quality "hot spots" are generally well defined ahead of production by the 300 m spaced coal quality holes.

Table 4.3 Typical Coal Properties in Peak Downs Mine

Typical Coal Properties	Peak Downs Mine
Chemical Analysis	
Moisture (ad) %	1.0
Total Moisture (ar) %	9.5
Volatile Matter (ad) %	20.5
Ash (ad) %	9.7
Sulphur (ad) %	0.60
CSN (FSI)	8.5
Phosphorus (incoal) %	0.035
Alkali (inash) %	1.3
RuhrDilatometer	
Softening Temp (°C)	405
Max Concentration Temp (°C)	435
Max Dilatation Temp (°C)	480
Max Contraction %	22
Max Dilatation %	+80
Gieseler Plastometer Initial Softening Temp (°C)	425
Max Fluidity Temp (°C)	470
Resolidification Temp (°C)	505
Plastic Range	80
Maximum Fluidity (ddpm)	350
Petrographic Analysis	
Vitrinite Type %	V12-5
%	V13-48
%	V14-42
%	V15-5
Mean Max Reflectance of Vitrinite (%)	1.4
Maceral Composition Vitrinite (%)	68
Exinite (%)	0
Semi-fusinite (%)	18
Other Inertinite (%)	9
Mineral Matter (%)	5
Size Analysis	
Minus 50mm (%)	100
Minus 25mm (%)	90
Minus 0.5mm (%)	27
Coke Properties	
MicumM40	84
MicumM10	7
ASTM – Stability	62
JIS – Drum Index 30/15	95
NSC – Coke Strength After Reaction	74
Pilot Coke Oven / Wall Pressure (psi)	<0.5
Rev Date: 13 December 2001	

4.3.8.2 Coal definition

The Caval Ridge exploration program has collected coal quality samples on a broad product parameter to allow for basic value analysis on raw data to find a product fit for these specific seams. The expected dominant product will be a hard coking coal that is derived from a blend of the Dysart and Harrow Creek seams. In the Caval Ridge Project area it is possible that Q and Harrow Creek seams will assume a larger proportion of the blend.

The principal coal quality parameters in the Caval Ridge Project area are ash, phosphorous, volatile matter, total sulphur, fluidity and yield. The rank of the coal within the Caval Ridge Project area is similar to the main Peak Downs Mine coals. Low yields are present in historical data and inherent ash increase along with increased banding due to seam splits also appear responsible for this.

Samples are sized and washed for determination of clean coal properties. Several modifications have been made to the sizing and testing procedure over time, notably in 1997 to reflect changes in the coal preparation plant following the installation of Jameson cells.

Washability data is stored in the GBis database on a ply by ply basis and imported into the Vulcan Isis database for modelling. The Vulcan Isis database is used to create coal quality mapfiles for gridding purposes, and a washability database to derive underground working sections.

The following brightness graphic of the major seams over the project area shows the banded characteristics of the seams (**Figure 4.13**).

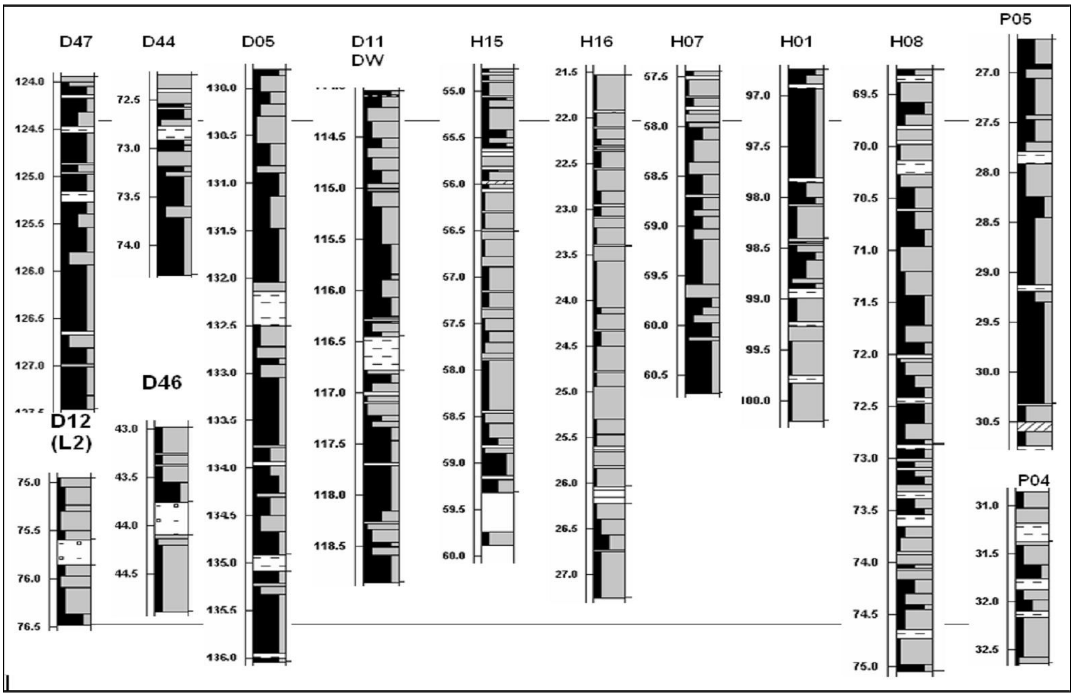


Figure 4.13 Major Coal Seams- Banded Characteristic

4.3.8.3 Modelling procedures

Mapteks Vulcan software was used for the geological modelling of the Caval Ridge Project area. Models are created using a series of modelling scripts that are run in T shell. The structural model is generated using triangulation algorithms. Mapfiles are created to produce point data on structural and quality parameters.

The fixdhd interpolator is run to interpolate daughter seams from parent seams and intercepts in holes where the seam does not exist due to a variety of reasons. This is mainly due to subcrop or the hole not drilled sufficiently deep. The interpolator also estimates the seam roof or floor for the holes listed to be nullified (seams intercepts that have either an unreliable roof or floor due to faulting, LOX thinning etc). These files are then used to build the stratigraphic model from which thicknesses of seams and midburdens are calculated basically from the basal marker upwards.

The model was independently audited in 2008 to check process and geological validity.

The property reserves option of the Vulcan Grid Reserves Utility (RSVUTE) was used to calculate resources. This option allows polygons divided by JORC status and depth to be intersected with polygons divided by tenement, pit and seam.

4.3.8.4 Classification of Resources

The classification of coal resources into Measured, Indicated or Inferred used the following criteria, as recommended in the Coal Guidelines:

- Measured coal resources have been estimated using points of observation up to 500 m apart and extrapolated no more than 250 m.
- Indicated coal resources have been estimated using points of observation up to 1,000 m apart and extrapolated no more than 500 m.
- Inferred coal resources have been estimated using points of observation up to 4,000 m apart. On the outer limits of the inferred resources, extrapolation was restricted to the last borehole data point or 500 m from the last point of observation, but no more than 2,000 m.

4.3.8.5 Resource statements

The resource statement for BMA FY2009 Coal Reserve Estimate JORC with Inferred Reserves Estimates - Caval Ridge Project, reserve numbers reported by Pit is presented in Table 4.4.

Table 4.4 Coal Reserve Estimate, JORC with Inferred Estimates, Caval Ridge Project FY 2009

Pit Name	Proved Tonnes (tonnes ROM)	Probable Tonnes (tonnes ROM)	Marketable Tonnes (tonnes sprd)	Total Tonnes
Horse	27,013,454	130,898,779	81,774,006	239,686,239
Cherwell	1,930,114	4,794,300	3,722,137	10,446,551
Heyford	46,349,821	84,709,648	67,091,844	198,151,313
			TOTAL	**448,284,103**
Inferred reserves	**Measured tonnes**	**Indicated tonnes**	**Inferred Tonnes**	**Total Tonnes**
Peak Downs Mine	231,681,197	594,859,299	699,666,510	1,526,207,007
Caval Pit (not incl Heyford Pit)	27,034,615	130,235,097	59,431,526	216,701,237

4.4 Soils

A soil survey and land resource assessment was undertaken in November 2007 to classify soil profile types, assess suitable topsoil material and identify the potentially hostile soil material within the project site. The survey was conducted in accordance with the survey methodology described in this section. The survey results are presented in Section 4.4.8.

4.4.1 Soils Mapping

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

4.4.1.1 Aerial Photographs and Topographic Maps

Aerial photographs and topographic map interpretation was used as a remote sensing technique, allowing detailed analysis of the landscape and mapping of features related to the distribution of soils within the project site.

4.4.1.2 Previous soil survey results

A number of previous studies have been undertaken in the area. Information sourced for this assessment was compiled from the following studies:

- GTES (2000) Peak Downs Mine Land Suitability and Capability Assessment of Mine Lease Areas
- GTES (2000) Wattle / Ripstone 1: 25,000 soils map
- NRA (1993) 1: 50,000 capability map
- Raine (1990) 1: 25,000 soils map
- Galloway et al (1967) 1: 500,000 Land Systems.

GTES (2000) Peak Downs Mine Land Suitability and Capability Assessment of Mine Lease Areas

GTES described 44 sites in 2000 to assist in the definition of land suitability for all Peak Down mining lease areas. This work focused on areas south of the Peak Downs Highway and represents a mapping scale of 1: 50,000. The area north of the Peak Downs Highway was initially mapped from air photographs into similar patterns with limited field checking by GTES in May 2000. Basically, soil units described in the area follow those of Galloway et al (1967) with mapping reconnaissance scale intensity at about 1: 250,000.

GTES (2000) – Wattle / Ripstone Soils

Approximately 1,000 hectares of soils in advance of the Peak Downs Mine Wattle and Ripstone Pits were mapped at a scale of 1: 25,000 by Graham Tuck of GTES (2000) which followed methods described by Gunn et al (1988) and the DME (1995). A total of 37 sites were described with representative soils sampled for detailed laboratory analysis. Five soil types were described:

- A1 – non-cracking clays of brigalow and associated species.
- A2 – cracking melanhole clays of brigalow and associated species.
- B1 – texture contrast soils of brigalow, eucalypt woodlands.
- B2 – sandy, texture contrast soils of eucalypt woodlands
- C1 – deep loamy sand recent alluvia.

Natural Resource Assessments (NRA) (1993)

Areas in advance of mining at Peak Downs Mine were assessed for land capability at 1: 50,000 scale using the work of Raine (1990) and CSIRO (Galloway et al, 1967) in addition to a further 13 field descriptions. NRA delineated a total of 14 soil units.

Raine (1990)

Steve Raine mapped areas in advance of Peak Downs mining in 1990 at a sampling scale of 1: 25,000. He described 60 sites from which the following soils were isolated:

- Two black and brown self mulching clays on basis of soil depth.
- Five duplex soils on the basis of depth of A horizon and reaction trend.
- Earthy sands and loams.

Isaac-Comet Land Systems (Galloway et al 1967)

CSIRO (Galloway et al, 1967) mapped land systems at a scale of 1:500,000 for the Isaac-Comet area which included all ML areas currently designated for the Peak Downs Mine. Land systems mapped in the project site and soil units identified are summarized in Table 4.5. Electronic soils data for the project site was also referenced from the Interactive Resource and Tenure Map (IRTM) webGIS, available through the DERM website. These surveys were referenced to gain an indication of likely soil units situated within the project site.

4.4.1.3 Stratified Observations

Following production of an approximate soil map, surface soil exposures throughout the potential disturbance areas were visually assessed to verify potential soil units, delineate soil unit boundaries and determine preferred locations for targeted subsurface investigations.

Table 4.5 CSIRO Land Systems and Units on the Project Site

Land Systems	Land Unit	Description
Connors	2 3	Deep sandy loam recent alluvia Texture contrast levees and floodplains – older alluvia
Daunia	5 1	Brigalow with associated species with cracking and non-cracking clays Sandy rises of Ironbark and polar box
Durrandella	1 3 4	Flat and undulating mesa tops up to 3% slope with uniform sandy and shallow soils Jump-ups, breakaways and low stony hills. Undulating, foot-slopes below mesas
Humboldt	3 4 5	Undulating plains of texture contrast soils with thin sandy surface over alkaline clays of brigalow, blackbutt and polar box Cracking and non-cracking soils with brigalow blackbutt Melanhole cracking clays of brigalow
Monteagle	3	Undulating plains and lowlands with texture contrast soils poplar box and ironbark
Oxford	1	Shallow cracking clays on basalt

Source: Galloway et al, 1967

4.4.2 Profiling

A total of 17 soil profile exposures were assessed at selected sites to enable soil profile descriptions to be made. These soil profile exposures were excavated with a backhoe. Soil profile site locations are shown in Figure 4.14. Sub-surface exposure locations were selected to provide representative profiles of the soil types encountered over the project site. The soil layers were generally distinguished on the basis of changes in texture and/or colour. Soil colours were assessed according to the Munsell Soil Colour Charts (Macbeth, 1994). Photographs of soil profile exposures were also taken. Numerous surface exposures were also assessed to confirm soil units and boundaries between different soils.

4.4.3 Field Assessment

Soil profiles within the project site were assessed generally in accordance with the soil classification procedures in the Australian Soil and Land Survey Field Handbook (McDonald et al, 1990). Soil layers at each profile site were also assessed according to a procedure devised by Elliot and Veness (1981) for the recognition of suitable topsoil material. This procedure assesses soils based on grading, texture, structure, consistence, mottling and root presence. This system remains the benchmark for land resource assessment in the Australian coal mining industry.

4.4.4 Laboratory Testing

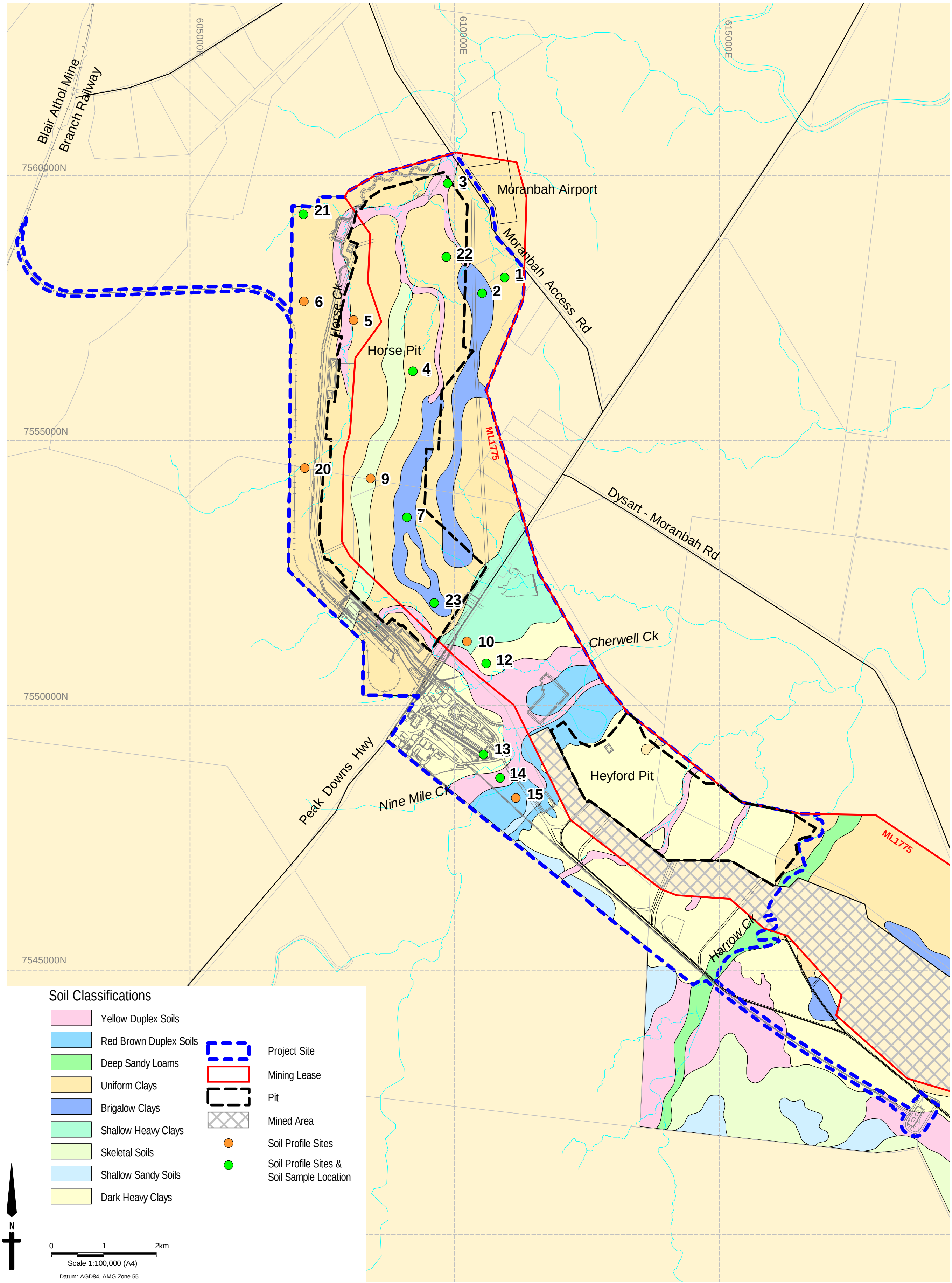
Soil samples were collected from the exposed soil profiles to a depth of less than 2 m below ground surface and subsequently despatched to the Department of Lands Soil and Water Testing Laboratory at Scone, NSW for analysis.

Samples were analysed to establish the geochemical suitability of surface and near-surface soil horizons as a potential growth medium, and identify high value or high risk soils. Samples were analysed from the sites shown on Figure 4.14. At each of these locations three soil samples were analysed including a surface horizon sample and two subsoil horizon samples. These samples were analysed for the following parameters:

- Particle size analysis
- Emerson Aggregate Test (soil aggregate slaking and coherence)
- pH
- Electrical conductivity (EC)
- Total nitrogen
- Available phosphorus
- Cation exchange capacity (CEC) and exchangeable cations.

Profiles 5, 6, 8, 9, 10 and 15 were not analysed as they displayed similar soil characteristics to previously sampled profiles.

A description of the significance of each test and typical values for each soil characteristic is included in Appendix F, Section 2.5. The laboratory test results were used in conjunction with the field assessment results to determine the depth of soil material that is suitable for recovery and use as a growth medium in rehabilitation and to identify potentially hostile material. The soil test results for the soil survey are provided in Appendix F, Section 3.



Source: DCDB Oct2008; 250th Geodata; Graham Tuck (May 2000) & GSS Environmental 2008

Client: BMA — BHP Billiton Mitsubishi Alliance	Project: CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	Title: **SOIL CLASSIFICATION AND SAMPLING LOCATIONS**
URS	Drawn: VH / Approved: RS / Date: 08-05-2009	Figure: **4.14** / Rev:B
	Job No: **4262 6158** / File No: 42626158-g-531b.wor	A4

4.4.5 Land Capability Assessment

The project site was assessed in accordance with Rosser et al (1974) for pre-mining land capability. The system includes eight possible classifications and refers to the overall agricultural potential of the land. The various classes are provided in Table 4.6 and illustrated on Figure 4.14.

Table 4.6 Land Capability Classes

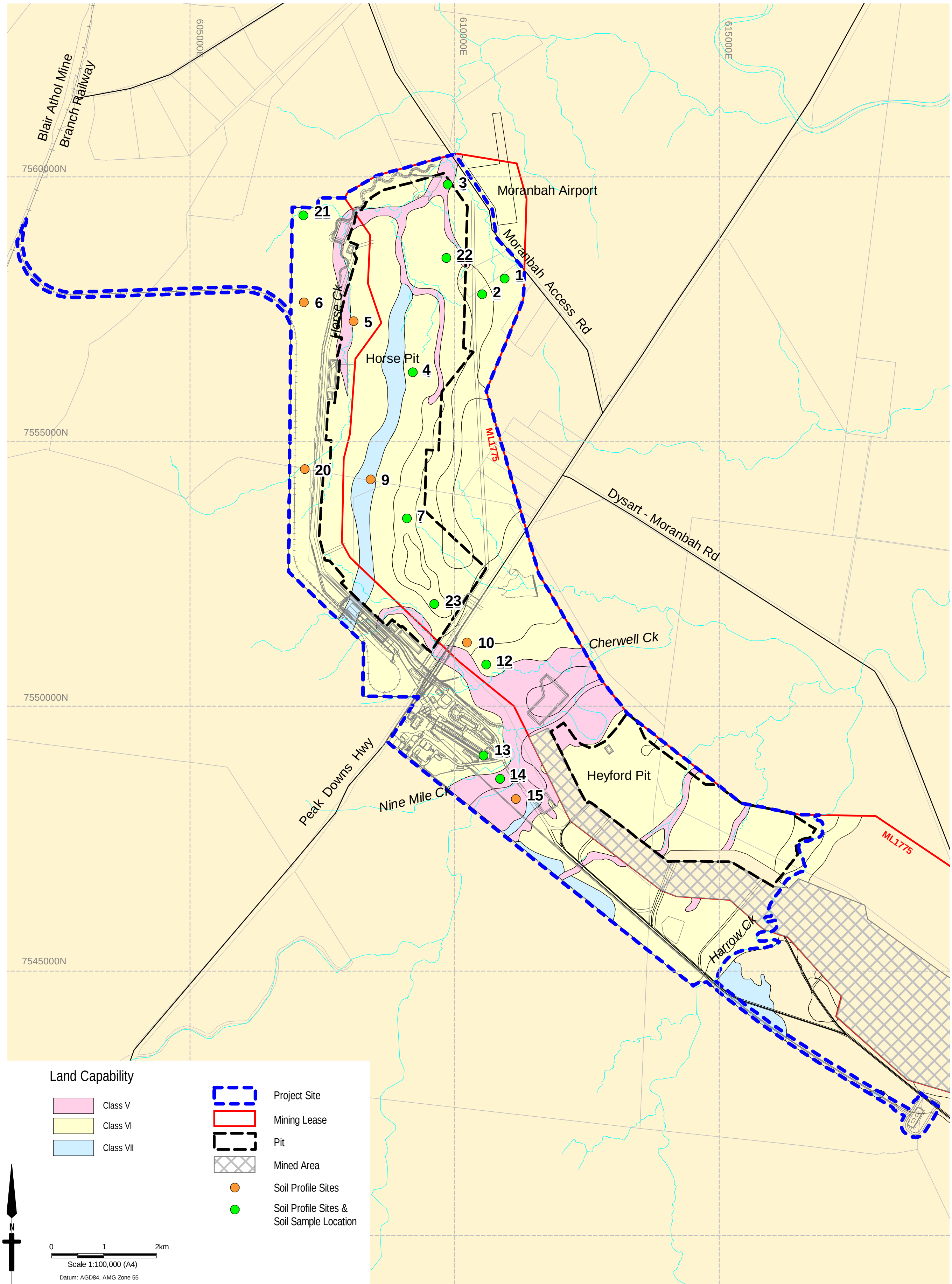
Category	Class	Description
Suitable for Cultivation	Class I	No special practices required.
	Class II	Simple management practices required.
	Class III	Complex or intensive practices required to sustain cropping.
	Class IV	Occasional or limited cultivation but with severe management inputs required to prevent degradation.
Not Suitable for Cultivation	Class V	Suitable soil and topography for crops but economically not viable. High quality grazing land.
	Class VI	Moderately susceptible to degradation requiring proper management to sustain use.
	Class VII	Highly susceptible to degradation requiring severe restrictions on use; grazing may be conducted with rigorous management inputs required to prevent degradation.
Not Suitable for Grazing	Class VIII	Wildlife reserves, bushland, recreation or water supply catchments.

4.4.6 Land Suitability Assessment

Agricultural land suitability of the project site has been assessed largely using criteria provided in the Guidelines for Agricultural Land Evaluation in Queensland (Queensland Department of Primary Industries, Land Resources Branch, 1990).

The method of land suitability assessment takes into account a range of factors including climate, soils, geology, geomorphology, soil erosion, topography and the effects of past land uses. The classification does not necessarily reflect the existing land use. Rather, it indicates the potential of the land for such uses as crop production, pasture improvement and grazing.

The system allows for land to be allocated into five possible classes (with land suitability decreasing progressively from Class 1 to Class 5) on the basis of a specified land use that allows optimum production with minimal degradation to the land resource in the long term.



Source: DCDB Feb2009; 250th Geodata; Graham Tuck (May 2000) & GSS Environmental 2008

Client	Project	Title	
BMA BHP Billiton Mitsubishi Alliance URS	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	**LAND CAPABILITY**	
	Drawn: VH / Approved: RS / Date: 08-05-2009	Figure: **4.15**	Rev:B
	Job No: **4262 6158** / File No: 42626158-g-533b.wor		A4

Land is considered less suitable as the severity of limitations for a land use increase. Increasing limitations may reflect any combination of:

- Reduced potential for production.
- Increased inputs to achieve an acceptable level of production.
- Increased inputs required to prevent land degradation.

The agricultural land suitability classes are described in Table 4.7.

Table 4.7 Agricultural Land Suitability Classes

Class	Agricultural Description	Conservation Description
Class 1	Land with negligible limitations, which is highly productive requiring only simple management practices to maintain economic production.	Areas well suited for conservation uses must possess significant conservation benefits in the pre mining environment and be capable of being returned to that use post mining.
Class 2	Land with minor limitations which either reduce production or require more than the simple management practices of Class 1 land to maintain economic production.	Areas are suited to conservation use that a significant component of re mining conservation values can be restored post mining. There will however be some loss in conservation values where soil terrain or hydrogeological post-mining conditions may inhibit the full replication of the pre-mining values.
Class 3	Land with moderate limitations which either further lower production or require more than those management practices of Class 2 land to maintain economic production.	Land contains significant conservation values pre mining, however, restoration of all of these values may not be feasible. These areas could however, be restored to a form of conservation use which provides alternative conservation benefits.
Class 4	Marginal lands with severe limitations which make it doubtful whether the inputs required achieving and maintaining production outweigh the benefits in the long term (presently considered unsuitable due to the uncertainty of the land to achieve sustained economic production).	Lands may contain a limited conservation value pre mining and/or are incapable of being effectively restored post mining to any alternative conservation use which provides similar benefits. The area could however be restored to provide a stable form of use which does not impact on surrounding conservation values.
Class 5	Unsuitable land with extreme limitations that preclude its use for the proposed purpose.	Lands contain no significant conservation values.

4.4.7 Good Quality Agricultural Land

The project site, and immediately surrounding land, were also assessed to identify potential Good Quality Agricultural Land (GQAL) in accordance with the Guidelines for the identification Good Quality Agricultural Land (Qld DPI & DHLG&P, 1993) (referred to as the Good Quality Agricultural Land guidelines). Agricultural land is defined as land used for crop or animal production, but excluding intensive animal uses (i.e. feedlots and piggeries). GQAL is land which is capable of sustainable use for agriculture, with a reasonable level of inputs, and without causing degradation of land or other natural resources. The DPI guidelines have been introduced to provide local authorities and development proponents with a system to identify areas of good quality agricultural land for planning and project approval purposes. Descriptions of the agricultural land classes are provided in Table 4.8. The current NRW GQAL mapping is illustrated on Figure 4.16.

Table 4.8 Agricultural Land Classes

Class	Description
Class A	Crop land - Land that is suitable for current and potential crops with limitations to production which range from none to moderate levels.
Class B	Limited crop land - Land that is marginal for current and potential crops due to severe limitations; and suitable for pastures. Engineering and/or agronomic improvements may be required before the land is considered suitable for cropping.
Class C (Class C1 and C2)	Pasture land - Land that is suitable only for improved or native pastures due to limitations which preclude continuous cultivation for crop production; but some areas may tolerate a short period of ground disturbance for pasture establishment.
Class D	Non-agricultural land - Land not suitable for agricultural uses due to extreme limitations. This may be undisturbed land with significant habitat, conservation and/or catchment values or land that may be unsuitable because of very steep slopes, shallow soils, rocky outcrop or poor drainage.

4.4.8 Results

4.4.8.1 Soils

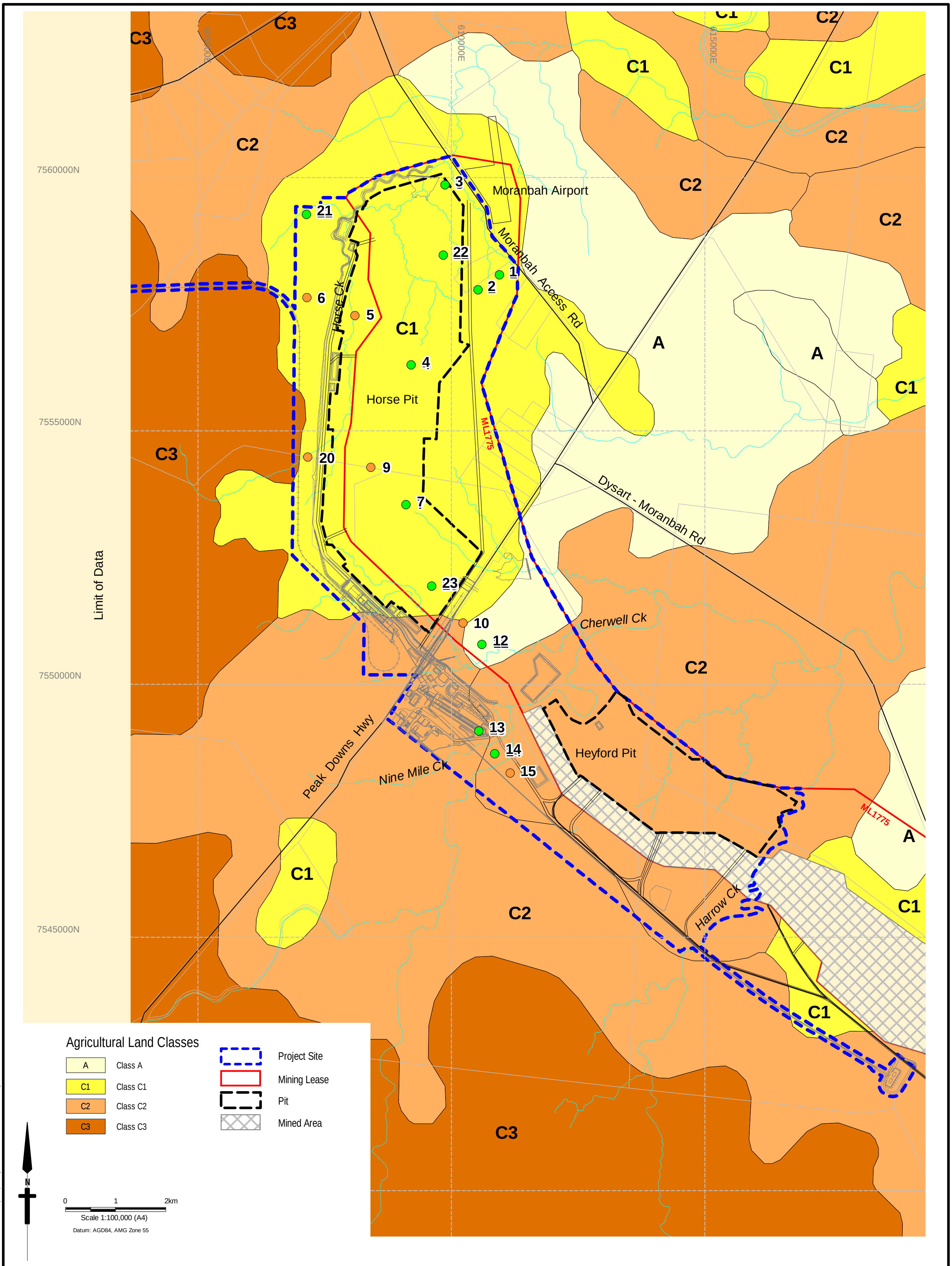
The following soil units were identified within the project site:

- Uniform Clays
- Yellow Duplex Soils
- Brigalow Clays
- Skeletal Soils
- Shallow Heavy Clays
- Dark Heavy Clays.

The distribution of these soils is illustrated in Figure 4.16. Exposed profiles of major soil units are shown below.

Uniform Clay

The soil unit occurs on the undulating plains which include minor areas of linear gilgai. This soil unit generally consist of yellowish and reddish brown to light brownish and reddish yellow uniform clays. Uniform soils display little textural change down the profile. This soil unit is associated in the north western areas of the project site. This soil unit encompasses approximately 41% of the project site. A representative profile of this soil unit is presented in Table 4.9. Figure 4.17 shows typical Uniform Clay profile.



Source: Qld Dept. NRW, Land Resources & Evaluation of the Capricornia Coastal Lands, 1995

Client	Project	Title
BMA BHP Billiton Mitsubishi Alliance	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	**GOOD QUALITY AGRICULTURAL LAND**
URS	Drawn: VH / Approved: RS / Date: 08-05-2009	Figure: **4.16** / Rev:B
	Job No: **4262 6158** / File No: 42626158-g-551b.wor	A4

Topsoil

The topsoil is approximately 15 cm in depth and light yellowish brown in colour. Textures include clay loam to light clay, with a weak to moderate platy to sub-angular blocky structure. Clay content varies between 17% and 39%. Emerson ratings of between 2(1) and (3)1 indicate that this soil is moderately dispersive to slightly dispersive and generally stable. Some sites (e.g. 4 and 22) display high levels of stability with Emerson ratings of 6 and 8. The topsoil is non-saline (EC 0.04 to 0.32 dS/m) and generally slightly acid (pH 6.4-7.0).

Total nitrogen levels range from low (0.13%) to moderate (0.18%). Available phosphorus levels vary widely from very low (site 22 – 3 mg/kg) to low (site 4 – 9 mg/kg) to moderate (site 1 – 21 mg/kg). Total CEC is high. Exchangeable Na% is low. Calsium (Ca) and magnesium (Mg) are high whilst potassium (K) levels are low (site 4 - 0.2 me/100g) to high (site 22 - 1.7 me/100g). A sparse to consistent pasture grass cover (generally Buffel Grass dominated) was noted and root penetration was observed as many to common.

Subsoil

The lower boundary of the soil varied between 45 cm and 69 cm in depth. Subsoil colour is yellowish brown to brown and reddish yellow to yellowish red. Texture includes clay loams clays to clays. Structure is generally moderate and angular blocky or massive. The subsoils are moderately dispersible to generally stable (Emerson ratings of 4 to 2(1) and alkaline (pH 7.1 to 9). Clay content in the subsoils was between 29% and 44% and is non-saline to saline at depth (e.g. Site 1 has an EC of 1.71 ds/m in layer 3). Root penetration was noted as common to none and stone content is generally low.

Limiting Factors

Generally the Uniform Clay topsoil does not display any specific management risk related to potential disturbance during stripping. The clay subsoil is texturally and structurally unsuitable for stripping. Salinity levels and alkalinity increases with depth and are prohibitive with respect to supporting vegetation. The clay subsoils should not be recovered or used as a surface cover in rehabilitation, due to high clay content, massive structure, high salinity and alkalinity. The Uniform Clay topsoil is suitable for stripping to a depth of 15 cm. The topsoil is generally considered suitable as a surface cover in the establishment of vegetation.

Table 4.9 Uniform Clay Profile

Soil Unit: Uniform Clay		
Layer	**Depth (m)**	**Description**
1	0 – 0.15	Yellowish brown (10YR5/4) clay loam. Weak consistence, angular-blocky peds, 5-10 mm diameter. Many roots and nil stone content. The lower boundary is sharp and even to layer 2.
2	0.15 – 0.69	Yellowish brown (10YR5/4) clay loam. Moderate consistence, sub-angular blocky peds, 20-50 mm diameter. Roots noted as common and stone content minor. The boundary is clear to layer 3.
3	0.69 – 1.05+	Light yellowish brown (10YR6/4) clay loam. Strong consistence and massive. Stone and root content noted as nil.

Figure 4.17 Uniform Clay Profile

Table 4.10 and Figure 4.18 provide the red variant to the soil profile described above.

Table 4.10 Uniform Clay (red variant)

Soil Unit: Uniform Clay		
Layer	**Depth (m)**	**Description**
1	0 – 0.20	Reddish brown (7.5YR4/6). Moderate consistency and pedality. Angular blocky, 10-20 mm peds. Roots noted as many and 10-20% sub-rounded weathered stones 2-6 mm in diameter. Boundary is clear to layer 2.
2	0.20 – 1.05	Yellowish Red (5YR5/6) clay loam. Moderate consistence. Angluar blocky, 10-20 mm peds. Roots noted as many. Stone content 10-20%. Weathered stones 6-20 mm diameter. Boundary is clear to layer 3.
3	1.05 – 1.25+	Reddish yellow (7.5YR6/6) clay loam. Strong consistence and Apedal massive. No roots stone content 2-10%, 2-6 mm in diameter.

Figure 4.18 Uniform Clay (red variant) Profile

Yellow Duplex Soil

This soil unit is associated with the floodplain areas, and encompasses some 10% of the project site. The soil is characterised by dark yellow sandy and clay loam of varying depths. A representative and typical profile of this soil unit is presented in Table 4.11 and Figure 4.19.

Topsoil

The topsoil generally consists of a coarser textured surface layer, overlying a structured clay horizon up to 15 cm in depth. It is generally dark yellow to brown in colour. The structure of the fine layer is typically single grained, with the underlying horizon formed by moderate angular-blocky peds. Texture generally consists of loam to clay loam, with clay content of approximately 22% and sand content of 60%.

The topsoil is structurally stable, with an Emerson rating of 8/3(1), indicating a low potential for dispersion. The topsoil is generally of low salinity (EC of 0.09 dS/M) and slightly alkaline (pH of 7.1). Total nitrogen and available phosphorus levels are moderate (0.15% and 15 mg/kg, respectively). Total CEC is high. Exchangeable Na% is low. Ca, K and Mg levels are high. Stones were observed throughout some profile of this soil unit. The stones were generally rounded to sub-rounded and sedimentary in origin. Surface stone cover observed to vary between 2% and 20%. Surface vegetation generally consisted of Buffel Grass pasture. Root penetration in the topsoil was noted as common.

Subsoil

Yellowish brown subsoils show strong consistence and are massive in structure. Textures consist mainly of light clays, with clay content between 26% and 43%. The subsoils are non-saline (EC range of 0.04 to 0.15 dS/m) and alkaline (pH range of 8.5 to 9.1). Stabile subsoils indicate a low potential for dispersion, with Emerson ratings of 4 to 5. Root penetration in the soil was moderate in the initial subsoil to none low down and stone content was typically between 5-10%.

Limiting Factors

Generally the Yellow Duplex topsoil does not display any specific management risk related to potential disturbance during stripping. The lower level clay subsoil is texturally and structurally unsuitable for stripping. Alkalinity increases with depth and is prohibitive with respect to supporting vegetation. The lower clay subsoils should not be recovered or used as a surface cover in rehabilitation, due to high clay content, massive structure and alkalinity. The Yellow Duplex topsoil is suitable for stripping to a depth of 40 cm. The topsoil is generally considered suitable as a surface cover in the establishment of vegetation.

Table 4.11 Yellow Duplex Soils Profile

Soil Unit: Yellow Duplex Soils		
Layer	**Depth (m)**	**Description**
1	0 – 0.15	Dark yellow (10YR5/4) clay loam. Moderate consistence with angular-blocky peds, 5-10mm in diameter. Roots many and 2-10% weathered sedimentary stones 2-6mm diameter. Lower boundary is sharp to layer 2.
2	0.15- 0.45	Yellowish brown (10YR5/3) light clay. Strong consistence and massive. Roots few to common and 20%--50% weathered sedimentary stones, 2-6 mm diameter. Boundary is clear to layer 3.
3	0.45 – 1.45+	Yellowish brown (10YR7/4) light clay. Strong consistence and massive. Roots and stone content not noted.

Figure 4.19 Yellow Duplex Soil Profile

Brigalow Clays

The soil unit occurs on the lowlands and plains (up to 1% slope). These areas contain melanholes and normal gilgai. The soil is characterised by brown light to medium clays throughout the profile. The unit encompasses some 6% of the project site. A representative profile of this soil unit is presented Table 4.12. A typical Brigalow Clay profile is shown in Figure 4.20.

Topsoil

The topsoil consists of a fine surface layer, 10-15 cm in depth. It is generally light brown in colour with a weak platy structure. Clay content is approximately 25%. The soil is non-saline (EC of 0.17 dS/m) and moderately alkaline (pH of 8.0). Structurally the topsoil is generally stable with an Emerson rating of 3(1). Stones are minimal in the profile. Root penetration in the topsoil is common.

Subsoil

The boundary of the sub-soil varies in depth to approximately 40 cm. It is generally brown with moderate sub-angular blocky pedality and light clay texture. Clay content within the subsoil is approximately 37%. Below 100 cm the sub-soil becomes apedal massive. The subsoil is non-saline (EC of 0.11 dS/m) and moderately alkaline (pH of 8.9). With an Emerson Rating of 4 the subsoil does not exhibit dispersion potential. Few roots penetrate the subsoil and no stones were observed. Stone content increased below 100 cm depth, as weathered bedrock fragments were encountered.

Limiting Factors

Generally the Brigalow Clay topsoil does not display any specific management risk related to potential disturbance during stripping. The lower level clay subsoil is texturally and structurally unsuitable for stripping. Alkalinity increases with depth and is prohibitive with respect to supporting vegetation. The Brigalow Clay topsoil is suitable for stripping to a depth of 15 cm. The topsoil is generally considered suitable as a surface cover in the establishment of vegetation.

Table 4.12 Brigalow Clay Profile

Soil Unit: Brigalow Clay		
Layer	**Depth (m)**	**Description**
1	0 – 0.15	Brown (10YR5/3) light clay. Weak consistency and pedality. Platy <2 mm primary peds. Roots are common. Stone content <2%, weakly weathered sub-rounded stones, 2-6 mm diameter. Boundary is clear and wavy to layer 2.
2	0.15- 0.40	Brown (10YR4/3) light clay. Moderate consistency and pedality. Sub-angular blocky, 2-5 mm peds. Roots noted as few. Stone content 2-10%, weakly weathered sub-rounded stones, 2-6 mm diameter. Boundary is clear but uneven to layer 3.
3	0.40 – 1.10+	Brownish yellow (10YR6/6) light clay. Strong consistency and apedal massive. No roots. Nil stone content.

Figure 4.20 Brigalow Clay Profile

Skeletal Soils

This soil unit is characterised by shallow reddish brown stony clay soils associated with the steeper eroded side slopes and ridgelines throughout the project site. The soil unit encompasses some 3% of the project site. Description of the soil unit was based on surface observations and no samples were collected. A representative profile of this soil unit is presented in Table 4.13. A typical Skeletal Soil profile is presented in Figure 4.21.

Topsoil

The topsoil consists of a surface layer approximately 5-10 cm in depth. It is generally light reddish/brown with a weak angular-blocky pedal structure. Surface stones were generally observed over the surface of the soil unit. The stones were generally between 2-50 mm in diameter, rounded to sub-rounded and sedimentary in origin. Surface stone density was observed to vary between 10% and 90%. Root penetration in the topsoil was noted as common.

Subsoil

During excavation, refusal occurred at approximately 80 cm in depth. It is generally light reddish brown with a moderate angular blocky structure, going to massive below 45 cm.

Limiting Factors

Iron stone and other rock matter is well within the soil profile. Stripping is not recommended due to significant rock content.

Table 4.13 Skeletal Soils Profile

Soil Unit: Skeletal Soils		
Layer	**Depth (m)**	**Description**
1	0 – 0.10	Light reddish brown light clay. Weak consistency and pedality. Angular blocky, 5-10 mm peds. Roots noted as common. Stone content 10-20% sub-rounded weathered stones. Boundary is sharp to layer 2.
2	0.10- 0.45	Light reddish brown medium clay. Weak consistency and pedality. Angular blocky, 5-10 mm peds. Roots noted as common. Stone content 50-90% sub-rounded weathered stones. Boundary is clear to layer 3.
3	0.45 – 0.80+	Red/yellow medium clay. Strong consistency and apedal massive. No roots. High stone content matter, 50-90%, 20-60 mm diameter.

Figure 4.21 Skeletal Soil Profile

Shallow Heavy Clays

Shallow dark cracking clays occur on undulating plains and low hills within the project site. Description of the soil unit was based on surface observations and no samples were collected. The soil unit encompasses some 9% of the project site. A representative profile of this soil unit is presented in Table 4.14. A typical Shallow Heavy Clay profile is presented in Figure 4.22.

Topsoil

The topsoil consisted of a fine surface layer, 5-10 cm in depth. It is generally a very dark grey/black colour, with a crumby structure and heavy clay texture. Stones were noticeably minimal in the soil profile. Root penetration in the topsoil was noted as common.

Subsoil

The lower boundary of the subsoil varies in depth to approximately 70 cm. It is generally black with a moderate sub-angular blocky pedality and heavy clay texture. Below 100 cm, the structure becomes apedal massive. Few roots penetrate the subsoil and no stones were observed. Stone content increased below 100 cm depth, as weathered bedrock fragments were encountered.

Limiting Factors

Generally the Shallow Heavy Clay topsoil is marginally suitable for stripping due to high clay content, massive structure, high salinity and alkalinity. The Shallow Heavy Clay topsoil can be stripped to a depth of 10 cm. The topsoil is generally considered marginally suitable as a surface cover in the establishment of vegetation.

Table 4.14 Shallow Heavy Clay Profile

Soil Unit: Shallow Heavy Clay		
Layer	**Depth (m)**	**Description**
1	0 – 0.10	Dark greyish heavy clay. Weak consistence and weak pedality, with 2-5 mm crumby peds. Roots are common and 2-10% sub-rounded stones, 2-6 mm in diameter are present. The lower boundary is sharp and even to layer 2.
2	0.10- 0.70	Black and heavy clay. Moderate consistence and moderate pedaility. Sub-angular blocky, rough faced, 50-100 mm, peds. Roots are common and 2-10% stones, 2-6 mm diameter are present. The boundary is clear and wavy to layer 3.
3	0.70 – 1.20+	Grey white weathered sedimentary material.

Figure 4.22 Shallow Heavy Clay Profile

Dark Heavy Clay

The Dark Heavy Clay consists of heavy dark uniform clays, with a fine mulched surface layer, Given that the unit is a uniform soil, very little textural change down the profile occurs. Parthenium infestation was heavy in areas where this unit occurs. The soil unit represents 26% of the project site. A representative of this profile is presented in Table 4.15. A typical Dark Heavy Clay profile is presented in Figure 4.23.

Topsoil

The topsoil consists of a very fine textured surface layer, 5-10 cm in depth. It is generally a very dark grey/black colour, with a crumby structure and heavy clay texture. Clay content is approximately 58%. The soil is non-saline (EC of 0.14) and moderately alkaline (pH of 8.2). Structurally, the topsoil was stable with an Emerson Rating of 4. This indicates little potential for dispersion or surface hardsetting. Total nitrogen and available phosphorus levels are low (0.09% and 11 mg/kg, respectively). Total CEC is very high. Exchangeable Na% is low. Ca and Mg are very high whilst K levels are moderate. Stones were noticeably minimal in the soil profile. Root penetration in the topsoil was noted as common.

Subsoil

The initial boundary of the subsoil varies in depth to approximately 45 cm. It is generally black with a moderate sub-angular blocky pedality and heavy clay texture. Clay content within the subsoil is approximately 61%. Below 100 cm, the structure becomes apedal massive. Clay content increases to 67%. The subsoil is non-saline (EC of 0.12 dS/m) and moderately alkaline (pH of 8.7). With an Emerson Rating of 4 the subsoil does not exhibit any dispersion potential. Few roots penetrate the subsoil and no stones were observed. Stone content increased below 100 cm depth, as weathered bedrock fragments were encountered.

Limiting Factors

Generally the Dark Heavy Clay topsoil is marginally suitable for stripping due to high clay content, massive structure, high salinity and alkalinity. The Dark Heavy Clay topsoil can be stripped to a depth of 10 cm. The topsoil is generally considered marginally suitable as a surface cover in the establishment of vegetation particularly given that the surface horizon will contain a substantial seed bank of Parthenium which potentially could re-spread throughout the rehabilitated post mining landform if specific weed control practices are not implemented.

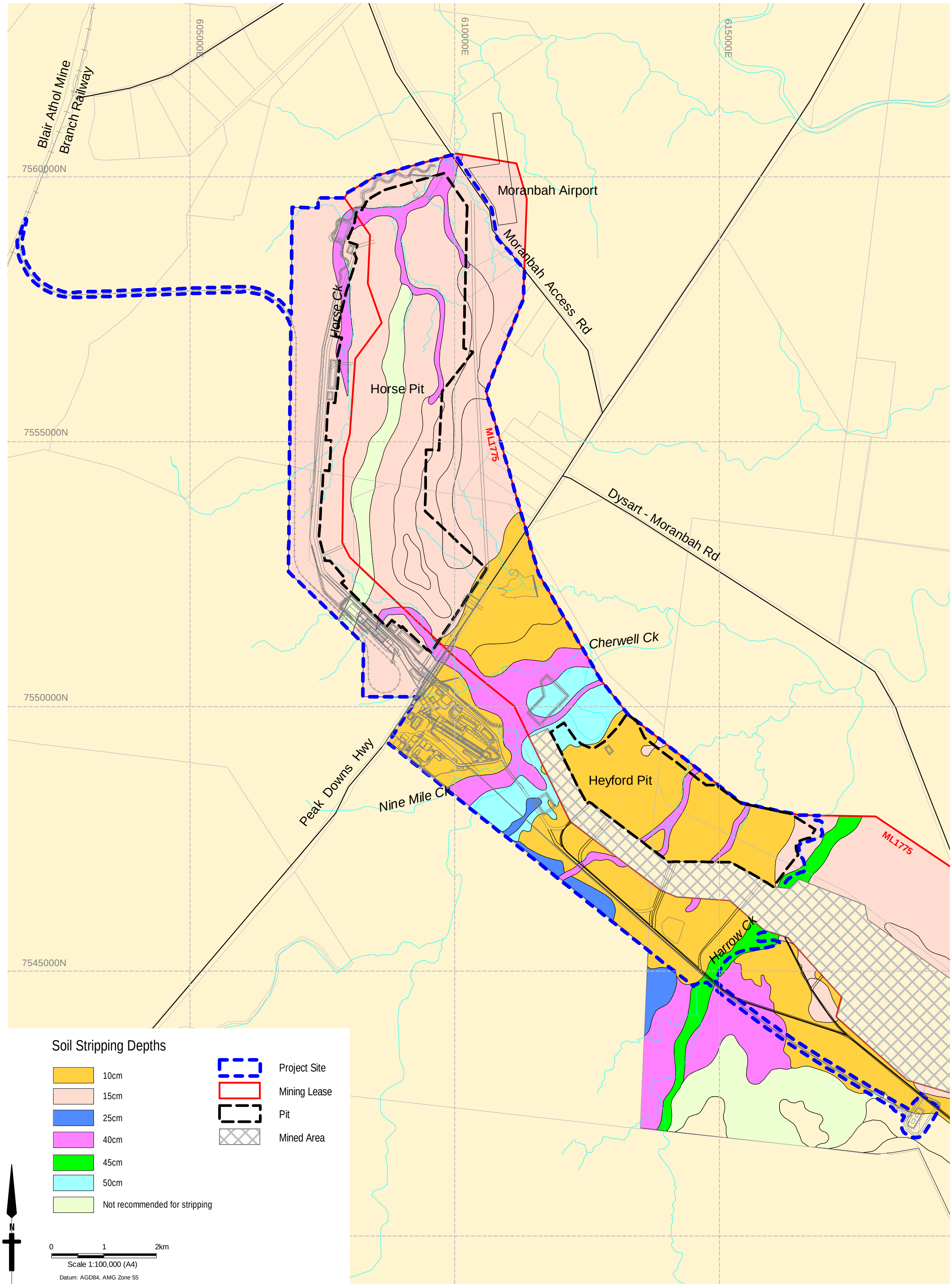
Table 4.15 Dark Heavy Clay Profile

Soil Unit: Dark Heavy Clay		
Layer	**Depth (m)**	**Description**
1	0 – 0.10	Dark greyish heavy (10YR3/1) clay. Weak consistence and weak pedality, with 2-5 mm crumby peds. Roots are common and 2-10% sub-rounded stones, 2-6 mm in diameter are present. The lower boundary is sharp and even to layer 2.
2	0.10 – 0.45	Black and heavy clay (10YR3/1). Moderate consistence and moderate pedaility. Sub-angular blocky, rough faced, 50-100 mm, peds. Roots are common and 2-10% stones, 2-6 mm diameter are present. The boundary is clear and wavy to layer 3.
3	0.45 – 1.25+	Black and heavy clay (10YR3/1). Strong consistence and apedal massive. No roots and stone content 2-10%, 2-6 mm diameter.

Figure 4.23 Dark Heavy Clay Profile

4.4.8.2 Topsoil Suitability

The major land disturbance is likely to result from excavation of the open cut pit, placement of out-of-pit overburden dumps and haul road and Caval Ridge MIA construction. It is recommended that topsoil be recovered in these areas of disturbance. Soil analysis results (Appendix F, Section 3) were used in conjunction with the field assessment (Appendix F, Section 2.4) to determine the depth or thickness of soil materials suitable for recovery. Structural and textural properties of subsoils are the most significant limiting factors in determining depth of soil suitability for re-use. However, salinity levels, pH and dispersion potential are also limiting factors in some soils in the project site. Indicative soil analyte levels with respect to soil suitability are shown in Table 4.16. Recommended topsoil depths for each soil unit are provided in Table 4.16 and are presented in Figure 4.24.



Source: DCDB Feb2009; 250th Geodata; Graham Tuck (May 2000) & GSS Environmental 2008

Client	Project	Title
BMA BHP Billiton Mitsubishi Alliance URS	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	**RECOMMENDED SOIL STRIPPING DEPTHS**
	Drawn: VH · Approved: RS · Date: 08-05-2009	Figure: **4.24** · Rev:C
	Job No: **4262 6158** · File No: 42626158-g-532c.wor	A4

Table 4.16 Soil Suitability Criteria

Structure	30% peds present coherent when wet or dry no mottle present
Texture	finer than sandy loam sand & gravel content < 60%
Dispersion	EAT > 2 (2) exchangeable Na% < 12%
pH	> 4.5 & < 8.4
Conductivity	< 1.5 dS/m

Table 4.17 Recommended Soil Stripping Depths for Soil Types

Soil Unit	Recommended Stripping Depth (cm)
Uniform Clays	15
Yellow Duplex Soils	40
Brigalow Clays	15
Skeletal Soils	Not recommended for stripping
Shallow Heavy Clays *	10
Dark Heavy Clays *	10
Shallow Sandy Soils	25
Red Brown Duplex Soils	50
Deep Sandy Loams	45

* High clay content material may benefit from mixing with a sandy textured material for use in rehabilitation.

4.4.8.3 Erosion Potential

Some of the Uniform Clay sites have indicated a moderate erosion potential with Emerson Aggregate Test ratings of 2 to 3, which indicates a moderate potential for dispersion and surface hardsettingness. Once this material is disturbed, the potential for erosion may be increased. If this disturbance occurs within the vicinity of a drainage line, this could impact on the health of downstream watercourses, through an increase in the sediment load. These soils should, therefore, be managed to ensure that the soils are not disturbed without suitable erosion and sediment controls being implemented. These measures include the construction of structural soil conservation works such as contour, graded and diversion banks and drop structures together with sediment control basins. The use of cover crops and/or organic ameliorants will reduce soil dispersion and surface crusting thereby reducing runoff and increasing infiltration which will subsequently reduce erosion and sedimentation.

4.4.8.4 Potential Acid Generating Material

The potential for acid generation from regolith material (topsoil and subsoil) within the project site is low. Acid generation potential of overburden (below 2-3 m depth) and rejects are discussed in the Section 5.2.1 (Mineral Waste).

Acid Sulphate Soils (ASS), which are the main cause of acid generation within the soil mantle, are commonly found less than 5 m above sea level, particularly in low-lying coastal areas such as mangroves, salt marshes, floodplains, swamps, wetlands, estuaries, and brackish or tidal lakes. The project site is located within the Central Highlands region (which is located approximately 150 km from the coast at > 260 m AHD). There has been little history of acid generation from regolith material within this region.

4.4.8.5 Land Capability

The majority of the project site has a Class VI land capability – not suitable for cultivation and is moderately susceptible to degradation requiring proper management to sustain the land use (Figure 4.15). Some Class V land (high quality grazing land) occurs adjacent to Cherwell and Caval Creeks. The land surrounding Horse Creek and its tributaries and two smaller creeks in the southern section of the project site have also been identified as Class V land capability.

The rocky hills and ridgelines, along with the highly eroded and Skeletal Soils, are considered to be Class VII - land that is highly susceptible to degradation requiring severe restrictions for use. Grazing may be conducted with rigorous management inputs required to prevent degradation. Class V, VI and VII lands are all grazing land classes and are not suitable for cultivation. The distribution of these land capability classes within the project site is presented in Figure 4.15.

4.4.8.6 Land Suitability

Pre-Mining

The project site is currently used for low intensity cattle grazing. As a result of this historical and current land use, there has been extensive tree clearing throughout the area. The land use is consistent with that of the adjoining land, which is also predominantly used for low intensity cattle grazing. Land suitability classes, with respect to both cropping and grazing are provided in Table 4.18 for each soil unit.

The majority of land within the project site is Class 5 land unsuitable for cropping. Some Duplex Soils in the vicinity of the northern end of the existing Heyford Pit are Class 4 lands that are extremely marginal for cropping. This includes the well drained areas of flat to gently sloping Duplex Soils. However, these areas comprise Class 2 land with respect to grazing (i.e. suitable for low intensity grazing, with minor limitations that lower production or require management practices). The remainder of the project site is Class 2 and 4 land with respect to grazing potential and is land that has either moderate limitations or is marginal grazing land.

Table 4.18 Land Suitability Classes

Soil Unit	Cropping	Grazing
Yellow Duplex Soils	5	3
Red Brown Duplex Soils	4	2
Deep Sandy Loams	5	4
Uniform Clays	5	2
Brigalow Clays	5	3
Shallow Heavy Clays	5	2
Skeletal Soils	5	4
Shallow Sandy Soils	5	4
Dark Heavy Clays	5	3

The majority of land within the project site is unsuitable for cropping. The Red Brown Duplex Soils are marginally suitable for cropping, however the inputs required to achieve and maintain production will generally outweigh the benefits of cropping this soil unit in the long term. Grazing suitability varies throughout the project site. Land with minor limitations includes areas containing Red Brown Duplex Soils, Uniform Clays and Shallow Heavy Clays. Land with Moderate limitations includes areas containing Yellow Duplex Soils, Brigalow Clays and Dark Heavy Clays and marginal grazing lands encompass the Deep Sandy Loams, Skeletal Soils and the Shallow Sandy Soils.

Good Quality Agricultural Land

The definition of GQAL classes is provided in Table 4.8. NRW (1995) have mapped the majority of the project site as Class C – suitable for improved or native pastures due to limitations that preclude cultivation for crop production. The remaining 4% of the project site is Class A land. This GQAL occurs within the project site but does not occur within the pit footprint area and, therefore, will not be disturbed. Figure 4.13 shows Good Quality Agricultural Land within the project site.

Post Mining

The proposed post-mining land use for the project site is expected to be a mosaic of self sustaining vegetation communities and grazing land. In terms of soil conservation and agricultural land suitability, the proposed impacts are considered manageable and the proposed post-mining land use of a mosaic of self sustaining vegetation communities and grazing land is considered achievable for those areas not subject to significant landscape modification (open cut pit and out-of-pit spoil dumps). In the areas impacted by significant landscape modification, agricultural suitability class may be altered. In areas where mining impacts land with a land suitability Class 2 or Class 3, a greater level of management will be required to prevent land degradation and change in suitability class.

In order to sustain the desired land use without degradation, it is important that the post-mining land only be used in accordance with the limits of the agricultural suitability class. Soil conservation practices such as stocking rate control and establishment or re-establishment of permanent pasture are recommended for areas of mining impact. The overriding principle is to maintain the most beneficial future use of land that can be sustained in view of the range of limiting factors. The proposed post-mining land must provide and sustain a sufficient bulk of nutritious forage in addition to the following management considerations:

- The ability to access and manage livestock.
- Flood free and relatively dry ground conditions.
- Adequate stock drinking water and shelter.
- Stock routes throughout the land.

Provided that environmental controls such as structural soil conservation works and appropriate revegetation are in place and operating properly during mine construction, operation and closure, there should be no adverse effects to the project site or the surrounding grazing land. Rehabilitation and post mining land use is discussed in further detail in Section 4.8.

4.4.9 Disturbance Management

The following management and mitigation strategies are recommended for implementation during mining, in order to reduce the potential for degradation within the project site and adjoining lands. These recommendations are based on the assessment of the existing site conditions and experience with the management of mining surface impacts at sites throughout New South Wales and Central Queensland.

There is the potential for fossil specimens to be present within the project site. If fossil materials are encountered during the project, operations shall be managed to preserve the materials and the materials conserved subject to the directions of the Queensland Museum.

4.4.9.1 Topsoil Stripping and Handling

Where topsoil stripping and transportation is required, the following topsoil handling techniques will be employed to prevent excessive soil deterioration.

- Develop a topsoil balance as part of the EM plan.
- Strip material to the depths stated in Table 4.17, subject to further investigation as required.
- Topsoil should be maintained in a slightly moist condition during stripping. Material should not be stripped in either an excessively dry or wet condition.
- Marker pegs should be used to indicate required stripping depth in the uniform clays (brown clays and dark clays). Especially where over-stripping may expose potentially dispersive subsoils.
- Place stripped material directly onto reshaped overburden and spread immediately (if mining sequences, equipment scheduling and weather conditions permit) to avoid the requirement for stockpiling.

- Grading or pushing soil into windrows with graders or dozers for later collection by elevating scrapers, or for loading into rear dump trucks by front-end loaders, are examples of less aggressive soil handling systems. This minimises compression effects of the heavy equipment that is often necessary for economical transport of soil material.
- Soil transported by dump trucks may be placed directly into storage. Soil transported by bottom dumping scrapers is best pushed to form stockpiles by other equipment (e.g. dozer) to avoid tracking over previously laid soil.
- The surface of soil stockpiles should be left in as coarsely textured a condition as possible in order to promote infiltration and minimise erosion until vegetation is established and to prevent anaerobic zones forming.
- As a general rule, maintain a maximum stockpile height of 3 m. Clayey soils, such as the brown clay topsoil, should be stored in lower stockpiles for shorter periods of time (i.e. less than 12 months) compared to sandier soils, selected from the alluvial soils.
- If long-term stockpiling is planned (i.e. greater than 12 months), seed and fertilise stockpiles as soon as possible. An annual cover crop species that produce sterile florets or seeds should be sown. A rapid growing and healthy annual pasture sward provides sufficient competition to minimise the emergence of undesirable weed species. The annual pasture species will not persist in the rehabilitation areas but will provide sufficient competition for emerging weed species and enhance the desirable micro-organism activity in the soil.
- An inventory of available suitable surface cover material should be maintained to ensure adequate topsoil materials are available for planned rehabilitation activities.

4.4.9.2 Topsoil Respreading

Not all reshaped overburden areas will require topdressing using conserved topsoil reserves. Topsoil can often be more of a hindrance when direct tree seeding techniques are implemented in the revegetation program, as it allows weed and grass species to compete with trees. Therefore, some zones throughout the progressive rehabilitation areas will be devoid of replaced topsoil to enhance tree and shrub germination and establishment. Sampling and analysis of topsoil resources, whether stockpiled or in-situ, is recommended prior to respreading. This will assist in identifying potential soil deficiencies and estimating required rates of fertiliser or ameliorant (i.e. gypsum or lime) application.

Where possible, suitable topsoil will be re-spread directly onto reshaped areas. Where topsoil resources allow, topsoil will be spread to a minimum depth of 100 mm (preferably 150 -200 mm) on all regraded spoil. Topsoil will be spread, treated with fertilizer or ameliorants (if required) and seeded in one consecutive operation, to reduce the potential for topsoil loss to wind and water erosion. Prior to re-spreading stockpiled topsoil onto reshaped overburden (particularly onto designated tree seeding areas), an assessment of weed infestation on stockpiles will be undertaken to determine if individual stockpiles require herbicide application and / or scalping of weed species prior to topsoil spreading.

4.4.9.3 Landform Design and Erosion Control

Rehabilitation strategies and concepts proposed below have been formulated according to results of industry-wide research and experience. Stormwater run-off control strategies are presented in Section 6.2.3.

Post Disturbance Regrading

The main objective of regrading is to produce slope angles, lengths and shapes that are compatible with the proposed land use and not prone to an unacceptable rate of erosion. Integrated with this is a drainage pattern that is capable of conveying runoff from the newly created catchments whilst minimising the risk of erosion and sedimentation. Final slope gradient should not exceed 17%, or approximately 10°.

Erosion and Sediment Control

The most significant means of controlling surface flow on disturbed areas is to construct contour furrows or contour banks at intervals down the slope. The effect of these is to divide a long slope into a series of short slopes with the catchment area commencing at each bank or furrow. This prevents runoff from reaching a depth of flow or velocity that would cause erosion.

Contour ripping across the grade is by far the most common form of structural erosion control on mine sites as it simultaneously provides some measure of erosion protection and cultivates the surface in readiness for sowing.

Graded banks are essentially a much larger version of contour furrows, with a proportionately greater capacity to store runoff and/or drain it to some chosen discharge point. The banks are constructed away from the true contour, at a designed gradient (0.5% to 1%) so that they drain water from one part of a slope to another; for example, towards a watercourse or a sediment control dam.

Eventually, runoff that has been intercepted and diverted must be disposed of down slope. The use of engineered waterways using erosion blankets, ground-cover vegetation and/or rip rap is recommended to safely transfer runoff downslope.

The construction of sediment control basins are recommended for the purpose of capturing sediment laden runoff prior to off-site release or reuse on site. Sediment control basins are responsible for improving water quality throughout the mine site and, through the provision of semi-permanent water storages, enhance the ecological diversity of the area.

The following points will be considered when selecting sites for sediment control basins.

- Each basin should be located so that runoff may easily be directed to it, without the need for extensive channel excavation or for excessive channel gradient. Channels must be able to discharge into the basin with minimal risk of erosion. Similarly, spillways must be designed and located so as to safely convey the maximum anticipated discharge.

- The material from which the basin is constructed must be stable. Dispersive clays, such as the subsoils of the dark clays, will require treatment with lime, gypsum and/or bentonite to prevent failure of the wall by tunnel erosion. Failure by tunnelling is most likely in basins which store a considerable depth of water above ground level, or whose water level fluctuates widely. Basins should always be well sealed, as leakage may lead to instability, as well as allowing less control over the storage and release of water.
- The number and capacity of basins should be related to the total area of catchment and the anticipated volume of runoff. The most damaging rains, in terms of erosion and sediment problems are localised, high intensity storms.

Seedbed Preparation

Thorough seedbed preparation will be undertaken to ensure optimum establishment and growth of vegetation. All topsoiled areas should be contour ripped using a small dozer with a 3 tyned ripper attachment (after topsoil spreading) to create a key between the soil and the spoil. Ripping should be undertaken on the contour and the tynes lifted for approximately 2 m every 200 m to reduce the potential for channelised erosion. Best results will be obtained by ripping when soil is moist and when undertaken immediately prior to sowing. The respread topsoil surface should be scarified prior to, or during seeding, to reduce run-off and increase infiltration. This can be undertaken by contour tilling with a fine-tyned plough or disc harrow.

4.5 Land Use

This section of the EIS assesses the historic and current land uses. It also assesses the impact the project will have on the land use of the project site and surrounding areas. In particular this section will assess:

- Existing land use of the site and surrounds.
- Land tenure and ownership, including land with special purposes.
- Existing infrastructure, infrastructure reserves, (e.g. road reserves), stock routes.
- Administrative context of the project and the project site including local government zoning, relevant state instruments (e.g. state planning policies) and strategic documents.

An assessment of the sensitive environmental areas surrounding the project is provided in Section 4.6.

The project site and adjoining areas have historically been and are currently used for cattle grazing, extractive industries (coal mining) and commercial uses. Grazing activities occur north of Cherwell Creek on partially cleared land of native and buffel grass pastures. South of Cherwell Creek is Heyford Pit. Heyford Pit was mined as part of the Peak Downs Mine (BMA owned and operated) operations BMA is no longer mining in this pit. The area north of Harrow Creek including Heyford Pit will be included in Caval Ridge Mine.

The town of Moranbah is located 6.2 km north of the most northern point of the project site. Moranbah is a purpose-built mining town in the northern part of the Isaac Regional Council Area, with a population of approximately 7,432 people (ABS 2007a). The Isaac Regional Council was formed after the amalgamation of the Belyando, Broadsound and Nebo Shires in March 2008. The Belyando Planning Scheme (local planning scheme) (July 2008, adopted 20/01/2009) still applies in the area that was previously the Belyando Shire.

BMA has a mining lease (ML1775) and mining lease application (MLA 70403) over the project site and is the land owner for the majority of the properties underlying the mining lease and application. BMA is currently negotiating with land owners for properties they do not own that underlie the project site or will be impacted by the project. The properties adjoining the project site (which are not owned by BMA) are predominantly large freehold and leasehold rural holdings used for grazing cattle. Non-rural properties and commercial operations in the area include the Moranbah airport and workshops. Access to the project site will be via the Peak Downs Highway. An overpass will be constructed to minimise interaction between the mining operations and the public.

An assessment of the soils and land suitability for areas within and surrounding the project site, including GQAL, has been undertaken and the findings are provided in Section 4.4 above. An assessment of non indigenous and indigenous cultural heritage, including identification of the location and owner / custodians of native title is provided in Section 15 (Cultural Heritage).

4.5.1 Description of Environmental Values

4.5.1.1 Tenure and Infrastructure

Land tenure underlying the project site and within the surrounding areas is illustrated in Figure 4.25. Land tenure and the existing land use underlying the project site is described in Table 4.19. Tenure underlying the project site is predominantly freehold, however some land has been designated as special lease or special purpose. BHP Billiton Coal and their associated parties (BHP Coal and Others) have acquired the majority of these land parcels. Land parcels owned by BHP Coal and Others have been leased to graziers and commercial businesses. BHP Coal and Others are in the process of acquiring the land parcels underlying the project site that they do not currently own. These dwellings on these properties will not be occupied during mining operations.

Special Lease (SL) 12/40052, adjacent the northern boundary of the project site is the Moranbah airport and is owned by BHP Coal. Land parcels identified as SL 12/42239 were granted to BHP Coal Pty Ltd and Others (CQCA Joint Venture participants) under the then *Land Act* in 1979 for industrial (coal mining) purposes. These land parcels are illustrated on Figure 4.25.

The Peak Downs overhead 66 kV easement and transmission line, owned by BMA, starts at the Moranbah substation and ends at the Peak Downs Mine. The easement and transmission line transects the western section of the project site. Another overhead 11 kV easement and transmission line, owned by Ergon, is within a transmission line easement directly west of the Moranbah Access Road. Although this transmission line is not within the project site it forms the project's north-eastern boundary (Figure 3.15). The Peak Downs 66 kV transmission line will remain in its current alignment until mining requires its relocation. This transmission line will provide power to the mine industrial area and electrical equipment such as draglines.

The Peak Downs Highway and its road reserve transect the centre of the project site and the Moranbah Access Road forms the north eastern boundary of the project site. An overpass will be constructed to minimise interaction with mining operations and the public.

The Blair Athol railway line is located to the north-west of the project site. Although the project will not directly impact on the railway line's location, the construction of the project's proposed rail spur will require works within the Blair Athol railway easement.

The Peak Downs Highway stock route follows the Peak Downs Highway, traversing the central section of the project site (Figure 4.28). Schedule 4 of the *Land Protection (Pest and Stock Route Management) Regulation 2003* states that the Isaac Regional Council amongst others is required to prepare a stock route network management plans. The Isaac Regional Council has not yet prepared this plan, however recent council meetings have identified that "*Escalation of fuel prices associated with road transport are causing landowners to seriously consider movement of stock via stock routes and unused road reserves which provide a higher level of safety and security for animals than is that case along council and main roads in the current mining boom environment*" (IRC, May 2008). It is proposed to realign the stock route at the proposed Peak Downs Highway overpass to ensure continuity of the stock route.

No water or gas pipelines have been identified within or adjacent the project site. The location of underground services to the dwellings was not identified as part of this assessment. It was noted during the contaminated land site visit that these properties have self-contained potable water and septic systems (refer Section 4.9).

4.5.1.2 Mining and Petroleum Leases

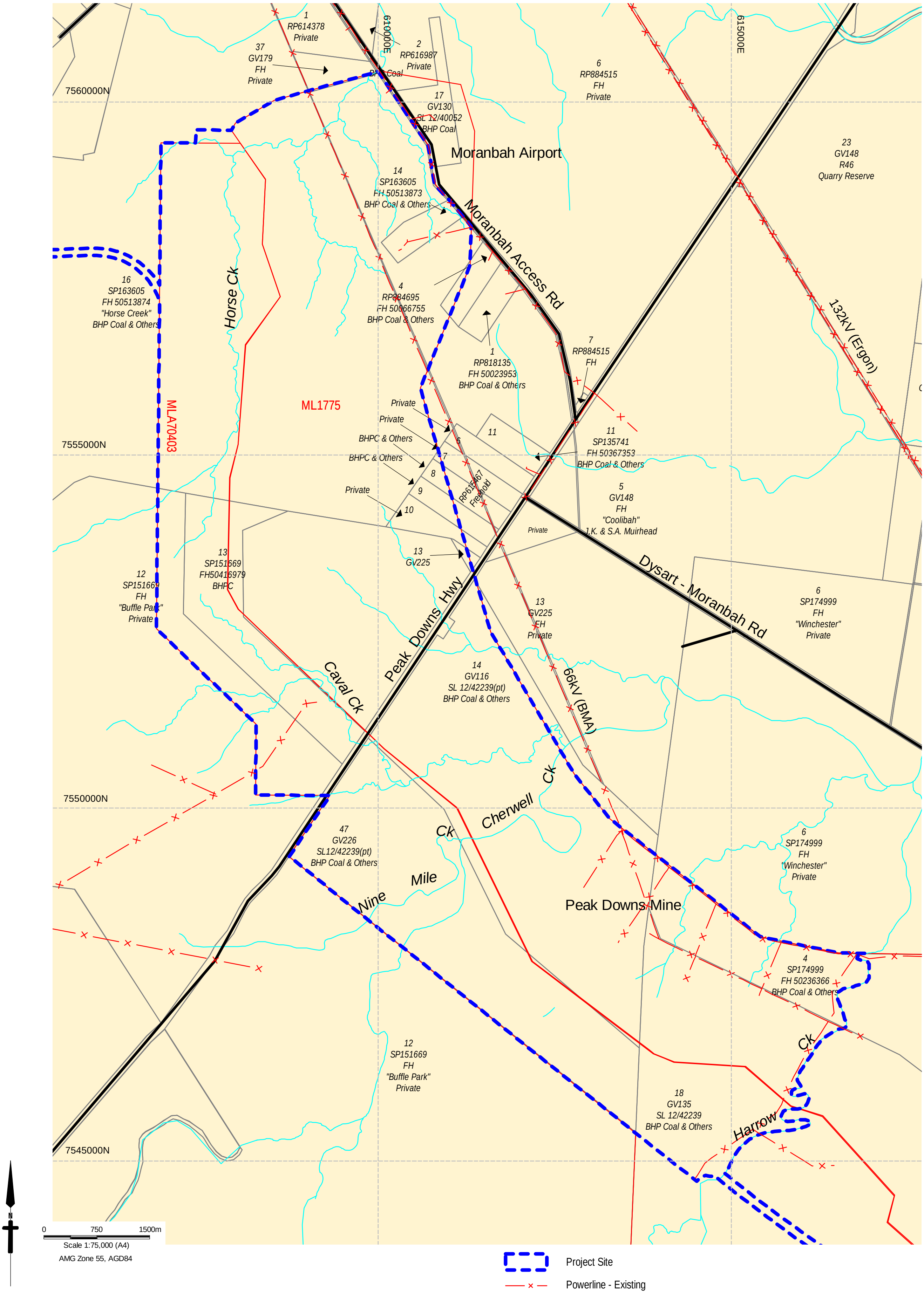
The project will be located over ML 1775 and MLA 70403 (Figure 4.26). Actual coal mining operations for the project will be situated on ML 1775 (Peak Downs) held by the CQCA. Project infrastructure and temporary landforms will be located on MLA 70403.

The CQCA Agreement was entered into between the Queensland Government and the CQCA on 1 January 1969. This agreement was authorised and given the force of law through the *CQCA Agreement Act 1968*. The CQCA Agreement provided for the compulsory acquisition of land and the granting of special leases to the CQCA for, among other things, infrastructure purposes for coal mining where the CQCA were unable to acquire land. SL 12/42239 was subsequently granted under the then *Land Act* in 1979 for industrial (coal mining) purposes. ML 1775 was granted in 1984 under the *CQCA Agreement Act 1968* rather than the general mining legislation in place at the time.

MLA 70403 which is located to the west of ML 1775 is required for project related infrastructure (haul roads, rail spur and loop, train loadout, sediment basins, mechanical workshops, warehouses, power reticulation structures and a coal reject stockpile), temporary landforms and to maximize resource recovery from ML 1775. MLA 70403 overlaps SL 12/42239 and EPC 545.

There are several mining development leases (MDL), EPC and exploration permits minerals (EPM) located within 20 km of the project site. These leases are illustrated on Figure 4.26 and their location in relation to the project site is detailed in Figure 4.25.

Most of the project site is underlined by exploration permits for petroleum (EPP) or authorities to prospect (ATP). A small section of a petroleum lease underlies the project site. These are illustrated on Figure 4.27 and detailed in Figure 4.25. BMA is required as a minimum to consult with other parties that have overlapping tenement. Agreements or compensation packages may be required.



Source: DCDB Oct2008; 250th Geodata; Client Supplied Data

Client	Project	Title
BMA BHP Billiton Mitsubishi Alliance	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	**LAND TENURE**
URS	Drawn: VH; Approved: RS; Date: 08-05-2009; Job No: **4262 6158**; File No: 42626158-g-502b.wor	Figure: **4.25**; Rev:B; A4

Table 4.19 Land Tenure Summary

Tenure	Lot No	Plan No	Land Type	Registered Owner	Use
ML 1775	4	RP884695 – Freehold 50066755	Freehold	BHP Coal and Others	Heritage Cattery and Dog Kennels and residential (dwelling is not within the project site)
	4	SP174999 – FH50236366	Freehold	BHP Coal and Others	Peak Downs Mine
	7	RP615467	Freehold	Private	Goat farming
	8	RP615467	Freehold	BHP Coal and Others	Goat farming
	9	RP615467	Freehold	BHP Coal and Others	Goat farming
	10	RP615467	Freehold	Private	Goat farming
	13	SP151699 – FH50416979 (Buffle Park)	Freehold	BHP Coal	Cattle grazing and residential
	13	GV225 FH	Freehold	Private	Cattle grazing
	14	GV116 - SL12 on 42239(pt)	Freehold / Special Lease	BHP Coal and Others	Bushland, cattle grazing, mining
	14	SP163605 – FH50513873	Freehold	BHP Coal and Others	Residential and cattle grazing
	16	SP163605 – FH50513874 (Horse Creek)	Freehold	BHP Coal and Others	Cattle grazing, Kalari Workshop and Yard
	Easement A	GV80	Freehold	BMA	Peak Downs Overhead 66 kV Transmission Line
	Easement	GV77	Freehold	Ergon	Overhead 11 kV Transmission Line
			State Land	Department of Transport and Main Roads	Peak Downs highway, access to the project site
				Queensland Rail	Transportation of coal
				Peak Downs Highway Stock Route	Movement of stock
MLA 70403	1	RP616897	Freehold	Private	Cattle grazing and residential (dwelling is not within project boundary)
	10	SP137499 – SL12 on 42239 (pt)	Freehold / Special Lease	BHP Coal and Others	Mining related infrastructure and mining
	12	SP151669 (Buffle Park)	Freehold / Special Lease	Private	Cattle grazing
	13	SP151699 – FH50416979	Freehold	BHP Coal	Cattle grazing

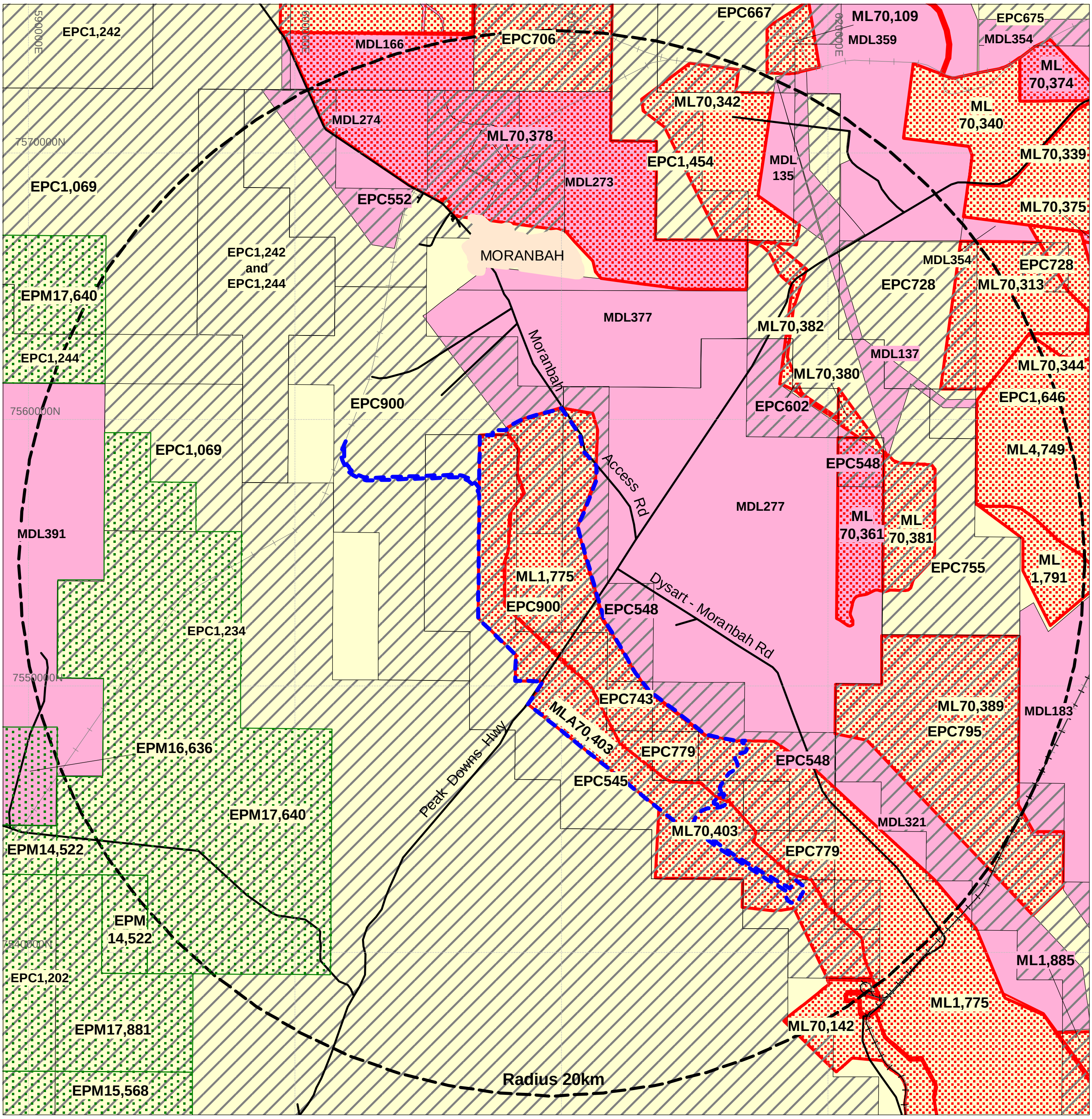
Tenure	Lot No	Plan No	Land Type	Registered Owner	Use
	16	SP163605 - FH50513874 (Horse Creek)	Freehold	BHP Coal and Others	Cattle grazing, Kalari Workshop and Yard
	18	GV135 – SL12 on 42239	Freehold	BHP Coal and Others	Mining relate infrastructure, mining and bushland
	47	GV226 – SL12 on 42239 (pt)	Freehold	BHP Coal and Others	Bushland, mining related infrastructure and cattle grazing

SP – Survey Plan SL – Special Lease FH – Freehold GV – Crown Plan Country of Grosvenor

Table 4.20 Mining and Petroleum Tenures within 20 km of the Project

Tenure	Holder	Location in relation to the Project
Mining Tenement associated with the project		
ML 1775 Peak Downs	BHP Coal Pty Ltd and Others (CQCA Joint Venture participants)	Caval Ridge mining and mining related infrastructure
MLA 70403	BHP Coal Pty Ltd and Others (CQCA Joint Venture participants)	Caval Ridge mining related infrastructure
Mineral Development Leases		
MDL 277	Exxaro Australia Pty Ltd	Adjacent
MDL 377	Anglo Coal (Grosvenor) Pty Ltd	Adjacent
MDL 321	BHP Coal Pty Ltd	Within 20 km
MDL 274	The Shell Company of Australia Ltd	Within 20 km
MDL 273	Anglo Coal (Grosvenor) Pty Ltd	Within 20 km
MDL 135	Millennium Coal Pty Ltd	Within 20 km
MDL 137	Millennium Coal Pty Ltd	Within 20 km
MDL 166	Moranbah North Coal Pty Ltd	Within 20 km
MDL 391	Diamond Creek Coal Pty Ltd	Within 20 km
MDL 359	Vale Aust. Pty ltd	Within 20 km
MDL 183	Qld. Coal Pty Ltd	Within 20 km
Mining Leases		
ML 70389	Bowen Central Coal Pty Ltd	Within 20 km
ML 70381	Vale Aust. (IP) Pty Ltd	Within 20 km
ML 70361	Vale Aust. (IP) Pty Ltd	Within 20 km
ML 70380	Isaac Plains South Access	Within 20 km
ML 70382	Isaac Plains South 2A	Within 20 km
ML 70342	Vale Aust. (IP) Pty Ltd	Within 20 km
ML 70378	Anglo Coal (Grosvenor) Pty Ltd	Within 20 km
ML 70313	Millennium Coal Pty Ltd	Within 20 km
ML 70344	Millennium Coal Pty Ltd	Within 20 km
ML 4749	BHP Mitsui Coal Pty Ltd	Within 20 km
ML 1791	BHP Mitsui Coal Pty Ltd	Within 20 km

Tenure	Holder	Location in relation to the Project
Exploration Permit Coal		
EPC 545	Cherwell Creek	Adjacent and underlying
EPC 743	BHP Coal Pty Ltd	Underlying
EPC 548	Anglo Coal (Grosvenor) Pty Ltd	Adjacent and underlying
EPC 1234	Queensland Coking Coal	Within 20 km
EPC 779	BHP Coal Pty Ltd	Adjacent
EPC 795	Bowen Central Coal Pty Ltd	Within 20 km
EPC 755	Vale Australia (IP) Pty Ltd	Within 20 km
EPC 1646	BHP Mitsui Coal Pty Ltd	Within 20 km
EPC 728	Millennium Coal Pty Ltd	Within 20 km
EPC 602	Anglo Coal (Grosvener) Pty Ltd	Within 20 km
EPC 1454	Anglo Coal (Grosvener) Pty Ltd	Within 20 km
EPC 552	Anglo Coal (Grosvener) Pty Ltd	Within 20 km
EPC 1242 and EPC 1244	Energy Minerals Pty Ltd	Within 20 km
EPC 1069	Acsett Resources& Industries Pty Ltd	Within 20 km
EPC 1244	Energy Minerals Pty Ltd	Within 20 km
EPC 1234	Queensland Coking Coal Pty Ltd	Within 20 km
EPC 900	Energy Minerals Pty Ltd	Adjacent and underlying
Exploration Permit Minerals		
EPM 17640	Ridge Exploration Pty Ltd	Within 20 km
EPM 14522	Ridge Exploration Pty Ltd	Within 20 km
Petroleum Exploration Permits		
EPP 688	BNG (Surat) Pty Ltd	Adjacent and underlying
EPP 793	Diamond Creek Coal Pty Ltd	Within 20 km
EPP 814	Eureka Petroleum Pty Ltd	Within 20 km
EPP 364	CH4 Pty Ltd	Within 20 km
EPP 814	Eureka Petroleum Pty Ltd	Within 20 km
Petroleum Lease		
PL 222	CH4 Pty Ltd	Adjacent and underlying
PL 224	CH4 Pty Ltd	Within 20 km
PL 196	CH4 Pty Ltd	Within 20 km
PL 191	CH4 Pty Ltd	Within 20 km
PL 224	CH4 Pty Ltd	Within 20 km
PL 223	CH4 Pty Ltd	Within 20 km

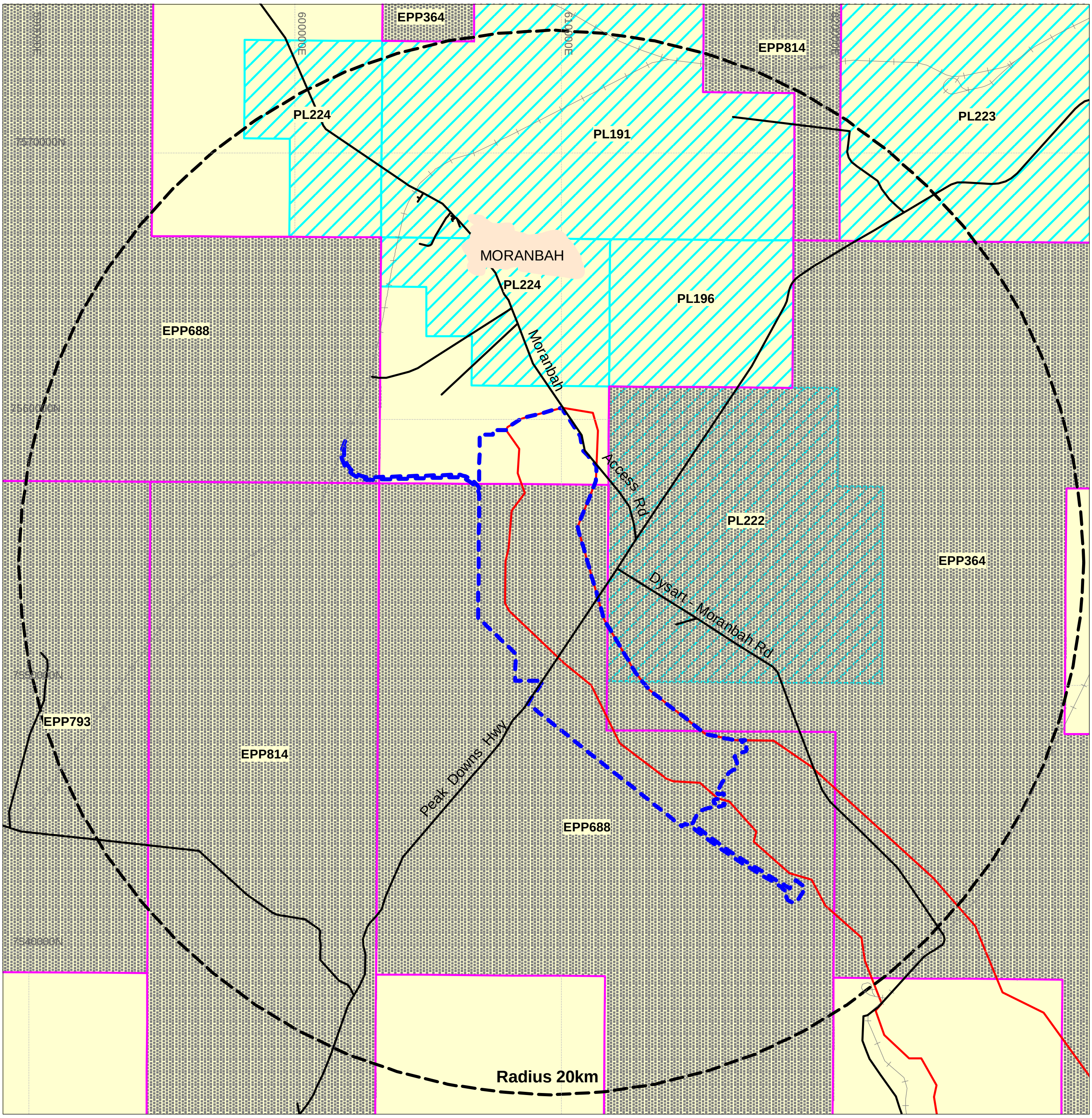


Project Site
20km Buffer
Exploration Permit Minerals (EPM)
Exploration Permit Coal (EPC)
Mining Lease (ML) or Mining Lease Application (MLA)
Mineral Development Licence (MDL)

0 3.75 7.5km
Scale 1:225,000 (A4)
Horizontal Datum: AGD64, Zone 55

Source: Mining Tenures - NRMW, Queensland Government, Nov 2008.

Client	Project	Title
BMA BHP Billiton Mitsubishi Alliance	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	MDLs, MLS, EPCs AND EPMs UNDERLYING AND ADJACENT TO THE PROJECT
URS	Drawn: VH · Approved: RS · Date: 08-05-2009	Figure: **4.26** · Rev:B
	Job No: **4262 6158** · File No: 42626158-g-501b.wor	A4



Project Site
20km Buffer
Mining Lease
Exploration Permit for Petroleum (EPP)
Petroleum Lease

0 3.75 7.5km
Scale 1:225,000 (A4)
Horizontal Datum: AGD64, Zone 55

Source: Mining Tenures - NRMW, Queensland Government, Nov 2008

Client	Project	Title
BMA BHP Billiton Mitsubishi Alliance	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	**EPPs AND PLs UNDERLYING AND ADJACENT TO THE PROJECT**
URS	Drawn: VH; Approved: RB; Date: 02-03-2009	Figure: **4.27**
	Job No: **4262 6158**; File No: 42626158-g-501b.wor	Rev:B A4

4.5.1.3 Native Title

A search of the DME online Interactive Resource and Tenure Maps Database (DME, October 2008) identified the Barada Barma Kabalbara and Yetimarla #4 group (BBKY) as having lodged a native title claim (claim number QC01/025) on the project site. The claim was filed on 31/07/2001 and is in Active Status. The Interactive Resource and Tenure Map also identified the project site as being within the Gurang Land Council Aboriginal Corporation Representative Aboriginal Body Area.

BMA has entered into discussions with the Native Title claimants and is committed to ensuring that the Native Title interests are captured during community consultation and the EIS process and that an agreed cultural heritage management plan (CHMP) is developed. The *Aboriginal Cultural Heritage Act 2003* applies to all aspects of the project. Work will be carried out in accordance with the Act's duty of care guidelines.

Section 15.2 Cultural Heritage provides a detailed description of the traditional owners and native title claims relevant to the project, and discusses whether there have been previous grants that extinguish native title rights over the mining lease.

4.5.2 Existing Land Use of the Project Site and Immediate Surrounds

4.5.2.1 Local Land Use Context

Existing land uses within the project site are shown on Figure 4.28 and include:

- A light industrial trucking workshop (the Kalari Workshop)
- Bushland
- Cattle grazing
- Coal exploration
- Unused coal mining pits
- 66 kV powerline
- The Peak Downs Highway
- Two dwellings
- Farming infrastructure (access tracks, fences, stockyards and sheds)
- A small quarry.

There are several ephemeral creeks and surface water dams located on the project site. These creeks and dams provide habitat, movement corridors and water for terrestrial fauna species within the project site. The dams provide a water source for livestock and other terrestrial fauna and migratory birds, especially when the creeks are dried. Cattle grazing is the predominant land use, a review of historical photos shows evidence of cattle grazing since at least 1957.

Notable features within the local surrounds includes residents, a cattery/kennel (Heritage Boarding Kennels and Cattery), the Moranbah airport, Peak Downs Mine, the Peak Downs Highway, the Moranbah Access Road, the Dysart – Moranbah Road, Moranbah township (6.2 km north of the project site), Moranbah emerging community area, a Shell Roadhouse, rural cropping land, a quarry reserve and the Blair Athol Railway Line. These features are shown on Figure 4.28.

4.5.2.2 Regional Land Use Context

The project site is situated within the Bowen Basin, approximately 6 km south of Moranbah and 160 km west of Mackay. The Bowen Basin is a highly productive coal resource area. Cattle grazing and mining are the predominant land use within the region. The WHAM Regional Plan (2006) has identified a large section of the Bowen Basin as a major mining growth area. It has also identified the Peak Downs Highway and other major roads in the region as tourism route opportunities (Figure 4.29a).

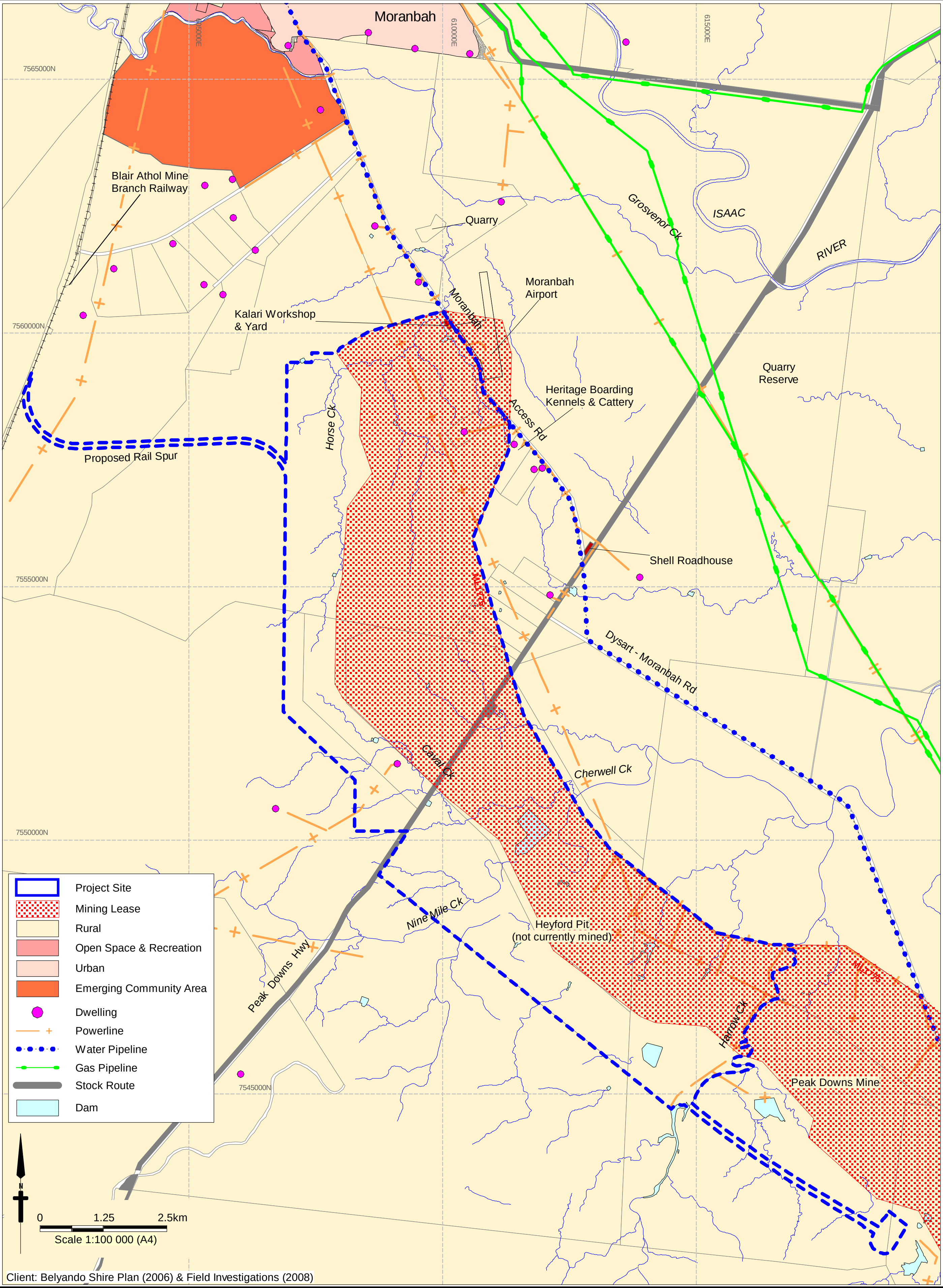
Mackay is the main urban and administrative hub for the region. A number of other towns and settlements in the region service the coal mining and agricultural industries including Moranbah, Nebo, Dysart, Coppabella and Clermont. These regional cities and towns are briefly described below. Additional information is provided in Section 17 (Social Impact Assessment). Figure 4.30 shows the location of existing and proposed coal mines in the areas surrounding the project site.

4.5.2.3 Regional Cities and Towns

Mackay City

Mackay supports a population of approximately 84,889 people (ABS 2007i). Mackay is located within Mackay Regional Council area and is the administrative, commercial and economic hub and the largest population centre for the region. Mackay provides state government services for the region as well as a range of community services.

Mackay and numerous satellite towns including Walkerston and Sarina are the primary residential areas for many of the mine workers who commute from these coastal communities to employment in the Bowen Basin coalfields. There are strong economic links between Mackay and the inland coal and rural industries. Rail lines transport coal from the Bowen Basin coalfields to Hay Point and Dalrymple Bay coal terminals located to the south of Mackay. Light, medium and heavy industries servicing the mining sector form a significant component of the land use within the Mackay Regional Council area.



Client: Belyando Shire Plan (2006) & Field Investigations (2008)

Client	Project	Title
BMA BHP Billiton Mitsubishi Alliance	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	**EXISTING LOCAL LAND USE**
URS	Drawn: VH / Approved: RS / Date: 08-05-2009	Figure: **4.28** / Rev:B
	Job No: **4262 6158** / File No: 42626158-g-526b.wor	A4

Moranbah

Moranbah has a population of approximately 7,432 people (ABS 2007a). Moranbah is one of the largest towns servicing the mining industry in the Bowen Basin, and is situated approximately 6 km from the northern most point of the project site. The town is centrally located to many of the Northern Bowen Basin coalfields and is the home to many of the mine employees, ancillary mining industry employees and their families.

Moranbah is currently experiencing population growth pressures with the booming mining industry creating demand for additional housing for mining workers. Expansion of the town for residential and other land uses is partially constrained by mining leases that surround much of the town. These mining leases are effectively limiting development potential for residential and other non-mining uses. An area to the south-west of Moranbah has been zoned as an emerging community area (Figure 4.28) within the Belyando Planning Scheme. Refer to Section17.3.2 (Social) for additional housing information.

Nebo

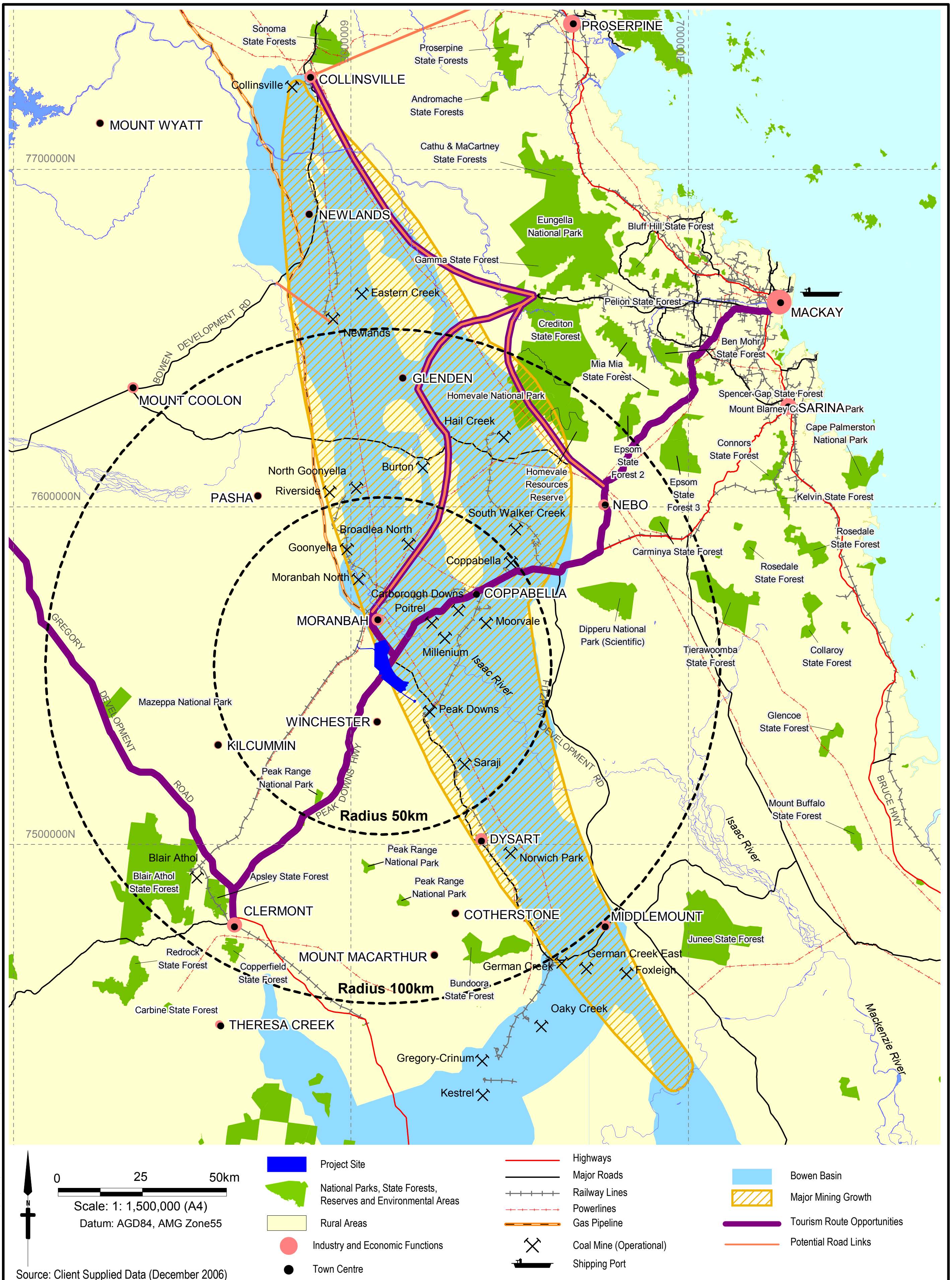
Nebo has a population of approximately 231 people (IRC 2008). Nebo is close to existing and proposed mines and is becoming attractive as an additional service centre for the mining industry. A large accommodation camp is located on the outskirts of the town, and there is an industrial estate with several industrial businesses providing mining support services on the outskirts of town. There is a shortage of housing and serviced lots within the town, however there are some large parcels of reserved land which could potentially be made available for additional residential, commercial and industrial sites (DLGPSR, 2006).

Coppabella

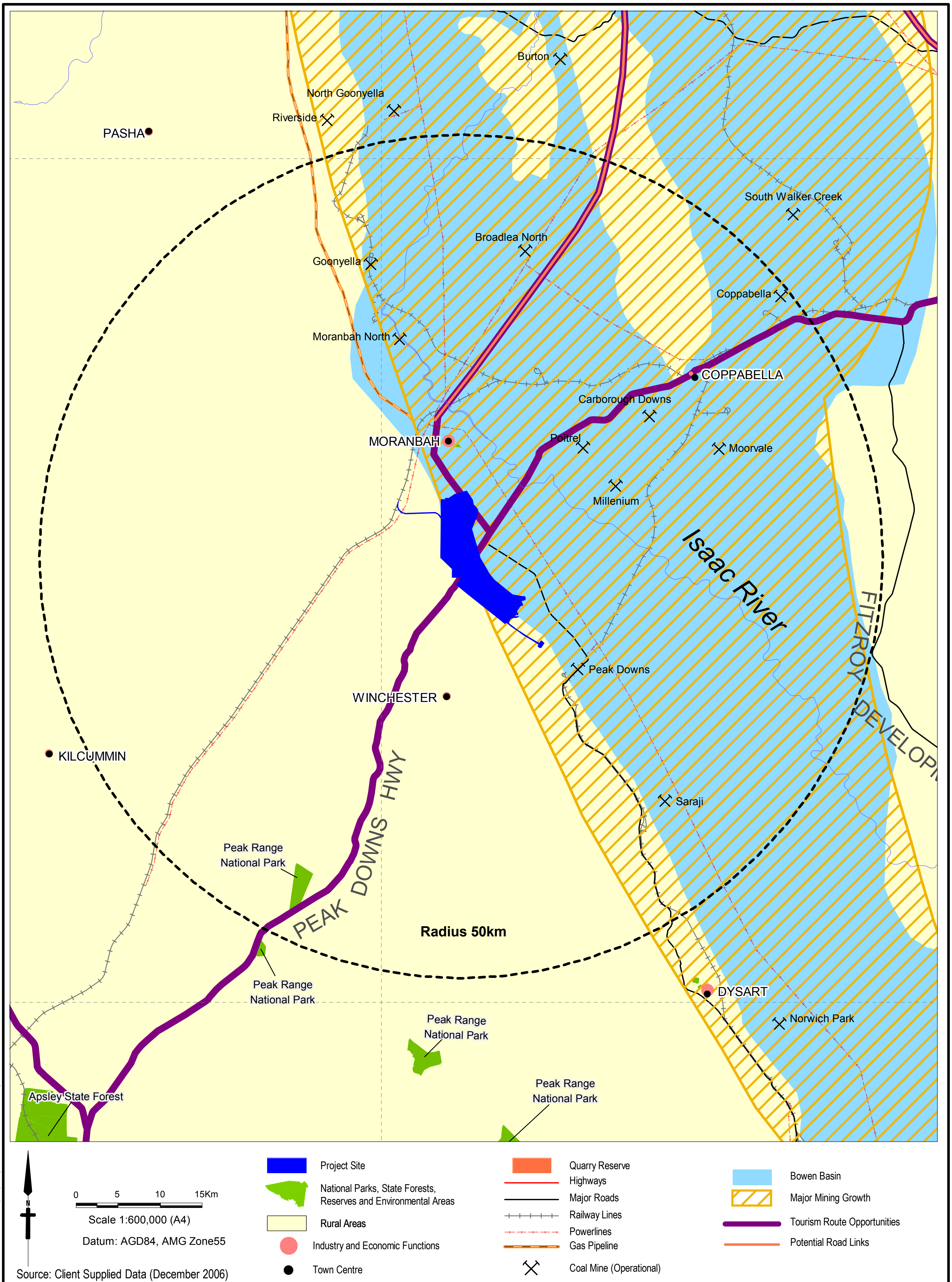
Coppabella supports a population of approximately 350 people (IRC 2008). Coppabella is situated between Moranbah (approximately 42 km) and Nebo (approximately 50 km). Its development history has traditionally been associated with servicing the railway line; however, the community is currently experiencing growth management issues due to an increased demand for housing due to the expansion of the mining industry. A large accommodation camp is situated on the outskirts of town, however there is likely to be a demand for a wider range of accommodation types beyond that provided by temporary camps (DLGPSR, 2006).

Clermont

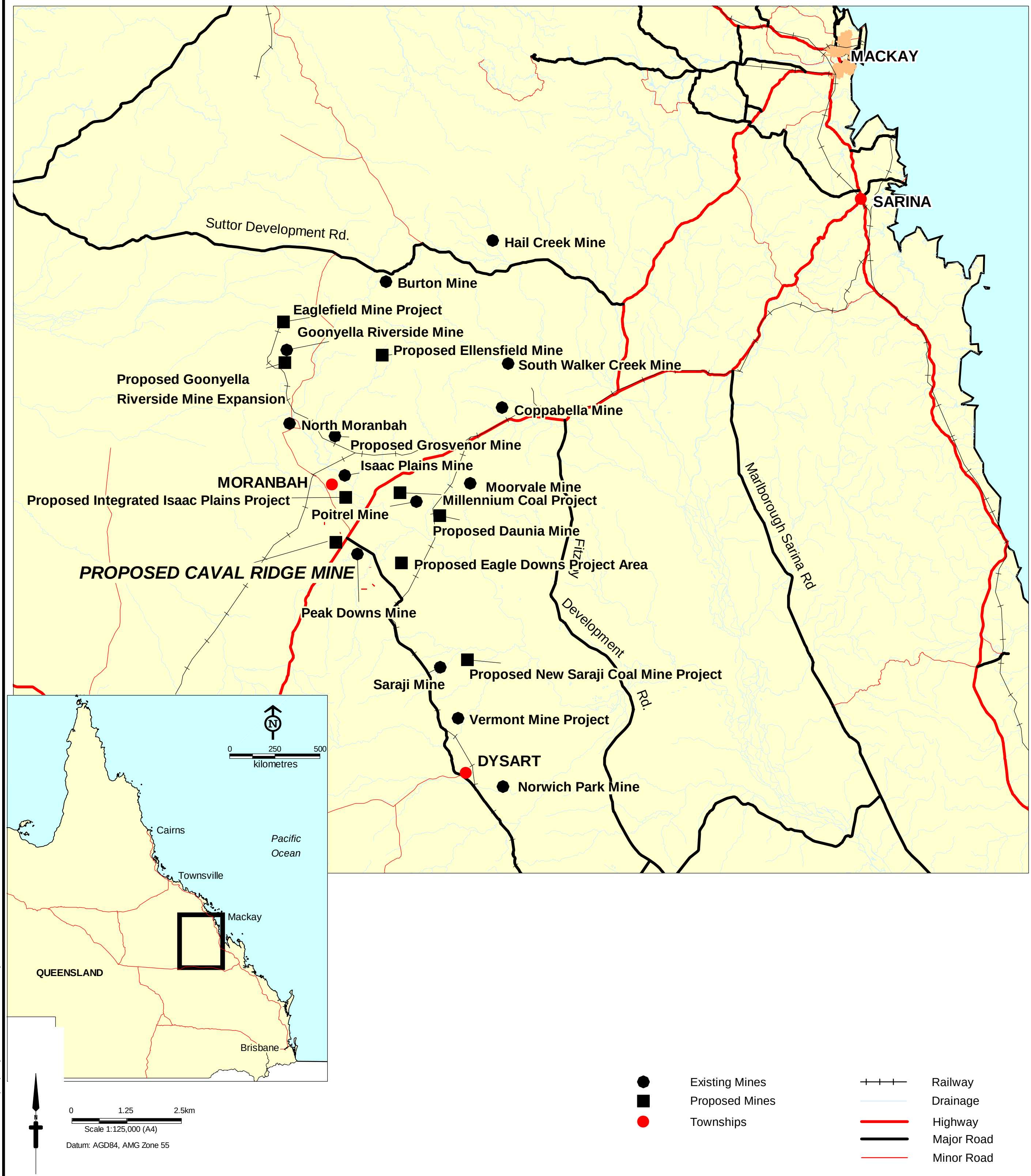
Clermont has a population of approximately 2,500 people (IRC 2008). Clermont is primarily a service centre for the agricultural industry. The town is not currently facing the same growth management issues as other towns in the region (DLGPSR, 2006).



Client	Project	Title	
BMA BHP Billiton Mitsubishi Alliance	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	**REGIONAL LAND USE**	
URS	Drawn: CA/VH · Approved: RS · Date: 08-05-2009	Figure: **4.29a**	Rev:B
	Job No: **4262 6158** · File No: 42626158-g-504b.wor		A4



Client	Project	Title
BMA BHP Billiton Mitsubishi Alliance URS	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	**REGIONAL LAND USE** **50km RADIUS**
	Drawn: CA/VH · Approved: RS · Date: 15-05-2009	Figure: **4.29b** · Rev:B
	Job No: **4262 6158** · File No: 42626158-g-504b.wor	**A4**



Client

BHP Billiton Mitsubishi Alliance

Project

CAVAL RIDGE PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Title

EXISTING AND PROPOSED MINES IN THE REGION

Drawn: VH	Approved: RS	Date: 08-05-2009
Job No: **4262 6158**	File No: 42626158-g-605.wor	

Figure: **4.30**

Rev:A

A4

4.5.3 Land Use Planning Provisions

The project site is located in the Parish of Moranbah, County of Grosvenor and is within the recently created Isaac Regional Council area. The Isaac Regional Council (IRC) was formed on 15 March 2008 following the amalgamation of the Belyando, Broadsound and Nebo local governments. Prior to the council amalgamations, the project site was situated in Belyando Shire local government area.

The project will occur mainly on mining tenements granted under the *Mineral Resources Act 1999* (MRA) with the remainder on MLA 70403. The project is exempt from assessment under the local authority planning scheme for the following reasons:

- As per Schedule 9 of the IPA, mining and petroleum activities (as defined under the MRA*)* are exempt from assessment from a planning scheme.
- As per Section 319 of the MRA, "Subject to subsection (2) and (3) the Planning Act does not apply to development authorised under this Act."

However, it should be noted that the local government planning scheme will apply for any aspect of the project that is not subject to s319 of the MRA or Schedule 9 of IPA. This includes project infrastructure on a mining lease. In addition, BMA will apply to IRC for other approvals relating to construction and operational, if required. These may include:

- Operational works
- Building works
- Plumbing and drainage works.

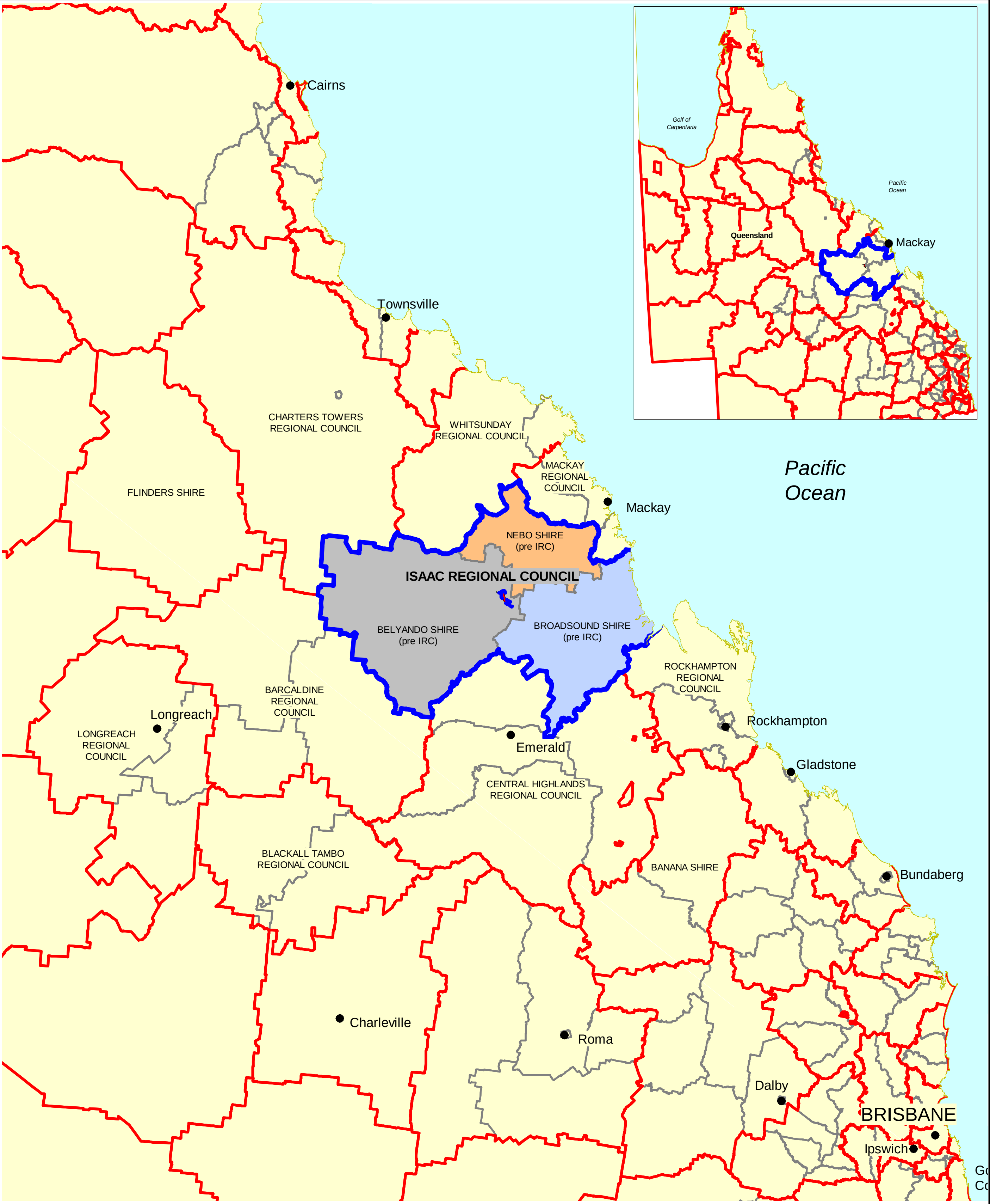
Some project related activities such as other infrastructure facilities may be located outside of mining lease areas and hence would not be exempt from the provisions of the IPA. These would require development approval under the local government planning scheme. BMA will submit the relevant town planning applications to IRC as required. However, because the project will have had an EIS assessed under the State Development and Public Works Organisation Act process, the referral, public notification and review stages of the development application process will be deemed to have been already undertaken. Hence any development applications that will be lodged for project related infrastructure outside of mining lease areas will progress from the acknowledgement stage to the assessment stage of the application process.

Projects that are considered as assessable development under Section 8 of the Integrated Planning Act (IPA) generally require development approval in accordance with the provisions of the relevant regional council town planning scheme. Under the transitional arrangements for the amalgamated councils, the planning schemes for the former shires remain applicable in assessing development until the regional council's planning schemes are prepared. In the case of the project, the draft Belyando Shire Planning

Scheme (Version: July 2008, adopted 20/01/2009) will remain the relevant planning scheme until the Isaac Regional Council's planning scheme is approved.

Figure 4.31 shows the previous local government areas and the amalgamated Isaac Regional Council area. The former Belyando, Broadsound and Nebo shires all had traditional links to grazing, agriculture and mining.

Despite the exceptions of the project from IPA, an assessment has been undertaken against the local and regional planning schemes as well as State Planning Polices to gain an understanding of the local planning considerations, identify any land use planning issues and to ensure the project is consistent with the local authority's plan for the area.



0 100 200km

Scale 1:6,000,000 (A4)

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Source: Qld DNRW, DCDB Oct 2008

- Project Site
- Issac Regional Council
- Local Government Boundary (post March 2008)
- Local Government Boundary (pre March 2008)
- Town Centre

Client	Project	Title
BMA BHP Billiton Mitsubishi Alliance	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	**LOCAL GOVERNMENT BOUNDARIES**
URS	Drawn: CA / Approved: RS / Date: 08-05-2009 / Job No: **4262 6158** / File No: 42626158-g-534.wor	Figure: **4.31** / Rev:A / **A4**

4.5.3.1 Belyando Shire Planning Scheme

Although the project is generally exempt from assessment under the Belyando Shire Planning Scheme (Version: July 2008, adopted 20/01/2009) (Belyando Shire Council, 2008) under IPA, the project has been reviewed in relation to the planning scheme to gain an understanding of the local planning considerations and to ensure the project is consistent with the local authority's plan for the area.

The planning scheme zones organise the local government area into broad land use allocations. The project site has been zoned as rural under the planning scheme. The planning scheme land use zoning is shown on Figure 4.28. The intent of this zone is to protect those agricultural or grazing areas surrounding the town of Moranbah from undesirable urban development and to ensure their retention for rural purposes. This zone is also intended to cover those rural areas which do not have any value for agriculture or grazing but which nevertheless, need to be preserved and retained in their natural state (Belyando Shire Council, 2008).

The project is best described within the planning scheme as Extractive industry which means premises used for mining or an industrial activity involving:

- The extraction of sand, gravel, clay, soil, rock, stone or any similar substance from land, whether or not any overburden is also extracted;
- The rehabilitation of the land; and
- The treatment including crushing or screening of that substance on, or on land abutting, the land from which that substance is extracted.

Within the rural zone, extractive industries are an appropriate land use where it is located and operated so as to ensure no unacceptable detrimental impact on surrounding uses or on the environment. The planning scheme land characteristic mapping identifies areas of environmental, economic, or cultural importance where specific outcomes are sought to protect or promote the identified qualities, resources or constraints. The project site has been identified as mining lease areas and the areas to the north and east of the project site as mineral development licences.

The project is impact assessable under the planning scheme, however, as discussed above, the planning scheme does not apply to this development and the IRC will have the opportunity to comment on the EIS as part of the community consultation and public review for the EIS.

The planning scheme identifies a number of strategic directions, desired environmental outcomes (DEO) and strategies to meet the desired environmental outcomes. Table 4.21 summaries the DEO and strategies relevant to the project, as well as a response in relation to the project.

Table 4.21 Belyando Planning Scheme Desired Environmental Outcomes and Responses

Strategic Direction	DEO	Applicable Strategy	Response
Natural Environment and Cultural Heritage	Ecological systems, the natural environment and items and places of cultural and heritage significance are protected such that biodiversity, cultural heritage values and existing and intended landscape character are maintained.	(a) Development is regulated to minimise any adverse impacts on air and water quality, to prevent land degradation, loss of unique habitat and biodiversity and to maintain the integrity of riparian areas, ridgelines and escarpments. (b) Development is regulated to be compatible with the environmental, habitat, biodiversity and landscape values and historic significance of protected areas and areas, local items and places of cultural.	The project is regulated though the EIS process to ensure minimal impact on the surrounding environments.
Economic Development	The viability of the mining industry is protected, while the economy of Belyando Shire is diversified in a manner that supports the intended land use structure and character of the urban centres of Clermont and Moranbah and the rural parts of the Shire. Activities that do not require a rural location are consolidated within the towns of Clermont and Moranbah, so that investment in the towns is maximised. Moranbah's role as the primary service centre for the northern Bowen Basin mining industry is enhanced. Town centres in each of the Shire's urban communities form vibrant and compact commercial and community cores. Industrial nodes in Clermont and Moranbah are consolidated. Natural resources (including land, water and mineral resources) are used sustainable.	(a) The planning scheme reinforces the roles of Clermont and Moranbah as the principal places for administrative services, business, industry, retail, education and community services and transport services within the Shire. (b) Sufficient and suitable areas are identified for urban development, and key transport infrastructure are identified and protected. (e) Confidence in investment in the Shire's towns and in its major industries is maintained by identifying clear development intentions. (g) Productive rural land, rural industries and unique natural features (including mineral and extractive resources and tourist resources such as national parks, conservation parks and wetlands) are protected to preserve their continued economic potential and viability.	The project does not affect the DEO of the planning scheme to consolidating Moranbah and Claremont towns to maximise investment in the centre and ensuring future urban development is suitably located in relation to extractive industry. The project has been planned to ensure Moranbah continues to be a major service centre for coal mines in the Bowen Basin. An economic assessment has been undertaken to identify the economic benefits that the project will bring to Moranbah and Queensland (see Section 18). Social and accommodation impacts have been assessed (see Section 17). A transport assessment has been undertaken to assess the projects impact on key transport infrastructure (see Section 13). The project does not adversely impact unique natural features. The project will impact on the availability of rural land, the project is located on land currently zoned as rural but identified as a mining lease areas. The project will require clearing of rural land.

Strategic Direction	DEO	Applicable Strategy	Response
Community Wellbeing	Moranbah and Clermont provide a wide range of government and community services and employment opportunities. Moranbah continues to have a significant role as the primary service centre for the northern Bowen Basin mining industry. The towns of Moranbah and Clermont accommodate strong, connected and vibrant communities, well supported by recreational and other community facilities, highly accessible by walking and cycling. Town centres provide a clear community focal point. Moranbah and Clermont are characterised by a strong and growing permanent resident population. A wide range of affordable housing types is available and all housing is designed to contribute to the quality of the urban environment. Dwelling units providing for permanent accommodation are predominant, with a significantly smaller proportion of other forms of accommodation intended for temporary residents. The rural amenity and productive capacity of other parts of the Shire is maintained	(a) The planning scheme seeks to ensure that people are connected to public spaces (including recreational areas) and community services through an appropriate land use structure and the provision of infrastructure within the towns of Clermont and Moranbah. (b) Increased opportunities are created for a larger proportion of the mining (and related) workforce and their families to permanently reside in the Shire's towns through: (c) The planning scheme seeks to ensure all residential activities (with minor exceptions) are located within the towns of Clermont and Moranbah. (f) Infrastructure reflects community expectations and needs, meets appropriate engineering and environmental standards and is provided in an orderly and logical sequence to ensure cost effectiveness. (g) Rural communities are protected from incompatible forms of development, and rural residential development is not supported by the planning scheme.	The EIS has assessed the projects impact on the community, community services and accommodation for the construction and permanent workforces (see Section 17).

4.5.3.2 Whitsunday Hinterland and Mackay Regional Plan (WHAM)

The WHAM Regional Plan was endorsed by the Queensland Government in June 2006. WHAM is a non-statutory document that amongst other things identifies preferred regional land use and sets out a strategic framework for managing growth in the region. The WHAM document describes land use for the project site and surrounding areas as follows (Figure 4.29a and Figure 4.29b):

- The project site is located within the mining – coal basins land resource. Dryland agriculture is also identified as a land resource around the project site (refer Map 3 – Natural Resources)
- Having a possible presence of linear habitat connections associated with the Isaac River in the northern section of the project site and Cherwell Creek (refer Map 2 – Natural Environment)
- Moranbah is identified as a sub – regional centre.

The WHAM identifies the preferred physical and spatial arrangement of the region, the project is generally supported by the plan. The project will result in the loss of agricultural land, however this land is not considered good quality agricultural land. The project footprint has been orientated to minimise clearing where possible.

The WHAM identifies the possible presence of linear habitat connections associated with the Isaac River. Rivers and creeks function as fauna movement corridors, particularly in degraded landscapes, such as the project site. Although riparian vegetation in the project site is degraded and narrow it would still serve as a route by which species traverse the landscape or as a stepping stone habitat for some migratory bird species. Arboreal mammals would also move along the creek lines. No corridors are mapped for the project site by other state, regional or local levels under the bioregion's biodiversity planning assessment (BPA)(EPA 2003) and, overall, recent ecological assessment identified the project site as containing little by way of movement opportunities for terrestrial fauna (refer to Section 8).

4.5.3.3 Sustainable Futures Framework for Queensland Mining Towns

The Sustainable Futures Framework for Queensland Mining Towns (DLGP 2006) was initiated by the Queensland Government to provide an overview of the existing situation within mining towns in the Bowen and Surat Basins. The aim of framework is to develop strategies to resolve serious growth management issues (including land use issues) that are having an adverse impact on some of these mining towns (DLGPSR, 2006).

The key objective of the framework is to protect the social, economic and environmental values and economic growth of Queensland's mining communities, through collaboration between state and local governments, the mining industry and the community, to build a productive mining industry built on sustainable, vibrant Queensland communities.

BMA is working closely with the IRC to ensure the needs of the local community are met through the provision of housing and infrastructure developments in the region. The EIS has assessed the projects impact on the community, community services and accommodation for the construction and permanent workforces (Section 17).

4.5.3.4 State Planning Policies

A number of State Planning Policies (SPPs) and management plans have been developed according to the provisions of the *Integrated Planning Act 1997*. The SPPs hold statutory weight and establish State Government's requirements in regard to planning and development matters. SPPs potentially relevant to the project include:

- SPP 1/92 Development and the Conservation of Agricultural Land
- SPP 1/02 Development in the Vicinity of Certain Airports and Aviation Facilities
- SPP 1/03 Mitigating the Adverse Impacts of Flood, Bushfire and Landslide
- SPP 2/07 Protection of Extractive Resources.

The applicability of these SPPs to the proposed development and the project site are discussed below.

SPP 1/92 Development and the Conservation of Agricultural Land

SPP 1/92 provides for the protection of GQAL capable of sustainable use for agriculture. The policy principles of SPP 1/92 state:

"Good quality agricultural land has a special importance and should not be built on unless there is an overriding need for the development in terms of public benefit and no other site is suitable for the particular purpose" (SPP 1/92)

The majority of the project site has a Class VI land capability – not suitable for cultivation and is moderately susceptible to degradation requiring proper management to sustain the land use (Figure 4.15). Some Class V land (high quality grazing land) occurs adjacent to Cherwell and Caval Creeks. The land surrounding Horse Creek and its tributaries and two smaller creeks in the southern section of the project site have also been identified as Class V land capability.

The rocky hills and ridgelines, along with the highly eroded and Skeletal Soils, are considered to be Class VII - land that is highly susceptible to degradation requiring severe restrictions for use. Grazing may be conducted with rigorous management inputs required to prevent degradation. Class V, VI and VII lands are all grazing land classes and are not suitable for cultivation. The distribution of these land capability classes within the project site is presented in Figure 4.15.

SPP 1/02 Development in the Vicinity of Certain airports and Aviation Facilities

This SPP sets out broad principles for protecting airports and associated aviation facilities from encroachment by incompatible developments in the interests of maintaining operational efficiency and community safety. SPP1/02 prescribes outcomes for development subject to the policy. Land use related outcomes which should be considered as being relevant to the proposed development include:

- "When undertaking development to which this SPP applies, adverse effects on the safety and operational efficiency of operational airspace and the functioning of aviation facilities are avoided";
- "…Within areas defined by the 20 ANEF10 contour around airports to which this SPP applies, material changes of use are compatible with forecast levels of aircraft noise".
- "Development within the public safety areas at the ends of airport runways avoids significant increases in people living, working or congregating in those areas; and the use or storage of hazardous materials".

The Moranbah Airport is adjacent the northern section of the project site, the Moranbah Airport is not listed under SPP1/02 as an airport/aviation facility of state significance, however due to the proximity of the project site to the airport and its operational airspace, potential impacts on this aerodrome have been considered in the EIS. BMA is currently proposing to upgrade or relocate the Moranbah Airport as part of the BMA BBCGP, the development of the project and the airport will be considered during the planning for the airport.

SPP 1/03 Mitigating the Adverse Impacts of Flood, Bushfire and Landslide

SPP 1/03 aims to mitigate the adverse impacts of flood, bushfire and landslide for assessable development. This SPP applies generally throughout Queensland, however, the bushfire and landslide outcomes apply only to local governments listed in the SPP. Belyando Shire is exempt from these bushfire and landslide outcomes due to the low risk of either of these events (DLGP, 2003).

There is potential for flooding within the project site as a result of the development of the project. Extensive flood modelling has been done to identify areas that may flood. Flood immunity and mitigation measures for the control and management of flood waters have been incorporated into the project's design (Section 4.2 and Section 6.1.2.3). There is a potential for bushfires to occur in the area and management strategies have been developed for the project (Section 4.1). Naturally occurring erosion is evident within the region, however given the relatively flat topography of the project site it is unlikely that a landslide will occur.

SPP 2/07 Protection of Extractive Resources

SPP 2/07 identifies those extractive resources of state or regional significance where extractive industry development is appropriate in principle, and aims to protect those resources from developments that might prevent or severely constrain current or future extraction when the need for utilization of the resource arises. Extractive resources include sand, gravel, quarry rock, clay and soil which are used in concrete, asphalt, road bases and a range of other products (State of Queensland, 2007). There are no Key Resource Areas or Potential Key Resource Areas identified under SPP 2/07 located in or near the project site.

4.5.3.5 Potential Impacts and Mitigation Measures

During the operational phase of the project, the project site will be used for mining, coal processing, transport of coal product and associated infrastructure. Upon the completion of mining operations, the project site will be rehabilitated in accordance with the site closure plan. The project site will also be rehabilitated progressively throughout the life of the project. Rehabilitation of the project will return the land to a stable landform (refer to Section 4.8). The closure plan will stipulate criteria including final grades, drainage requirements and cover requirements including topsoil depths and vegetation to be planted or sown. These criteria will meet the overriding objectives of returning a stable, self-sustaining, beneficial landform and preserving downstream water quality.

The current land use of the project site and surrounding areas is largely rural (grazing), commercial (trucking yard, kennels and adjacent Moranbah Airport) and extractive industries. The project site has been zoned under the Belyando Planning Scheme (2008) as rural. The project is best described in the planning scheme as extractive industries, which is an appropriate land use within the rural zone when it is operated to minimise impact on the surrounding land uses.

BMA have mining tenement over the project site, however have not acquired surface rights for the entire project site. Properties impacted potentially included:

- Lot 12 on SP151669
- Lot 6 on RP 615467
- Lot 7 on RP 615467
- Lot 10 on RP 615467
- Lot 13 on GV225

BMA is currently in negotiations with land holders to acquire surface rights. These properties will be leased for rural uses however, will not be inhabited during the project.

Most of the project site is underlined by exploration prospect for petroleum (EPP) or authorities to prospect (ATP). A small section of a petroleum lease underlies the project site. MLA 70403 is overlapped by the following Petroleum Tenure holders: EPP 364 (CH4 P/L 1% and AGL Energy P/L 99%), EPP 688 (BNG Surat P/L 25%, Hamilbent P/L 25% and Westside ATP688P P/L 50%) and EPP 727 (CH4 P/L 100%). Consents from BNG & Westside are outstanding). The Petroleum Lease that covers in part, ML 1775, is excluded from ML 1775 for the reason that ML 1775 is granted for the purpose of mining coal and gaseous hydrocarbons.

The Peak Downs Highway and stock route will be impacted by the project and will require realignment. With the planned overpass works to accommodate the mining operations either side of the Peak Downs Highway, an alternative route has been defined as shown in Figure 3.2d. From the Peak Downs Highway, the route will follow Nine Mile Creek along its southern bank and cross Nine Mile Creek at its convergence with Cherwell Creek. The route will then follow the northern bank of Cherwell Creek into ML1775, before crossing Caval Creek to follow a path back to the Peak Downs Highway. The route proposed through MLA70403 to the south of the MIA will cross under some associated mining infrastructure including an elevated overland conveyor, light vehicle access road (under bridge) and haul road (under bridge). The route will be fenced according to the appropriate standards to prevent any stock movements outside of the corridor and the relevant DERM processes will be implemented for stock route usage.

The Peak Downs 66 kV transmission line will remain in its current alignment until mining requires its relocation. This transmission line will provide power to the MIA, and electrical equipment such as draglines.

Approximately 4% of the project site is classified as Class A GQAL, however, this land does not occur within the pit footprint area and, therefore, will not be disturbed.

There are potential impacts on the Moranbah Airport and its operational airspace due to it's proximity to the project. The Moranbah Airport is not listed under SPP1/02 as an airport/aviation facility of state significance. The Belyando Shire Planning Scheme has provisions for development within the vicinity of an airport.

Despite the project exemptions from being assessable development under Schedule 8 of IPA, a planning assessment has been undertaken against the local and regional planning schemes as well as the relevant State Planning Policies. BMA continues to work closely with local and regional authorities to ensure the needs of the local community are addressed in the EIS.

4.6 Sensitive Environmental Areas

4.6.1 Description of Environmental Values

4.6.1.1 Land Subject to Treaty

There is no known land subject to treaties or land that is known to likely to become subject to treaties, within or adjacent the project site.

4.6.1.2 International Treaties (Ramsar Convention, JAMBA, CAMBA, or Bonn Convention)

The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources (Ramsar, 1996-2008).The nearest Ramsar Wetland is approximately 80 km north of Rockhampton (Shoalwater and Corio Bays) and approximately 250 km east of the project. Although the project is within the same catchment of this wetland, due to the nature of the project and the distance to Shoalwater and Corio Bays, it is unlikely that the project will have a significant impact on Ramsar Wetlands.

The Japan-Australia Migratory Bird Agreement (JAMBA) and China-Australia Migratory Bird Agreement (CAMBA) agreements list terrestrial, water and shorebird species which migrate between Australia and the respective countries. In both cases the majority of listed species are shorebirds (EPA 2008).

The Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA) formalises Australia's relationship with the Republic of Korea in respect to migratory bird conservation and provides a basis for collaboration on the protection of migratory shorebirds and their habitat (EPA 2008).

The Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or Bonn Convention) came into force in 1983, Australia has been a party since 1 September 1991. The Bonn Convention aims to conserve terrestrial, marine and avian migratory species throughout their range. It is an intergovernmental treaty, concluded under the aegis of the United Nations Environment Programme, concerned with the conservation of wildlife and habitats on a global scale. Migratory species threatened with extinction are listed in Appendix K, Section 5.6 and migratory species that need or would significantly benefit from international co-operation are listed in Appendix K, Section 4.3. A Memorandum of Understanding between the Bureau of the Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention) and the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) was signed in 1997 (Peck, 1997).

A search of the project site on the DEWHA matters of national environmental significance (MNES) database identified a number of migratory bird species listed under the EPBC Act. Species identified on this list and species identified at the project site are provided in Table 4.22. Some species identified at the project site but not listed on the MNES database are also provided. Table 4.22 identifies species currently listed under the BONN Convention, JAMBA, CAMBA and ROKAMBA.

Table 4.22 Species Listed under International Migratory Treaties

Genus Species	Common Name	Bonn Convention	JAMBA	CAMBA	ROKAMBA	NC Act	EPBC Act
Nettapus coromandelianus	Cotton Pygmy-goose					R	M
Ephippiorhynchus asiaticus	Black-necked Stork					R	Not EPBC Listed
Ardea alba	Great Egret		x	x		S	M
Bubulcus ibis	Cattle Egret		x	x		S	M
Haliaeetus leucogaster	White-bellied Sea-Eagle			x		S	M
Rostratula australis	Australian Painted Snipe			x		V	V
Gallinago hardwickii	Latham's Snipe		x	x	X	S	M
Numenius minutes	Little Curlew		x	x	X	S	M
Tringa stagnatilis	Marsh Sandpiper	x	x	x	X	S	M
Actitis hypoleucos	Common Sandpiper	x	x	x	X	S	M

Genus Species	Common Name	Bonn Convention	JAMBA	CAMBA	ROKAMBA	NC Act	EPBC Act
Calidris ruficollis	Red-necked Stint	x	x	x	X	S	M
Calidris acuminate	Sharp-tailed Sandpiper	x	x	x	X	S	M
Sterna caspia	Caspian Tern		x	x		S	M
Hirundapus caudacutus	White-throated Needletail		x	x	X	S	M
Apus pacificus	Fork-tailed Swift		x	x	X	S	M
Merops ornatus	Rainbow Bee-eater		x			S	M
Rhipidura rufifrons	Rufous Fantail	x				S	M
Monarcha melanopsis	Black-faced Monarch	x				S	M
Myiagra cyanoleuca	Satin Flycatcher	x				S	M
Acrocephalus australis	Australian Reed-Warbler	x				Not NC Act Listed	Not EPBC Listed

Note: Queensland's Nature Conservation Act 1992 (NC Act): E = Endangered, V = Vulnerable, R = Rare, S = Special Least Concern (Migratory), CS = Least Concern (Culturally Significant), C = Least Concern wildlife.

Federal Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act): E = Endangered, V = Vulnerable, M = Migratory Species

4.6.1.3 Protected Estate, National Parks, Conservation Areas, Wilderness Areas or Scientific Reserve

An ecomap search was carried out to identify any environmentally sensitive areas near the project site, as determined by the Queensland EPA. The EPA ecomap (Appendix K, Figure 4.1) indicates that there are no category A environmentally sensitive areas near the project site. Ecomapping indicates the presence of endangered regional ecosystems (category B environmentally sensitive areas) within and around the southern boundary of the project site. Section 8.1 (Terrestrial Ecology) provides a detailed assessment of the regional ecosystems at the project site. There are no other lands known to be likely to become registered as part of the national estate within the project area.

Figure 4.29a shows the location of national parks, state forests, and conservation areas in the region. The only national park, state forest, reserve or conservation area within a 50 km radius of the project site is the Peak Range Area (I.D No. 8886, Register of National Estate). The Peak Range National Park incorporates a number of conservation areas and was placed on the Register of National Estate on 21/10/1980. A large quarry reserve is located to the east of the project site within the 50 km radius, another small quarry is located to the north-east of the project site (Figure 4.29b)

4.6.1.4 Declared Fish Habitats or Aquatic Reserves

A declared fish habitat area (FHA) is an area that is protected against physical disturbance from coastal development. Although the project is not within a FHA, the creeks that flow through the project site converge with the Isaac River. The Isaac River is a tributary of the Mackenzie River which forms the Fitzroy River. The Fitzroy River is a declared fish habitat. The project site is greater than 150 km upstream of the confluence of the Isaac and Mackenzie rivers, and approximately 200 km upstream of any declared fish habitat areas of the Fitzroy. No implications from the project are anticipated for declared for fish habitat areas.

4.6.1.5 Heritage, Historic or Cultural Areas or Items

Heritage Estates

The DEWHA online Australian heritage database was searched on 8 October 2008 for Register of National Estates, Commonwealth Heritage List, National Heritage List and World Heritage List within the Belyando local government area. The following places, listed on the Register of National Estates were identified by the search:

- Doogmabulla Spring (Doongmabulla via Aramac) – Indicative Place
- Epping Forest National Park (1798 boundary) (Clermont) – Registered
- Lake Buchanna and Catchment (Yarrowmere) – Registered
- Lake Gailee Basin (Aramac) – Indicative Place
- Mazeppa National Park (Clermont) – Registered
- Old Bowen Downs Road (Strathmore via Collinsville) – Indicative Place
- Peak Downs Areas (via Clermont) – Registered
- St Josephs Convent and School Building (Clermont) - Removed from Register or IL
- Wilandspey Environmental Park (Beenboona via Moranbah) - Registered

None of the above listed places are within a 50 km radius of the project site.

The non-indigenous cultural heritage survey did not identify any sites, places or objects of significant cultural heritage significance during recent investigations. Five sites of historical interest were identified (i.e. telegraph line, saw mill remnants, dam and windmill, cattle trough and yards). The Indigenous cultural heritage assessment identified numerous cultural heritage sites, items and significant natural features of indigenous origin (NAC 2008). Section 15 (Cultural Heritage) provides details of the cultural heritage located at the project site.

4.6.1.6 World Heritage Listings

A search of Matters of National Environmental Significance database (MNES – under the Commonwealth EPBC Act) was conducted for the project site and surrounds (11 July 2008) did not identify any world heritage properties or places within or adjacent the project site. Non-indigenous cultural heritage surveys and investigations have not identified any world heritage properties or places within or adjacent the project site. The closest world heritage area is the Great Barrier Reef World Heritage Area (GBRWHA), the GBRWHA is approximately 140 km from the project site.

4.6.1.7 EPBC listed Nationally Significant Matters

The results of the MNES database search (11 July 2008) and supplementary field surveys undertaken since 2005 found that no EPBC-listed plant species were recorded from the study area. Two Endangered Ecological Communities were confirmed as occurring in the study area: the Brigalow Ecological Community (Brigalow (*Acacia harpophylla* dominant and co-dominant) communities); and the Bluegrass Dominant Grasslands (Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin). Two fauna species of National Environmental Significance (NES) have been recorded in the study area: the Southern Squatter Pigeon; and the Ornamental Snake. Four fauna species of NES have been identified as likely to occur in the project area: Australian painted snipe; greater long-eared bat; yakka skink; and brigalow scaly-foot.

4.6.2 Potential Impacts and Mitigation Measures

There is no known land subject treaties within or adjacent the project site. Due to the nature of the project and the distance from the project to any of the protected estates, national parks, conservation areas, wilderness reserves or scientific areas, declared fish habitats, GBRWHA, RAMSAR wetland, it is unlikely that the project will have an impact on these areas.

Although migratory species that are listed under JABMA, CAMBA, ROKAMBA and the Bonn Convention are likely to be present on the project site there is little evidence to suggest that the site supports an ecologically significant proportion of a population of these migratory species. Given their migratory habits, the ephemeral nature of important food and habitat resources and the extent of similar and comparable habitat throughout the range of these species, it is likely that the habitats on the project site would be utilised infrequently and on a transitory basis only. Refer to the Section 8.2.1 (Nature Conservation) for additional information.

No, Commonwealth Heritage List, National Heritage List and World Heritage List were identified within a 50 km radius of the project as indicated in Figure 4.29a (Refer to Appendix 2 of Appendix K). One area of registered national estate, an area of the Peak Range National Park (I.D No. 8886, Register of National Estate) is identified within 50 km of the project (Figure 4.29a). No likely impacts are anticipated for this area due to geographic distance. Potential impacts on other regionally or locally significant biodiversity values are addressed in Section 8.1.2 and Section 8.2.2.

No sites, places or objects of significant non indigenous cultural heritage significance were identified during recent investigations. It is unlikely that the project will have an impact on the non indigenous cultural heritage values of the area.

Indigenous cultural heritage surveys of the project site undertaken by Northern Archaeology Consultancies Pty Ltd and representatives of BBKY#4 between July and November 2008, resulted in the identification of numerous cultural heritage sites, items and significant natural features of indigenous origin (NAC 2008). There is significant potential for the cultural values associated with the watercourses on site to be degraded due to erosion and sedimentation resulting from construction, diversion and operational activities. Measures to mitigate and manage adverse impacts on Indigenous cultural heritage are identified in the Cultural Heritage Management Plan (CHMP) (Refer to Section 15.2) within the context of the *Aboriginal Cultural Heritage Act 2003* and associated Duty of Care Guidelines.

The current status of the endangered Brigalow and Bluegrass Ecological Communities and the six fauna species of NES have been assessed with reference to potential impacts of the project (refer Section 8.1.2). The project has adopted the hierarchical approach of avoiding impacts on remnant vegetation in the first instance, minimising impacts on remnant vegetation where clearing is unavoidable and rehabilitating areas of remnant vegetation as offsets. It is considered that neither the Brigalow Ecological Community or Bluegrass Dominant Grasslands, nor any of the six fauna species of NES are likely to suffer significant adverse impacts as a result of the project. Refer to Section 8.1.2 for information regarding vegetation management offsets.

4.7 Landscape Character and Visual Amenity

This section describes in general terms the existing landscape character of the project site and surrounding areas. It includes comments on changes to the natural landscape that have taken place since European settlement. A description is also provided of the general impression of the landscape character that is obtained when travelling through and around the project site.

4.7.1 Regional Context

The project site is located within the central portion of the Bowen Basin, which forms part of the Brigalow Belt Bioregion (National Land & Water Resources Audit, 2001).

4.7.2 Local Context

The project site is located on the western edge of the Isaac River Valley, which is a broad valley approximately 30 km wide that generally runs north to south. The project site extends from approximately 6 to 24 km south of Moranbah. Grazing is the principal land use on the project site and surrounding areas. Moranbah Airport, which is located adjacent the northern end of the project site on the eastern side of Moranbah Access Road, forms a prominent element of transport infrastructure in the local landscape context.

The landscape character of the project site and surrounding areas results from the combination of landform, vegetation, land uses and development as discussed below. Figure 4.32 illustrates the view to the project site from Moranbah Access Road, with the central hill on the skyline.

Figure 4.32 VS 13 - View to Project Site from Moranbah Access Road

4.7.3 Landform

Topography across the Isaac River Valley in the vicinity of the project site varies from approximately 200 m elevation along the Isaac River east of the project site to approximately 450 m elevation along portions of the Denham Range that define the western edge of the Isaac River Valley. This variation in elevation is over a distance of approximately 25 km and represents an average gradient of approximately 1v:100h. The relatively steep slopes associated with the Denham Range, contrast with the extensive flat areas along the base of the valley, which have gradients significantly less than 1v:100h. Drainage along the western slopes of the Isaac River Valley generally takes the form of deeply incised gullies flowing east and north-east towards the Isaac River. The general landform in the vicinity of the project site is illustrated on Figure 4.33.

The northern portion catchments of the project site generally drain north-east to the Isaac River while the southern portion catchments of the project site generally drain south-east to the Isaac River. Drainage lines are generally not deeply incised or visually prominent in most of the project site. However, steep embankments and the woodland vegetation associated with Cherwell Creek create a more visually distinctive landscape character in the central portion of the project site.

4.7.4 Vegetation

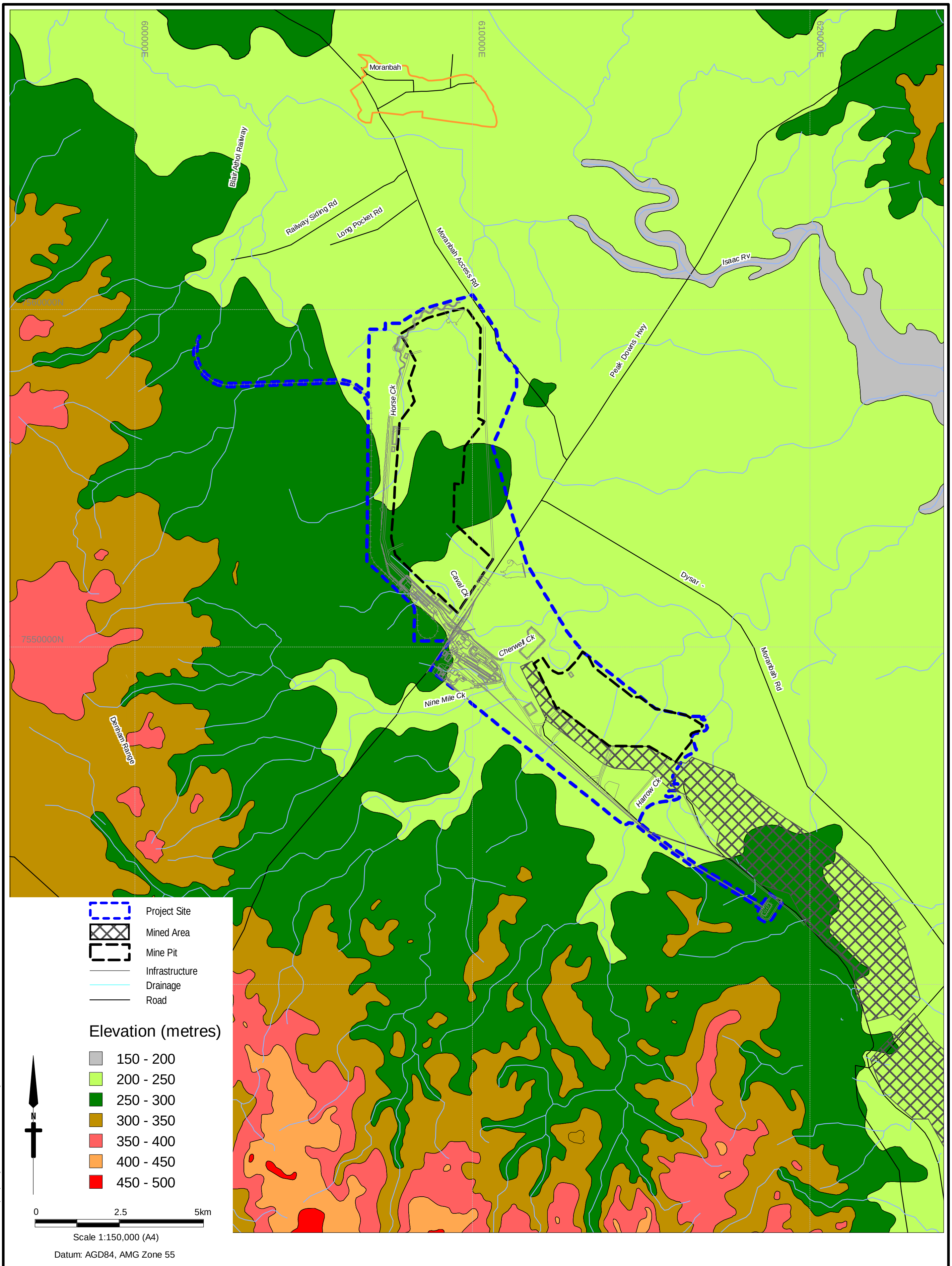
Most of the project site has been cleared for grazing, with the only significant remnant vegetation being located south of the Peak Downs highway. Areas of significant remnant vegetation are confined to stands of woodland south of the Peak Downs highway and a small area of grassland on basalt derived soils in the north-western corner of the project site. The extent of remnant vegetation is discussed in detail in the Section 8.1.1.2 (Terrestrial Ecology).

Remnant vegetation south of the Peak Downs highway includes Open Woodland (*Eucalyptus orgadophila*), Brigalow (*Acacia harpophilla*) Shrubby Open Forest/Woodland, and Poplar Box (*E. populnea*) Woodland associated with Cherwell Creek and tributaries in the southern portion of the project site. The remnant woodland vegetation creates a visually enclosed landscape character, with views from Peak Downs Highway and Dysart-Moranbah Road generally being blocked by vegetation. A small patch of Acacia Open Forest is located near the intersection of the Peak Downs Highway and Dysart-Moranbah Road.

The northern portion of the project site is predominantly pastoral grassland, there are small patches of remnant vegetation and regrowth of shrubs and trees. The open visual character of this grassland, combined with the undulating landform, provides a visually open landscape character with extensive views across the project site to intermediate tree-covered slopes and to the Denham Range on the skyline beyond.

The Brigalow communities that originally occurred throughout the region prior to European settlement have been extensively cleared. Clearing activities have fundamentally changed the landscape character by opening up views across extensive grassland areas. Consequently, views from Peak Downs Highway and Moranbah Access Road are now far more open and extensive than would have been the case prior to land clearing when views would generally have been blocked by roadside Brigalow woodland vegetation.

Soil erosion is now a common feature in the landscape where vegetation has been cleared from steeper slopes and ridges. Soil exposed by erosion and earthworks forms a visually distinctive landscape element.



Source: Geoscience Australia

Client	Project	Title
BHP Billiton Mitsubishi Alliance	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	**REGIONAL LANDFORM**
URS	Drawn: TE/VH · Approved: RS · Date: 08-05-2009	Figure: **4.33** · Rev:B
	Job No: **42626158** · File No: 42626158-g-584b.wor	A4

4.7.5 Mining Operations

While current open cut coal mining operations are visually prominent in many locations within the Bowen Basin they are generally not visible from the sections of Peak Downs Highway or Moranbah Access Road that adjoin the project site. An exception is the northern part of Peak Downs Mine in which the upper portions of the overburden stockpiles are visible in views to the south-west from some elevated sections of the Peak Downs Highway. However, these visible portions are not dominant due to the view distance, which is in the order of 5 km, and the lower portions of the overburden landform generally being screened by remnant woodland vegetation and local landforms.

Figure 4.34 illustrates the views to the south-west from Peak Downs Highway with Peak Downs Mine overburden stockpiles visible in mid distance and Denham Range on the skyline.

Figure 4.34 VS 14 - View to South-West from Peak Downs Highway

The Peak Downs mining operations do form a visually prominent element in the landscape along sections of the Dysart-Moranbah Access Road that runs close to the mine at a point approximately 10 km south of the Peak Downs Highway turnoff. Figure 4.34 illustrates the views to the south-west from Peak Downs Highway with Peak Downs Mine overburden stockpiles visible in mid distance and Denham Range on the skyline.

4.7.6 Commercial and Industrial Development

Commercial and industrial developments in the vicinity of the project site are generally limited in extent and do not form visually prominent elements across the landscape.

The Shell Roadhouse located at the Moranbah turnoff from the Peak Downs Highway is a landmark visual development for motorists travelling along the Peak Downs Highway, particularly those turning to travel into the Moranbah township and the various coal mines to the north.

The truck and machinery service facilities (Kalari Workshop and Trucking Yard) located alongside the Moranbah Access Road at the northern end of the project site also forms a visually prominent element. The buildings and machinery visible from Moranbah Access Road form a strong visual contrast against rural landscape setting in which they are viewed.

The Moranbah Airport is a visually prominent feature in the landscape, particularly when commercial aircraft are landing, taking off or stationary at the terminal. The aircraft are relatively large and their distinctive shape further increases their visual prominence. There are two small white airport terminal buildings. Signage associated with the airport also forms a visual feature for motorists travelling along the Moranbah Access Road. The elevated location of the airport in relation to the road contributes to the visual prominence of aircraft and the terminal buildings.

4.7.7 Moranbah Township

Moranbah is visually integrated into the landscape setting largely due to the extensive tree cover within and around the township. Some elements such as the white water tower and other large structures are visible from the section of Moranbah Access Road adjoining the project site, when approaching the township from the south.

4.7.8 Roads

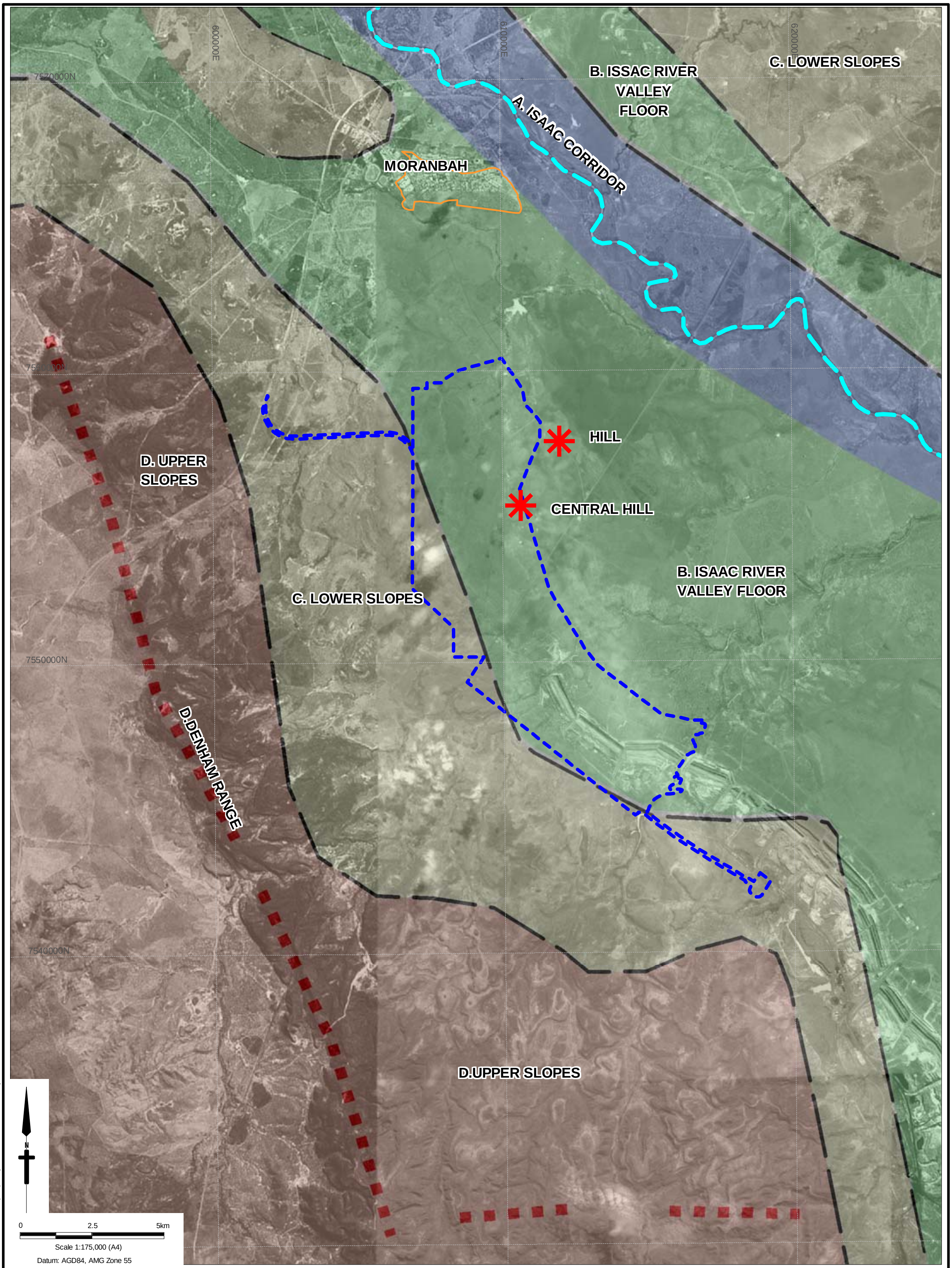
Peak Downs Highway forms the main transport route between Mackay and Central Queensland. In addition to carrying regional and local traffic associated with mining and agricultural activities, it also functions as a major tourist route. The highway is mostly a two-lane undivided bitumen sealed road with passing lanes at various locations. While the highway generally follows the natural landform, there are a number of bridges and culverts at creek and river crossings with associated roadside cuttings. Consequently views from the section of Peak Downs Highway in the vicinity of the project site alternate between open long distance views across cleared grazing land and sections that are visually enclosed by woodland vegetation and roadside cuttings. The section of Peak Downs Highway passing through the central portion of the project site is generally adjoined by woodland vegetation that blocks views from the highway.

Moranbah Access Road provides the main entrance to Moranbah township from the Peak Downs Highway. It is a two-lane undivided bitumen sealed road that generally follows the undulations of the natural landform. The only significant cutting occurs where the road crosses over a prominent hill approximately 2 km north of the Peak Downs Highway turnoff. Exposed red soil in the cutting is a visually prominent element in the landscape. The Moranbah Access Road crosses Grosvenor Creek via a causeway near the northern end of the project site.

The section of Dysart-Moranbah Road running south from Peak Downs Highway is generally parallel to the eastern boundary of the project site at a distance of approximately 3 km. Views towards the project site from the Dysart-Moranbah Road are generally screened by woodland vegetation associated with drainage lines located between the road and project site. Views of existing Peak Downs Mine overburden landforms in the southern portion of the project site are visible from the Dysart-Moranbah Road where it comes closer to the boundary at about 10 km south of the Peak Downs Highway turnoff.

4.7.9 Regional Landscape Zones

The primary landscape zones within the Isaac River Valley in the vicinity of the project site are illustrated on Figure 4.35 and described below.



Client	Project	Title
BMA BHP Billiton Mitsubishi Alliance URS	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	REGIONAL LANDSCAPE ZONES

Drawn: TE/VH	Approved: RS	Date: 08-05-2009	Figure: **4.35**	Rev:A
Job No: **42626158**	File No: 42626158-g-583.wor			A4

A. Isaac River Corridor Landscape Zone

- Broad flat sandy river bed defined by relatively steep embankments.
- Woodland vegetation throughout the riparian zone and extending onto the adjoining flood plain in some locations.
- The major bridge at the Peak Downs Highway crossing, combined with the visual enclosure of river-side trees, creates a landmark for motorists.

View along Isaac River showing tree cover

View of Isaac River and bridge

Figure 4.36 VS 15 - View from Peak Downs Highway at Isaac River Crossing

B. Valley Floor Landscape Zone

- Flat areas adjoining the Isaac River that have been extensively cleared for grazing and cultivation.
- Restricted drainage is common together with constructed water storage basins.
- Gently undulating landform further away from the river corridor provides varying views across the generally grass-covered grazing areas.

Figure 4.37 VS: Hill on Project Site - View North-East from Project Site across Isaac River Valley Floor

C. Lower Slopes Landscape Zone

- Moderately undulating landform with defined drainage ways.
- Woodland vegetation commonly occurs on steeper slopes.
- Views from roads and dwellings are generally restricted by vegetation and local landform.

Figure 4.38 VS: Hill on Project Site - illustrates the view to the west from the project site with lower slopes in the mid distance and Denham Range ridgeline on the horizon.

Figure 4.38 VS: Hill on Project Site - View to West from Project Site

D. Upper Slopes and Denham Range Ridgeline Landscape Zone

- Steep slopes and deeply incised drainage lines and escarpments.
- Forest and woodland vegetation covers most of these slopes and ridge lines which form a backdrop to views to the west from Peak Downs Highway, Moranbah Access Road, residents and Moranbah township.
- Erosion on slopes is common and forms a visually prominent landscape element in many locations.

Figure 4.39 illustrates the view to the south west from Peak Downs Highway with Denham Range on the skyline.

Figure 4.39 VS: Hill on Project Site - View South-West from Peak Downs Highway

4.7.10 Landscape Quality

The landscape quality of the project site has been significantly altered by agricultural land uses over many years and more recently by open cut mining. An assessment of the current landscape quality was carried out using a methodology that has been adapted from the United States Bureau of Land Management (BLM) methodology (BLM, 1984). The assessment criteria used are defined in Table 4.23 and the maximum potential rating for each of the criteria is shown by a number in the bottom right corner of each cell.

Table 4.23 Scenic Quality Ratings Table (Source: BLM, 1984)

Key Factors	Rating Criteria and Scores		
Landform	High vertical relief as expressed in prominent cliffs, spires or massive rock outcrops or severe surface variation or highly eroded formations or detailed features, dominant and exceptionally striking and intriguing.	Steep valleys, volcanic cones, hills or ridges; or interesting erosion patterns or variety in size and shape of landforms; or detailed features which are interesting though not dominant or exceptional.	Low rolling hills, foothills or flat valley bottoms or few or no interesting landscape features
	5	3	1
Vegetation	A variety of vegetative types has expressed in interesting forms, textures and patterns	Some variety of vegetation, but only one or two major types	Little or no variety or contrast to vegetation
	5	3	1
Water	Clear and clean appearing, still or cascading white water and any of which are a dominant factor in the landscape	Flowing or still, but not dominant in the landscape	Absent or present, but not noticeable
	5	3	0

Key Factors	Rating Criteria and Scores		
Colour	Rich colour combinations, variety or vivid colour or pleasing contrast in the soil, rock, vegetation, water or snowfields	Some intensity of variety in colours and contrast of soil, rock and vegetation, but not a dominant scenic element	Subtle colour variations, contrast or interest; generally muted tones
	5	3	1
Influence of adjacent scenery	Adjacent scenery, greatly enhances visual quality	Adjacent scenery moderately enhances overall visual quality	Adjacent scenery has little or no influence on overall visual quality
	5	3	0
Scarcity	One-of-a-kind or unusually memorable or very rare within the region. 5+	Distinctive, though somewhat similar to others within the region 3	Interesting within its setting, but fairly common within the region 1
	5+	3	1
Cultural modifications	Modifications add favourably to visual variety while promoting visual harmony	Modifications add little or no visual variety to the area and introduce no discordant elements	Modifications add variety, but are very discordant and promote strong disharmony
	2	0	-4

The maximum potential rating that could be achieved is 32. This rating would apply to a landscape that was assessed as meeting all of the criteria in the left hand column. The Scenic Quality Rating Categories defined in the BLM system are:

- 19 - 32 = High
- 12 - 18 = Medium
- 11 or less = Low

The Scenic Quality of the project site was assessed by applying the criteria in Table 4.23 and allocating a rating for each factor. Results of the assessment are presented in Table 4.24.

Table 4.24 Scenic Quality Rating of the Project Site

Key Factors	Rating	Comments
Landform	3	Undulating landform with distinct ridge line
Vegetation	3	Remnant clumps or individual trees and regrowth with pasture grass dominant ground cover
Water	0	No significant bodies of permanent water in drainage lines or visible in the landscape
Colour	3	Colour contrast between pasture grasses and patches of shrub/woodland; patches of red soil visible along edges of central ridge
Influence of adjacent scenery	3	Views to forest-covered range to west of project site as well as trees along some sections of drainage line create visual contrast with pasture on most of the project site
Scarcity	3	The landscape character of the project site is distinctive in the regional setting
Cultural modifications	0	Cultural modifications include fencing, structures, signs and powerlines that add little visual variety to the area
Total	15	

The rating of 15 out of a possible 32 indicates that the Scenic Quality of the project site is considered to be Medium in accordance with the BLM system. The implications of this medium Scenic Quality Rating in relation to the proposed mining operations are summarised by the following points:

While the proposed mining operations will result in changes to the existing landscape, the visual impacts will be limited to the period of mining.

- The proposed visual impact mitigation measures will minimise any potential reduction on the Scenic Quality Rating during the period of mining.
- Rehabilitation of the site following completion of mining operations will result in a landscape that is expected to have a Scenic Quality rating that is as high or higher than the current medium rating, because the post mining rehabilitated landscape will have more variation in landform and diversity in vegetation than the current landscape.

4.7.11 Visual Amenity

This section describes the existing landscape features and views that are considered most likely to be valued by sectors of the local and broader community. It includes consideration of local, regional, state, national and international landscape significance of the project site. Major issues addressed in assessing the visual amenity of the project site include:

- Viewshed of the project site and major views from public roads, townships and residents that contribute to the visual amenity of the area.
- Visual landscape features including focal points, land marks, gateways, ridge lines and other features that contribute to visual quality of the area.
- Visual character of the project site and surrounding area, including built form and natural features such as landform and vegetation.
- Capacity of the project site to accommodate change in land use(s) without detriment to the existing visual quality and landscape character.
- Value of existing vegetation as a visual screen.

4.7.11.1 Viewshed

The estimated Viewshed of the project site is indicated on Figure 4.42. The extent of the Viewshed has been determined by a review of contour plans and a series of panorama figures of the surrounding areas taken from the ridgeline located near the centre of the project site. Key aspects of the Viewshed are:

- The hill located in the centre of the project site is visible from some locations in the eastern portion of Moranbah township, which is located approximately 10 km to the north, but the areas of lower elevation in the northern portion of the project site are screened from view by the low ridge on which Railway Siding Road is located.

- Potential views from Moranbah township to the portion of the project site south of Peak Downs Highway are blocked by the central hill.
- The project site is potentially visible from locations along the lower slopes of the Denham Ridge but the extensive vegetation cover would generally block most of these potential views.
- Views from the section of Peak Downs Highway that runs through the centre of the project site are generally blocked by roadside woodland vegetation.
- The project site is highly visible to motorists travelling west along the section of Peak Downs Highway commencing approximately 3 km east of the Moranbah Access Road turn and extending to the Dysart – Moranbah Access Road turnoff.
- The project site is highly visible from most of Moranbah Access Road north of the Peak Downs Highway to the turn off to Long Pocket Road; exceptions are where the road passes through a cutting on the hill top about 2 km north of the Peak Downs Highway turnoff and near the Railway Siding Road turnoff, where views are blocked by roadside cut slopes and vegetation.
- The upper portions of the central hill in the of the project site are likely to be visible from rural areas between Moranbah Access Road and the Isaac River but the extent of visibility varies locally as a result of vegetation and local landforms.
- The portion of project site south of the Peak Downs Highway is generally not visible from the highway due to screening by woodland vegetation; similarly potential view of the site from or the Dysart-Moranbah Road are generally blocked by woodland vegetation associated with the broad floodplain located between the road and the site. Views of the tops of the overburden stockpiles associated with the Peak Downs Mine are available from a limited number of locations.

4.7.11.2 Major Views

Major views of the project site are indicated on Figure 4.42 and described below.

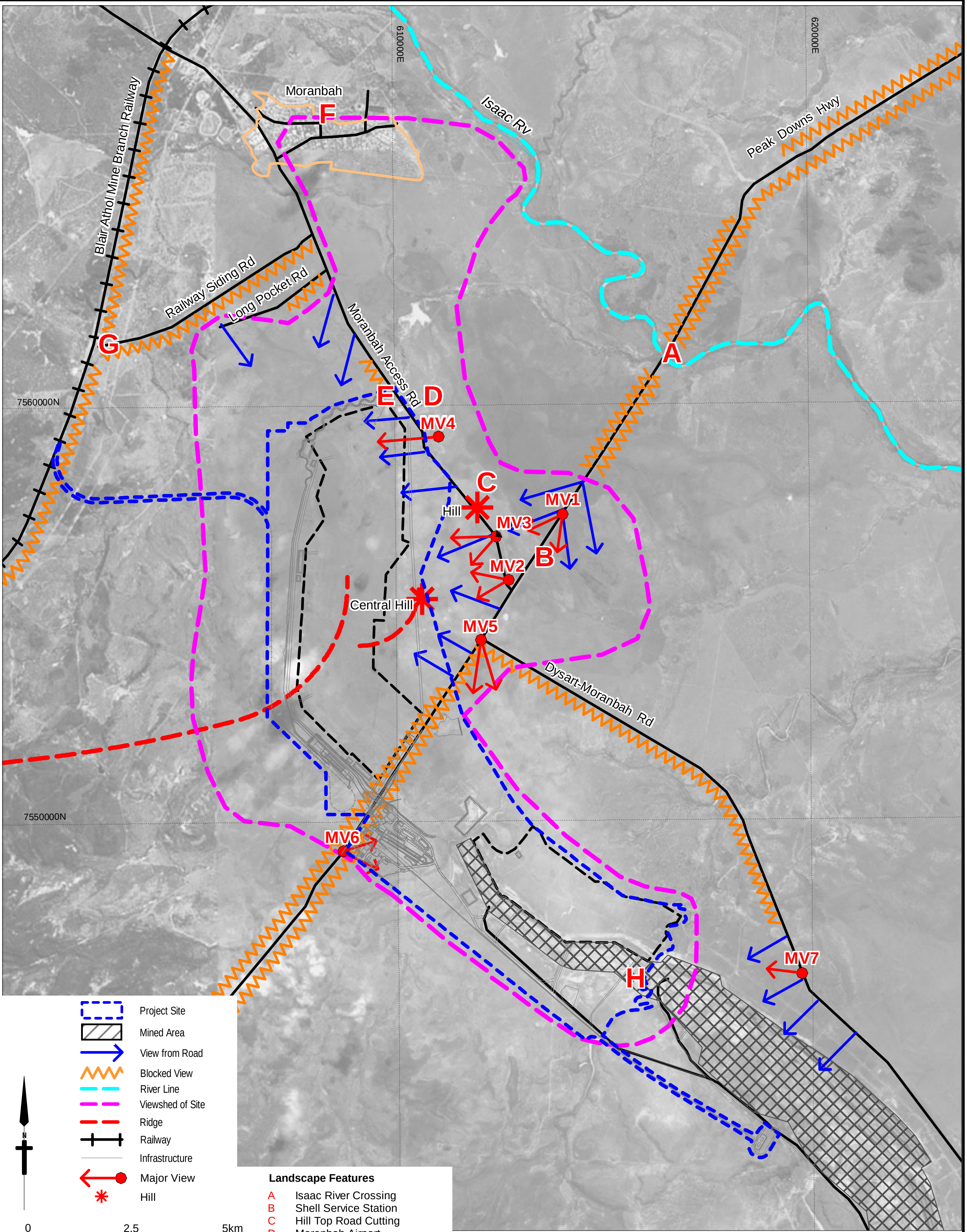
Figure 4.40 Major View 1 - Peak Downs Highway near the Moranbah Road Intersection

Some of the most significant views of the project site are from the section of Peak Downs Highway that extends for approximately 3 km in either direction from the Moranbah Access Road intersection (Figure 4.40). These views are particularly significant due to:

- The large number of motorists travelling along this section of highway.
- The context of this area of landscape adjoining a regional highway and forming part of the entrance to Moranbah township.

Figure 4.41 Major View 2 – Peak Downs Highway/Moranbah Access Road Intersection

The Peak Downs Highway/Moranbah Access Road intersection is marked by the Shell Roadhouse which forms a landmark along the Peak Downs Highway (Figure 4.41). It also marks the turn off to the Moranbah township.



Landscape Features

A Isaac River Crossing
B Shell Service Station
C Hill Top Road Cutting
D Moranbah Airport
E Vehicle Service Depot
F Moranbah Township
G Moranbah Railway Station
H Peak Downs Mine Overburden

0 2.5 5km

Scale 1 : 125,000 (A4)

AMG Zone 55, AGD84

Source: Image from Google Earth 2007

Client	Project	Title
BMA BHP Billiton Mitsubishi Alliance	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	PROJECT SITE VISIBILITY
URS	Drawn: TE/VH Approved: RS Date: 08-05-2009	Figure: **4.42** Rev:B
	Job No: **42626158** File No: 42626158-g-581b.wor	A4

Figure 4.43 Major View 3 – Moranbah Access Road

Views from the Moranbah Access Road are very significant as they create the visual experience of entering Moranbah township. The rural landscape character of this section of road creates a visual contrast to the urban development character of Moranbah and the industrial character of mining operations to the north of the township (Figure 4.43). The general lack of rural residential and industrial/commercial development alongside most of this section of Moranbah Access Road highlights the visual contrast and contributes to the visual experience.

Travelling south from Moranbah the central hill of the project site forms a visually prominent landform with changing perspective as the road ascends and descends a small hill north of the Peak Downs Highway intersection.

Figure 4.44 Major View 4 – From the Moranbah Airport

Views from Moranbah airport are very significant as they strongly influence the first impressions for visitors as they arrive by plane and drive out of the airport on to the Moranbah Access Road (Figure 4.44). Views from aircraft landing and taking off from the Moranbah airport are also highly significant.

Figure 4.45 Major View 5 – Dysart-Moranbah Road/Peak Downs Highway Intersection

Views from the section of Dysart-Moranbah Road immediately south of the Peak Downs Highway intersection are very significant due to the elevation of the road. Views travelling south extend to the Peak Downs Mine overburden landforms while those travelling north (Figure 4.45) extend to the Central Hill within the project site.

Figure 4.46 Major View 6 – Peak Downs Highway West of Project Site

Views for motorists travelling east along the section of Peak Downs Highway located west of the project site are significant as they are generally visually enclosed by roadside woodland vegetation and contrast with the section of highway to the north-east which generally provides open views across grazing paddocks. The long distance view to the east from the hill top immediately west of the project site extends to the central hill within the project site (Figure 4.46).

Figure 4.47 Major View 7 – Dysart-Moranbah Road adjoining Peak Downs Mine

Views from the section of Dysart-Moranbah Road adjoining Peak Downs Mine are significant due to the visual prominence of overburden landforms created by the Peak Downs Mine (Figure 4.47).

There are no public lookouts in the vicinity that would provide major views of the project site. Potential views of the project site from parks and open spaces within Moranbah township are generally screened by trees and local landforms.

4.7.12 Key Landscape Features

The site analysis identified a number of key landscape features that comprise the visual character of the project site and surrounding areas. These include the Isaac River, Moranbah township, public roads (Peak Downs Highway, Moranbah Access Road, and Dysart-Moranbah Road), Moranbah airport and Moranbah railway station. The locations of these key landscape features are shown on Figure 4.42 and their visual character is illustrated by the Figure 4.48 to Figure 4.54 and below discussion.

4.7.12.1 Isaac River Crossing

- Peak Downs Highway crosses the Isaac River over a substantial concrete bridge.
- Distinctive Eucalypt/Casuarina riparian woodland vegetation and glimpses of water and sandy river bed creates a landmark for motorists.
- Roadside woodland vegetation creates visual enclosure.

Figure 4.48 VS 15 - Isaac River Crossing

4.7.12.2 Shell Roadhouse

- Light-coloured buildings and associated advertising signs with parked trucks and other vehicles combine to create a visual landmark for motorists.

Figure 4.49 VS 14 - Shell Roadhouse

4.7.12.3 Hill Top cutting along Moranbah Access Road

- Red soil visible on road-side cuttings creates a landscape feature.
- Visual enclosure of the cutting contrasting with long distance views along the direction of the road to create a distinct landscape feature.

Figure 4.50 VS 14 - Hill Top Road Cutting

4.7.12.4 Moranbah Airport

- Roadside signage combined with views of the terminal building and parked aircraft create a landmark for motorists travelling along the Moranbah Access Road.

Figure 4.51 VS 11 - Moranbah Airport

4.7.12.5 Kalari Workshop and Trucking Yard (northern edge of project site)

- Buildings, parked vehicles, signage and perimeter security fence combine to create a landscape feature that contrasts with the surrounding rural landscape.

Figure 4.52 VS 11 - Kalari Workshop and Trucking Yard

4.7.12.6 Moranbah Township

- Avenue of trees along Moranbah Access Road creates a gateway feature to the township entrance.
- Extensive tree cover throughout the township, combined with parks and open spaces, create a distinct landscape feature.

Figure 4.53 VS: Hill on Project Site - Moranbah Township located in Trees along Ridge forming Skyline

4.7.12.7 Moranbah Railway Station

- Located at the western end of Railway Siding Road, the goods handing facilities and station form a significant transport infrastructure feature, even though it is not visible from Moranbah Access Road or the project site.

4.7.12.8 Peak Downs Mine

- Overburden stockpile landforms associated with Peak Downs Mine are visible from a section of Peak Downs Highway approximately 2 km east of the Moranbah Access Road intersection and form a distinctive landscape feature due to the visual contrast of the light coloured overburden material and the darker tone of trees within the view (Figure 4.54).

- The overburden stockpile landforms and mining machinery are visually prominent from a section of the Dysart-Moranbah Access Road approximately 10 km south of the Peak Downs Highway intersection where the road is within 1 km of the stockpiles.

Figure 4.54 VS 22 - Overburden Landforms at Southern end of the Project Site

4.7.13 Landscape Significance of the project site

The landscape significance of the project site varies in terms of local, regional, state, national and international context. At a local level the project site is highly significant as it forms part of the entrance zone into Moranbah township. All traffic travelling into and out of Moranbah from the Peak Downs Highway must drive past the northern portion of the project site. In the vicinity of the Moranbah Airport the boundary of the project site immediately adjoins the Moranbah Access Road. The project site also forms a major part of the visual experience of passengers arriving at the Moranbah Airport as it is not only visible from aircraft landing and taking off but also from vehicles driving out of the airport onto Moranbah Access Road.

The project site is also significant in a regional landscape context as it is visible from sections of the Peak Downs Highway, which carries significant volumes of regional traffic between Mackay, Clermont, Emerald and other Central Queensland towns. However, the landscape character of the project site is similar to extensive sections of landscape along the Peak Downs Highway. A number of operating mines, with overburden landforms in varying stages of rehabilitation, are also visible from the Peak Downs Highway east of the project site.

Given the extent of rural areas with similar landscape character to the project site throughout Queensland, it is not considered to be of State significance. Similarly the project site does not contain landscape features that would make it significant at a national or international level.

4.7.14 Project Site Capacity to Visually Absorb Change

The generally open visual character of the portion of project site north to Peak Downs Highway means that any significant change to land use would be visible from the adjoining public roads, airport and residents. The capacity of the project site to visually absorb a land use change would be significantly increased if a buffer zone of woodland vegetation was established along the edge of Moranbah Access Road and Peak Downs Highway to screen views of the project site. However, establishment of a vegetation buffer would fundamentally change the existing visually open landscape character and return it to a landscape character similar to the original character that existed prior to vegetation clearing for agriculture. Establishing a buffer would involve planting on land outside of the project site and vegetation could take up to 20 years to achieve a height that would provide an effective visual screen.

The hill located near the centre of the project site is visible from surrounding areas and forms a landmark for motorists travelling along the Peak Downs Highway, particularly those travelling to and from Moranbah township. However it does block views of the portion of the project site to the west and thus provides some visual absorption capacity.

The portion of the project site south of the Peak Downs Highway has a moderate capacity to visually absorb change due to the extensive remnant woodland vegetation associated with the broad drainage channels located between the road and the project site. The only industrial development on the project site is the Kalari workshop and trucking yard. Consequently it has a low capacity to visually absorb development that involves construction of substantial structures. However, the woodland vegetation south of Peak Downs Highway provides some capacity to visually absorb development provided an adequate buffer strip of trees is maintained along the roadside.

4.7.15 Lighting

As discussed above, the project site is located to the south of the township of Moranbah, in a rural setting predominantly used for cattle grazing and coal mining. Lighting in the vicinity of the project site is therefore generally limited to vehicles using the Peak Downs Highway, neighbouring residences and lighting from the Peak Downs Mine operations.

4.7.16 Screening by Existing Vegetation

Remnant woodland vegetation in the portion of the project site south of Peak Downs Highway provides effective screening of potential views to the south. Current open cut mining is generally not visible from this section of the highway due to screening by the existing woodland vegetation. Similarly views of the overburden landforms from the Dysart-Moranbah Road are generally screened by trees along the broad drainage channels south-west of the road.

Potential views to the north across the project site from the Peak Downs Highway are also screened to some extent by existing vegetation along the northern edge of the highway. However, the upper portions of the central hill of the project site are often visible in these views.

The existing grassland vegetation over most of the northern portion of the project site does not screen views from the adjoining sections of Moranbah Access Road or Peak Downs Highway. However woodland vegetation adjoining Moranbah Access Road south of Railway Siding Road screens views of part of the project site.

4.7.17 Potential Visual Impacts Assessment

4.7.17.1 Proposed Mine Operations

The project will involve a new open cut coal mine north of and adjacent to the existing Peak Downs Mine. The coal will be processed at an on-site CHPP. A total area of approximately 3,400 ha will be disturbed over the life of the project including the mine area, out of pit waste dump footprints and associated infrastructure. Initially, the waste rock produced by mining at the project will be placed in out of pit waste rock dumps, most likely located within and close to the perimeter of the mining lease to contribute to bunding for environmental management. When sufficient space is created within the mined-out areas, subsequent waste rock will be placed within in-pit waste rock dumps.

The proposed 24 hour mining operations will require lighting of the coal handling and preparation plant as well as the mining operations area. The two situations in which lighting may be visible from public roads will include:

- The coal handling, preparation and loading facilities that will adjoin Peak Downs Highway on the western edge of the project site.
- Lighting associated with the mining operations.

Lighting associated with the coal handling and preparation facilities will include floodlighting to allow safe night operations as well as lower intensity security and safety lighting on buildings and structures. Vehicle operating in this area will also have their head lights on. Lighting associated with the mining operations will move with the progression of these operations. It will include lighting on the three draglines as well as shovels and other equipment used in the removal of overburden, extraction of coal. Lighting will also be associated with trucks transport and dump the overburden as well as the spreader used in placing the overburden.

4.7.17.2 Assessment Methodology

The methodology used to assess the potential visual impact of the project involved identifying the extent to which the development will be visible (Visibility) and the significance of the visible change to the landscape that may result from the development.

The level of significance of the potential visual impact of the project is dependent on the Magnitude of Visibility of change to existing views together with the Sensitivity of the viewers to that change.

The Magnitude of Visibility of change to existing views will depend on a combination of scale, extent and duration of the views. It would be influenced by the:

- Extent of area from which the project development would be visible.
- Number and type of viewers who see the development.
- Distance of the view to the development.
- Duration of change to the view (i.e. temporary or permanent, continuous or intermittent) that would result from the development.
- Scale of change to the view that would result from the development (i.e. proportion of the view occupied by the development).
- Degree of contrast between the development and the existing landscape in terms of form, scale, line, height, colour and texture.

Viewer Sensitivity is the extent to which a viewer is willing to accept a change to the landscape resulting from the development without perceiving it as an adverse impact on the existing landscape character or value attributed to the current view. Viewer Sensitivity may range from high to low and is dependent on the:

- Location of the viewer (e.g. dwelling, workplace, recreation/open space, road/highway).
- Context of the view (e.g. visibility of existing mines, power lines).
- Expectations and activity of the viewer (e.g. resident, visitor, worker, motorists, cyclists, pedestrian, recreation/sporting participant).
- Importance of the view (e.g. identified in regional scenic resources assessment, referenced in tourist maps/guides, numbers of people deliberately seeking the view, reference to the view in literature and art).

Viewers with the highest sensitivity levels are likely to include:

- Residents with views affected by the development.
- Users of public open space where their attention is focused on visual landscape values, such as scenic lookouts, natural landscape areas with attractive views.
- Communities where the development would result in changes to the landscape setting of views that are valued by the community.

Viewers with the lowest visual sensitivity are likely to be:

- At places of work were attention is focused on work activities.
- Motorists whose attention is focused on driving.
- People engaged in recreation activities that do not involve viewing the landscape.

The various levels of Visual Impact Significance that result from the combinations of Magnitude of Visibility and Viewer Sensitivity are presented in Table 4.25 , and are defined as:

- Negligible Visual Impact - only a very small part of the development would be discernible and/or it would be located at such a distance that it would be scarcely visible.
- Low Visual Impact - the development would constitute only a minor component of the wider view and might be missed by the casual observer or awareness of the development would not have a marked effect on the overall quality of the view.
- Moderate Visual Impact - the development may form a visible and recognisable new element within the overall scene and may be readily noticed by an observer.
- High Visual Impact - the development would form a significant and immediately apparent part of the view that would affect and change its overall character (the change may be positive or negative).

Table 4.25 Visual Impact Significance Matrix

	Viewer Sensitivity		
Visibility Magnitude	**Low**	**Medium**	**High**
High	Moderate	Moderate/High	High
Medium	Low/Moderate	Moderate	Moderate /High
Low	Low	Low/Moderate	Moderate
Negligible	Negligible	Negligible/Low	Low

Note: the levels of Visual Impact Significance in shaded cells are not considered to be significant enough to constitute potential barriers of the development or land use change. However mitigation measures may still be required.

The visual assessment involved:

- Analysis of the existing landscape character.
- A field inspection to determine the extent to which the site is generally visible.
- Identification of the various viewing situations from which the project may potentially be visible from surrounding areas.
- Particular attention was given to potential views of the site from residents, Moranbah township, Peak Downs Highway, other public roads, and areas adjoining the project site. Views from the site were analysed to identify the extent to which the residents and public roads were visible from the site, which provided an indication of the likely level of visibility from those residents and sections of road. This analysis was based on the principle of intervisibility, which means that if a dwelling or section of road is visible from the site then the site would be visible from those viewing situations. The precise level of visibility was confirmed by visiting the sections of public road and other potential viewing situations. The various criteria used to determine Magnitude of Visibility are defined in Table 4.26.

Table 4.26 Magnitude of Visibility Assessment Criteria

Criteria	Definition
Number of Viewers	
High	>5,000 people per day
Moderate	1,000-5,000 people per day
Low	100-1,000 people per day
Very Low	<100 people per day
View Distance	
Long	>5 km
Medium	1-5 km
Short	200-1,000 m
Very short	<200 m
Period of View	
Long term	>2 hrs
Moderate term	1 minute to 2 hours
Shirt term	< 1 minute

The levels of Magnitude of Visibility resulting from combination of the various criteria in Table 4.26 are presented in Table 4.27. These categories of Magnitude of Visibility are defined further below.

Table 4.27 Magnitude of Visibility Matrix

	Long Distance			Medium Distance			Short Distance			Very Short Distance		
Period of View	**Long**	**Medium**	**Short**	**Long**	**Medium**	**Short**	**Long**	**Medium**	**Short**	**Long**	**Medium**	**Short**
No. of viewers - High	M	L	L	H	M	M	H	H	M	H	H	H
No. of viewers - Medium	L	L	N	M	M	L	H	M	M	H	H	M
No. of viewers - Low	L	N	N	M	L	L	M	M	L	H	M	M
No. of viewers - Very Low	N	N	N	L	N	N	L	L	L	M	L	L

Note: N = negligible Magnitude of Visibility M = medium Magnitude of Visibility

H = high Magnitude of Visibility L = low Magnitude of Visibility

Negligible Magnitude of Visibility is defined as very minor loss or alteration to one or more key element/features/characteristics of the baseline visual character (i.e. pre-development landscape or view) and/or introduction of elements that are not uncharacteristic to the existing landscape (i.e. approximating the no change situation).

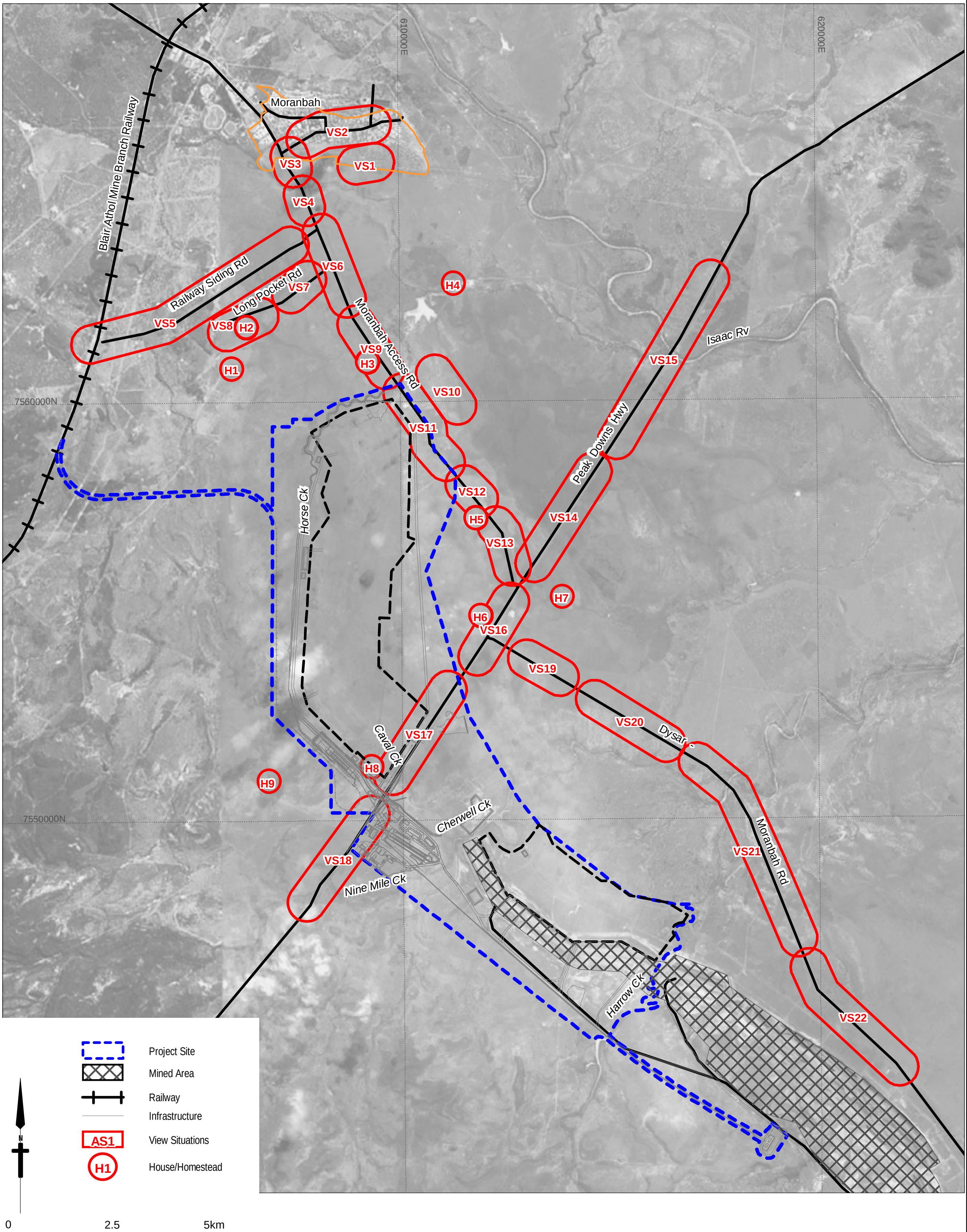
Low Magnitude of Visibility is defined as minor loss of/or alterations to one or more key elements/features/characteristics of the baseline visual character (i.e. pre-development landscape or view) and/or introduction of elements that are not uncharacteristic of the existing landscape.

Medium Magnitude of Visibility is defined as partial loss of or alteration to one or more key elements/features/characteristics of the baseline visual character (i.e. pre-development landscape or view) and/or introduction of elements that may be prominent but not considered to be substantially uncharacteristic of the existing landscape.

High Magnitude of Visibility is defined as total loss of key elements/features/characteristics of the baseline visual character (i.e. pre-development landscape or view) and/or introduction of elements considered to be totally uncharacteristic of the existing landscape.

4.7.17.3 View Situations

The locations of the various view situations (VS) are shown on Figure 4.55 and the visual character of each is illustrated by the series of figures below. It should be noted that no photograph is presented for view situation 2 which is the section of Mills Av. Moranbah within Moranbah township where views are blocked by houses.



Scale 1 : 125,000 (A4)

AMG Zone 55, AGD84

Source: Image from Google Earth 2007

Client: BMA BHP Billiton Mitsubishi Alliance

URS

Project: CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT

Title: **VIEW SITUATIONS**

Drawn: TE/VH	Approved: RS	Date: 08-05-2009	Figure: **4.55**	Rev:B
Job No: **42626158**	File No: 42626158-g-585b.wor			A4

Figure 4.56 VS 1 – View South from Moranbah Recreation Reserve

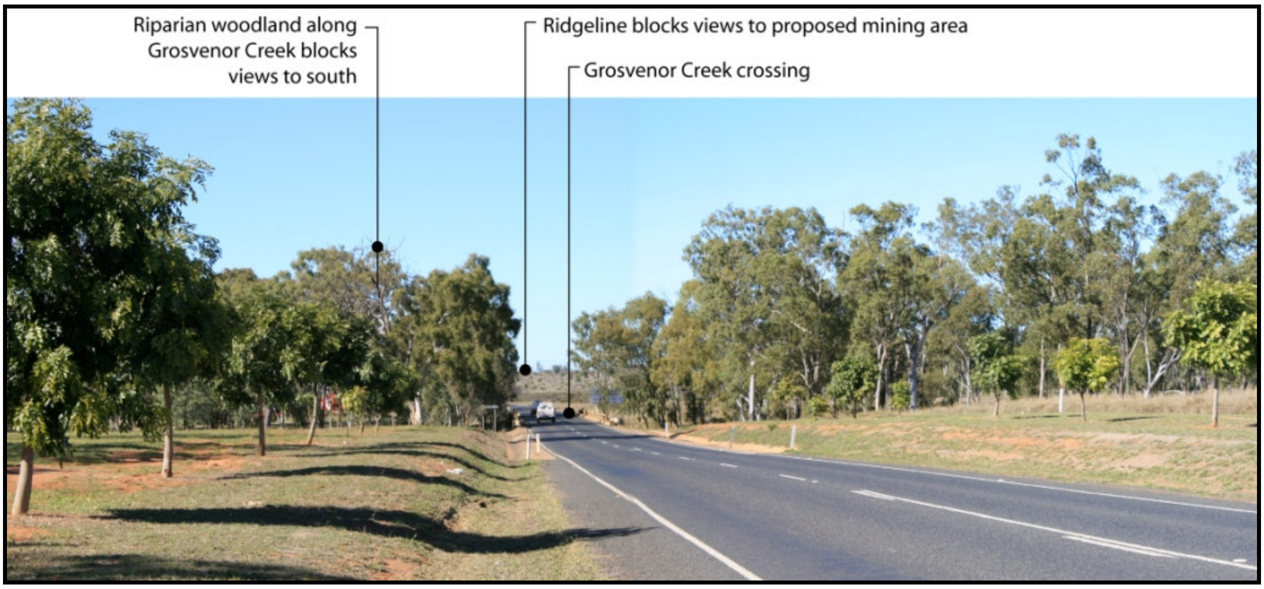


Figure 4.57 VS 3 – View South from Moranbah Access Road at Federation Walking Path

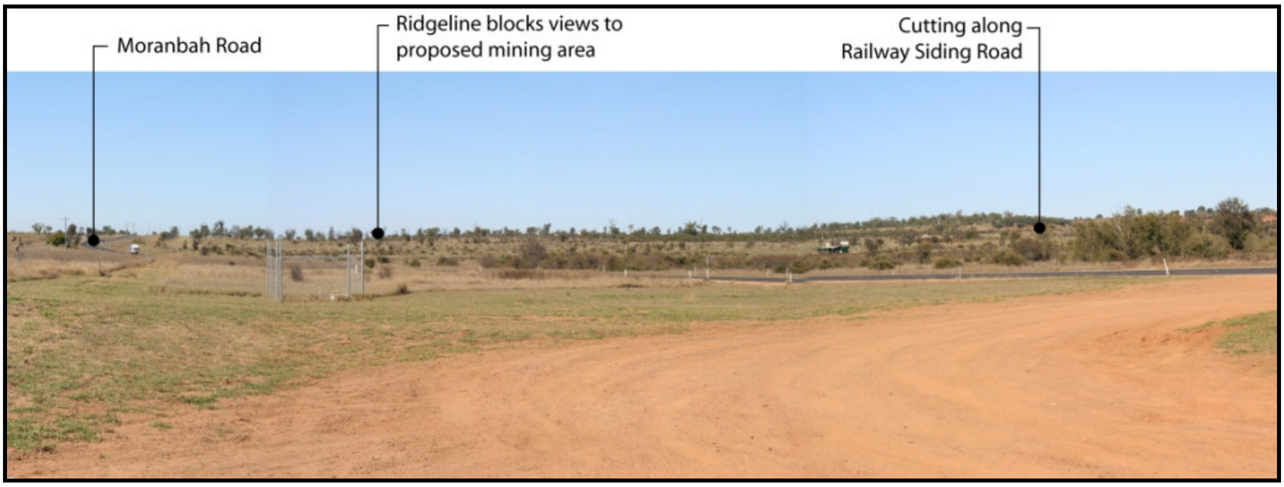


Figure 4.58 VS 4 – View South from Rest Area to Moranbah Access Road

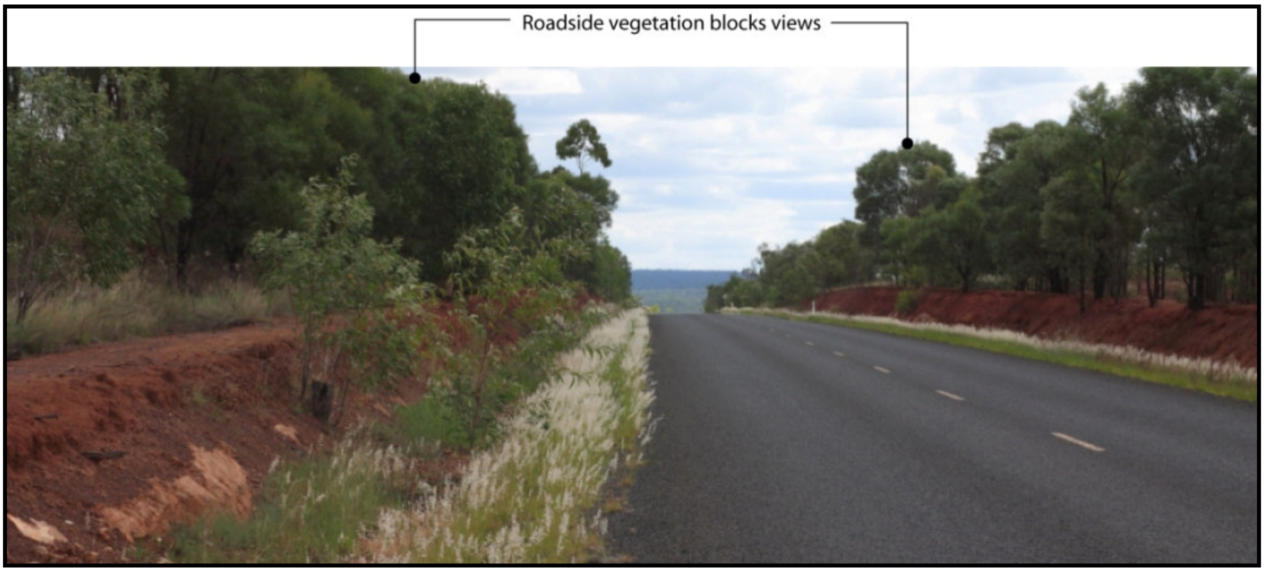


Figure 4.59 VS 5 – View West along Railway Siding Road

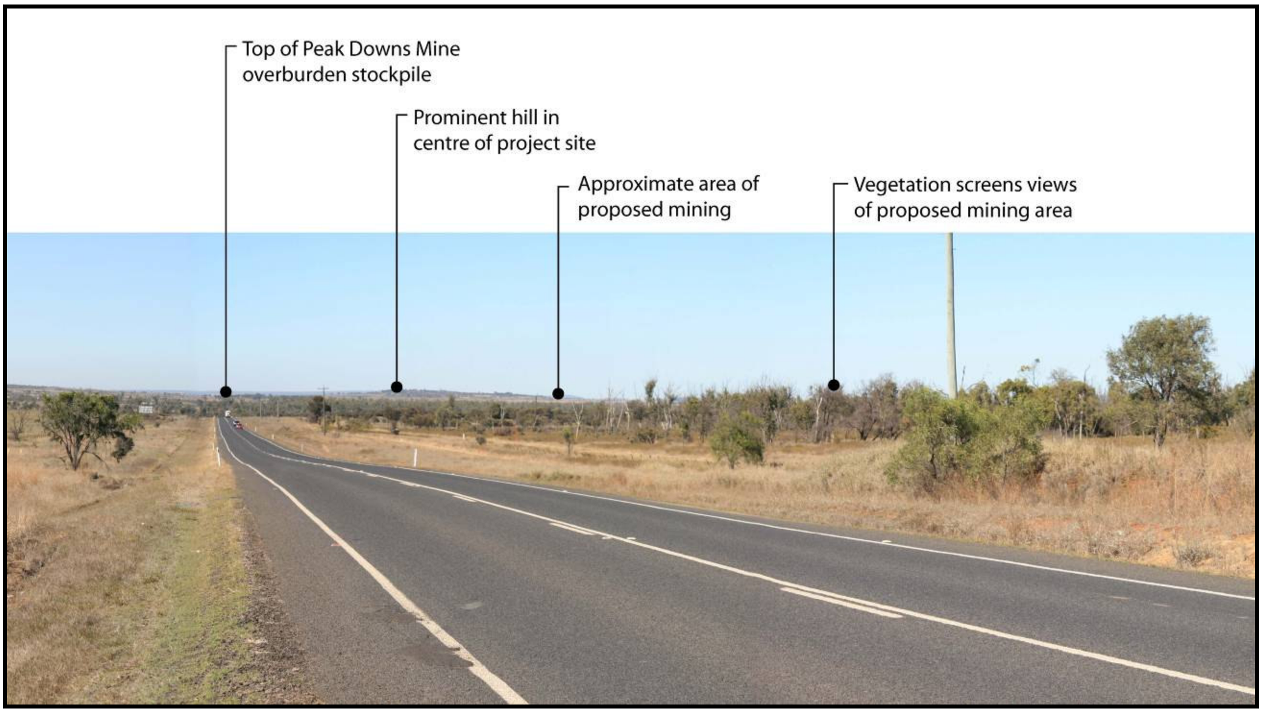


Figure 4.60 VS 6 – View South along Moranbah Access Road towards Airport

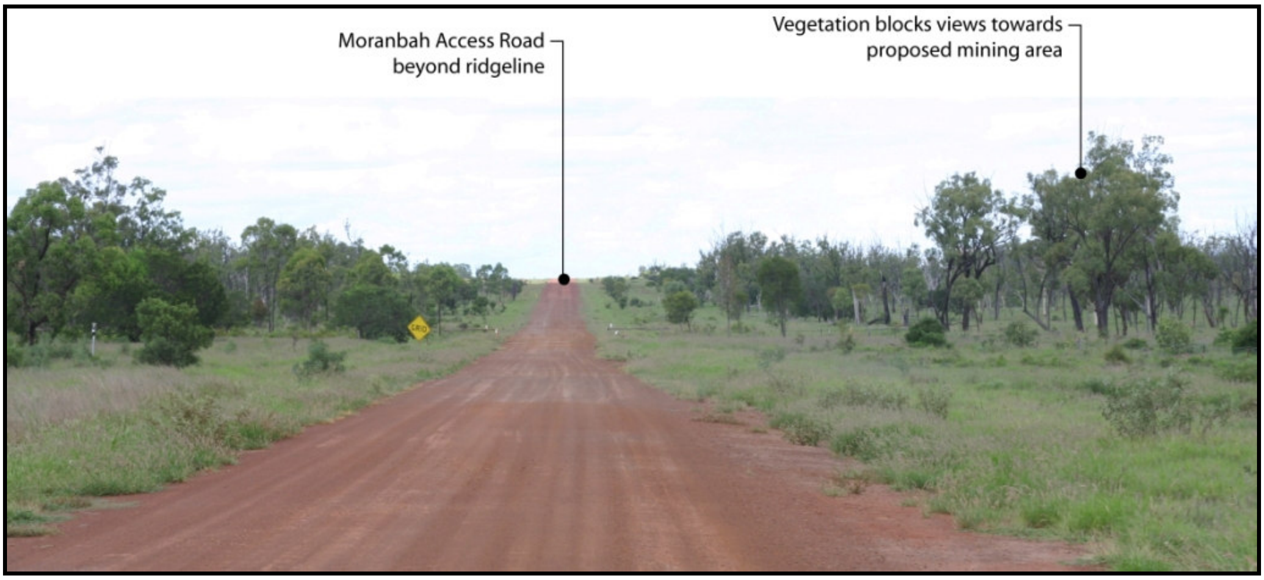


Figure 4.61 VS 7 – View East along Long Pocket Road

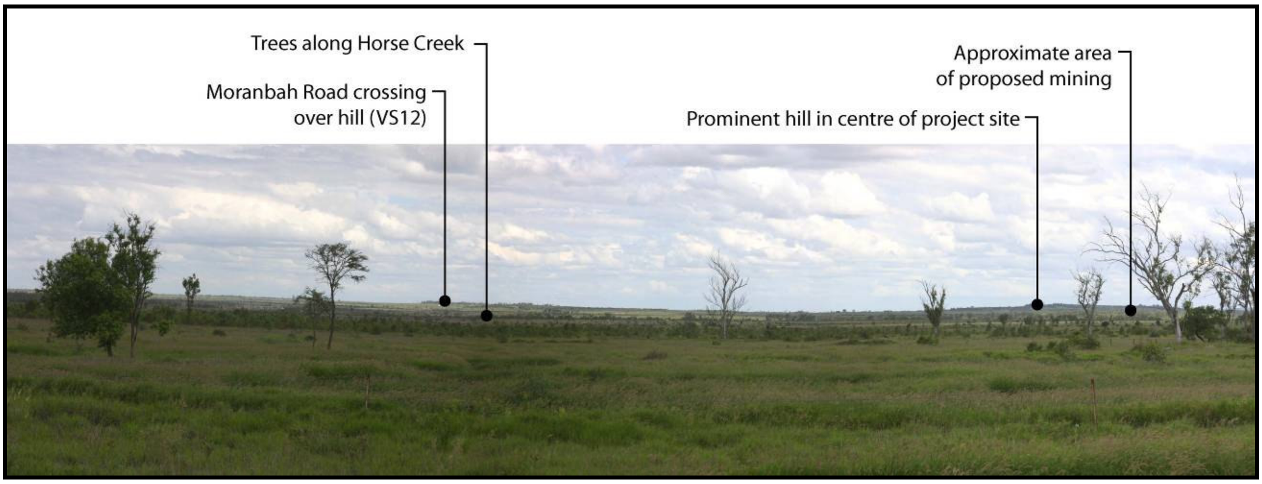


Figure 4.62 VS 8 – View South from Long Pocket Road

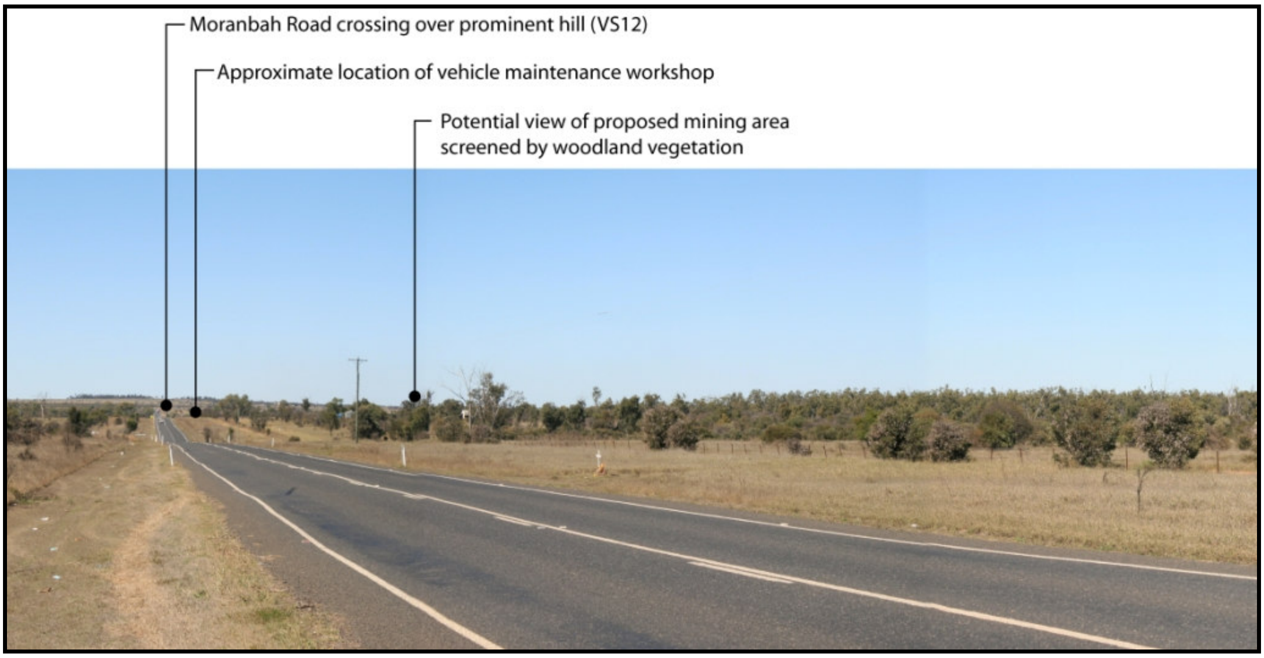


Figure 4.63 VS 9 – View South along Moranbah Access Road

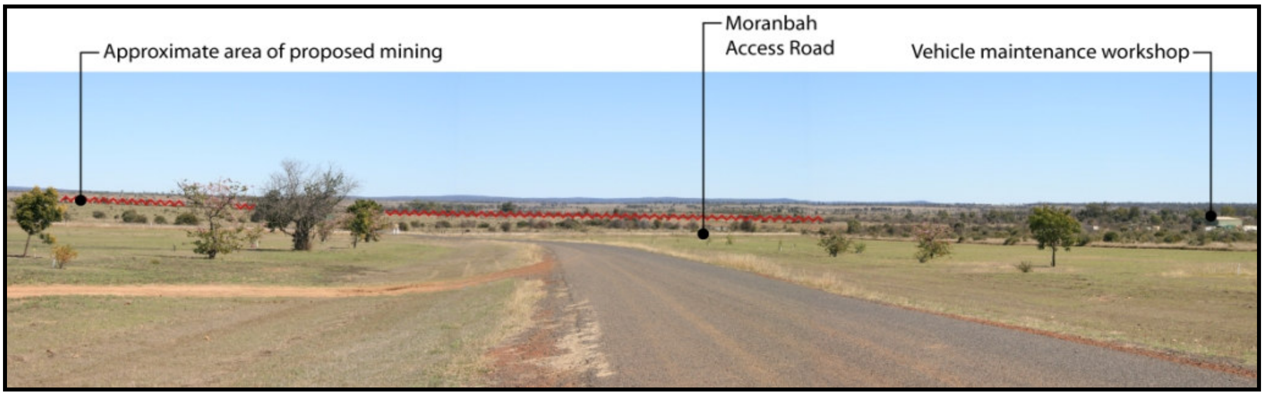


Figure 4.64 VS 10 – View South from Moranbah Airport

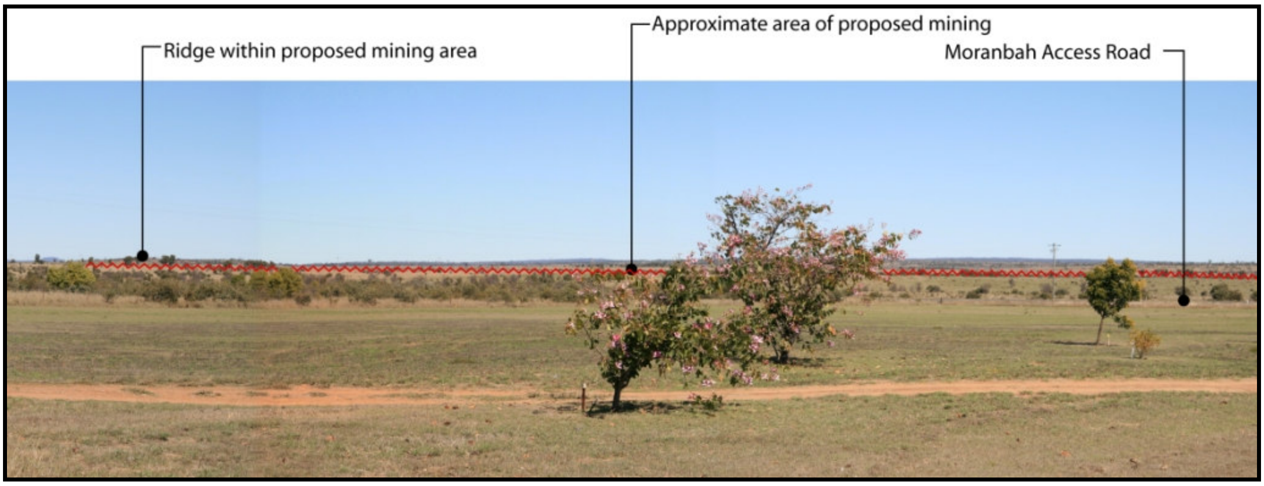


Figure 4.65 VS 10a - View West from Moranbah Airport

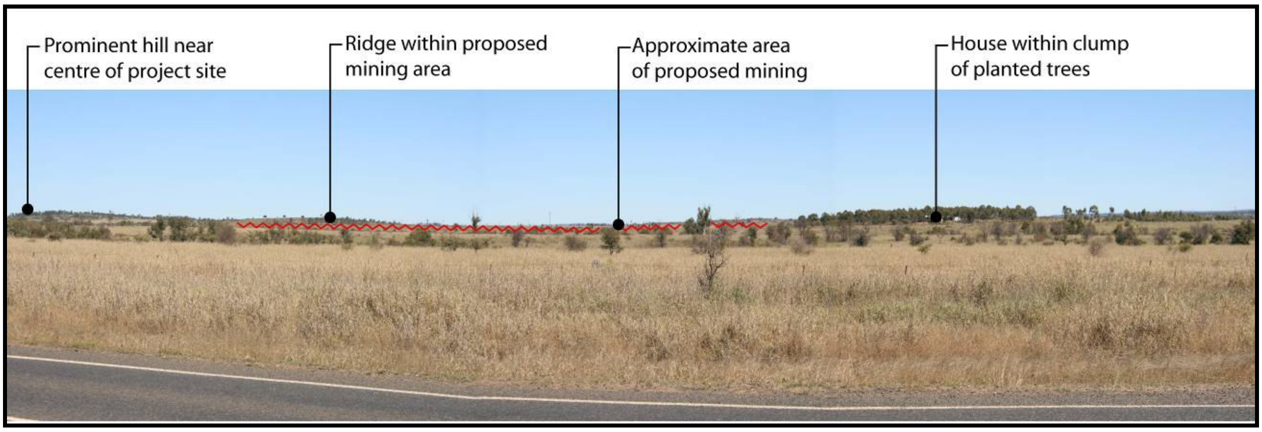


Figure 4.66 VS 11 – View West from Moranbah Access Road

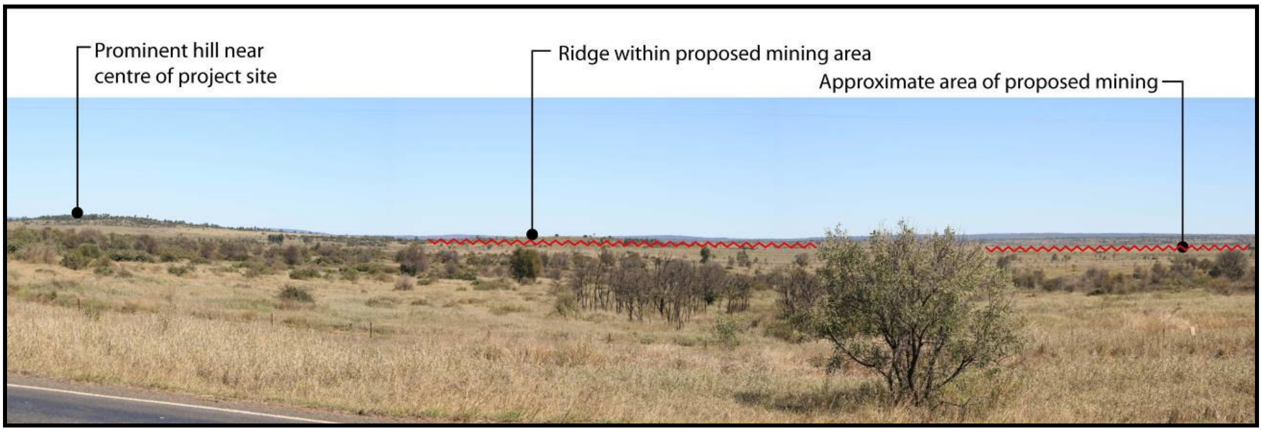


Figure 4.67 VS 12 – View West from Moranbah Access Road

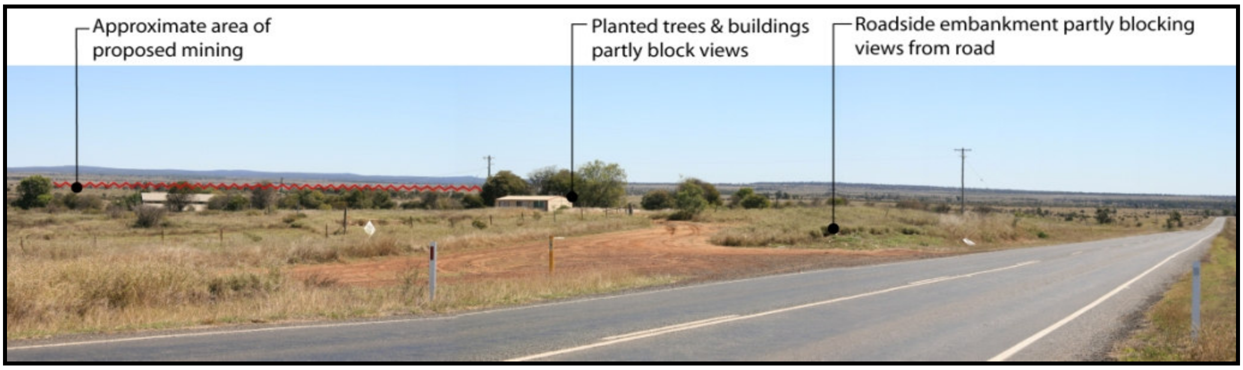


Figure 4.68 VS 12 – View North from Moranbah Access Road

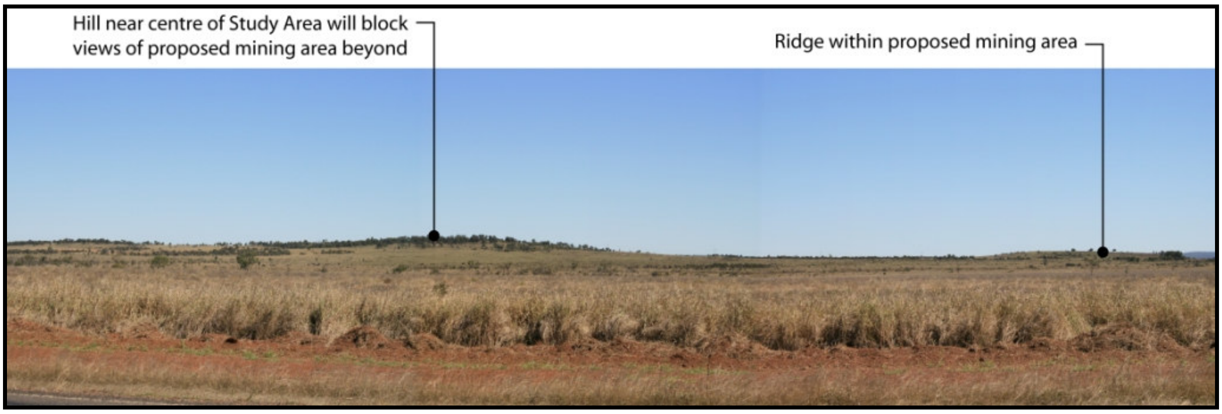


Figure 4.69 VS 13 – View North-West from Moranbah Access Road

Figure 4.70 VS 13 - View North from Moranbah Access Road near Shell Roadhouse

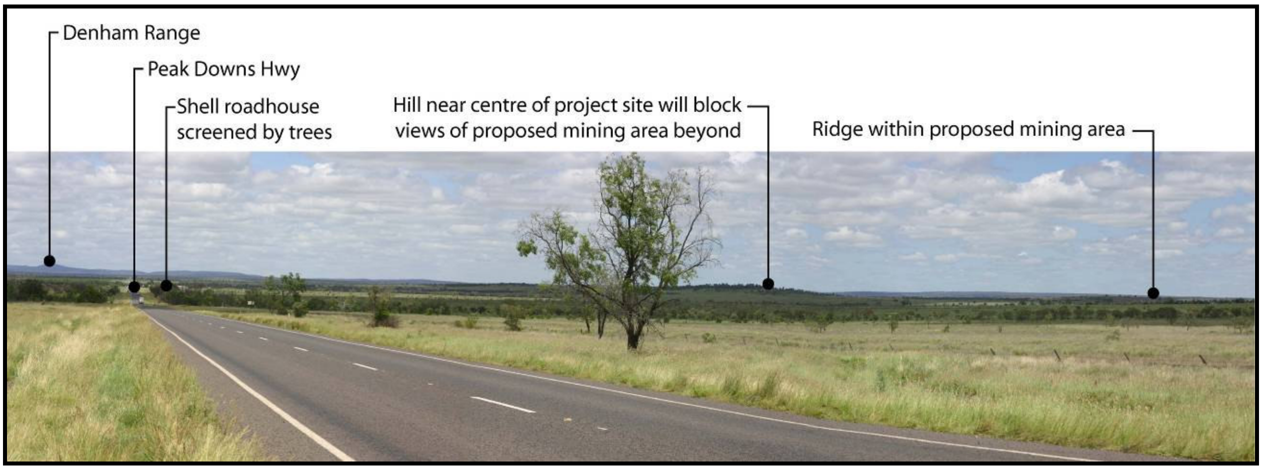


Figure 4.71 VS 14 – View North-West from Peak Downs Highway

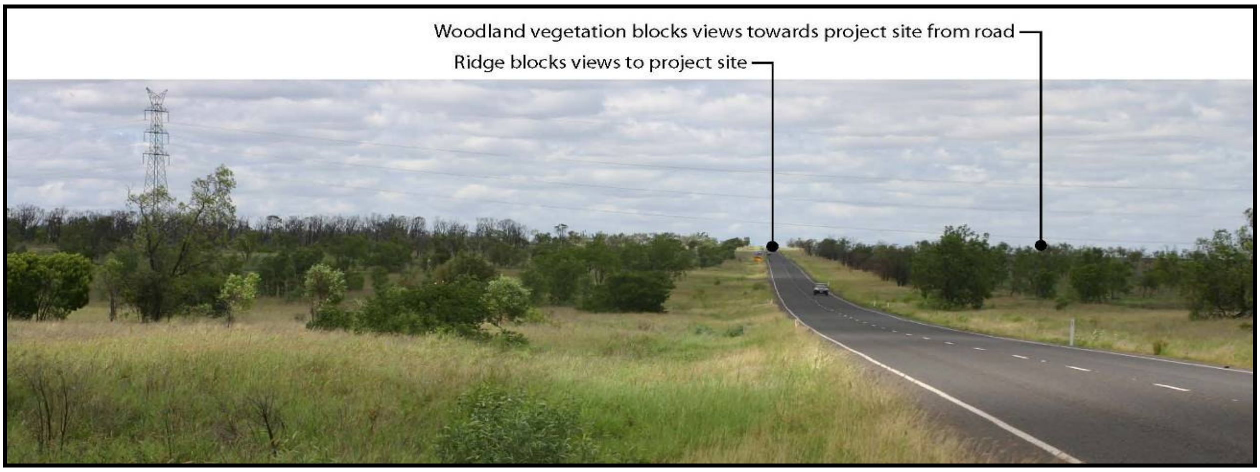


Figure 4.72 VS 15 – View North-West along Peak Downs Highway

Figure 4.73 VS 16 – View North from Peak Downs Highway

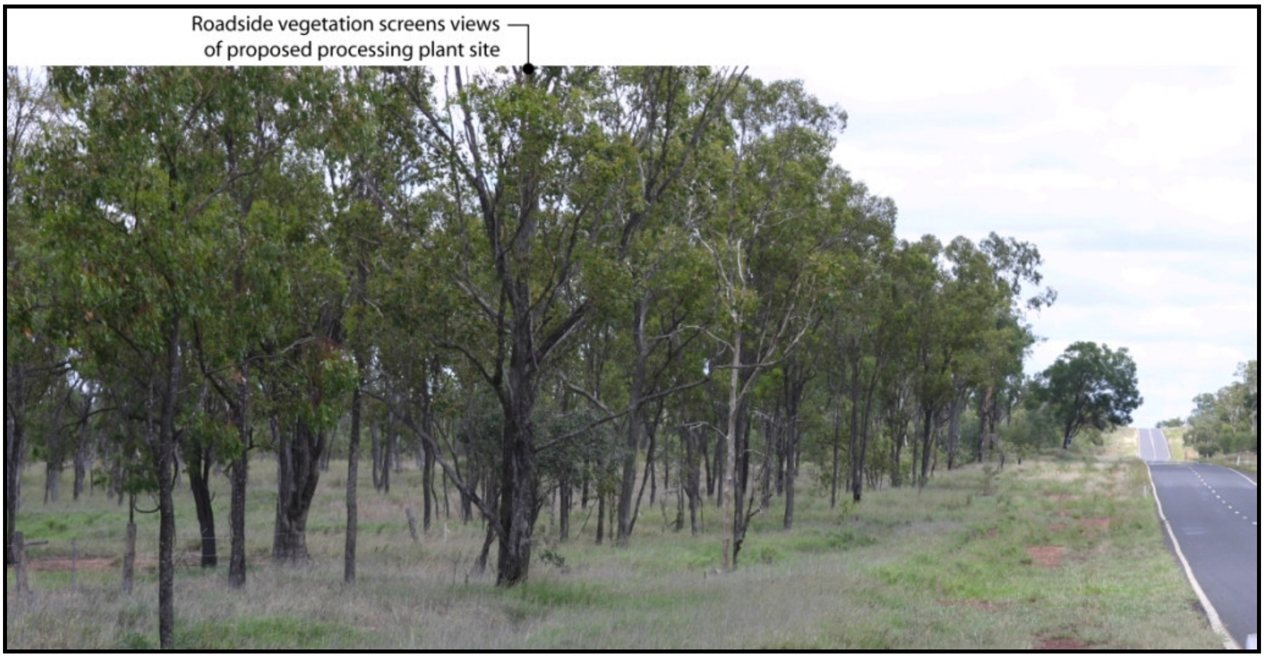


Figure 4.74 VS 17 – View East along Peak Downs Highway

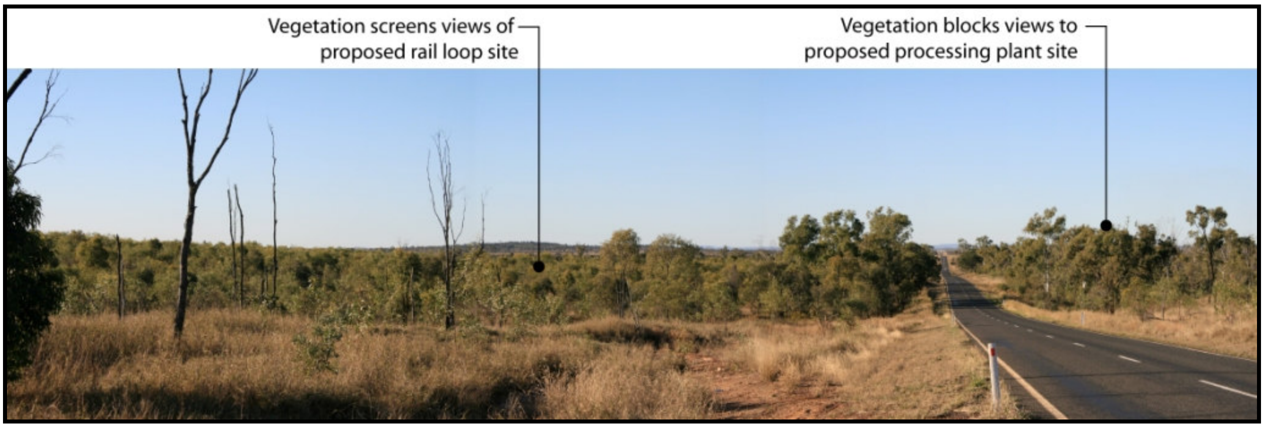


Figure 4.75 VS 17 – View West along Peak Downs Highway

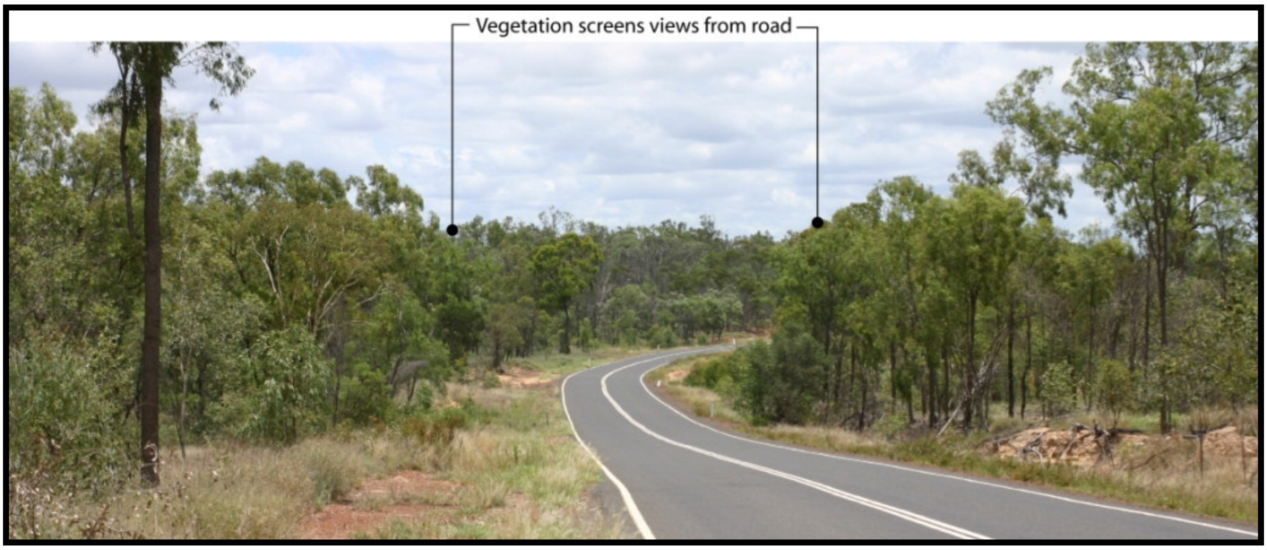


Figure 4.76 VS 18 – View West along Peak Downs Highway

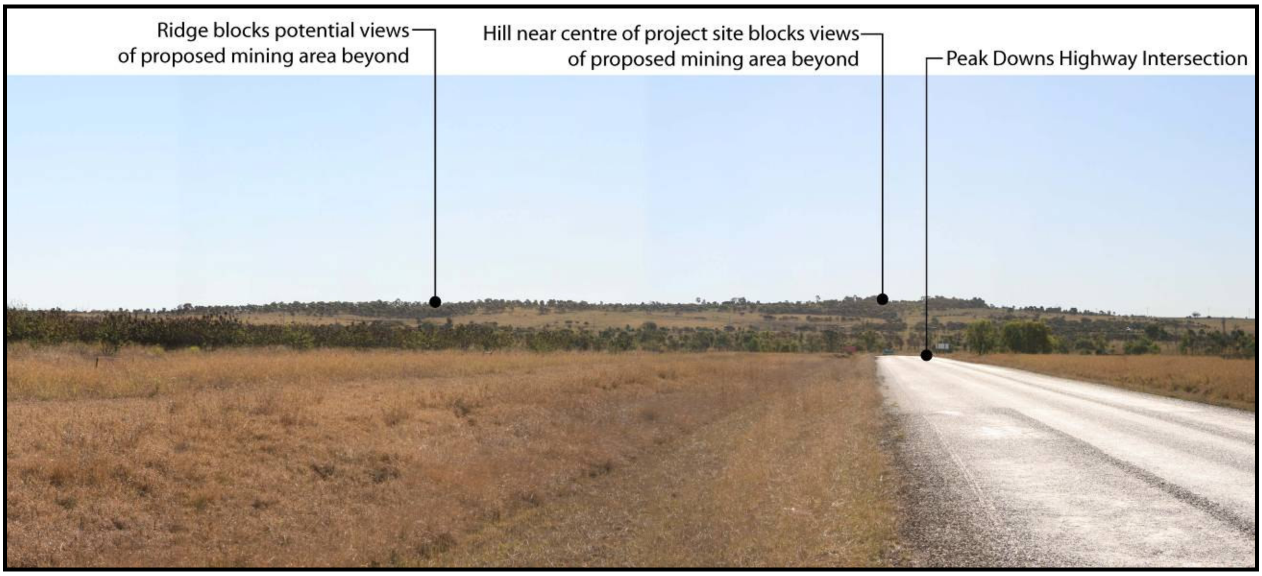


Figure 4.77 VS 19 – View North along Dysart-Moranbah Road

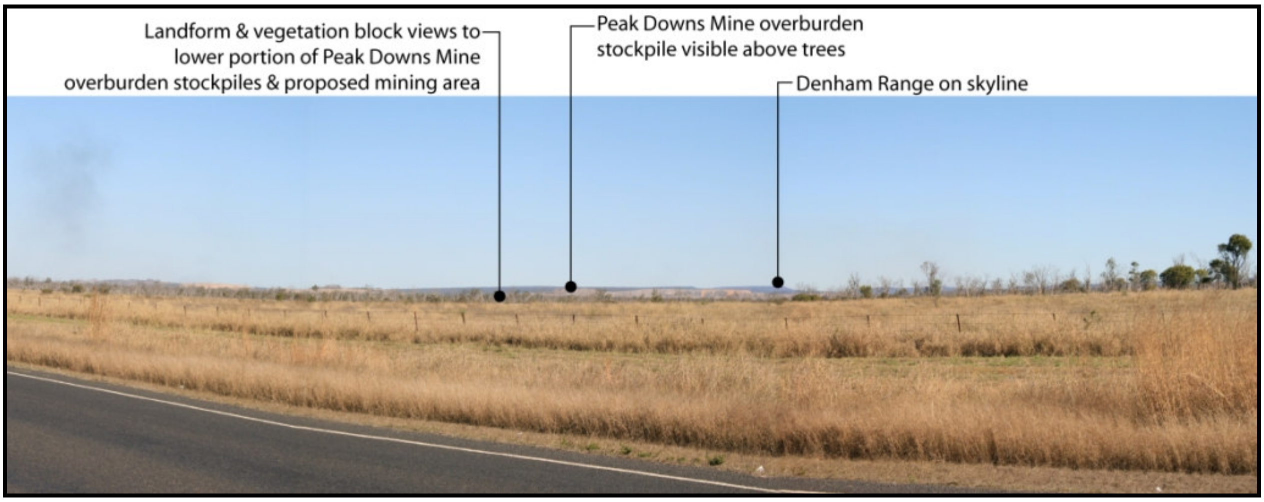


Figure 4.78 VS 19 – View South-West from Dysart-Moranbah Road

Figure 4.79 VS 20 – View West from Dysart-Moranbah Road

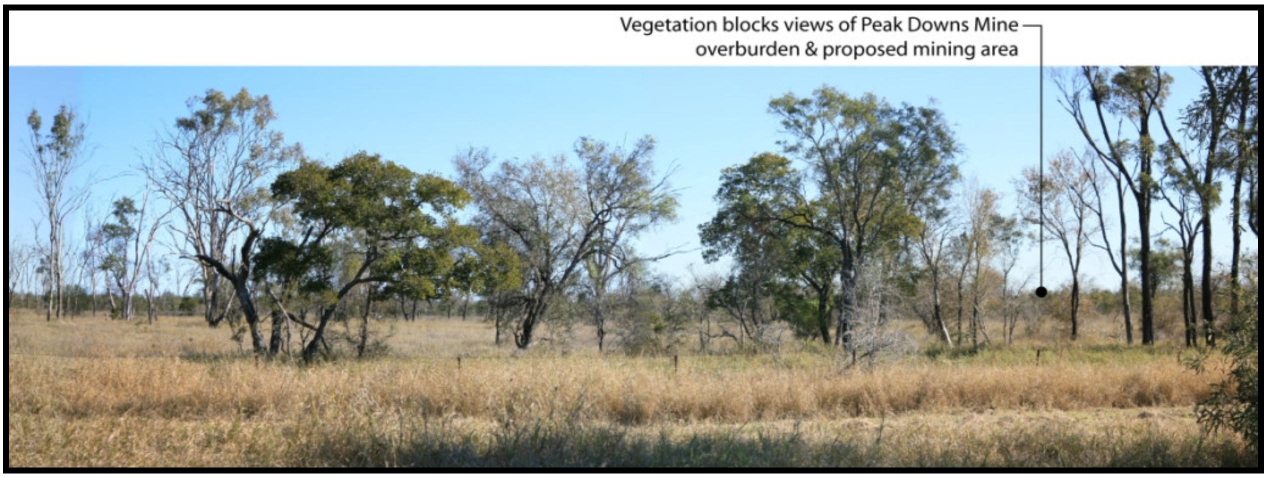


Figure 4.80 VS 21 – View West from Dysart-Moranbah Road

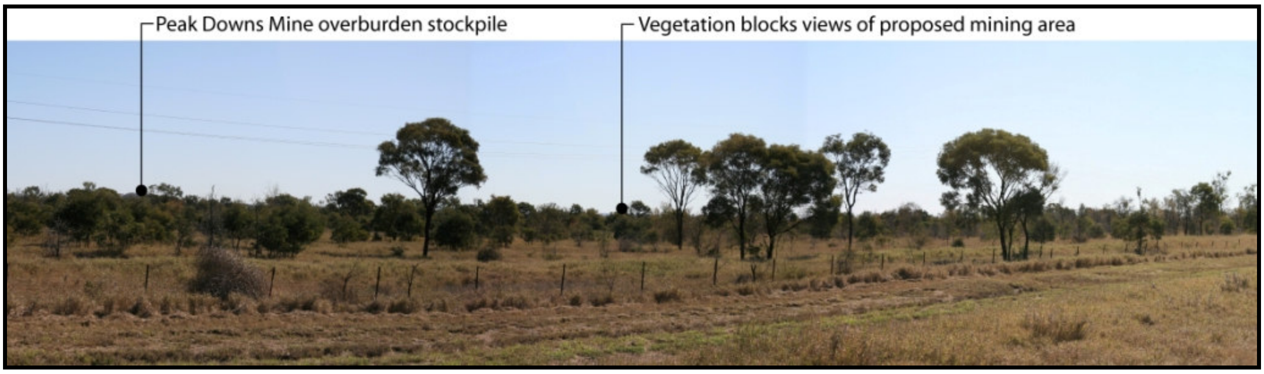


Figure 4.81 VS 21 – View North-West from Dysart-Moranbah Road

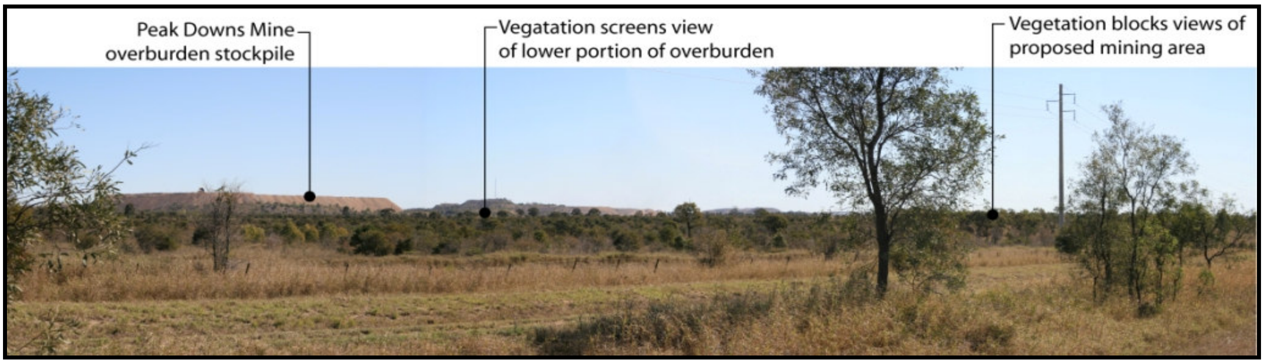


Figure 4.82 VS 22 - View North from Dysart-Moranbah Road

4.7.17.4 Visual Simulations

A series of visual simulations were prepared to illustrate how the final landform to be created by the proposed mining operations would appear in the landscape. The simulations are of views from:

- View Situation 11, at the entrance to Moranbah Airport (Visual Simulation 1).
- View Situation 13, along Moranbah Access Road north of the intersection with Peak Downs highway (Visual Simulation 2).
- View Situation 19, along Dysart-Moranbah Road south of the intersection with Peak Downs highway (Visual Simulation 3).

The locations of the View Situations are identified on Figure 4.55.

The visual simulations were prepared through the following process:

- Key view locations were identified and their coordinates recorded using a GPS.

- A set of photographs were taken from each view location with a 55 mm focal length digital camera looking towards the proposed mining operations.
- Each set of photographs was merged together using specialist software to create a single panorama photograph for each view situation.
- A view of the 3-D digital terrain model of the existing landform was set up using the same coordinates and view direction as the panoramic photograph.
- The 3-D model view was superimposed over the panoramic photograph for each view situation to match the landforms visible in the photographs.
- The 3-D model of the final landform at the end of the 30 year mining period was then superimposed over the existing landform 3-D model and the panorama photo.
- The surface of the final landform 3-D model was then rendered by cutting and copying an image of an existing area of grass in the panorama.

It should be noted that the surface of the new landform is shown as being covered with grass in the visual simulations, which represents the situation after the initial site rehabilitation works. There will be a period during which the rehabilitation works are being carried out in which portions of the visible slope will consist of bare soil prior to establishment of a vegetation cover. Also the landform shown in the visual simulations represents the situation at the completion of mining operations which are expected to take about 30 years. The simulations represent the maximum visual impact of the mining operations because during the early stages of the mining operations they will be located significantly further away from the visual simulations locations.

Visual Simulation 1

The visual simulation presented in Figure 4.83 illustrates how the final landform would appear from View Situation 11 at the entrance to the Moranbah airport from the Moranbah Access Road. The slope on the left hand side of the landform is one side of a cutting that would extend through the new landform, which rises up again to the left of the photograph.

The visual simulation illustrates the high visual impact that would result at this location as a result of the new landform to be created by the proposed mining operations. It also demonstrates that vegetation located close to the viewer, such as the small flowering tree in the centre of the photograph, could effectively screen views of the new landform. Such planting would need to include tall-growing trees planted dense enough to create a continuous visual screen. The existing long distance view illustrated in Figure 4.84 extends well beyond the project site to the mountain range on the skyline.

Figure 4.83 Visual Simulation of View from View Situation 11

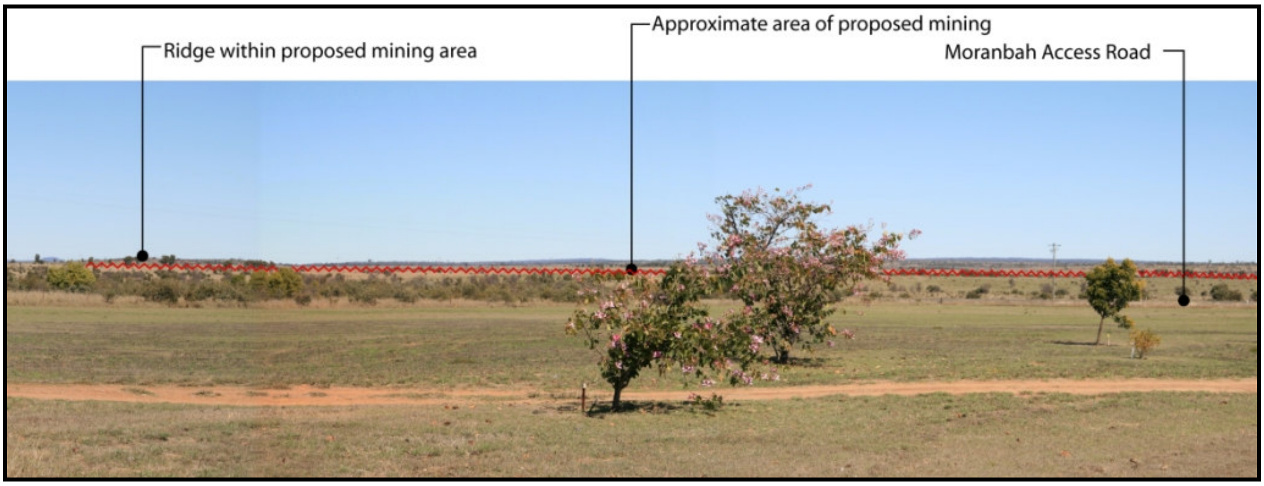


Figure 4.84 Existing View from Moranbah Airport

Visual Simulation 2

The visual simulation presented in Figure 4.85 shows the final landform viewed from View Situation 13 along the Moranbah Access Road north of the intersection with the Peak Downs Highway. The steep slope in the centre of the landform is associated with a cutting through the new landform.

The visual simulation illustrates that the existing ridgeline would partly screen views of the lower slopes of the new landform but the upper slopes will be visible, resulting in a moderate visual impact. The simulation also demonstrates if earth mounding was carried out near the road edge and planted with trees then the view of the new landform could be screened as the trees matured.

The existing view from Moranbah Access Road is illustrated in Figure 4.86. The view extends across grazing paddocks in the mid distance to the hill and ridge on the skyline.

Figure 4.85 Visual Simulation of the final landform from View Situation 13

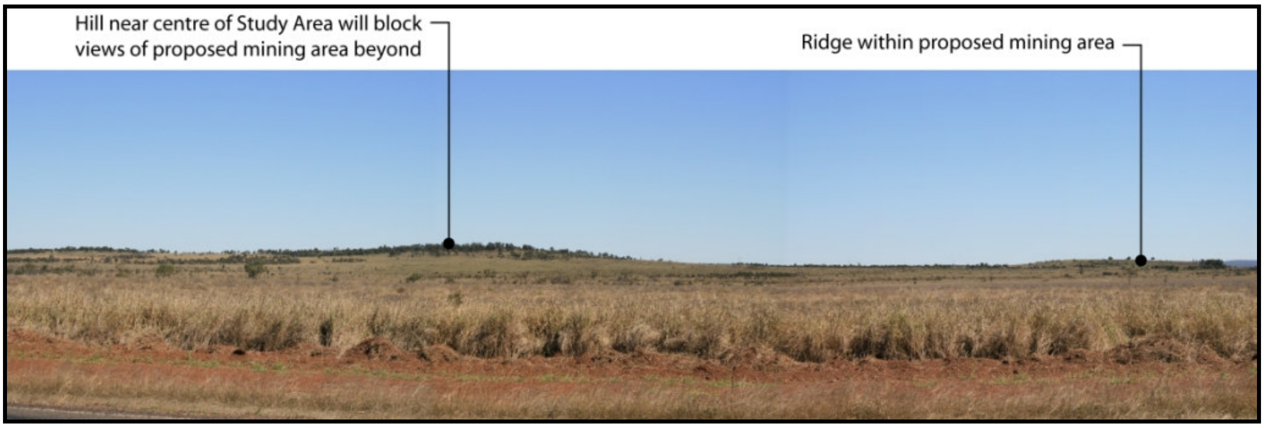


Figure 4.86 Existing view from Moranbah Access Road

Visual Simulation 3

The visual simulation presented in Figure 4.87 shows the final landform viewed from View Situation 19 along the section of Dysart-Moranbah Road south of the intersection with the Peak Downs Highway. The steep slopes in the centre of the landform are associated with a cutting through the new landform.

The visual simulation illustrates that the existing landform between the road and the mine site would partly screen views of the lower slopes of the new landform, but the upper slopes will be visible. The simulation also demonstrates if earth mounding was carried out near the road edge and planted with trees then views of the new landform could be screened as the trees matured.

The existing view from Dysart-Moranbah Road looking toward Peak Downs Mine is illustrated in Figure 4.88. The view extends across grass-covered grazing paddocks in the mid distance to the Peak Downs Mine overburden landforms with the Denham Range visible on the skyline.

Figure 4.87 Visual Simulation of view of the final landform from View Situation 19

Figure 4.88 Existing view from Dysart-Moranbah Road

4.7.17.5 Visual Impact Assessment

Potential visual impacts associated with the project will result primarily from the construction of:

- Out-of-pit overburden dumps
- New overpass along the Peak Downs Highway
- CHPP structures
- Coal loading facilities
- Administration buildings.

Visual impacts of the project on the various view situations identified in this section will vary throughout the 30-year period of mining and site rehabilitation works. For example the visual impact of the mining operations on a particular view situation will increase as the mining moves closer to it. Similarly, the visual impact of out-of-pit overburden dumps will be greatest immediately after they are created and will decline as they are regraded and vegetation established on the visible slopes. Due to this variation in potential visual impact over the life of the mine, the results presented in this section are an overall assessment that takes account of visual impacts throughout the full 30-year period of the project.

The two principal sections of public road that adjoin areas where mining operations will be carried out are Moranbah Access Road near the airport, and the section of Peak Downs Highway that passes though the centre of the project site. The operating face of the mining operations that will adjoin Moranbah Access Road will run parallel to the road and be oriented away from it. Consequently lighting on the draglines and other equipment will generally not visible from the road as it will face away from the road and the mining operations will be blow the natural ground surface. However, the upper portion of the active slope created by dumping overburden material will above the natural ground surface elevation and will face towards Moranbah Access Road. Consequently lighting on trucks and the spreader used in placing the overburden may be visible from the road. However proposed mitigation measures include earth mounding and tree planting alongside Moranbah Access Road to block views of the mining operations both daytime and at night. It should be noted that mining operations only come within 1 km of the Moranbah Access Road during the last 5 years of the planned 30 year life of the mine.

The operating face of the mining operations adjoining the northern edge of Peak Downs Highway will be oriented at right angles to the road alignment. Consequently there will be a significant difference between the views of motorists depending on the direction of travel. Motorists travelling to the west will potentially see the lights of vehicles and equipment operating on top of the overburden slope. Lighting associated with the coal extraction face will be below the natural ground surface and therefore generally not directly visible. For motorists travelling east along Peak Downs Highway the lighting on vehicles and equipment operating on the overburden landform will not be directly visible because the slope will be oriented away from the viewer. In addition the existing woodland vegetation adjoining this section of the highway would provide substantial visual screening of potential views to the mining operations. As the mining operations that will adjoin the northern edge of Peak Downs Highway are planned to take place over the 30 year life of the mine it will be necessary to minimise the potential visual impact form lighting associated with mining operations as well as the coal processing facilities.

The assessment of significance of potential visual impact is based primarily on an analysis of the View Situations described in Section 4.7.17.3. Results of the assessment are presented in Table 4.32 and illustrated in Figure 4.89.

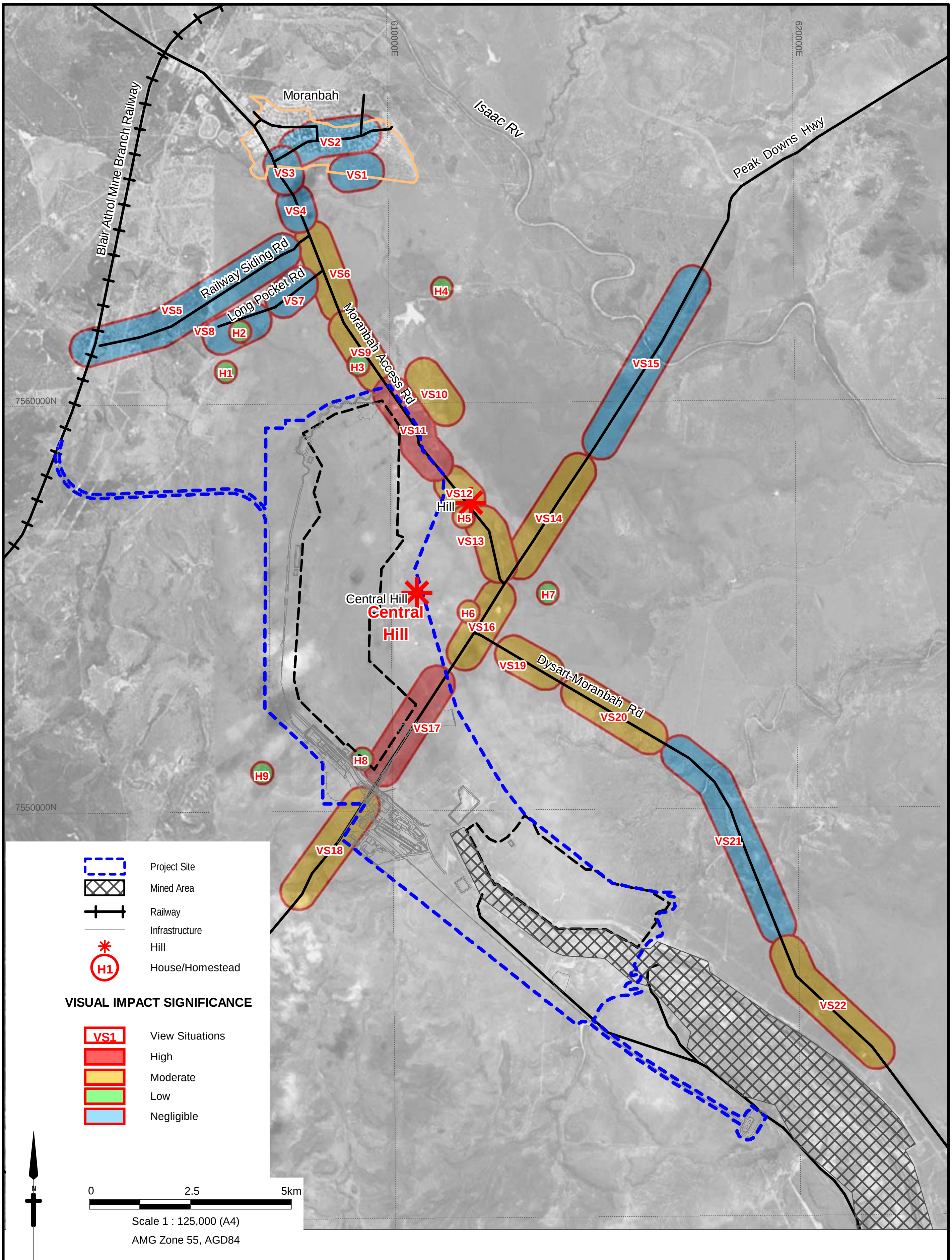
Table 4.28 Visual Impact Assessment

VIEW SITUATION	CATEGORY OF VIEWER	APPROX. DISTANCE TO MINE	APPROX. PERIOD OF VIEW	RELATIVE No. OF VIEWERS	MAGNITUDE OF VISIBILITY	VIEWER SENSITIVITY	VISUAL IMPACT SIGNIFICANCE	COMMENTS
VS 1. Recreation Reserve Moranbah Township	Sports participants and spectators	L	M	L	N	L	N	Views to proposed mining area blocked by vegetation and landform
VS 2. Mills Av. Moranbah	Residents, motorists and pedestrians	L	S	M	N	L	N	Views to proposed mining area blocked by houses. No photograph is presented for this reason
VS 3. Federation Walking Track and Moranbah Access Rd.	Pedestrians and motorists	L	S	M	N	M/L	N	Views to proposed mining area blocked by vegetation and landform
VS 4. Moranbah Access Rd. and roadside rest area	Motorists	L	S	M	N	M/L	N	Views to proposed mining area blocked by vegetation and landform
VS 5. Railway Siding Rd.	Motorists	M	M	L	N	M	N	Views to proposed mining area blocked by vegetation and landform
VS 6. Moranbah Access Rd. toward airport	Motorists	M	M	M	L	M	L/M	Views to proposed mining area partly blocked by vegetation and landform
VS 7. Long Pocket Rd. (east)	Motorists	M	S	VL	N	L	N	Views to proposed mining area blocked by vegetation and landform
VS 8. Long Pocket Rd. (south)	Motorists	M	M	VL	N	L	N	Views to proposed mining area partly blocked by vegetation and landform
VS 9. South along Moranbah Access Rd.	Motorists	M	M	M	M	M	M	Views to proposed mining area partly blocked by vegetation and landform
VS 10. View from Moranbah airport	Passengers and airport staff	S	M	M	M	M	M	Views from terminal and entrance road are directly towards the proposed mining area
VS 10a. Aircraft in flight	Passengers and aircrew	L	M	L	L	M	L/M	Views only available from window seats on one side of the aircraft
VS 11. West from Moranbah Access Rd.	Motorists	VS	M	M	H	M	H	Proposed mining operations will immediately adjoin the road
VS 12. West and north from Moranbah Access Rd.	Motorists	S	S	M	M	M	M	Views of mining area will be partly screened by landform and vegetation

VIEW SITUATION	CATEGORY OF VIEWER	APPROX. DISTANCE TO MINE	APPROX. PERIOD OF VIEW	RELATIVE No. OF VIEWERS	MAGNITUDE OF VISIBILITY	VIEWER SENSITIVITY	VISUAL IMPACT SIGNIFICANCE	COMMENTS
VS 13. North and north-west from Moranbah Access Rd.	Motorists	M	M	M	M	M	M	Central hill in project site will partly screen views of mining area
VS 14. North-west from Peak Downs Hwy.	Motorists	L	M	M	L	M	L/M	Central hill in project site will partly screen views of mining area
VS 15. North-west from Peak Downs Hwy.	Motorists	L	M	M	L	M	N	Views to proposed mining area blocked by vegetation and landform
VS 16. North from Peak Downs Hwy.	Motorists	M	M	M	M	M	M	Views to proposed mining area partly blocked by ridge and vegetation
VS 17. East and west along Peak Downs Hwy.	Motorists	VS	M	M	H	M	H	Views to proposed mining area and coal handling facilities may be partly blocked by woodland vegetation if it is retained along road corridor
VS 18. Peak Downs Hwy.	Motorists	M	M	M	N	M	N	Views to proposed mining area blocked by vegetation and landform
VS 19. North along, and south-west from, Dysart-Moranbah Rd.	Motorists	M	M	M	M	M	M	View from Road travelling north is focused towards Central Hill in project site that blocks views to proposed mining area
VS 20. West from Dysart-Moranbah Rd.	Motorists	M	M	M	M	M	M	Long distance view includes Peak Downs Mine overburden
VS 21. North-west from Dysart-Moranbah Rd.	Motorists	M	M	M	N	M	N	Views to proposed mining area blocked by vegetation and landform
VS 22. North from Dysart-Moranbah Rd.	Motorists	M	M	M	M	M	M	Peak Downs Mine overburden visually prominent
Houses								
H1. Long Pocket Rd. – House 1	Residents	M	M	VL	N	H	L	Views to proposed mining area partly blocked by trees and landform
H2. Long Pocket Rd. – House 2	Residents	M	M	VL	N	H	L	Views to proposed mining area partly blocked by trees and landform
H3. Mitchell Residence	Residents	M	M	VL	N	H	L	Views to proposed mining area generally blocked by woodland vegetation
H4. Grosvenor Downs Residences	Residents	M	M	VL	N	H	L	

VIEW SITUATION	CATEGORY OF VIEWER	APPROX. DISTANCE TO MINE	APPROX. PERIOD OF VIEW	RELATIVE No. OF VIEWERS	MAGNITUDE OF VISIBILITY	VIEWER SENSITIVITY	VISUAL IMPACT SIGNIFICANCE	COMMENTS
H5. Cattery and Residence	Residents	VS	M	VL	L	H	M	
H6. Hornery Residence	Residents	S	M	VL	L	H	M	Central hill on project site partly blocks views of proposed mining area
H7. Muirehead Residence	Residents	M	M	VL	N	H	L	Central hill on project site partly blocks views of proposed mining area
H8. Batchelor Residence	Residents	M	M	VL	N	H	L	
H9. Buffle Park Residence	Residents	M	M	VL	N	H	L	

Note: N = negligible Magnitude of Visibility
L = low Magnitude of Visibility
M = medium Magnitude of Visibility
H = high Magnitude of Visibility



Source: Image from Google Earth 2007

Client	Project	Title
BMA BHP Billiton Mitsubishi Alliance	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	VISUAL IMPACT SIGNIFICANCE
URS	Drawn: TE/VH · Approved: RS · Date: 08-05-2009	Figure: **4.89** · Rev:B
	Job No: **42626158** · File No: 42626158-g-582b.wor	A4

4.7.17.6 Mitigation Measures

The potential visual impact of the project would be significantly reduced through implementation of a range of mitigation measures. The objectives of these mitigation measures are to:

- Minimise the extent to which the mining operations would be visible from the various View Situations by screening or blocking potential views of the operations.
- Minimise the visual contrast between major components of the mining operations, such as out of pit overburden dumps and new structures, and the surrounding landscape in which they would be seen.

The most effective screening of views is achieved by locating screening objects such as, vegetation or structures as close as possible to the viewer. In the case of the project this means locating visual screening measures as close as possible to the public roads, dwellings and airport that may have views of the mining operations.

Visual mitigation measures vary significantly in terms of the time they would take to be effective. For instance vegetation generally takes at least 5 years to provide significant visual screening. In contrast earth mounding can provide immediate visual screening. Consequently the selection of the most appropriate visual mitigation measures must take account of the timing of those components of the project that will potentially be visible. Coal processing infrastructure and loading facilities, the railway line, Peak Downs Highway overpass and administration buildings will be constructed as the first stage to allow mining operations to proceed. Where visual mitigation measures are required in relation to these components of the project development, then they will need to be implemented within a short time frame. These mitigation measures could include earth mounding to block views from adjoining sections of Peak Downs Highway as well as selection of appropriate colours for those structures that are likely to be visible from the highway.

For view situations where the mining operations will not be visible for more than 10 years it would be appropriate to use tree planting to provide visual screening as there will be adequate time for the trees to reach sufficient height to provide the visual screening required. Similarly, where the mining operations will not be significantly visible for more than 10 years, it may be feasible to facilitate natural regeneration of the indigenous woodland vegetation to provide visual screening of the mine. This would require the removal of grazing and control of weeds to allow the natural regeneration of vegetation to occur.

As discussed above, the proposed 24 hour operation of the project will require lighting. Mitigation measures will therefore be required to minimise potential visual impacts on motorists travelling along the Moranbah Access Road, Peak Downs Highway and Dysart-Moranbah Road as well as dwellings in the vicinity of the mine.

A range of mitigation measures are proposed to minimise the potential visual impact of project. These mitigation measures would be applied in particular locations as required to achieve the most appropriate mitigation outcome. The alternative mitigation measures include:

- Earth mounding with tree and shrub planting.
- Tree and shrub planting in natural ground.
- Retention of existing vegetation buffer zones.
- Management of natural regeneration in buffer zones.
- Colour selection for various structures including the CHPP, loading facilities, administration and other buildings.
- Lighting design for the MIA including the ROM, CHPP infrastructure and conveyors.

Earth Mounding and Tree Planting

Soil and waste rock material from the mining operation will be used to construct sections of mounding as close as possible to the sections of public road where visual mitigation is considered necessary. In order to provide immediate visual screening the height of the mounding will be in the order of 5 to 10 m, subject to detailed assessment in relation to the mining operation. Tree planting on the outer slope of the mound will be carried out to provide additional visual screening over time and to integrate the mounding into the landscape setting by mitigating the constructed character of the new mounding. In situations where there are no significant existing stands of trees then the character of the mounding will primarily be grassland with scattered clumps of trees. Design of the mounding in these situations will aim to create natural looking landforms. However, in situations where there are existing woodland and remnant trees then planting on the mounding should aim to reinforce the existing landscape character.

Tree and Shrub Planting in Natural Ground

In situations where mounding is not considered feasible or is not necessary due to the long period before the mining operation becomes visible, then planting of trees into natural ground would provide effective visual screening within the time frame of the mining operation. Indigenous plant species would be used in order to maximise survival rate and to minimise maintenance requirements while contributing to enhancement of biodiversity.

Retention of Existing Vegetation in Buffer Zones

The extensive stands of remnant woodland vegetation alongside the section of Peak Downs Highway running through the project site creates an opportunity to retain buffer zones that would provide visual screening of the CHPP and loading facilities for motorists travelling along the Peak Downs Highway. The buffer zones will be a minimum of 50 m wide on both sides of the highway and supplemented with tree planting in some locations to ensure effective visual screening.

Management of Natural Regeneration in Buffer Zones

Natural regeneration of the remnant woodland vegetation occurs in many locations throughout the project site, even in some grazing paddocks where most of the original vegetation has been cleared. Management of natural regeneration is an effective and appropriate means of providing visual screening of mining operations in some locations. The time required to create effective screening would be in the order of 10 to 15 years depending on growing conditions and the nature of the remnant vegetation. Management of the regeneration requires the removal of grazing, control of weeds and fire management to allow the natural regeneration to occur.

Colour Selection for Structures and Buildings

The potential visual impact of structures and buildings will greatly depend on the level of contrast between the structures and the surrounding landscape against which they are seen. Colour contrast and reflectivity are major factors in the level of visibility. Consequently colours to be used for the various structures would be selected with the aim of minimising the level of contrast. In situations where structures are likely to be seen against a background of woodland vegetation the preferred colours will be in the dark grey-green range such as Colorbond 'Woodland Grey'. In situations where the upper portion of structures will be seen against a sky background, lighter colours such as Colorbond 'Dune or 'Shale Grey' will be used. Low reflectivity finishes will also be used on structures and buildings. The proposed location of structures, which will be set back from the Peak Downs Highway, will minimise reflection of sunlight for motorists.

Lighting Design

Design of the lighting for the project will aim to minimise light spill and avoid direct line of sight to lights associated with the CHPP and loading facilities. This will involve the use of hoods and shields where necessary and ensuring lights are not directed at adjoining public roads. Existing stands of trees alongside Peak Downs Highway will be retained to the maximum extent possible to provide visual screening for both day and night situations. Where necessary visual screens will be installed to block potential views from the Highway to the CHPP and associated infrastructure as well vehicles and equipment operating in the area.

Mitigation measures proposed for lighting associated with the mining operations where they come within 1 km of Moranbah Access Road or Peak Downs Highway would include directional lighting to avoid direct line of sight between flood lighting and adjoining sections of public road. The planning of truck movements would aim to avoid their headlights shining directly at motorists travelling along either of the roads.

The proposed earth mounding and tree planting alongside Moranbah Access Road would potential views of the mining operations both during the daytime as well as at night. It should be noted that mining operations only come within 1 km of the Moranbah Access Road during the last 5 years of the planned 30 year life of the mine, by which time proposed tree planting will be reaching mature heights. Potential impacts of lighting on fauna and flora is addressed in Section 8, Table 8.12.

In View Situations where the level of Visual Impact Significance has been assessed as High or Moderate, a series of appropriate mitigation measures have been identified aimed at minimising the potential visual impact. These recommended mitigation measures are presented in Table 4.29.

Table 4.29 Proposed Mitigation Measures

View Situation	Proposed Mitigation Measures
VS 9. South along Moranbah Access Rd.	- Roadside vegetation to be retained to maintain visual screening of views from road to the mine.
VS 10. View from Moranbah Airport	- Earth mounding combined with tree planting along the western edge of Moranbah Access Road to provide visual screening of views from the airport access road. - Additional planting alongside the access road and adjoining the terminal building to screen views of the mine. - Rehabilitation of the out of pit overburden dumps to create a natural landscape character post-mining.
VS 11. West from Moranbah Access Rd.	- Earth mounding combined with tree planting along the western edge of Moranbah Access Road to provide visual screening of views from the road. - Rehabilitation of the out of pit overburden dumps to create a natural landscape character post-mining.
VS 12. West and north from Moranbah Access Rd.	- Roadside tree planting and management of natural regeneration to screen views of the mine. - Rehabilitation of the out of pit overburden dumps to create a natural landscape character post-mining.
VS 13. North and north-west from Moranbah Access Rd.	- Roadside tree planting and management of natural regeneration to screen views of the mine. - Rehabilitation of the out of pit overburden dumps to create a natural landscape character post-mining.
VS 14. North-west from Peak Downs Hwy.	- Rehabilitation of the out of pit overburden dumps to create a natural landscape character post-mining.
VS 16. North from Peak Downs Hwy.	- Roadside tree planting and management of natural regeneration to screen views of the mine.
VS 17. East and west along Peak Downs Hwy.	- Retention of existing woodland vegetation alongside both sides of the Peak Downs highway to provide a visual buffer zone (minimum 50 m wide). - Additional tree planting where necessary to fill gaps in the existing roadside woodland vegetation in the proposed buffer zone. - Rehabilitation of the out of pit overburden dumps to create a natural landscape character post-mining. - Selection of appropriate colours for the CHPP and buildings that may be visible from the Peak Downs highway. - Design of lighting to avoid light spill on to adjoining section of the highway.

View Situation	Proposed Mitigation Measures
VS 19. North along, and south-west from Dysart-Moranbah Rd.	- Retention of existing vegetation and management of natural regeneration is to screen potential views of the mine in the longer term. - Rehabilitation of the out of pit overburden dumps to create a natural landscape character post-mining.
VS 20. West from Dysart-Moranbah Rd.	- Retention of existing vegetation and management of natural regeneration to screen potential views of the mine. - Rehabilitation of the out of pit overburden dumps to create a natural landscape character post-mining.
VS 22. North from Dysart-Moranbah Rd.	- Retention of existing vegetation and management of natural regeneration to screen potential views of the mine. - Rehabilitation of the out of pit overburden dumps to create a natural landscape character post-mining.

4.7.17.7 Monitoring

Monitoring of the effectiveness of the proposed visual impact mitigation measures is to be carried out over the period of the mining operations. Site inspections are to be carried out at least every two years by an independent professional with appropriate qualifications and experience in visual assessment and management. The inspection is to include both day and night conditions. The reviewer is to prepare a report that documents the results to the assessment, including photographs from the key viewing points identified in the EIS. Recommendations are to be made in the report for any additional actions that may be considered necessary to achieve the mitigation outcome identified in the EIS. Copies of the report are to be submitted to the relevant authority as required.

4.8 Land Disturbance

The following sections describe the rehabilitation strategy and decommissioning procedures for the project.

4.8.1 Rehabilitation Objectives

The objectives of rehabilitating disturbed land that will result from the project will include the following:

- Achievement of acceptable post-disturbance land use suitability – Mining and rehabilitation should aim to create a stable landform with land use capability and/or suitability compatible with the land pre-disturbance, unless other beneficial land uses are pre-determined and agreed. This will be achieved by setting clear rehabilitation success criteria (Refer to Section 4.8.6, Table 4.30 and Section 3.7.6 of Appendix Q) and outlining the monitoring requirements that assess whether or not these criteria are being accomplished.
- Creation of stable post-disturbance landform - Mine wastes and disturbed land will be rehabilitated to a condition that is self-sustaining or to a condition where maintenance requirements are consistent with an agreed post-mining land use.

- Preservation of downstream water quality – Surface and ground waters that leave the mining leases should not be degraded to a significant extent. Current and future water quality should be maintained at levels that are acceptable for users downstream of the site.

4.8.2 Post-Mining

4.8.2.1 Land Use

Prior to mining, the project site was used for broad scale cattle grazing. Much of the area was either uncleared or partially cleared. No areas were suitable for forage or cash cropping uses. Rehabilitation of the project site will return a stable landform capable of uses that are compatible with those uses prior to disturbance. To achieve this, the nominated post-mine land use for the site is a mosaic of bushland and grassland. The mosaic will link remnant native vegetation where possible and will aim to return some conservation values. Refer to Section 3.7.5.2 of Appendix Q for further detail.

4.8.3 Land Capability

The majority of the project site is considered Class VI – not suitable for cultivation and is moderately susceptible to degradation requiring proper management to sustain the land use. Some Class V land occurs in the vicinity of the northern end of the existing Heyford Pit. This land has suitable soil and topography for crops but they are not economically viable. It is however considered to be high quality grazing land.

The rocky hills and ridgelines, along with the highly eroded and skeletal soils, are considered to be Class VII - land that is highly susceptible to degradation requiring severe restrictions for use. Grazing may be conducted with rigorous management inputs required to prevent degradation.

4.8.4 Land Suitability

4.8.4.1 Pre-Mining

The project site is currently used for low intensity cattle grazing. As a result of this historical and current land use, there has been extensive tree clearing throughout the area. The land use is consistent with that of the adjoining land, which is also predominantly used for low intensity cattle grazing.

The majority of land within the project sites is Class 5 with respect to cropping. The land is unsuitable for cropping. Some duplex soils in the vicinity of the north end of the existing Heyford Pit are Class 4 lands that are extremely marginal for cropping. This includes the well drained areas of flat to gently sloping topography. The lands are Class 2 land with respect to grazing which is suitable for low intensity grazing, with minor limitations that lower production or require management practices. The remainder of the project site is Class 2 and 4 land with respect to grazing potential i.e. land that has either moderate limitations or is marginal grazing land.

4.8.4.2 Good Quality Agricultural Land

NRW (1995) have mapped the majority of the project site as Class C – suitable for improved or native pastures due to limitations that preclude cultivation for crop production. Some Class A land occurs within the project site but does not occur within the pit footprint area and, therefore, will not be disturbed. Approximately 4% of the project site is Class A land. The remainder is Class C land. Figure 4.13 shows Good Quality Agricultural Land within the project site.

4.8.4.3 Post-Mining

The proposed post-mining land use for the project site is expected to be a mosaic of self sustaining vegetation communities and grazing land. In terms of soil conservation and agricultural land suitability, the proposed impacts are considered manageable and the proposed post-mining land use of a mosaic of self sustaining vegetation communities and grazing land is considered achievable for those areas not subject to significant landscape modification (open cut pit and out-of-pit overburden dumps). In the areas impacted by significant landscape modification, agricultural suitability may decrease one class. Where significant impacts interact with drainage lines within the Class 2 or Class 3 lands, a greater level of management input may be required to prevent land degradation and a decrease in suitability class.

In order to sustain the desired land use without degradation, it is important that the post-mining land only be used in accordance with the limits of the agricultural suitability class. Soil conservation practices such as stocking rate control and establishment or re-establishment of permanent pasture are recommended for areas of mining impact. The overriding principle is to maintain the most beneficial future use of land that can be sustained in view of the range of limiting factors. The proposed post-mining land must provide and sustain a sufficient bulk of nutritious forage in addition to the following management considerations:

- The ability to access and manage livestock.
- Flood free and relatively dry ground conditions.
- Adequate stock drinking water and shelter.
- Stock routes throughout the land.

Provided that environmental controls are in place and operating effectively during mine construction and operation there should be no adverse effects to the project site or the surrounding grazing land.

4.8.5 Rehabilitation Strategy

All areas significantly disturbed by mining activities will be rehabilitated to a stable landform with a self-sustaining vegetation cover. Rehabilitation of disturbed land will generally proceed within two years of the areas becoming available for rehabilitation. In some situations, progressive rehabilitation may not be possible because the area may be effectively integrated with areas nearby that are unavailable for rehabilitation.

To achieve the objectives in Section 4.8.1, rehabilitation of disturbed land at the mine site will be conducted so that:

- Suitable species of vegetation are planted and established to achieve the relevant mosaic of self sustaining vegetation communities and grazing land post-mine land uses.
- Potential for erosion is minimised, including likelihood of environmental impacts being caused by the release of dust.
- The quality of surface water and seepage released from the site is such that releases of contaminants are not likely to cause environmental harm.
- The water quality of any residual water bodies meets criteria for subsequent uses and does not have the potential to cause environmental harm.
- The final landform is stable and not subject to slumping or erosion which will result in the agreed post-mining landform being maintained.

4.8.5.1 Landform Design and Planning

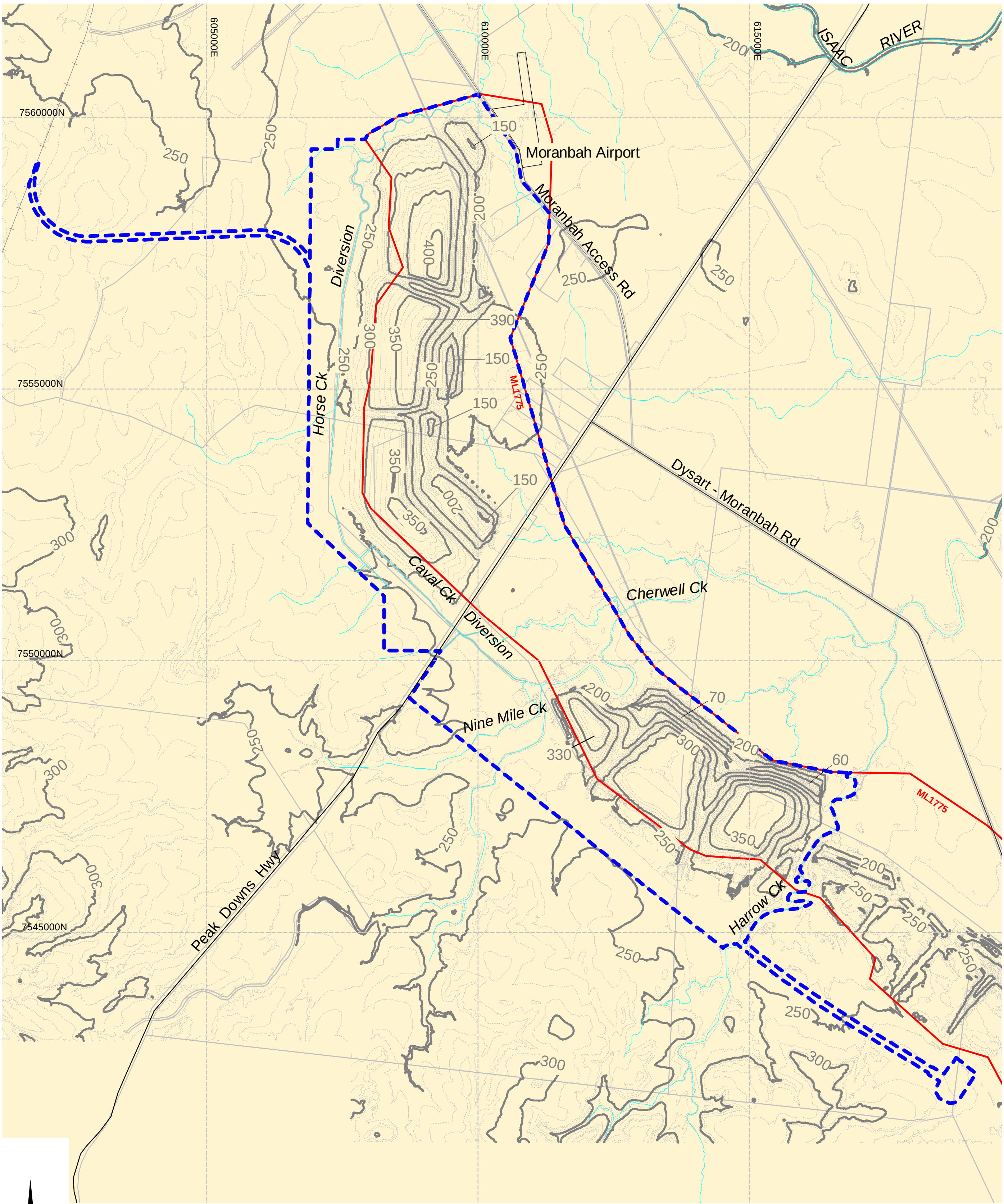
Rehabilitation planning at the project will ensure the total area of disturbance at any one time is minimised to reduce the potential for wind-blown dust, visual impacts and increased sediment-laden run-off.

Rehabilitation will be designed to achieve a stable final landform compatible with the surrounding environment. This will involve the reshaping, using large dozers, of the majority of overburden emplacement slopes to 10 degrees or less. Should slopes exceed 11 degrees, additional drainage and revegetation works will be carried out to ensure erosion / sediment control and groundcover establishment is achieved.

Natural re-contouring will be incorporated in rehabilitation design and construction wherever possible and treed vegetation along the toe of rehabilitation areas will not be cleared unless an unacceptable safety or erosion risk remains.

Where possible, rehabilitation planning will attempt to maximise opportunities for a diverse post-mining landscape and land-use. It is presently proposed that the final land-uses of the rehabilitated site will comprise a mosaic of self sustaining vegetation communities and grazing land. Waterways running through the site will have riparian areas rehabilitated to a post-mining standard to include a diverse vegetative community of native trees, shrubs and grasses. Monitoring will be undertaken to ensure that objectives are being met.

The final visual simulations of the final land form are provided in Section 4.7.17.4 and the conceptual final landform contour is illustrated on Figure 4.90.



Project Site
Mining Lease
Major Contour and Value (AHD)
Minor Contour (Interval 10m)

0 1.25 2.5km
Scale 1:100,000 (A4)
Datum: AGD84, AMG Zone 55

Source: DNRM Qld. 2009; Client Supplied Data

Client: BMA — BHP Billiton Mitsubishi Alliance; URS	Project: CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT		Title: DECOMMISSIONING AND REHABILITATION - FINAL LANDFORM
Drawn: VH	Approved: RS	Date: 08-05-2009	Figure: **4.90** — Rev:A
Job No: **4262 6158**	File No: 42626158-g-607.wor		A4

4.8.5.2 Success Criteria

Preliminary success criteria (or closure criteria) for the rehabilitation of the main mine areas have been proposed in Table 4.30 below. The success criteria are performance objectives or standards against which rehabilitation success in achieving a sustainable system for the proposed post-mine land use is demonstrated. Satisfaction and maintenance of the success criteria (as indicated by monitoring results) will demonstrate that the rehabilitated landscape is ready to be relinquished from the mine's financial assurance and handed back to stakeholders in a productive and sustainable condition.

The success criteria have been developed to comprise indicators for vegetation, fauna, soil, stability, land use and safety on a landform-type basis that reflects the nominated post-mine land use of bushland and grassland. For each element, standards that define rehabilitation success at mine closure are provided (refer Table 4.30). Based on the generic indicators in Table 4.30, each criterion will be further developed to be specific, measurable, achievable, realistic and outcome based, and to reflect the principle of sustainable development. The further development of each criterion will be based on results of research, monitoring of progressive rehabilitation areas and risk assessments. The success criteria will be reviewed every three to five years with stakeholder participation to ensure the criteria remain realistic and achievable.

4.8.6 Rehabilitation Methods

4.8.6.1 Progressive Rehabilitation

Rehabilitation will be progressively undertaken on areas that cease to be used for mining or mine-related activities within two years of becoming available. This will reduce the amount of disturbed land at any one time. The success criteria for evaluating rehabilitation progress are summarised in Table 4.30. Results of progressive rehabilitation will be used to refine rehabilitation methods for future application such as the selection of appropriate drainage measures including the use of contour banks and diversion drains to direct water into stable areas or sediment control basins and the selection of plant species for re-establishment. Areas available for progressive rehabilitation and the types of disturbance at those sites will be detailed in the Plan of Operations. Refer to Appendix Q Section 3.7.5 for further rehabilitation strategies and methods. The rehabilitation methods were primarily derived from the BMA Guideline for the design of Sustainable Mine Landforms, 2008.

Table 4.30 Rehabilitation Success Criteria[1]

Rehabilitation Element	**Indicator**	**Criteria**
1. In – pit and Out-of-Pit Spoil Dumps and Dragline Spoil Areas		
Landform stability	Slope gradient	No less than 75% of the area has slopes <10° and up to 25% of the area has slopes >10°. Where reject layers are present and exposed, the landform is capped.
	Erosion control	Erosion control structures are installed commensurate with the slope of the landform. Average soil loss per annum per domain unit is <40 tonnes/ha/yr (sheet erosion).
	Surface Water Drainage	Use of contour banks and diversion drains to direct water into stable areas or sediment control basins.
Water quality		Ensure receiving waters affected by surface water runoff have contaminant limits of electrical conductivity maximum of 1,500 µS/cm and pH range of 5.5 to 9.5.
Water Storages, Creek Diversions		Clean water storages and diversions to be stabilised and left as required. Dirty water storages to be cleaned out and rehabilitated to a stable non-polluting condition.
Topsoil	Salinity (electrical conductivity)	Soil salinity content is <0.6 dS/m.
	pH	Soil pH is between 5.5 and 8.5.
	Sodium content	Soil Exchange Sodium Percentage (ESP) is <15%.
	Nutrient cycling	Nutrient accumulation and recycling processes are occurring as evidenced by the presence of a litter layer, mycorrhizae and/or other microsymbionts. Adequate macro and micro-nutrients are present.
Vegetation	Land use	Area accomplishes and remains as a healthy working bushland ecosystem.
	Surface cover	Minimum of 70% vegetative cover is present (or 50% if rocks, logs or other features of cover are present). No bare surfaces >20 m^2 in area or >10 m in length down slope.

[1] Refer to section 3.7.5.2 of Appendix Q for explanation of success criteria.

Rehabilitation Element	Indicator	Criteria
	Species composition	Comprise a mixture of native trees, shrubs and grasses representative of regionally occurring woodland to open forest where possible.
	Community structure	Groundcover, understorey and overstorey structure similar to that of appropriate reference site(s)*.
	Resilience to disturbance	Established species survive and/or regenerate after disturbance. Weeds do not dominate native species after disturbance or after rain. Pests do not occur in substantial numbers or visibly affect the development of native plant species.
	Sustainability	Species are capable of setting viable seed, flowering or otherwise reproducing. Evidence of second generation of tree/shrub species. Vegetation develops and maintains a litter layer evidenced by a consistent mass and depth of litter over subsequent seasons. More than 75% of shrubs and/or trees are healthy when ranked healthy, sick or dead.
Fauna	Vertebrate species	Representation of a range of species characteristics (e.g. activity pattern, habitat usage, diet, dispersal character etc (WMB, 2003; Kimber et. al., 1999)) from each faunal assemblage group (e.g. reptiles, birds, mammals), present in the ecosystem type, based on pre-mine fauna lists and sighted within the three-year period preceding mine closure. Sighting of species of conservation significance or indicators of the presence of species of conservation significance (e.g. tracks) likely to be present in the established ecosystem type within the three-year period preceding mine closure (assuming non-mine related disturbance has not eliminated local populations thereby removing the colonising source). The number of vertebrate species does not decrease by more than 25% in the successive seasons prior to mine closure or by more than 40% over the two successive seasons prior to mine closure.
	Invertebrate species	Presence of representatives of a broad range of functional indicator groups involved in different ecological processes (including termites for soil structure, Collembola for decomposition, Hemiptera for herbivory and predatory groups such as arachnids, centipedes, earwigs, cockroaches and ants as indicators of a range of other processes (Bisevac and Majer, 1998).
	Habitat structure	Typical food, shelter and water sources required by the majority of vertebrate and invertebrate inhabitants of that ecosystem type are present, including: a variety of food plants; evidence of active use of habitat provided during rehabilitation such as nest boxes, stags and logs and signs of natural generation of shelter sources including leaf litter.
Safety		Risk assessment has been undertaken in accordance with the appropriate Guidelines for Hazard Analysis and Australian Standard AS 4360: Risk Management and risks reduced to levels agreed with the stakeholders.
2. Final Voids (including Ramps)		
Landform stability	Slope gradient	Highwall faces exhibit long-term geotechnical stability and a geotechnical report has been completed. Competent rock Highwall to have slope of <65°. Incompetent rock highwall to have slope of <17°. Low wall to have slope of

Rehabilitation Element	Indicator	Criteria
		<17°. Ramp walls not backfilled exhibit long-term geotechnical stability and a geotechnical report has been completed. In-pit rejects and spoil slope gradients can exceed 15%.
	Erosion control	Average soil loss per annum per domain unit is <40 tonnes/ha/yr (sheet erosion). Erosion mitigation measures have been applied to ensure slope stability
	Surface Water Drainage	Use of contour banks and diversion drains to direct water into stable areas or sediment control basins.
Water quality		Electrical conductivity of any void water may exceed 1,500 µS/cm if an ecological assessment shows the long-term ecological stability and groundwater quality is not adversely affected.
Water Storages, Creek Diversions		As for 1.
Topsoil		As for 1.
Vegetation	Land use	Where ramps and in-pit spoil design allow, area accomplishes and remains as a healthy working bushland ecosystem (although naturalised grasses may be used).
	Surface cover	As for 1.
	Species composition	Comprise a mixture grasses, shrubs and trees (where possible) suitable for establishment on steeper slopes
	Community structure	Groundcover and understorey structure to that of appropriate reference site(s)*.
	Resilience to disturbance	As for 1.
	Sustainability	More than 75% of individual grasses and shrubs are healthy when ranked healthy, sick or dead.
Safety		Risk assessment has been completed and risk mitigation measures have been implemented. Where risk mitigation measures include bunds, safety fences and warning signs, these have been erected generally in accordance with relevant guidelines and Australian Standards.
3. Rejects Dumps		
Landform stability	Slope gradient	Final slope of 1V:6H (9.5°)
	Erosion control	Reject emplacements have been capped to a depth of 1.5 m of inert material.

Rehabilitation Element	Indicator	Criteria
		Erosion mitigation measures have been applied. Average soil loss per annum per domain unit is <40 tonnes/ha/yr (sheet erosion).
	Surface Water Drainage	Drainage control measures including contour banks, drop structures and diversion drains to direct water into stable areas or sediment control basins are installed.
Water quality		As for 1.
Water Storages, Creek Diversions		As for 1
Topsoil		As for 1.
Vegetation		As for 1 where capping allows for tree establishment.
Fauna		As for 1.
Safety		As for 1.
4. Mine Plant/Industrial Areas		
Landform stability	Slope gradient	Area has gradient of <2°.
	Erosion control	Erosion mitigation measures have been applied. Average soil loss per annum per domain unit is <40 tonnes/ha/yr (sheet erosion).
	Surface Water Drainage	Use of contour banks and diversion drains to direct water into stable areas or sediment control basins.
Water quality		As for 1.
Water Storages, Creek Diversions		As for 1.
Topsoil		As for 1.
Vegetation	Land use	Buildings, water storage, roads (except those used by the public) and other infrastructure have been removed unless stakeholders have entered into formal written agreements for their retention. Areas are readily accessible and conducive to safe cattle management activities. Predicted economics and /or benefits have been defined and agreed by the stakeholders.
	Surface cover	As for 1.

Rehabilitation Element	Indicator	Criteria
	Species composition	Palatable, nutritious pasture grass species are present.
	Community structure	Desirable grass species comprise at least 60% of total grass cover. Tree density and height of >25 stems per 5 ha each being >2 m in height.
	Resilience to disturbance	As for 1.
	Sustainability	Nitrogen fixing grass species present. More than 75% of shrubs and/or trees are healthy when ranked healthy, sick or dead.
Fauna	Vertebrate species	Representation of a range of species characteristics (e.g. activity pattern, habitat usage, diet, dispersal character etc (WBM, 2003; Kimber et. al., 1999)) from each faunal assemblage group (e.g. reptiles, birds, mammals), present in the grassland ecosystem type, based on pre-mine fauna lists and sighted within the three-year period preceding mine closure. The number of vertebrate species does not decrease by more than 25% in the successive seasons prior to mine closure or by more than 40% over the two successive seasons prior to mine closure.
	Invertebrate species	Presence of representatives of a broad range of functional indicator groups involved in different pastoral ecological processes (including termites for soil structure, Collembola for decomposition, Hemiptera for herbivory and predatory groups such as arachnids, centipedes, earwigs, cockroaches and ants as indicators of a range of other processes (Bisevac and Majer, 1998).
	Habitat structure	Typical food, shelter and water sources required by the majority of vertebrate and invertebrate inhabitants of pastoral ecosystem type are present, including: a variety of food plants and signs of natural generation of shelter sources including leaf litter.
Safety		Risk assessment has been undertaken in accordance with relevant guidelines and Australian Standards and risks reduced to levels agreed with the stakeholders. Closure documentation includes the contaminated sites register which identifies contaminated sites and the treatment applied. Safety of site access post lease surrender will be covered in the closure plan.

Note: * Reference sites are discussed in Section 4.8.7 below.

4.8.6.2 Surface Preparation

Topsoil will be managed and respread as discussed in Section 4.4.9 above. Areas to be rehabilitated will be prepared prior to revegetating. The surface of landforms will be susceptible to erosion immediately after re-shaping, topsoiling and during the vegetation establishment period. To reduce the potential for surface erosion, dispersive soil will be buried under at least 1 m of other material where possible and away from the toe of the landform.

Additional erosion control measures such as the application of hydromulch will be considered, particularly in drainage lines. Sugar cane mulch in slurry provides cover for the soil to improve pasture growth, modifying the soil surface to control erosion, or a combination of both. Securely pressed against the surface of the soil, the mulch provides a high degree of erosion control and improves moisture availability to establishing pasture. The mulch also has the effect of protecting the soil surface against raindrop impact, improving the micro-environment for seed germination and establishment by reducing evaporation losses, and assisting in the control of surface erosion caused by raindrop impact and overland water flow.

Topsoil will be placed on landform surfaces to minimum depth of 100 mm (preferably 150-200 mm) where possible, depending on the available volume of topsoil and the characteristics of the material being topsoiled. Overburden material identified as suitable for vegetation establishment will not be topsoiled and treated, however, the surface will be contour ripped. The preparation of a loose and friable seedbed is essential for good vegetation establishment from seed. If it is very wet, the soil may become compacted. Products such as gypsum or lime may be added to improve topsoil, depending on the chemical nature of the substrate material.

4.8.6.3 Suitability of Overburden Material

The proposed mining strategy is to dump all rejects and almost all overburden materials together back into the void behind the mining (stripping) face in the Horse and Heyford Pits. Some quantity of overburden materials will need to be set aside for rehabilitation and revegetation of the spoil piles (i.e. it is generally not acceptable mining practice to allow rejects to report to final surfaces – typically they are buried well into the overburden material). Also, a small proportion of overburden (less than 2% of the overall total) will be disposed into an out-of-pit dump along the western edge of the Horse Pit box-cut. With this in mind, the suitability of mineral waste materials for use in revegetation and rehabilitation is focused on the overburden materials, even though from a basic soil chemistry viewpoint the overburden materials have similar characteristics compared to the potential reject materials, discussed below and in Section 5 (Mineral Waste). All of the tested overburden composite materials (and also the potential reject materials) had variously elevated Exchangeable Sodium Percentage (ESP) values, ranging from 8.5% to 25% (median 11%). An ESP value of between 6% and 14% indicates that these materials are regarded as marginally sodic to sodic and may be prone to dispersion (Isbell, 2002). Material with an ESP value greater than 14% is regarded as strongly sodic (Northcote and Skene, 1972). Strongly sodic materials are likely to have structural stability problems related to potential dispersion (Van de Graaff and Patterson, 2001). Treatment of all sodic overburden (and potential reject materials) would be required if these are to be used as vegetation growth medium.

Ideally, sodic and dispersive materials should be identified, selectively handled and placed within the core of spoil piles away from final surfaces, or returned to voids during mining. However, since most overburden and coarse reject material is expected to be marginally sodic, this method of managing potentially sodic material is unlikely to be cost effective (i.e. it should be assumed that all spoil material will be sodic). Therefore, it is likely that treatment of the sodic waste materials may be required if these were to be used as an additional source of topsoil.

In addition to potential dispersion problems, sodic soils often have unbalanced nutrient ratios that can lead to macro-nutrient deficiencies (Hazelton and Murphy, 2007). The Table 4.31 below shows the proportions of each exchangeable cation relative to the effective cation exchange capacity (eCEC). The desirable proportions of each major cation are also shown (Abbott, 1989, in Hazelton and Murphy, 2007).

Table 4.31 Proportions of eCEC of major exchangeable cations

Exchangeable Cation	Desirable ranges	Overburden	Potential Rejects
	% eCEC		
Calcium (Ca)	65 - 80	26 – 65 (average 53)	29 – 65 (average 50)
Magnesium (Mg)	10 - 15	15 – 35 (average 24)	14 – 34 (average 25)
Potassium (K)	1 - 5	3 – 20 (average 11)	10 – 25 (average 14)
Sodium (Na)	0 - 1	9 – 25 (average 13)	9 – 15 (average 12)

The median eCEC of overburden materials is 27 meq/100g, which is regarded as moderate (Metson, 1961, in Hazelton and Murphy, 2007). The shallow clay composite sample tested had a very high eCEC value (50 meq/100g) and high EC (approximately 1,380 µS/cm), which is probably the result of evaporative concentration of salts in shallow soil.

When compared to the desirable ranges for exchangeable cations in soil (Table 4.31) exchangeable cation proportions are outside the average ranges, but are not extreme. The exchangeable proportions of the alkali metals Na and K are high, which supports the naturally alkaline nature of most mineral waste materials (refer below). Exchangeable Ca and Mg proportions are marginally imbalanced, but are generally acceptable. Exchangeable Ca:Mg ratios less than two typically require some form of amelioration before these materials can be used as a growth layer. The overburden materials have a median exchangeable Ca:Mg ratio of 2:7, whereas the potential reject materials have a median exchangeable Ca:Mg ratio of 1:6, indicating that amelioration of overburden materials for use as a growth layer may not be required.

It should be noted that in soil chemistry a pH1:5 (solid:water w/v) of between 7.9 and 8.4 is regarded as moderately alkaline and a soil pH1:5 of between 8.5 and 9.0 is regarded as strongly alkaline. 58% of the overburden samples are regarded as moderately alkaline and 29 % are regarded as strongly alkaline. Comparatively, 77% of the potential reject samples are regarded as moderately alkaline and 16% are regarded as strongly alkaline. Therefore some degree of nutrient imbalance is likely to already exist in these materials, despite exchangeable Ca:Mg ratios in these materials being generally acceptable.

In summary, most of the overburden materials are regarded as moderately to strongly alkaline. All have generally moderate salinity (median EC = 700 µS/cm) and display moderate to high eCEC values. All overburden materials can be regarded as being marginally sodic and have a marginal exchangeable cation imbalance.

4.8.6.4 Revegetation

A revegetation strategy is proposed for the project disturbance area that seeks to compliment desirable post-mining land-use objectives whilst maintaining effective erosion and weed controls. Revegetation activities will be scheduled to occur after the completion of reshaping, re-topsoiling and drainage works. Where possible, the timing of these works will enable a preferred seasonal sowing of pasture and tree seed in autumn or spring. On prepared surfaces, selected tree, shrub and pasture species will be sown using seed stock and/or planted depending on the species, slope gradients and area to be revegetated. Tree and shrub species will be established at a density and richness consistent with the nominated post-mine ecosystem.

Plant selection for areas to be returned to bushland will focus on those species that will successfully establish on the available growth medium, species that that will bind the soil and species that will result in a variety of structure and food/habitat resources, with an aim to establishing woodland to open forest. Native species will be established through direct seeding or planting of tube stock/nursery-raised stock from local propagules. Seed will be collected from site where possible to ensure it is adapted to environmental conditions in the area.

Prior to application, some of the tree seed (e.g. *Acacia spp*) will be appropriately pre-treated in order to break dormancy restrictions to promote earlier germination, develop more robust seedlings, wider and more uniform germination and increased germination rates. Tree and shrub establishment on site will be dominated by the direct seeding method, currently being used at the majority of coal mines in the Bowen Basin. A preliminary tree and shrub mix, based on the species list from the terrestrial ecology assessment is provided below. This list will be reviewed and amended periodically depending on the results of rehabilitation monitoring, species trials and changes in technology/best practice.

Table 4.32 Preliminary Native Tree and Shrub Species Mix

Acacia leiocalyx	*Corymbia intermedia*
Acacia cambagai	*Corymbia polycarpa*
Acacia farnesiana	*Corymbia tessellaris*
Acacia holosericea	*Eucalyptus camaldulensis*
Acacia rhodoxylon	*Eucalyptus cambageana*
Acacia salicina	*Eucalyptus microtheca*
Acacia shirleyi	*Eucalyptus crebra*
Allocasuarina luehmannii	*Eucalyptus drepanophylla*
Atriplex muelleri	*Eucalyptus populneum*
Brachychiton australis	*Eucalyptus tereticornis*
Brachychiton rupestric	*Eucalyptus thozetiana*
Callistemon viminalis	*Melaleuca bracteata*
Corymbia erthrophobia	

A combination of native and introduced pasture species will be used on the bushland sites to ensure the quick establishment of a continuous groundcover, thereby reducing the risk of erosion. Legumes may also be selected to assist in the supply of bio-available nitrogen to the soil. If the use of introduced grasses and/or legumes is deemed necessary for erosion control in the bushland areas, pasture seed and fertiliser will be applied at a lower rate than for pasture outcomes to reduce competition with tree seed and/or seedlings. Native and exotic pasture species (warm season perennial, cool season perennial, yearlong green perennial and annual) will be sown where the risk of erosion is less and on the more protected aspects of landforms. Introduced, stoloniferous grass species (e.g. Rhodes Grass, Indian Couch) will be sown on the steeper slopes (>10°) as their growth habit provides more extensive coverage in a shorter time.

Recommended pasture species include:

- Indian Couch
- Rhodes Grass
- Bambasti Panic
- Purple Pidgeon Grass
- Siratro
- Stylo
- Red Natal Grass
- Sabi Grass
- Silk Sorghum.

Aerial sowing and ground broadcasting will be conducted for pasture seed as the preferred sowing methods and grazing will be restricted whilst the vegetation is establishing. All revegetated areas will be monitored to ensure long-term groundcover establishment and success. Revegetation techniques will be continually developed and refined over the life of mine through an ongoing process of monitoring at the site and recognition of other industry experiences.

4.8.6.5 Weed Management

The presence of weed species has the potential to be a major impact on revegetation and regeneration activities. In addition to this, the presence of weed species within the surrounding land has the potential to significantly decrease the integrity of the native vegetation. Weed management will be a critical component of mine rehabilitation and landscape reconstruction. Weeds will be managed across the site through a series of control measures, including:

- Hosing down equipment in an approved wash down area before entry to site.
- Scalping weeds off topsoil stockpiles prior to re-spreading topsoil.
- Regular inspections of rehabilitation to identify potential weed infestations.
- Identifying and spraying existing weed populations on-site together with ongoing weed spraying over the life of the mine.

The spread of weeds will be eliminated from rehabilitation areas by using weed-free soil from the open cut area and monitoring and controlling weed populations should they occur. Weed control, if required, will be undertaken in a manner that will minimise soil disturbance.

4.8.7 Monitoring

Regular monitoring of the rehabilitation will be required during the vegetation establishment period, to demonstrate whether the objectives of the rehabilitation strategy are being achieved and whether a sustainable landform has been provided.

In addition to rehabilitated areas, reference sites will be monitored to allow a comparison of the development and success of the rehabilitation against a control. Reference sites indicate the condition of surrounding un-mined areas or areas successfully rehabilitated that the mine sites must replicate. The rehabilitation at Peak Downs Mine will be reviewed to determine if any areas would provide suitable reference sites for the project. Monitoring will be conducted periodically by independent, suitably skilled and qualified persons at locations which will be representative of the range of conditions on the rehabilitating areas. Annual reviews will be conducted of monitoring data to assess trends and monitoring program effectiveness.

4.8.7.1 Water Quality Monitoring and Management

Leachate and site water derived from, or in contact with, spoil piles, reject materials or other mineral waste is not expected to be problematic with respect to pH (acidity) and metals, however the moderate EC of the overburden materials suggests that salt concentrations in leachate may need to be carefully monitored to ensure nearby drainages are not receiving salt loads that could impact upon the existing ecosystem. This will be managed by retaining seepage and runoff water on-site and re-using as part of the overall site water resource. This will be particularly important in the vicinity of the CHPP where coal washing is likely to produce brackish run-off.

Seepage collection ponds and drainages will be monitored to ensure that soluble metals and salt concentrations are below regulatory guidelines or licence conditions prior to discharge off-site. The parameters monitored and the frequency of monitoring will be considered in the design of the site water monitoring program, taking into account the results of the geochemical investigation (Section 5) and also the baseline surface water and groundwater water quality studies (Sections 6 and 7 respectively).

At a minimum, the range of analyses included in the water quality monitoring program for runoff/seepage from overburden and potential reject storage facilities will focus on pH, EC and total dissolved solids (TDS). Periodic sampling and testing of the full suite of dissolved metals described in this report (e.g. annually) will be included in the water quality monitoring program developed for the project. If the pH of runoff and seepage from overburden or potential reject materials drops below pH 6.0 or the EC value increases by more than 50 %, then a more comprehensive range of water quality analysis may be warranted. Also, if the pH drops below 6.0 or the EC increases, the handling and storage (management) of all mineral waste materials will be re-evaluated.

4.8.7.2 Rehabilitation Monitoring Program

Monitoring of the rehabilitated areas will broadly involve the following:

- Ongoing chemical analysis of topsoil.
- Comparison of soil erosion rates and rill and gully dimensions with measurements taken from reference sites.
- Comparison of vegetation measurements with measurements taken from reference sites.
- Ongoing analysis of water quality parameters collected at water storages, ramps and pits, sediment basins, and creeks (upstream and downstream of the mine) in accordance with requirements of the Environmental Authority and Environmental Management Plan.
- Visual surveillance including the use of digital photogrammetry/low level oblique or vertical aerial photography to monitor changes over time in the rehabilitation (e.g. changes in vegetation structure, erosion rates and landform drainage).

More specifically, a detailed rehabilitation monitoring program will be implemented on site and will include the elements identified in Table 4.33 to determine the level of achievement of success criteria.

Table 4.33 Rehabilitation Monitoring Program

Aspect of Rehabilitation	Elements to be Monitored
Ecosystem Establishment	
Ground cover	Percentage of ground covered by vegetation, rocks, logs and other obstructions. Obstruction lengths and widths (indicates the amount of ground cover that is present to collect, hold and disseminate available resources necessary for ecosystem function) for use in Landscape Function Analysis (LFA). Fetch lengths (measure of distances of soil surface that is bare of matter that could slow water velocity) for use in LFA.
Community structure and composition	Species composition. Number and form of ground cover and understorey species per plot. Density, height, canopy cover and DBH of tree and large shrub species. Numbers, heights and species identity (where able to be determined) of any seedlings. Evidence of reproduction/regeneration (e.g. flower heads, fruits/seeds, germination of seedlings etc). Assessment of individual plant health (healthy, sick or dead).
Habitat	Availability and variety of food sources (e.g. flowering/fruiting trees, presence of invertebrates etc). Availability and variety of shelter (e.g. depth of leaf litter, presence of logs, hollows etc). Presence/absence of free water.
Fauna	Presence and approximate abundance and distribution of functional indicator invertebrate species. General observations of vertebrate species (including species of conservation significance). Detailed fauna surveys including presence and approximate abundance and distribution of vertebrate species (focussing on species of conservation significance).
Weeds and pests	Species identity. Approximate numbers/level of infestation. Observations of impact on rehabilitation (if any).
Erosion Monitoring and Soil Characteristics	
Soil	Stability, infiltration and nutrient cycling undertaken according to LFA procedure. Electrical Conductivity, as a measure of salinity. pH. Soil exchangeable Na potential.

Aspect of Rehabilitation	Elements to be Monitored
Erosion	Location and extent of sheet wash. Location and extent of rill and gully erosion including measurements of depth, width and length. Extent of bare areas with potential to erode. Sediment movement and runoff.
Geotechnical Stability	
	Stability of batter and surface settlements, in particular where these features could impact on the performance of any surface water management system. Surface integrity of landform cover/capping (measurement of extent of integrity failure). Landform slumping (distance of material movement and extent).
Surface and Ground Water	
	Groundwater quality and depth. Efficiency of landform surface water drainage systems. Presence and quality of any surface water and seepage at selected locations at the lower part of potentially acid producing landforms such as reject dumps. Water quality including pH, EC and total suspended solids of water in water storages, ramps and pits, sediment basins and sewage effluent outfalls onsite. Water quality including pH, salinity and turbidity of water entering creek/river systems on site.
Creeks and Diversions	
	Vegetation density, diversity and vigour Structural stability of channel Water quality including pH, salinity and turbidity of water entering creek/river systems on site.

4.8.8 Maintenance

Maintenance of rehabilitated areas will be undertaken where necessary and in response to results of the monitoring program, to ensure success criteria are met, or in the case of progressive rehabilitation, are projected to be met at the time of mine closure. Depending on the criteria to be achieved, examples of maintenance works include re-seeding or planting of tube stock of tree and/or shrub species to meet required revegetation parameters and implementation of erosion protection measures to reduce erosion rates.

Responsibility for the maintenance of rehabilitation will lie with BMA, as owner/operator of the project. As extensive areas of disturbed land will not be available for progressive rehabilitation, much of the rehabilitation work will be required to be carried out at the end of mine life. Post-mining surveys of the rehabilitation will be undertaken across the site to determine whether the site meets success criteria and whether this result is being maintained over time. Once this occurs and the site is relinquished, the land will be returned to the relevant stakeholders and maintenance of the rehabilitation will no longer be required.

4.8.9 Infrastructure Decommissioning and Closure

4.8.9.1 Closure Methodology – Decommissioning of Infrastructure, Plant and Buildings

Site Services

All services including power, water, data and telephone for the entire site will be isolated, disconnected and terminated to make them safe. The inspection pits and junction boxes for underground services will be sealed. Generally all underground services will be made safe and left buried in the ground. Overhead power lines will be removed and the materials (i.e. poles and wire) recovered for potential re-sale or recycling as applicable. Switch room buildings will be disconnected and demolished. The substations will be removed from the site and either used on another project or sold as a going concern.

Infrastructure and Buildings

All sumps will be de-watered and the excess coal removed prior to the commencement of demolition. In addition all items of equipment will be de-oiled, degassed, depressurised and isolated and all hazardous materials (HAZMATs) removed from the site.

All buildings, including the main administration building, workshop, CHPP and fixed plant (including stacker / reclaimers, conveyors and gantries, transfer points, thickener tank, coarse reject hopper, vehicle wash, etc) will be required to be demolished and removed from the site. Where possible assets may be re-used or sold to other mines.

The remaining items will be demolished, removed and transported from the site as required. All recoverable scrap steel will be sold and recycled, with the remaining non-recyclable wastes either being taken to a licensed landfill or buried in the backfill of the final voids. Only inert wastes will be placed in the backfill.

All concrete footings and pads will be broken up to at least 1.5 m below the surface and removed with the non contaminated waste material being buried in the void before it is rehabilitated.

Roadways, Car Parks and Hardstands

The bitumen roadways, car parks and hardstand areas around the CHPP, workshop and administration areas will be ripped up with the inert waste material being placed in the open cut voids and buried.

Contaminated Land

At closure, a preliminary sampling and analysis program (Phase 1) will be implemented to determine whether an assessment (Phase 2 – detailed investigation of contamination involving drilling, etc) should be conducted to quantify the amount of contaminated material that will need to be bio-remediated on site.

4.8.9.2 Closure Methodology – Bulk Earthworks and Rehabilitation of the Site

Infrastructure, Plant and Buildings

The carbonaceous material on the base of the ROM and product stockpile areas will be stripped to a depth of at least 0.5 m and buried in the low wall of the open cut void. Where possible the material will be considered for reprocessing before the CHPP goes off line.

The entire CHPP and infrastructure areas will be dozer trimmed to facilitate the appropriate drainage of surface runoff from the site. Appropriate surface water management structures (contour banks, drains and settlement ponds) will also be constructed. The site will be rock raked to remove all surface rocks to a size of less than 500 mm and ripped to a depth of at least 1 m. Fertiliser and pasture/tree seed will be applied to assist establish pasture post-mine land use.

Hardstand and Haul Roads

Contaminated, carbonaceous or unsuitable (gravel, etc) material will be removed from the haul roads and hardstand surfaces and disposed of and covered in the low wall area. Minor dozer reshaping work will be undertaken to ensure surface level consistency with the surrounding areas. Any creek crossings (i.e. culverts, etc) will be removed and the pre-existing drainage line re-instated (where applicable). The site will be rock raked to remove all surface rocks to a size of less than 500 mm and ripped to a depth of at least 1 m. Fertiliser and pasture/tree seed will be applied to assist establish pasture post-mine land use.

A light vehicle access road is to be maintained to enable inspections of the site following closure of the mine. All roadside markers (tyres and guideposts) and signs are also to be removed from within the area once mine closure activities within the pit area have been completed.

Sediment Basins and Surface Water Features

All sediment basins which assist in the water flow from the final rehabilitated surface will be retained following mine closure. The water storage basins will be removed and the original drainage paths re-established wherever possible. These areas will be rock raked to remove all surface rocks to a size of less than 500 mm and ripped to a depth of at least 1 m. Fertiliser and pasture/tree seed will be applied to the entire site at rates currently used at similar BMA sites.

4.8.10 Post Closure and Monitoring

Following closure of the mine the existing environmental monitoring program will be maintained until all decommissioning and rehabilitation works have been completed. Notwithstanding this, there may be the need to establish some additional monitoring sites depending on the nature of the decommissioning works and also in response to finding possible sources of pollutants to the environment.

The type and location of this monitoring will be determined further during the sites decommissioning phase.

4.8.11 Void Management

Following closure of the mine, several key environmental issues may need to be considered for the long term management of the remaining void. The areas requiring management are outlined below.

4.8.11.1 Objectives

The primary objectives of the void management strategy are to:

- Propose mitigation measures to minimise potential impacts associated with the final void.
- Propose measures for the management and monitoring the potential impacts of the void over time.
- Present options for the final land use of the void following the completion of mining.

4.8.11.2 Final Void Management

Void Water Quality

Water should only be permitted to accumulate in the void if it maintains a quality that does not compromise its intended use or the quality of surrounding groundwater reserves. The aim is to provide a usable water storage or biologically viable water resource. Prior groundwater and surface water modelling will provide an indication of the expected water quality in the final void, however it is anticipated that waters will be alkaline and saline. Once this prediction is made, actions will be taken during the closure process regarding the control of external sources of water into the void. Maintaining void water quality will be essential to achieving the long term viability of the water resource. The following aspects need to be considered with respect to managing final void water quality:

- Stratification of the water column
- Concentration of dissolved salts resulting from the mining of the coal seams
- Control of surface flow into the void
- Determination of recharge rates to the spoil aquifer and void
- Understanding the movement of flow through the spoil aquifer
- Groundwater inflows and outflows
- Rainfall and evaporation.

All of the above have the potential to impact on the water quality of the final void and its potential end use. Post-closure, a water monitoring program will need to remain in place to closely monitor any changes to water chemistry within the void.

Void Slope Stability – Low Walls

Stability of the low wall will be achieved through implementing the following:

- The low wall will be battered back from the angle of repose to ensure that long term geotechnical stability of the face. Determination of geotechnical stability should be based on an assessment of the spoil material, the likely degree of settlement, and the degree of weathering expected in the long term. Where required the sides of the final void will be battered back to 17 degrees.
- Drainage on and over the low wall will be minimised through the construction of drainage control structures.
- Erosion of the low wall will be controlled by limiting the length of slope, minimising the degree of slope, and by the establishment of suitable vegetation.
- Battering of the low wall against the bottom of the high wall will enhance stability.
- Benching of the spoil material may need to be considered in some areas in order to achieve geotechnical stability and minimise erosion.

Void Slope Stability – High Walls

To ensure the safety of the final void, the surrounding final slopes will be left in a condition where the risk of slope failure is minimised. The following will need to be considered when assessing the geotechnical stability of the highwalls:

- Long term groundwater levels
- Long term final void water levels
- Height and inclination of slope and number and spacing of intermediate benches
- Shear strength of the highwall soils and rocks
- Density and orientation of fractures, faults, bedding planes, and any other discontinuities, and the strength along them
- The effects of the external factors, such as surface runoff.

Prior to closure, further investigations will be undertaken to confirm the criteria above and appropriate action will be taken to ensure effective long term safety, stability and management of the void.

Spontaneous Combustion

Spontaneous combustion is not known to occur at Peak Downs Mine and is therefore not expected to occur on the project site. However, it has been included for reference as it is often an issue associated with final voids. Spontaneous combustion above ground commonly occurs in waste dumps containing reject coal material, in unconsolidated heaps where oxygen can come into contact with the coal and heat can't dissipate. The problem is compounded when rainfall events cause erosion, progressively exposing the coal. Spontaneous combustion may also occur in the coal seam exposed in the remaining highwall of the final void. The following will be undertaken to reduce the potential for spontaneous combustion to occur:

- Accumulations of coal material, particularly pyritic, will be buried under inert spoil.
- Any remaining coal spalling will be removed from the highwall where possible.
- If any coal on the highwall face is prone to spontaneous combustion, it will be sealed with water, clay or inert soil where possible.
- Should any outbreaks of spontaneous combustion occur in the final void, details on the materials involved, presence of pyrites, location, date, time and climatic conditions will be recorded. This will be undertaken as part of the ongoing inspection and monitoring to occur post closure of the mine.

Control of Surface Inflow

The control of surface inflow into the final void is essential for the long term management of water quality within the pit and will also aid in the control of erosion to low walls and high walls.

Surface water flow can cause slope deterioration and ultimate failure. Drainage will be directed away from the highwall face through the construction of interceptor channel drains around the perimeter of the highwall and spoon drains will be utilised on the upslope side of all benches. Drainage over the low wall will be minimised through constructing surface water diversions, and drainage on the wall will be limited and controlled to reduce the erosion potential. Where possible, external catchments will be diverted around/away from the final void.

Safety

At mine closure, one of the main priorities for the void will be to render it safe in terms of access by humans, livestock and wildlife. The following will be considered at the time of closure to ensure that the void is left in a safe manner. These include:

- Instability of the high wall and low wall can induce failures or mass movement. To ensure the stability of the high walls and low walls they will be battered back to a stable slope angle as required.
- Exposed coal seams will be covered with inert material to prevent ignition either from spontaneous combustion, bush fires or human interference.
- A barrier at a safe distance from the perimeter of the void to prevent human access will be constructed. The highwall areas will be secured by the construction of a trench and a 2 m safety berm, as well as a

2.1 m security fence along the entire length of the remaining high wall. This is to provide an engineered barrier between the pit and the surrounding area. The trench and berm is to be constructed in such a way that it will physically stop most vehicles.

- Suitable signs, clearly stating the risk to public safety and prohibiting public access will be erected at 50 m intervals along the safety fence.
- Surface runoff from land surrounding the void will be diverted from entering the void so as to prevent flooding of the pit and potential development of instability of the void walls.
- Shrub and/or tree planting along the outside edge of the bund wall will be implemented where practicable to lessen the visual impact of the wall, and will be in accordance with the agreed post-mining rehabilitation criteria and land use.

Catchment Management Strategies

The catchments, formerly reporting to the final void, will be diverted away from the low wall areas to minimise the amount of clean water runoff accumulating in the voids. These catchment areas will be either rehabilitated or in an advanced stage of rehabilitation. Runoff from these areas will be diverted to appropriate sediment control measures prior to leaving the site through stable water disposal areas. The remainder of the regraded low wall area entering the void, will be stabilised with structural soil conservation earthworks (banks, drains, drop structures, etc), and vegetation endemic to the area. Pasture establishment will provide sufficient ground cover to minimise low wall erosion.

Low wall slopes with gradients of 17 degrees or less will be sown conventionally via ground broadcasting. Low wall slopes exceeding 17 degrees, and where structural soil conservation earthworks cannot be used, will be hydro mulched to enhance the surface stability of the slopes by hastening vegetative germination and establishment.

Prior to initiation of revegetation works, the re-spread topsoil on low wall slopes will be sampled and subsequently tested for pH, conductivity, exchangeable Na% and nutrient requirements. Nutrient requirement testing will be a useful tool to determine site specific fertiliser application rates to optimise nutrient utilisation by establishing pastures thus preventing nutrient overload to the catchment area potentially causing excessive nutrient leaching to the void and the resultant nitrification of water stored in the void. Post-sowing soil testing will be carried out on a regular basis to ensure that nutrient application has been targeted to match the establishing vegetations needs.

Long term mine planning will seek to infill voids with spoil and reject waste to the maximum extent practicable, however voids will remain at the end of mine life. Final voids will essentially serve to negate potential for downstream pollution. They will form water storage areas most of which may be moderately saline but possibly suited to limited stock use.

4.9 Contaminated Land

A contaminated land preliminary site investigation (PSI) was carried out at the project site to determine if any previous or current land uses have resulted in possible contamination issues. The PSI contains information gathered during a site history review of the properties associated with the project site lots, information obtained from the Queensland Government's Environmental Management Register and Contaminated Land Register, site inspections and interviews with local residents and Peak Downs Mine personnel. The PSI report for the project site is provided in Appendix G**.**

4.9.1 Environmental Protection Agency Registers

Activities identified as being likely to cause contamination are listed as notifiable activities under Schedule 3 of the EP Act. It is a requirement of the EP Act that the Queensland EPA be informed of any area that is or has been utilised for a notifiable activity or contaminated by a hazardous contaminant. Notifiable activities under the EP Act include, but are not limited to, petroleum product or oil storage, cattle dips, landfills, abrasive blasting, chemical storage, mineral processing and disposal of mine wastes. The EPA maintains two registers of contaminated sites in Queensland:

- The Environmental Management Register (EMR)
- The Contaminated Land Register (CLR).

The project site comprises a number of land parcels within the mining tenements (refer Section 4.6 Land Use for further detail). Table 4.34 presents the results of searches performed on the EPA's EMR and CLR.

Table 4.34 Results of EMR and CLR Searches

Lot	Plan	EMR Listed	CLR Listed
16	SP 163605	No	No
4	RP 884695	No	No
13	SP 151669	No	No
7	RP 615467	No	No
8	RP 615467	No	No
9	RP 615467	No	No
10	RP 615467	No	No
13	GV 225	No	No
14	SP 163605	No	No
14	GV 116	Yes	No
18	GV 135	Yes	No
4	SP 174999	No	No
47	GV 226	No	No
4	RP 818135	No	No
5	SP 135741	No	No

Lot	Plan	EMR Listed	CLR Listed
4	RP 616987	No	No
10	GV 303	No	No
10	SP 137499	Yes	No
1	RP 616897	No	No

4.9.1.1 Environmental Management Register

The EMR is a land use planning and management register. The EMR records properties that have been used or are being used for a notifiable activity (i.e. activities that may cause land contamination). The EMR provides information on historic and current land use registered with the EPA. Generally, sites registered on the EMR pose a low risk to human health and the environment. The listing of a site on the EMR does not automatically mean the land must be remediated or that the current land use must cease..

The properties within the project site currently listed on the EMR include:

- Lot 18 on GV 135 is listed on the EMR for the notifiable activity of Petroleum Product or Oil storage.
- Lot 14 on GV 116 is listed on the EMR for the notifiable activity of Petroleum Product or Oil storage.
- Lot 10 on SP 137499 is listed on the EMR for the following notifiable activities:
  - Chemical Manufacture or Formulation
  - Chemical Storage
  - Explosives Production or Storage
  - Waste storage Treatment or Disposal
  - Petroleum product or Oil Storage
  - Mine Wastes.

Lot 18 on GV135 is a part of Special Lease 12/42239 and underlies MLA 70403 and ML 1775. It is held by BMA and a portion is operated as part of the Peak Downs Mine. Various mobile petroleum storage activities take place at the mine, including mobile refuelling of plant and vehicles. There are no fixed locations for this activity, however, this is the likely reason for the registration.

Lot 14 on GV 116 is listed for the notifiable activity of Petroleum Product or Oil Storage. Discussions with local land holders and employees at the Peak Downs Mine were undertaken as well as a site investigation within the project site boundary in an attempt to ascertain the location of this storage activity. The storage facility was not located during the site investigation. A possible reason for listing this land parcel on the EMR may relate to mobile fuel storage and use. Further investigations to determine the location or previous location of the storage facility are required.

Lot 10 on SP 137499 is part of the operating Peak Downs Mine. Upon inspection of land tenure maps it was noted that the boundaries of the project site contain a very small part (15.53 ha) of the northern section of this lot, which is used by the Peak Downs Mine for (among other things): storage and formulation of explosives, the coal rejects pile, and mechanical workshops for water pumps for the mine. When the site investigation was conducted, it was noted that the area affected by the project does not contain any of these activities and is located some distance from any infrastructure associated with these activities.

4.9.1.2 Contaminated Land Register

The CLR is a register of Risk sites. If it has been scientifically proven that a site is contaminated, the site is registered on the CLR and action is required to either remediate or manage the site to reduce the risk of potentially serious harm to the environment and human health. None of the project site properties are currently listed on the CLR.

4.9.2 Site History

4.9.2.1 Historical Titles information

A search of current and historical land titles (1969 to 2007) available from the NRW was undertaken. Based on this review, it is revealed that the majority of the land parcels within the project site have historically been used for pastoral farming, grazing and agricultural purposes.

4.9.2.2 Aerial Photograph survey

As part of the site history assessment, a review of the 1957, 1966, 1977, 1985 and 2000 historical aerial photographs available from the NRW, was undertaken. A BMA aerial photography run flown in late 2007 was also used to assess current conditions. The aerial photographs show the development of infrastructure such as the Moranbah airport, Peak Downs Mine, dams, the road network and several buildings. The aerial photographs also show land being cleared over time for pastoral or cultivation purposes. The aerial photographs examined do not show any evidence of a cattle dip, race or dripping yards. However, the photograph scale and vegetation cover would make it difficult to accurately identify these features.

4.9.3 Potential Impacts

Two site inspections were carried out on the project site and surrounds in November-December 2007 and March 2008. The site inspections consisted of:

- Visits to areas of interest identified in the aerial photography review.
- Visits to areas of interest identified during interviews with local residents, and Peak Downs Mine employees.
- General site inspections to identify any areas of potential concern not listed on government databases, titles or aerial photographs.

The site inspections indentified several areas as having potential for contamination sources (Figure 4.91) including:

- Potential soil/groundwater impact from an in-ground oily water tank and minor impacts from petroleum product spills at the Kalari Workshop Trucking Yards.
- Potential residual pesticide impact at the cattle yards on Lot 13 on SP 151669.
- Potential lead residues in the soil at the rifle range site in the centre of the Horse Creek property.
- Potential soils impact as a result of chemical storage at the occupied dwelling.
- Potential contamination associated with petroleum product or oil storage on Lot 14 on GV 116 (exact location unknown).
- Potential soil contamination from leaks and spills of mobile transformer lubricants, winding oils and fuels on the operating mine.
- Potential soil contamination from fuels storage and transfer at mobile fuel tanks on the operating mine (including Lot 18 on GV 135).

The various areas investigated (as discussed below) with the exception of the dwelling, rifle range, and sawmill site are within the project foot print and will require assessment and potential removal of contaminated soils. Further information on the location and background of each of these potential areas of interest is provided in the Appendix G. Refer to Appendix Q sections 3.7.3 and 3.7.5 for remediation and rehabilitation plans.

4.9.3.1 Kalari Trucking Workshop and Yard

The Kalari Workshop and Yard is located on the north-eastern section of the project site on Lot 16 on SP163605, (Figure 4.91). The workshop and yard maintains long-haul trucks servicing the mining industry. Activities undertaken at the site include:

- Preventative maintenance of long haul trucks and trailers including:
  - Tyre changes
  - Oil and lubrication maintenance
  - Mechanical inspection and testing
  - Minor paint touch-ups and body cleaning.
- Storage of items and substances for the purposes of vehicle maintenance.
- Oil/water separation of oily liquid wastes from maintenance and washing activities.
- Sediment trapping from the wash down pad.
- Storage of defunct equipment and bulk chemical transport containers.
- A break and refreshment area for staff, with self contained water and septic systems.
- Administrative offices for supervisors.

During the site inspection and subsequent communication with the Kalari workshop and yard site supervisor several potential contamination sources or evidence of potential contamination were identified. Potential sources included oil staining, minor oil or detergent spills, potential heavy metal contamination at the wash down area, sediment tank and surrounds, stored empty agricultural chemical containers, disused empty diesel and fuel storage tanks, unknown chemical bulk transport containers and a soil stockpile area at the front of the gate to the yards and workshop.

The vehicle wash-down area comprises a concrete slab (approximately 5 m by 15 m) with gravity drainage to a coarse sediment trap. The trap drains to an in-ground tank along with the wastewater stream from the oil separator. Trucks coming to the workshop are used to transport vehicles and supplies to industries and mines within the Bowen Basin and elsewhere. There is potential for the wash-down pad, sediment traps, wastewater tank and surrounding areas to be impacted by heavy metals and other debris inadvertently picked up at these industrial sites during delivery activities and transported on the undercarriage and bodies of the trucks back to the yard.

The inspection pit is located within the workshop floor; it has a concrete floor and is lined with concrete blocks. At the time of the inspection the pit appeared to be in a well maintained and reasonably clean condition with no cracks visible in the floor.

Waste oil and water mixtures from maintenance activities are diverted to a triple interceptor, separated oil is transported to an above ground waste oil storage tank (stored in one of the shipping containers at the site) and water and sediment is transported to an in-ground storage tank. JJ Richards is contracted to remove waste from this sediment trap and water and sediment from the in-ground tank on an as-needs basis. The above ground waste oil tanks can hold up to 1,000 L. Northern Queensland Resources removes the waste oil from the storage tank on a monthly or as-needs basis.

Minor quantities of spray paint cans and other commercially packaged chemicals (radiator additives, glass cleaners, corrosion inhibitors etc.) are stored in the maintenance store room. The store room has an uncracked concrete floor and at the time of the inspection appeared to be in a clean and ordered condition with items stacked neatly in safety cupboards.

During the site inspection several empty pesticide containers were observed. It is understood that these containers are cleaned and rinsed three times before entering the yards. They are cut open and used as temporary traps to collect waste oil. Several small and large fuel and/or chemical storage tanks and drums are stored at the site. It is understood that these units are not currently being used and had been cleaned prior to being placed in their current locations. During the site investigation these units were empty.

Oily rags and used oil filters are stored in an empty 205 litre drum before being collected by Environmental Recovery Services (ERS). Several dry wood, scrap metals and domestic waste collection bins are located on the site. Waste from these bins is collected by JJ Richards.

Several shipping containers appear to be permanently situated at the site. Most of the containers were inspected during the site visit, but access to some was not possible as the containers were blocked by equipment or otherwise inaccessible. Those that were inspected contained oil drums, a lubrication room and paints as mentioned above. It is understood that the drum stored adjacent to the wash down area contained Biosol detergent. Evidence of leakage from this drum was apparent during the site visit.

Several 205 L drums of oil are located around the yards and workshop. In the lubrication room these drums are on a concrete floor with no visible cracks noted. At the time of the inspection the floor appeared to be clean, however there were several stains. Open drums are placed on drum drip trays designed to collect drips or spills. Oil from these drums is piped through the wall into the maintenance area. Within the maintenance area, a catchment bucket is located under the hose that is used to distribute oil around the workshop. Other drums located at the site were either placed on pallets or on the ground.

Used tyres are removed from site by a qualified contractor as needed. The septic sewage tank for the amenities on site is pumped once a year by a qualified contractor. ERS remove waste engine coolant water and waste solvent from the parts washer as needed. A soil stockpile was located at the front gate of the Kalari yard, contained within a wooden structure. No information regarding the source or nature of this material was available during the investigation. Licenses and permits were not available at the time of the site inspection.

4.9.3.2 Cattle Yards

A cattle yard is located on Lot 13 on SP151669 (Figure 4.91). The yard is near the eastern boundary of the project site, approximately 1,500 m to the north of the Peak Downs - Clermont highway. The yards are approximately 50 m by 75 m and constructed of steel posts and wooden rails. This area is divided into a number of smaller yards for separating cattle. During the inspection feeding troughs, a small crush for inspection and a loading ramp built at the north-east corner were present at the cattle yards. Currently the yards are used as a small feedlot and holding pen for cattle by the current landholder.

The surrounding terrain and underlying base for the yard are silty sands. The yard itself has been lined (approximately 300 to 500 mm) with a layer of fill comprising of mechanically compacted clay and gravel. Overlaying this is a floor comprising of sandy silt with a thickness of 70 to 100 mm. The yard is situated near the cottage and shed (described below). It is understood from discussions with the leaseholders at the time of the site inspection that the cattle yard had been in use as a feed lot and holding yards for cattle since the 1950s.

Anecdotal evidence available through leaseholder consultation indicates that in the 1990s the Department of Primary Industries (DPI) (now referred to as Queensland Primary Industries and Fisheries) conducted residue tests on the meat from animals that had been held in these yards and found some form of contamination. It is understood that the DPI issued a remediation order to have the top 300 to 500 mm of soil excavated and disposed of, and clean fill be laid. The current leaseholder indicated that this was duly carried out. The cattle held in the yards were purportedly later tested and the meat from these animals was found to be acceptable. A local resident indicated that the excavated soil was taken and stockpiled elsewhere on Lot 12 on SP151669 (Buffle Park), which is located outside the project site.

BMA has contacted the DPI and local council to request information from this event. It is understood that there is no further information to be found relating to the type of contamination, amount of material removed and type and quantity of backfill that was imported to site. There is also no information given regarding the location and nature of storage of the removed material, any delineation exercise to determine the limits of possible contamination or any validation sampling done to ensure all possible contaminated material had been removed.

Figure 4.91 shows the cattle yard in relation to the project development. The yard is expected to be in the spoil dump location and will require delineation and remediation exercise before any spoil material is placed in this area.

4.9.3.3 Possible Sawmill Location

Consultation with employees at the Peak Downs Mine and leaseholders indicated that a small sawmill was located in the 1970s on Lot 14 on GV116 (Figure 4.91). Section 15.2 (Cultural Heritage) discusses the sawmill further. Anecdotal evidence suggests that the sawmill may have also been used during the construction of the original diversion of Cherwell Creek (approximately 1990) to saw felled trees into railway sleepers. It was not known whether the timber was sawn by a fixed or mobile sawmill or if the railway sleepers were treated. A site walkover of the general area showed the saw mill had been removed, leaving a number of piles of off-cut lumber and un-sawn trees. There was no other indication of the exact location of the sawmilling operation.

4.9.3.4 Rifle Range

Discussions with local leaseholders indicated the presence of a rifle range and barbecue pit within the northern section of the project site (Figure 4.91). Following the site inspection it was found that the rifle range was used by a limited number of patrons for recreational purposes only. The assumed shooting targets were mounted on star pickets and placed in front of a bunded area. Due to the nature of activities in this area, there is potential for lead to be present in the soil that forms the bund and in the surrounding area.

4.9.3.5 Homestead and Cottage

There is one occupied homestead (Lot 14 on SP163605) and one occupied cottage (Lot 13 on SP151669) located within the project site (Figure 4.91). The homestead is situated approximately 750 m from the Moranbah Access Road on the north-eastern boundary of the project site and comprises a small house and caravans. This dwelling has self-contained potable water and septic systems. The cottage is situated adjacent to the cattle yards on Lot 13 on SP151669. The shed associated with the cottage and yard was visually inspected, the farmer was storing minor quantities of herbicides, pesticides, small engine lubricants and fuels, including a 205 L fuel tank with a hand pump, and empty fuel drums, typical of farms in the area. The cottage has self-contained potable water and septic systems.

4.9.3.6 EMR Identified Sites

The review of the EMR identified that Lot 14 on GV116 was listed for the notifiable activity of Petroleum Product or Oil Storage. Discussions with local land holders and employees at the Peak Downs Mine were undertaken as well as a site inspection within the project site boundary in an attempt to ascertain the location of this storage activity. The storage facility or a possible storage facility location was not identified during the site inspection. The reason for listing this land parcel on the EMR may relate to mobile fuel storage and use. Further investigations to determine the location or previous location of the storage facility are required.

Lot 10 on SP137499 is identified on the EMR for the following notifiable activities:

- Chemical Manufacture or Formulation
- Chemical Storage
- Explosives Production or Storage
- Waste storage Treatment or Disposal
- Petroleum product or Oil Storage
- Mine Wastes.

This lot forms part of the operational Peak Downs Mine. Upon visual inspection of land tenure maps it was noted that the boundaries of the project site contain a very small part (15.53 ha) of the northern end of this lot, which is used for: storage and formulation of explosives used on the mine, the coal rejects pile, and mechanical workshops for water pumps for the mine. It was noted that the area affected by the project does not contain any of these activities and is located some distance from any infrastructure associated with these activities. No further action needs to be taken in this area.

Lot 18 on GV135 is listed on the EMR for the notifiable activity of Petroleum product or Oil Storage. The fuel tanks discussed in Section 4.9.3.11 are likely to have triggered the notification.

4.9.3.7 Gravel Pit

During the site inspection a gravel pit was identified at the northern boundary of the project site (Figure 4.91). The pit is situated on relatively flat land and is approximately 1.5 m deep, approximately 40 m wide and 100 m long. There is no extraction activity currently being undertaken at the pit. No information regarding the operation of the pit was available at the time of the investigation. There are piles of unidentified spoil material and broken rock in the centre of the pit. Sail material and a Perspex dome were located adjacent to the west of the pit. Communications with a local resident indicated that this material was the remains of the roof for the Moranbah shopping centre square. It was removed in a redevelopment of the shopping centre in 2005. It is unknown why this material was discarded in this location, however, it is not considered likely to be a potential contamination source.

4.9.3.8 Dragline Transformers

Discussions with Peak Downs Mine staff indicated that at Peak Downs Mine, mobile step-down transformers are used to convert 66 kV power to 11 kV three-phase electricity for use by draglines. The transformers are parked at the end of electricity transmission stublines, and power is delivered to the draglines by cables laid along the ground. The transformers are on a caterpillar-tracked chassis and are earthed. The transformer is self-driven when moving between locations and is diesel powered. At the time of the site inspection, there were two draglines and transformers within the project site. Peak Downs Mine staff indicated that each transformer had been in place for approximately 6 months to a year and it was usual for a transformer to remain at a station for up to two years. Figure 4.91 shows the locations of the transformers in the project site during the site inspection. Both transformers had some oily staining around spigots and on the outside of the windings cases. Fresh leaks or pooled oils were not noted.

It was noted that one of the transformers (numbered TSS01 in the Peak Downs Mine numbering system) had a visible stain below the chassis. A sample of the surface soil was taken and sent to ALS Brisbane Laboratory for analysis of: eight metals (Arsenic, Cadmium, Chromium, Copper, Lead, Nickel, Zinc, and Mercury); Total Petroleum Hydrocarbons (TPH); Benzene, Toluene, Ethyl benzene and Xylene (BTEX); Phenols; Polynuclear Aromatic Hydrocarbons (PAH); and Poly-Chlorinated Bi-Phenyls (PCB). The sample contained TPH concentrations above laboratory limits of reporting for C_{10}-C_{14} 350 mg/kg; C_{15}-C_{28} 38,900 mg/kg; and C_{29}-C_{36} 810 mg/kg. The concentrations reported in these fractions exceed the adopted Environmental Investigation Levels (EILs), developed by the Queensland Environmental Protection Agency (QEPA) and published in the “Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland”. Concentrations exceeding the adopted EILs were also recorded for chromium (54 mg/kg) and nickel (88 mg/kg) in this sample (refer Appendix G, Section 7).

Samples were not taken at the second transformer (numbered TSS04) as there was no visible evidence of surface staining. Prior to any soil disturbance, further investigations of each of the areas of potential contamination will need a comprehensive sampling program to identify the impacts to soils and groundwater, if any.

4.9.3.9 Toilet Facility for Mine Staff

A toilet facility with self-contained septic tank and above-ground water supply was located north of the back access road close to the 10N pit (Figure 4.91). The toilet block is inspected fortnightly with the septic tank emptied by a licensed contractor on an as-needs basis. The toilet block was noted during the site inspection to be in an orderly and clean condition with no visible leaks.

4.9.3.10 Exploration Drill Pad Sumps

During the site inspection, three shallow pits or sumps used for exploration drilling were identified (Figure 4.91). These pits were approximately 2 m by 3 m each. At the time of inspection the pits had not been backfilled and were filled with rain water. There was no visible sheen on the water and no other visible impacts in the area. It is standard BMA procedure to rehabilitate the area after drilling.

4.9.3.11 Mobile Fuel Tanks

During the site inspection, two mobile fuel tanks were observed within the project site (Figure 4.91). A diesel tank was located on the northern side of 11N pit near the back access road. This tank may have been used to supply diesel to water pumps in the pit. The tank was mounted on skids and had a capacity of 2,500 L. The tank had a connected supply hose which led into the 11N pit. Peak Downs Mine staff were unable to determine the length of time that the tank had been in this location. The tank was intact and in good condition. Fuel staining was visible on the filling point for the tank and at the hose connection at the base. In addition, fuel staining was evident on the skids. There were no visible stains on the ground surface surrounding the tank, but soils had a strong petroleum odour. A surface soil sample and duplicate were collected next to the tank in the region of strong odours and sent to ALS Brisbane Laboratory for analysis of TPH, Phenols, PAH and BTEX. The sample contained TPH concentrations above laboratory limits of reporting for C_{10}-C_{14} 4,390 mg/kg; C_{15}-C_{28} 30,100 mg/kg; and C_{29}-C_{36} 170 mg/kg.

The concentrations reported in these fractions exceed the adopted EILs. Prior to any soil disturbance, further investigations of each of the areas of potential contamination will need a comprehensive sampling program to identify the impacts to soils and groundwater, if any.

A small trailer-mounted tank of approximately 250 L was located near the junction of the North Haul Road and the 10N ramp. It was temporarily parked in an area which appeared already heavily impacted by coal rejects and truck wash down debris . Samples were not taken at this location. The tank appeared in a reasonable, clean condition and appeared to have been recently parked. Lot 18 on GV135 is listed on the EMR for the notifiable activity of Petroleum Product or Oil Storage. These fuel tanks are located within this land parcel and are likely to have triggered the notification.

4.9.3.12 Parking Area / Waste Area

An area used for light vehicle parking (as indicated by the presence of a Peak Downs approved sign) was located at the junction of the main north haul road for the mine and the turn-off for the 10N ramp and was approximately 100 m by 50 m wide (Figure 4.91). This area appeared heavily impacted by coal rejects and fines, and wash-down dusts from trucks; and may have been mixed with materials used to construct the haul roads (which appeared to consist of gravels and bituminous fines). Peak Downs Mine staff indicated that the area is not an official parking area for coal haulers or reject trucks; or known as a dumping area for fines or rejects. In the parking zone, there was a trailer-mounted pump and a trailer-mounted fuel tank as mentioned above.

In addition to the parking area/waste area, there were a number of features (including bunds, haul road berms, and spoil piles) impacted in a similar manner to the area described above. Coal mining rejects and dust and coal spills appear to be a common feature around the mine transport corridors. No samples were taken at this location, however the area appeared to be impacted by mining activities and the fuel tank appeared to be temporarily parked.

4.9.3.13 Summary of Results

The northern section of the project site is located within a currently inactive portion of mining tenement. The majority of the project site has been vacant grasslands used for cattle grazing with a low potential for contamination. Two inhabited properties were identified within this section of the project site. Potential sources of contamination may exist, however further investigations are required to confirm the presence, type and extent of any impact. As a result of the potential occurrence of contaminated soil within the project site, further investigations will be carried out prior to undertaking earth moving activities in the area. The following areas may require further investigation due to current and past activities:

- Kalari Trucking workshop and yard
- Cattle yards and local farm shed
- Possible sawmill location
- Rifle Range location
- Homestead and cottage
- EMR identified site
- The gravel pit
- Any additional sites not identified during this investigation.

The northern section of the project site is situated on a mining lease and the activities listed above are on the whole consistent with those that would be expected to be found on such a lease. It is also expected that these identified areas of potential concern will be able to be managed at the opportune time as the mine develops and excavation of many of these locations occurs. A protocol will be developed to further assess (and manage as required) these areas. These assessments will include site inspections as deemed necessary and possible soil testing where required.

The development of the Heyford pit and associated infrastructure in the Peak Downs Mine (including 10, 11, and 12 North pits) have introduced a number of activities within this southern section with the potential for contamination. In particular, the use of mobile plant over the site, with the potential for unreported fuel spills and leaks, increase the likelihood of potential contamination issues in the area. The following potentially contaminated areas may require further investigation:

- Dragline transformer past and current locations
- Mobile fuel tanks, past and current locations
- Un-rehabilitated exploration drill pads
- Official and unofficial parking areas, waste off-load areas.

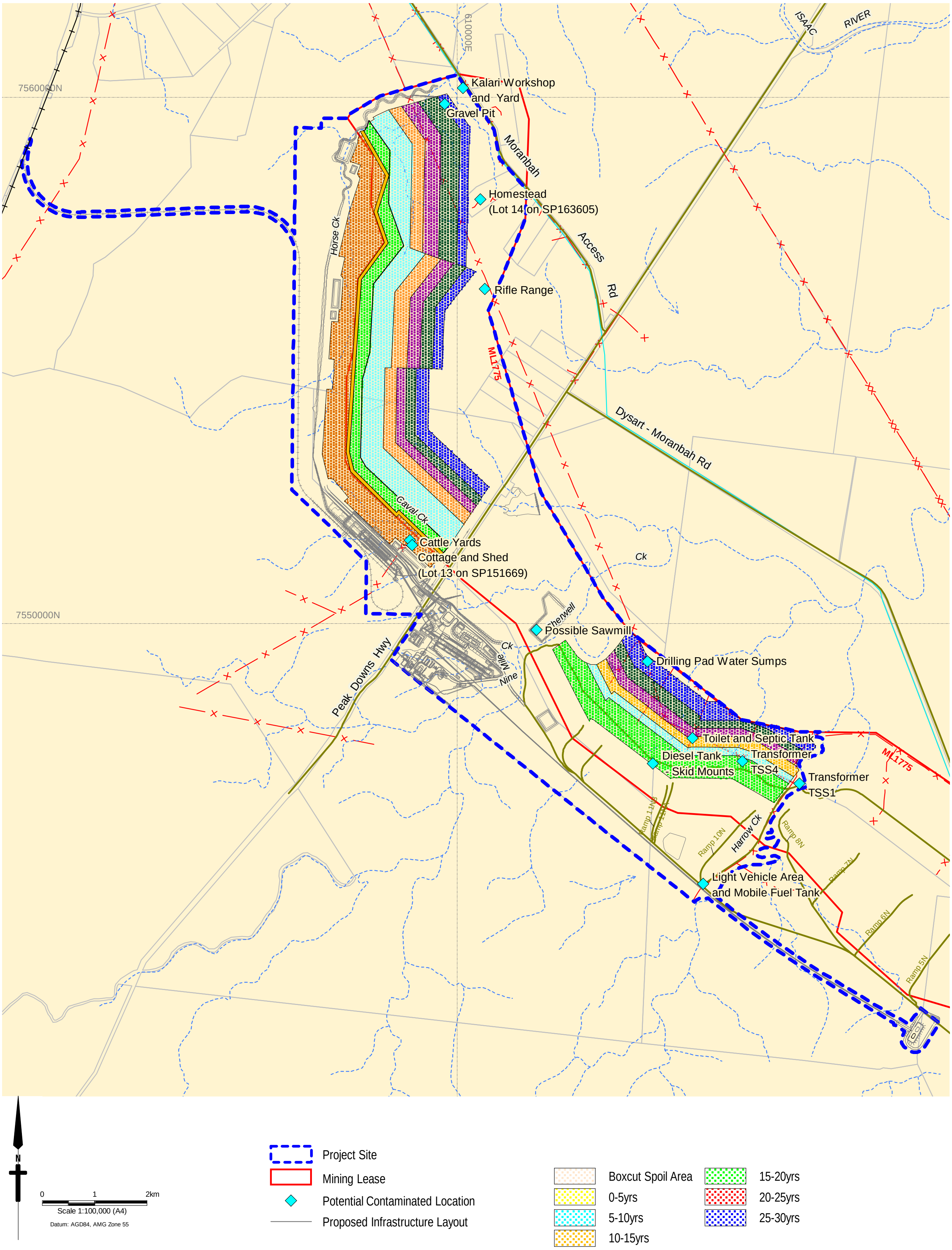
It should be noted that as this southern section of the project site is situated on an active mining lease it is expected that these identified areas of potential concern will be able to be managed at the opportune time as the mine develops and excavation of many of these locations occurs. A protocol will be developed to further assess (and manage as required) these areas. These assessments will include site inspections as deemed necessary and possible soil testing where required.

4.9.4 Mitigation Measures

The principal risks for land contamination from the construction and operation of the project result from hydrocarbon storage and use, waste storage and reject handling, and the potential for acid rock drainage. The management of mine wastes and rejects is discussed in Sections 5.3 and 5.4 (Mineral Waste). Mitigation measures to avoid the contamination of soil and groundwater, as well as the treatment for previously identified potentially contaminated land are given below (refer to Appendix Q section 3.4.4 for contractor and site control strategies and section 4.9.3.13):

- The cattle yard on Lot 13 on SP 151669 will be subjected to a delineation and assessment exercise to quantify any residual contamination issues. This area is the proposed location of the Horse Pit spoil pile. Any contaminated soil present in the site, identified through soil analysis, will be handled through an appropriate management strategy. Soil removed as part of the original remediation order will be located, assessed and if required, disposed of in an appropriate facility.
- Prior to any development of the project site taking place, the mining plan of operations shall be compared to the locations of the identified areas of potential contamination. A protocol will be developed to further assess (and manage as required) these areas in accordance with DERM's Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland. These assessments will include site inspections as deemed necessary and possible soil testing where required.
- The development of Heyford Pit may require the removal or in-situ remediation of potentially contaminated soils from five sites over the life of mine. These include areas that previously had diesel tank skid mounts, transformers, toilets and septic tanks, and drilling pad sumps.
- The development of Horse Pit may require the removal or in-situ remediation of potentially contaminated soils from a former gravel pit site, located on the northern section of the development.
- The development of Horse Creek Diversion, will require the removal or in-situ remediation of potentially contaminated soils from the site currently occupied by the Kalari Workshop and Yard,
- Contaminated material will be either removed and placed in an appropriate area for remediation or remediated in-situ. This material will be kept separate from any material used for topsoil rehabilitation.
- During excavation works, potentially contaminated fill material will be segregated from clean material. The fill material will be analysed prior to removal from site. If contaminated soil is to be removed from site, the DERM regulations for waste transport and disposal will be followed. Any fill material to be imported for use during construction works will be clean. The status of fill should be confirmed prior to delivery on site.

- Stockpiles, workshop areas, chemical stores, fuel tanks and waste disposal/storage areas will be located on hardstand or compacted soil. As runoff from these areas may be contaminated, runoff will be collected using appropriate drainage and water management structures. Potentially contaminated runoff may be remediated or disposed of in an approved manner.
- Relevant Australian Standards (e.g. for the storage and handling of flammable and combustible liquids and dangerous goods) will be complied with, and all chemical and fuel storage areas will be bunded.
- Where possible, hazardous chemicals and materials will be replaced with less harmful alternatives. Material Safety Data Sheets (MSDSs) for chemicals used or brought to site will be kept in a central register on site and at the area of use and be readily available to workers at all times.
- Spills will be cleaned up immediately. In particular, site vehicles will be equipped with appropriate spill kits. For significant chemical or fuel spills, the site emergency response plan will be followed and the appropriate authorities notified as soon as possible.
- Detailed records will be kept of any activities or incidents that have the potential to result in land contamination. Records will be kept in an inventory that contains information on storage locations, personnel training and disposal procedures for appropriate chemicals, fuel and other potential contaminants used on site. Records will be maintained by BMA and reviewed regularly. Regular inspections of containers, bund integrity, valves and storage and handling areas will be carried out.
- All staff will be trained as part of their site induction in appropriate handling, storage and containment practices for chemicals, fuel and other potential contaminants as relevant.



Project Site
Mining Lease
Potential Contaminated Location
Proposed Infrastructure Layout

Boxcut Spoil Area
0-5yrs
5-10yrs
10-15yrs
15-20yrs
20-25yrs
25-30yrs

Source: DCDB Feb2009; Client Supplied Data

Client	Project	Title
BMA BHP Billiton Mitsubishi Alliance / URS	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	**POTENTIAL CONTAMINATION LOCATIONS AFFECTED BY MINING PLAN**

Drawn: VH	Approved: RS	Date: 08-05-2009	Figure: **4.91**	Rev:A
Job No: **4262 6158** .20600	File No: 42626158-g-606.wor			A4