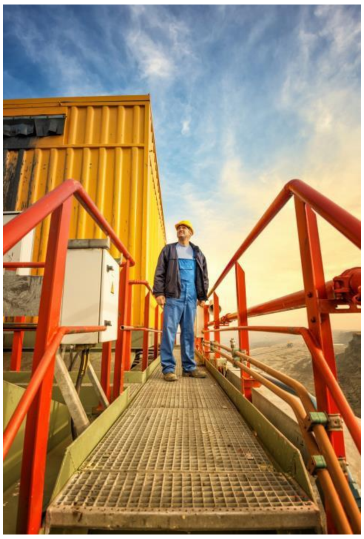

Taroborah Coal Project

Environmental Impact Statement

Section 4.2 – Environmental Values and Management of Impacts – Land

Prepared for:

Shenhuo International Group Pty Ltd

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4.2 LAND

4.2.1 Description of environmental values

4.2.1.1 Topography

The Project site is comprised of undulating alluvial plains and gently undulating rises and low hills, mainly of basaltic and sedimentary parent materials. The site is primarily agricultural land, with elevation ranges from approximately 200 metre (m) Australian Height Datum (AHD) to 280m AHD, with an average elevation of approximately 240m AHD. The most elevated areas of the Project site occur in the north-east, adjacent to Fairburn State Forest, with the lowest elevations encountered around Retreat Creek in the north of the site.

Two main drainage lines run across the Project site, with Retreat Creek crossing the north and Taroborah Creek crossing the south of the Project site (shown in Figure 4.13). Retreat Creek drains towards the east into Theresa Creek, which then feeds into the Nogoa River. This creek is associated with a number of local, ephemeral wetlands.

Taroborah Creek drains the south western section of the Project site and also flows in an easterly direction into the Nogoa River, downstream of Fairburn Dam and Lake Maraboon. Both creeks are part of the Fitzroy Basin Catchment Area.

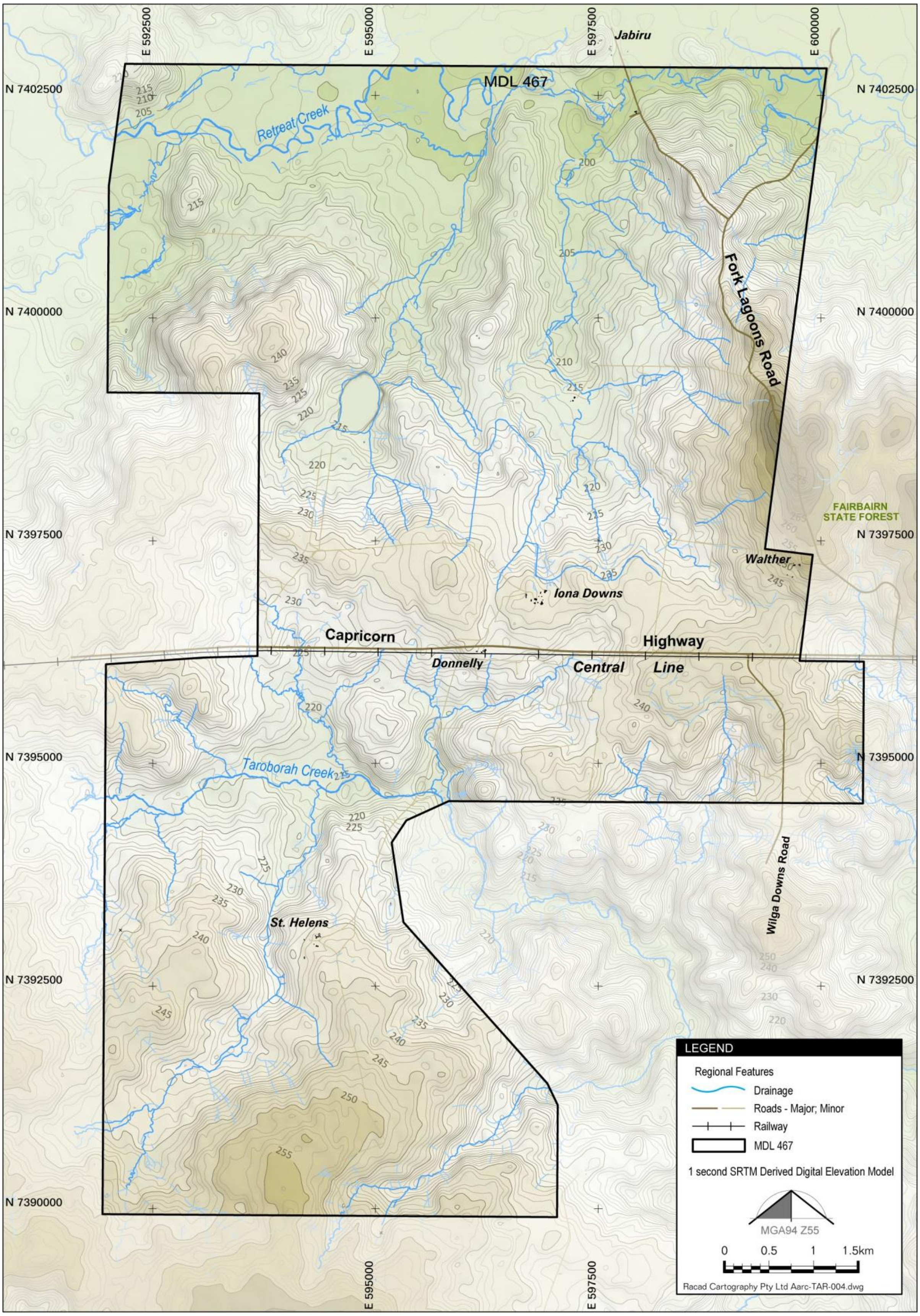


Figure 4.13 Local Topography and Drainage of the Project Site

4.2.1.2 Land Use, Tenure and Native Title

The following land uses occur on the Project site, with agricultural activities predominating:

- Low to medium intensity cattle grazing on native and improved pastures;
- Broadacre dryland cereal cropping;
- Road transport – the Capricorn highway;
- Rail transport – Central West railway system;
- Medium intensity goat grazing;
- Residential properties;
- Coal exploration; and
- Local transport – unsealed roads.

Details of the Lot on Plans which underlie Mineral Development License (MDL) 467 are presented in Table 4.6 (excluding easements); most of these properties are privately-held freehold land areas. A cadastral map of the Project site is presented in Figure 4.14, which details the Lot on Plan numbers that underlie MDL467. Additional discussion of land ownership tenure for the Project site is discussed in Section 3.1.2.1 of the EIS.

The locations of existing homesteads on and adjacent to the Project site are presented in Figure 4.15, which show that four homesteads exist within MDL467 and ten homesteads lie within 10 km of the MDL467 boundary.

The dominant land use both within and surrounding MDL467 is low to medium intensity cattle grazing on native and improved pastures and rainfed broadacre cereal cropping. Other land uses include local and regional road transport on sealed roads, use of unsealed roads for local transport, the railway system, medium intensity goat grazing, residential properties and coal exploration.

The local indigenous representatives are the Western Kangoulu People, although there is currently no Native Title over land within MDL467. In terms of cultural heritage issues, a direct dialogue is maintained with the Western Kangoulu People. Two native title registrations overlie the Project site as follows:

- Bidjara #7 People – Native Title Tribunal ID: QC2012/018; and
- Western Kangoulu People - Native Title Tribunal ID: QC2013/002.

The area within and surrounding the Project site is zoned as Rural under the *Central Highlands Regional Council Planning Scheme*, which was originally detailed in the Shire of Emerald Town Planning Scheme, August 2006 (Central Highlands Regional Council, 2012). Fairburn State Forest which lies to the east of MDL467 is zoned Open Space and represents the nearest alternative council zoned area. Refer to Figure 4.16 for details of this land zoning.

Table 4.6 Real Property Descriptions Underlying MDL467

Real Property Description	Tenure	Nature of land
Lot 76 on Plan PT372	Freehold	Private agricultural
Lot 12 on Plan RP881318	Freehold	Private agricultural
Lot 13 on Plan RP881318	Freehold	Private agricultural
Lot 14 on Plan RP881318	Freehold	Private agricultural
Lot 15 on Plan PLA4029	Freehold	Private agricultural
Lot 126 on Plan PT372	Freehold	Private agricultural
Lot 21 on Plan DSN29	Freehold	Private agricultural
Lot 201 on Plan DN40176	Freehold	Private agricultural
Lot 23 on Plan DN40176	Freehold	Private agricultural
Lot 24 on Plan DN40201	Freehold	Private agricultural
Lot 20 on Plan DSN377	Freehold	Private agricultural
Lot 124 on Plan PT367	Leasehold	Private agricultural
Lot 203 on Plan DSN377	Freehold	Private agricultural
Lot 4 on Plan PT352	Leasehold	Private agricultural
Lot 12 on Plan PT352	Leasehold	Private agricultural
Lot 81 on Plan SP122079	State Land	QLD Rail land, Railway Corridor
Lot 82 on Plan SP122079	State Land	QLD Rail land, Railway Corridor
Lot 101 on Plan SP122080	State Land	QLD Rail land, Railway Corridor
Lot 5 on Plan PT132	State Land	QLD Rail land, Capricorn Hwy

It should be noted that MDL467 overlies portions of both the Capricorn Highway and the Central West rail line. Project impacts upon this infrastructure may arise in terms of an anticipated increased usage and required modifications to both the highway and railway line.

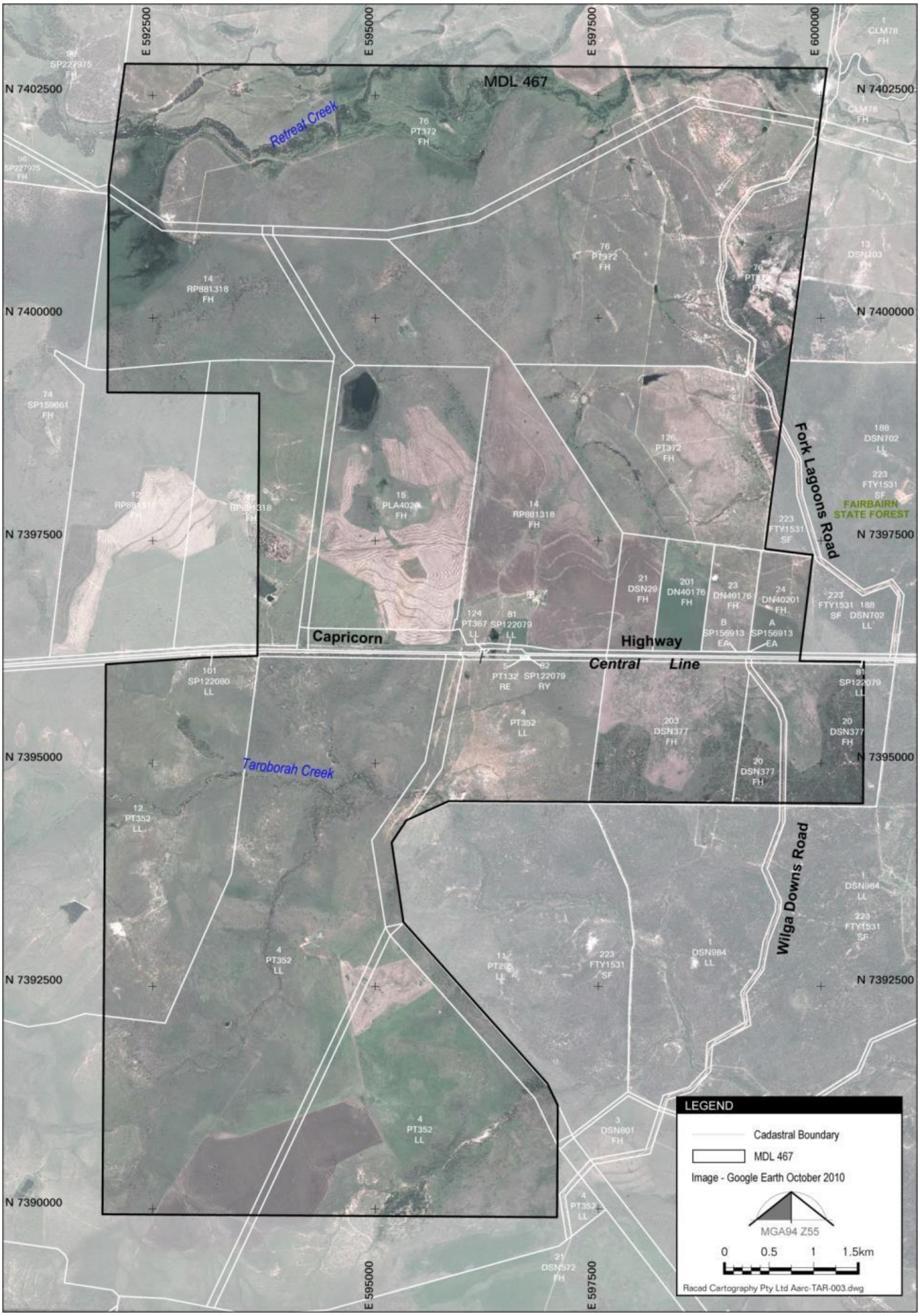


Figure 4.14 Local Land Ownership Tenure (Cadastre)

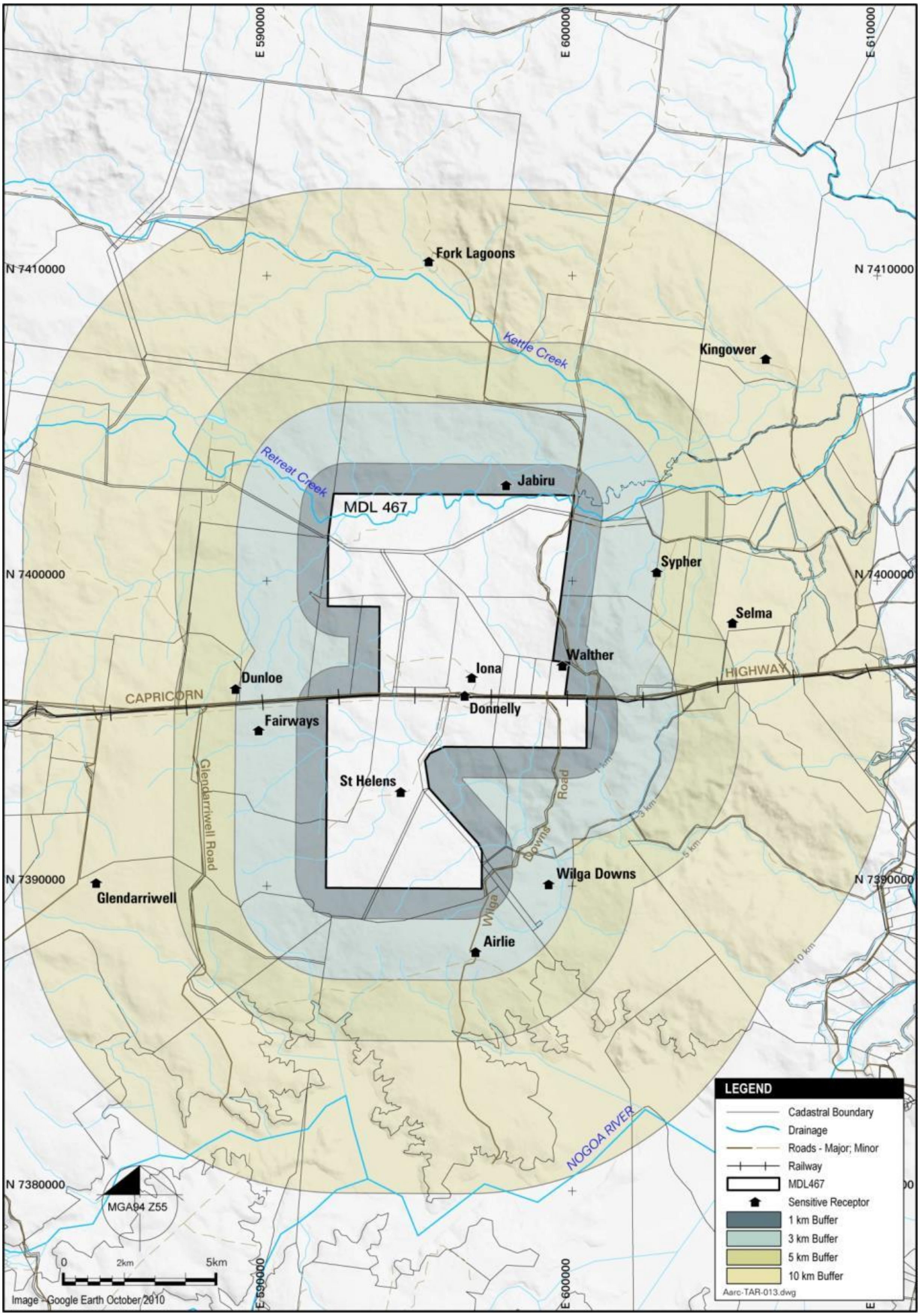
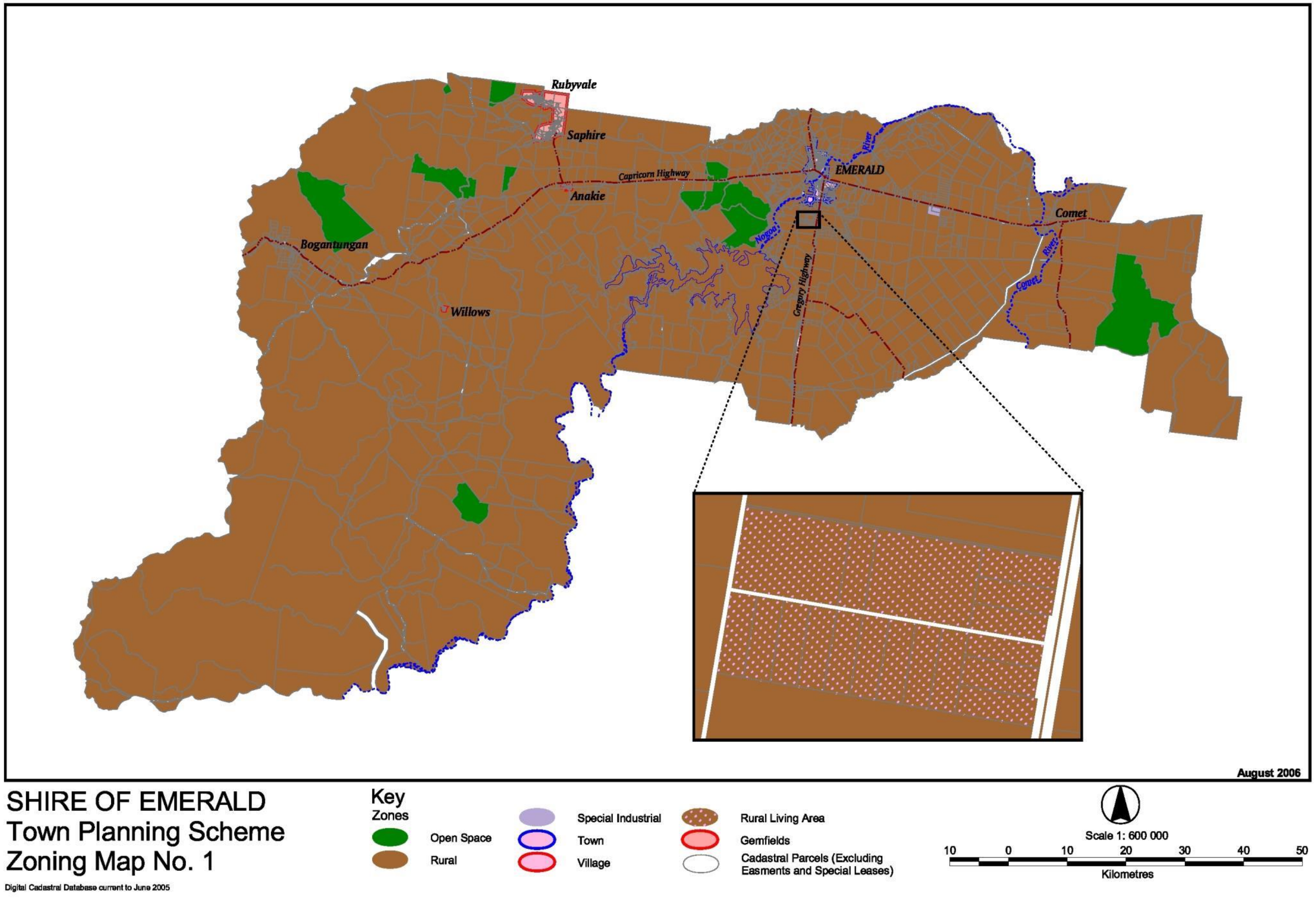


Figure 4.15 Location of Existing Homesteads on and Adjacent to the Project site



Source: CHRC 2013

Figure 4.16 CHRC Land Zoning Map

4.2.1.3 Geology and Geomorphology

Regional Geology

The Project site is located in the Queensland Bowen Basin, which forms part of a connected group of Permian coal basins in eastern Australia. Figure 4.17 illustrates the main structural elements of the Bowen Basin regional geology.

Throughout the Triassic period, the eastern sector of the Bowen Basin was severely deformed, with mineable coals preserved on NNW-SSE trending platforms or shelves separated by sedimentary troughs (protected tectonic platforms or syncline margins). In contrast, during most of the Permian period, this area was covered in shallow water, where terrestrial sedimentation and coals accumulated by the late Permian.

The regional geology of the area is predominantly characterised by Tertiary Basalt and younger Tertiary and Quaternary Alluvium deposited along creeks and rivers within the region. Permian sandstones, which host the coal bearing strata, underlie these more recent geological formations.

Local Geology

In terms of local geology, the Project site is located on the western extent of the Denison Trough. This area is covered by a considerable thickness of Lower Permian sediments that are unconformably overlain by Tertiary sediments.

The following geological strata have been identified within the Project site (refer to Figure 4.18 for details of the local geology):

- Qa: Quaternary alluvium – mainly occurs in the north of the Project site;
- Pb: Upper Permian quartz sandstone, feldspathic mudstone and coal - located mainly in the east of the Project site;
- Tb: Tertiary olivine basalt, trachy basalt minor agglomerate and tuff - mainly occurs in the west and south of the Project site; and
- Cz: undifferentiated soil, sand and gravel – located in the west of the Project site.

Stratigraphy

Taroborah lies within the southwest section of the Bowen Basin and apart from the Rowan FM and Reids Dome Beds, the stratigraphic units underlying the Project site are unique to the Bowen Basin. For a summary of the local geological stratigraphy refer to Table 4.7.

Permian coal seams are encountered at shallow depths in the southern area of the lease and deepen towards the north. These seams are composed of a sandstone/coal sequence, with the regionally extensive Aldebaran Sandstones directly overlying the coal seams.

Two successions of coal measures have been found to occur among marine beds, unconformably overlying the Retreat Granite and Devonian-Carboniferous sediments. Of the five coal seams which constitute these measures, the top 2 seams ("A" and "B" seam) are the most developed/thickest and are probably equivalent to the Cetus and Cygnus seams in the Freitag Formation. This formation sub-crops near Tieri to the northeast of Emerald, and contains thin and often split paralic coals. Exploration experience in the Denison Trough indicates that coal seams are often locally developed in this unit and consistent, widespread seams are not present.

Through the central and eastern sectors of the Project site, the coal seams dip gently to the north away from the subcrop. An anticlinal fold feature (which may exhibit some minor faulting) has also been recorded in the central west area of the proposed opencut mine. The local faulting and B seam floor structure that underlie the Project site are presented in Figure 4.19.

Structure

A basic assessment of geological structure has been undertaken using seam dips. The location of the major fault forming the eastern boundary of the resource area is based on widespread (0.5 km – 1 km) borehole spacing and represents a preliminary assessment, while the location of the major fault forming the western boundary has been more accurately delineated through infill drilling .

Significant geological structure (>10m faulting) is considered unlikely between these faults due to the spacing of exploration boreholes and the modelled seam elevation contours. However, minor geological structure is possible between faults.

Across the eastern and central portions of the mining area, the seams gently dip northwards away from the subcrop. A considerable 'kick' in the RL contours is evident in the central-west portion of the resource, likely representing a fold feature with a north-south running axis (refer to Figure 4.19). An apparent shift north of the B seam lines of oxidation (LOX) further indicates the presence of an anticlinal roll feature.

Depth of Cover

The modelled depth of cover for the A seam has been estimated to be 30 to 40m at the subcrop to a maximum of 197m in the north east of the Project site.

Overburden thickness (cover depth) to the roof of the B seam was modelled to be 40-50m at the subcrop to the south and reaching a maximum of 206m in the northeast, as indicated in Figure 4.20. The cover depth is relatively lower in the central section of the mining area as a result of the anticline in the central-west area of the resource and the rising topography to the east and west.

Seam Thickness

Coal seams A and B are separated by a 5-14m thick inter-burden of sandstone/siltstone inter-bedded with a carbonaceous mudstone unit. The average coal thickness of the A seam (which has been determined from current resource drilling) is 1.19m (minimum thickness = 0.1m in the north-west and maximum thickness = 1.90m in the south west), as indicated in Figure 4.21.

The total B seam thickness is relatively consistent across its extent, with a total thickness of approximately 3 – 3.5m (refer to Figure 4.22). Eastwards of the opencut resource area, total B seam thickness is slightly lower, ranging from 2.7 – 3m. To the north of the underground resource area, total B Seam thickness reduces to 2.3 – 2.5m. This is attributable to the bottom 0.5m of the seam rapidly splitting off into the floor.

Rock Strength

Samples of B seam roof material underwent uniaxial compressive strength (UCS) testing. Testing revealed UCS values of 15 – 25 megapascals (MPa), classed as moderate strength under the Bowen Basin guidelines and weak rock under the International Society of Rock Mechanics guidelines.

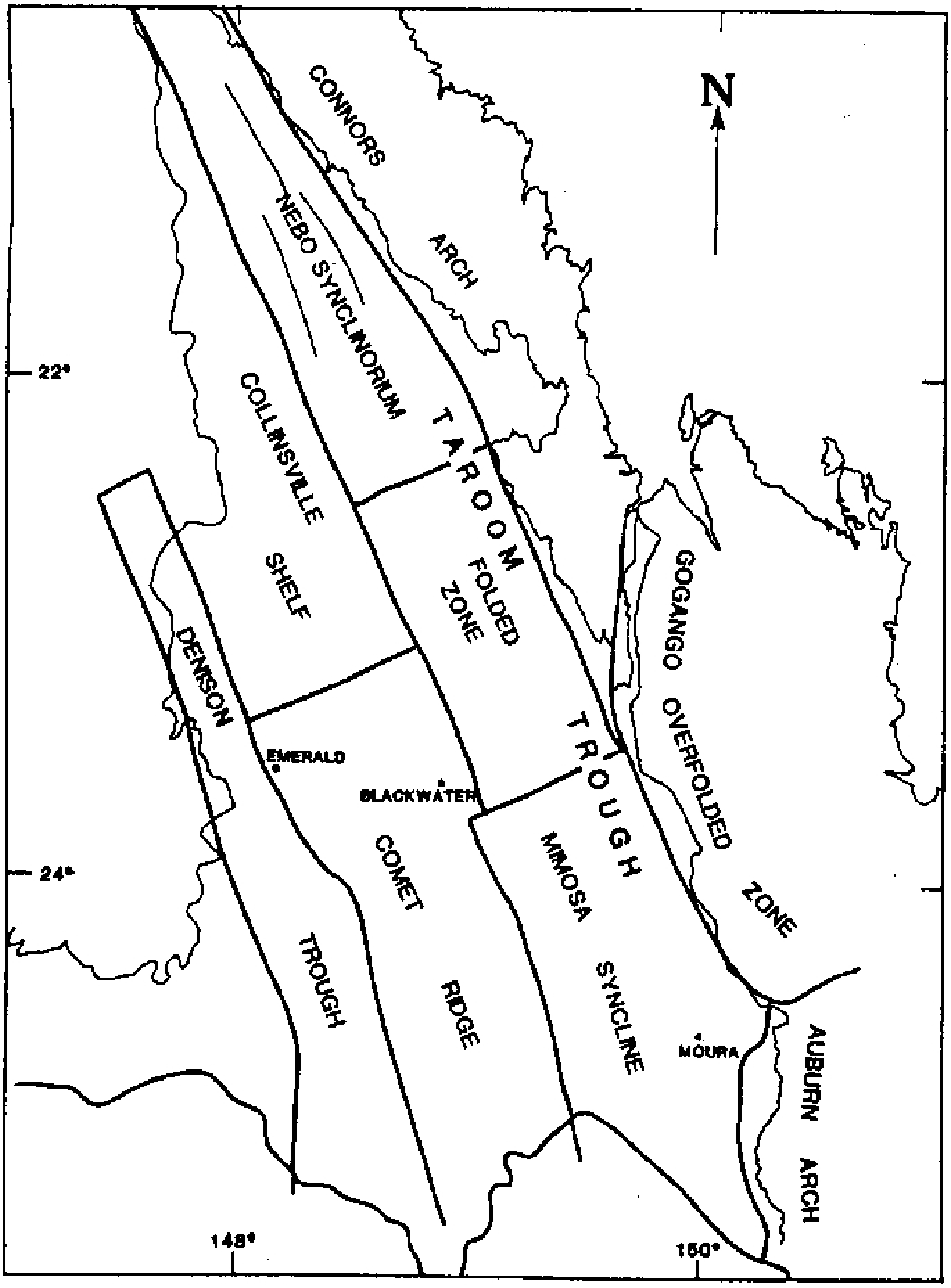


Figure 4.17 Main Structural Elements of the Bowen Basin

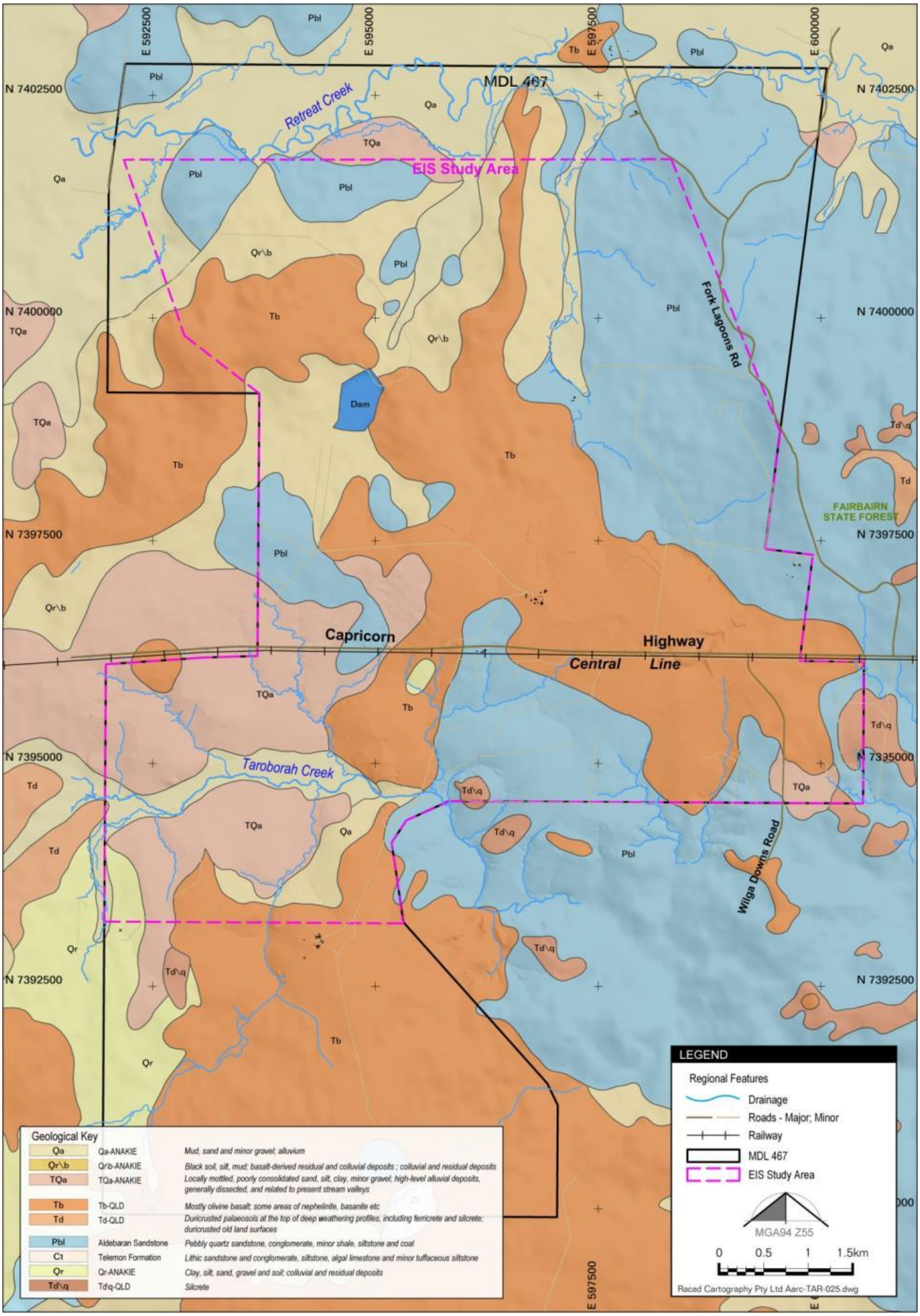


Figure 4.18 Local Geology

Table 4.7 General Stratigraphic Units of the Bowen Basin by Area

Tectonics		Southeast	Southwest	Central (West)	Central (East)	Northern	Coal Group	Facies
Compression with local sag	Foreland Basin Phase	Rowan FM	Rowan FM	Rowan FM		Rowan FM	IV	Terrestrial flood plain & flood basin
sag		Rangal CM	Bandanna FM	Rangal CM		Rangal CM		Coal measures gradually extend from the north to eventually cover all the basin
		Gyranda FM	Black Alley Sb.	Burngrove FM Fairhill FM		Fort Cooper Coal Measures	IIIa	
		Flat Top FM	Peawaddy FM	McMillam FM		Moranbah CM	III	
			Catherine FM / Crocker S/S	German CK FM				
Compression		Barfield	Ingelara FM	Maria FM		Blenheim FM		Widespread transgression with no non marine known
			Freitag FM	West	East			
	Transition	Oxtrack FM	Upper		Back Ck. Group	Gebbie	I	Shallow & marginal marine with local coal measures
		Brae FM	Aldebaran FM	Blair Athol CM		Collinsville CM		
		Pindari FM	Lower			Formation		
sag	Extension Phase		Cattle Ck. FM	.		Tiverton FM		Marine transgression with some coals
			Upper Reids Dome Beds					
Extension rifts		Camboon Volcanics	Reids Dome Beds	Upper Reids Dome Cong	Camilla Beds	Lizzie Ck. Volcanics		Coals in west volcanics (mainly terrestrial) in east

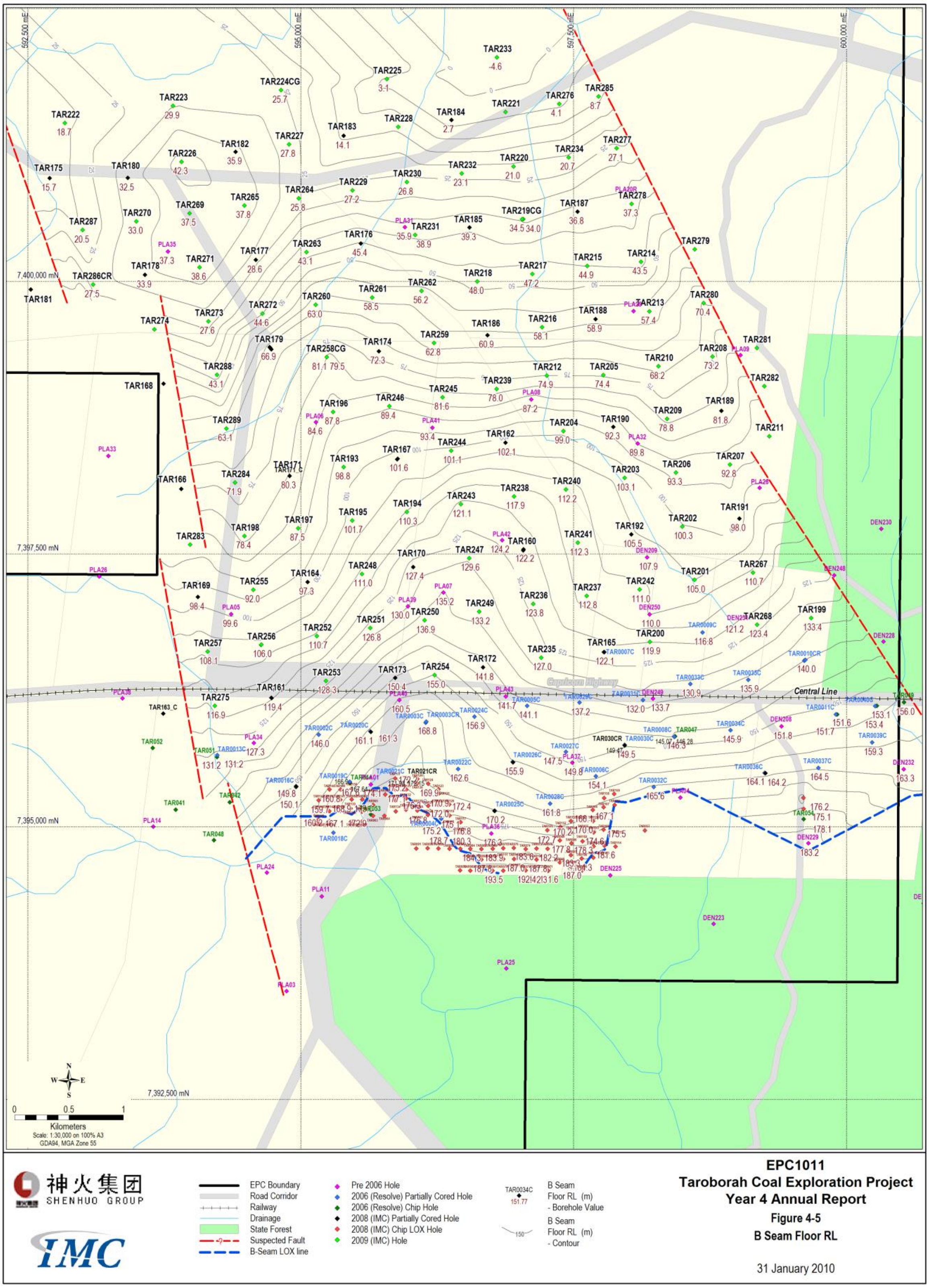


Figure 4.19 Local Faulting and B Seam Structure Contours

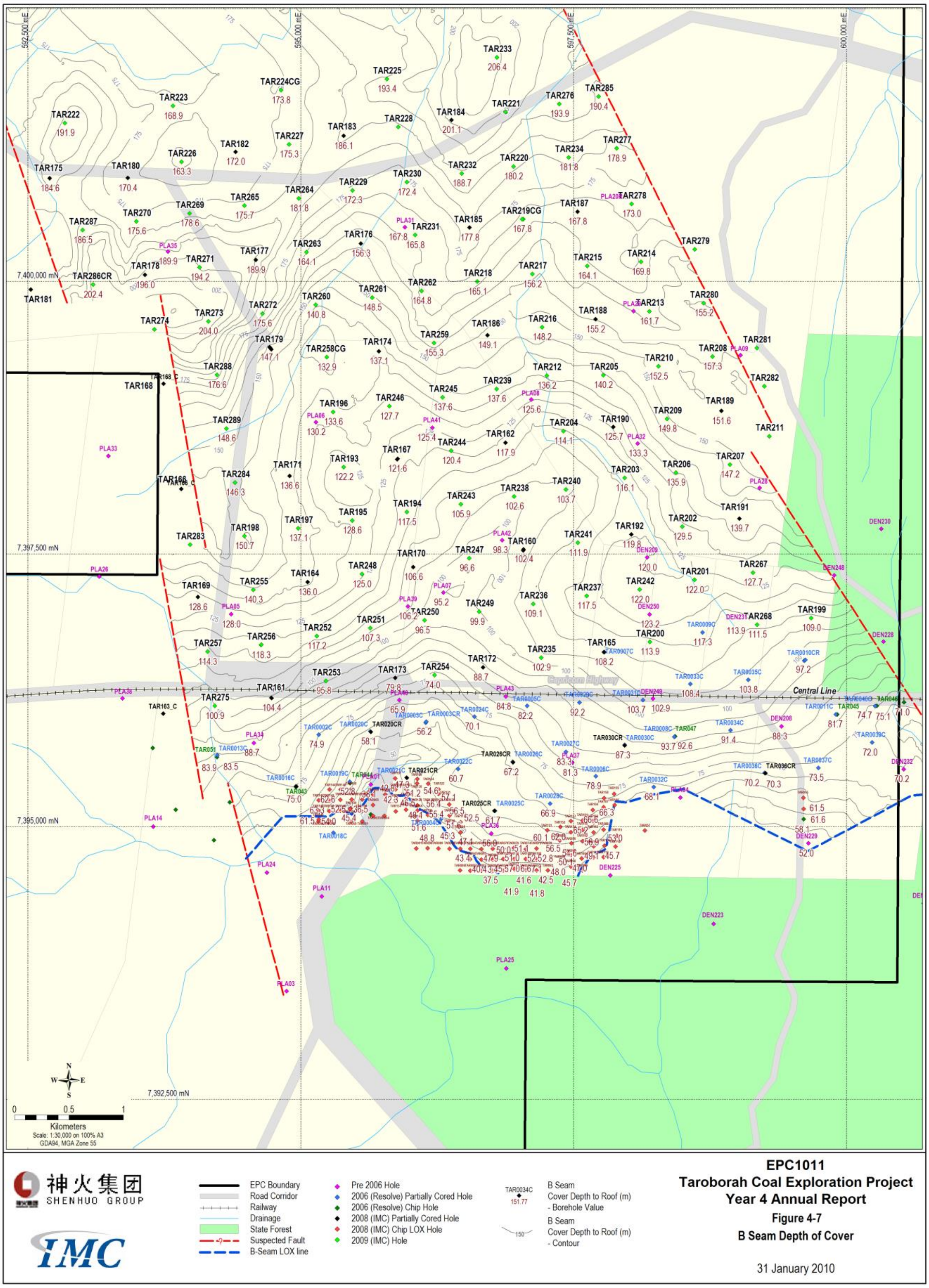


Figure 4.20 B Seam Depth of Cover Contours

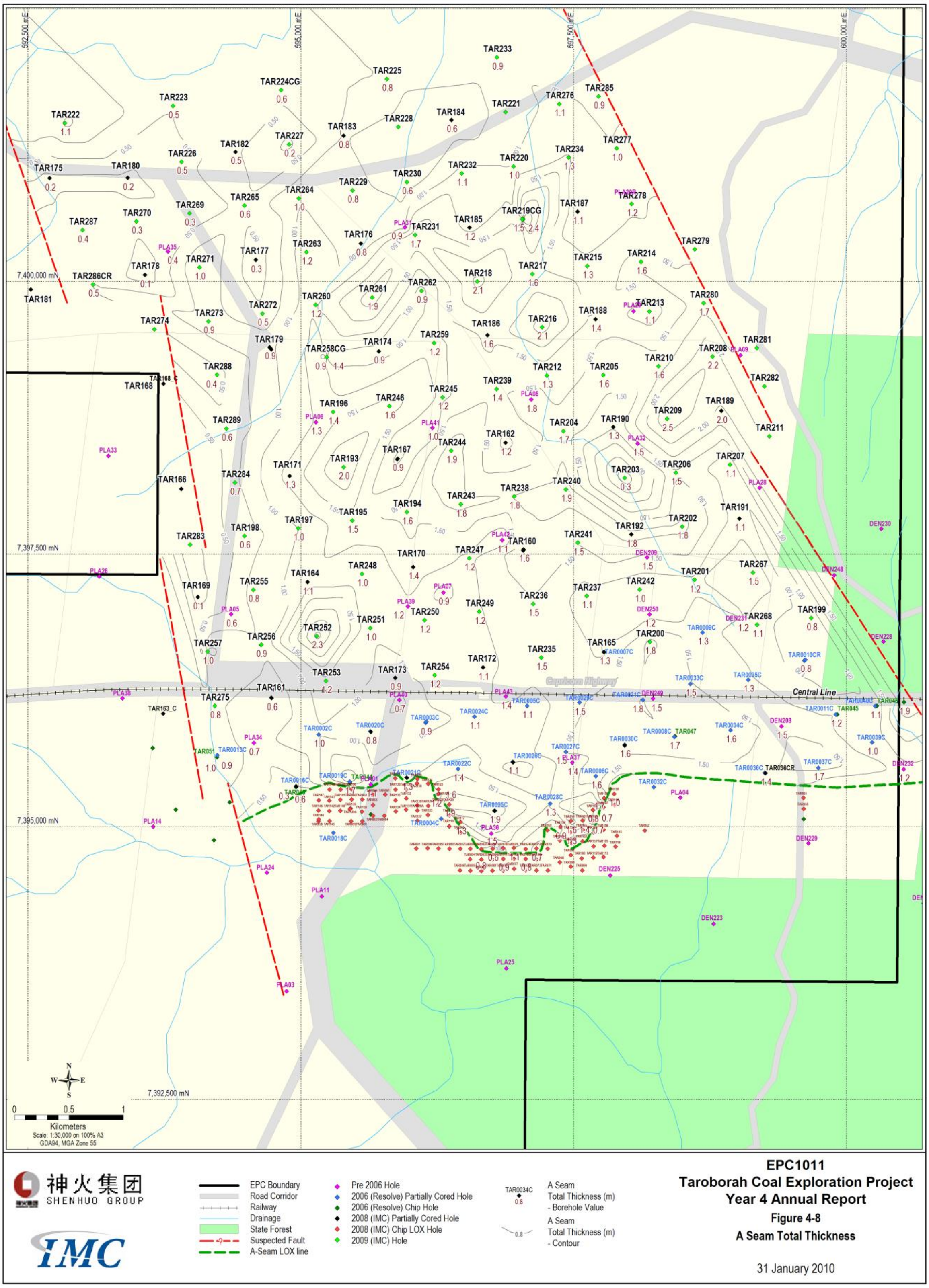


Figure 4.21 A Seam Thickness Contours

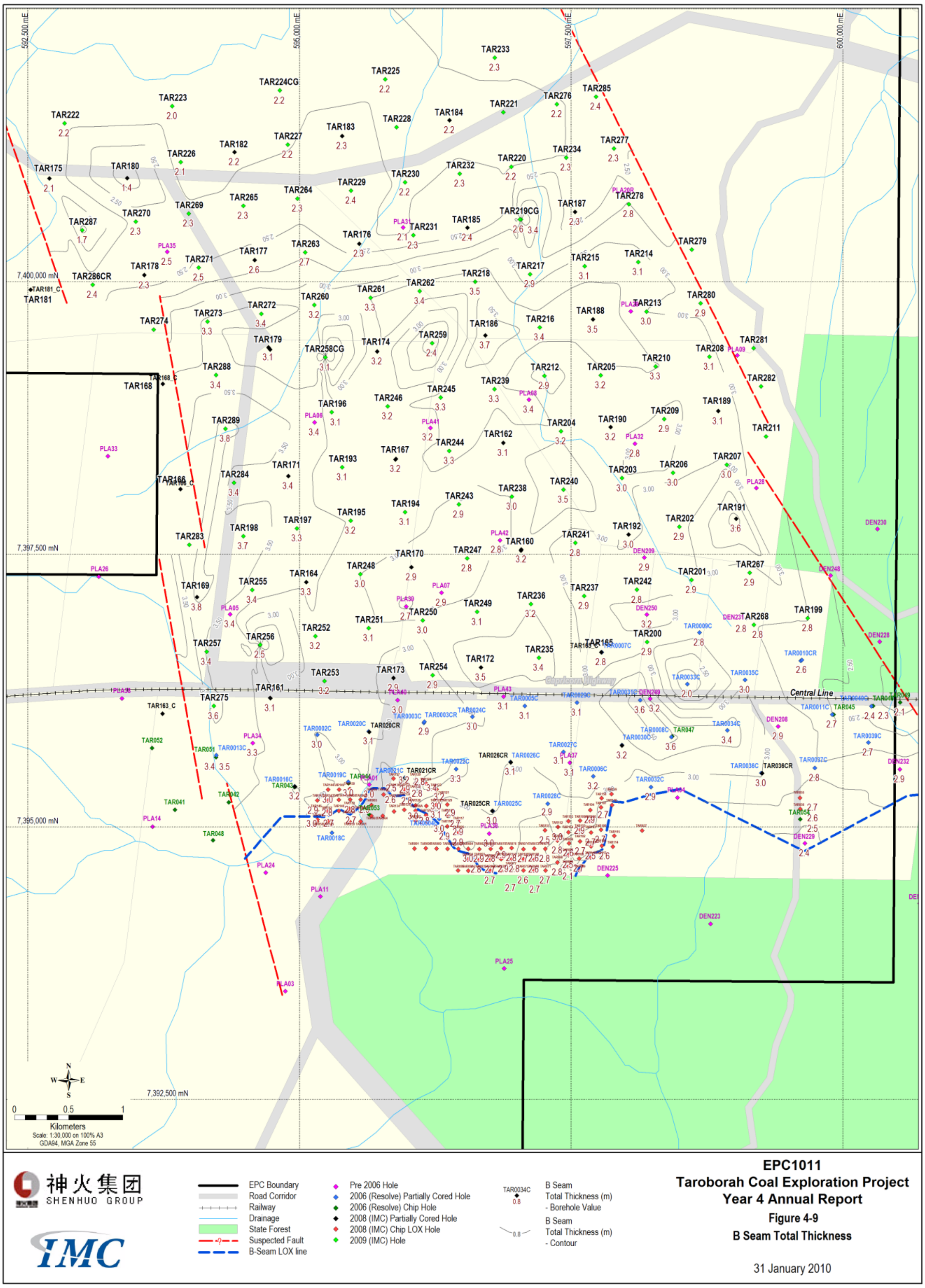


Figure 4.22 B Seam Thickness Contours

Overburden Characteristics

A summary of the overburden and inter-burden material associated with the A and B coal seams is provided in cross sectional form in Figure 4.23. This represents the typical stratigraphy occurring in the opencut area. As the depth to the seam increases to the north, the thickness of the various units remain fairly consistent except the fine-grained sandstone unit, which thickens and becomes interspersed with siltstone layers to make up the increasing overburden depth.

In general, the unweathered strata units overlying the A and B seams are fairly massive and vertically consistent, though not overly strong, with typical UCS values of 15-25Mpa. The chemical properties of these overburden materials are discussed in Section 4.4.

Fossilised Material

No evidence of significant fossil finds have been encountered during the resource drilling programmes that have been conducted on the Project site. The probability of encountering fossils within the Project area is considered to be low.

4.2.1.4 Coal Resources

The estimated total coal resources that lie within Exploration Permit for Coal (EPC) 1011 are presented in Table 4.8, whilst the estimated, mineable ROM and marketable product coal resources for the Project site derived from the pre-feasibility assessment for Taroborah are summarised in Table 4.9. Resource estimates were developed to "Measured Status" for the opencut area and the majority of the underground area, under the direction of a Competent Person, in accordance with the *Australian Code for Reporting of Mineral and Ore Reserves* (the JORC Code). The resource areas for both the A and B seams are illustrated in Figure 4.24 and Figure 4.25, respectively, while the currently planned extent of mining extraction is illustrated in Figure 4.26. Except for a small portion in the southeast underlying the Fairburn State Forest, these resource numbers are applicable to MDL467. The planned extent of mining is presented in Figure 4.26.

Table 4.8 Total Coal Resources as at 31 January 2010

Location	Measured (Mt)	Indicated (Mt)	Inferred (Mt)	Total (Mt)
EPC1011 - opencut and underground mines (500m drilling centres)	150.5	37.3	14.3	202.1

Table 4.9 Estimated Tonnages of Mineable ROM and Marketable Product Coal

Material	Opencut (Mt)	Underground (Mt)	Total (Mt)
ROM coal	11.11	68.65	79.76
Product coal	9.63	68.14	77.77

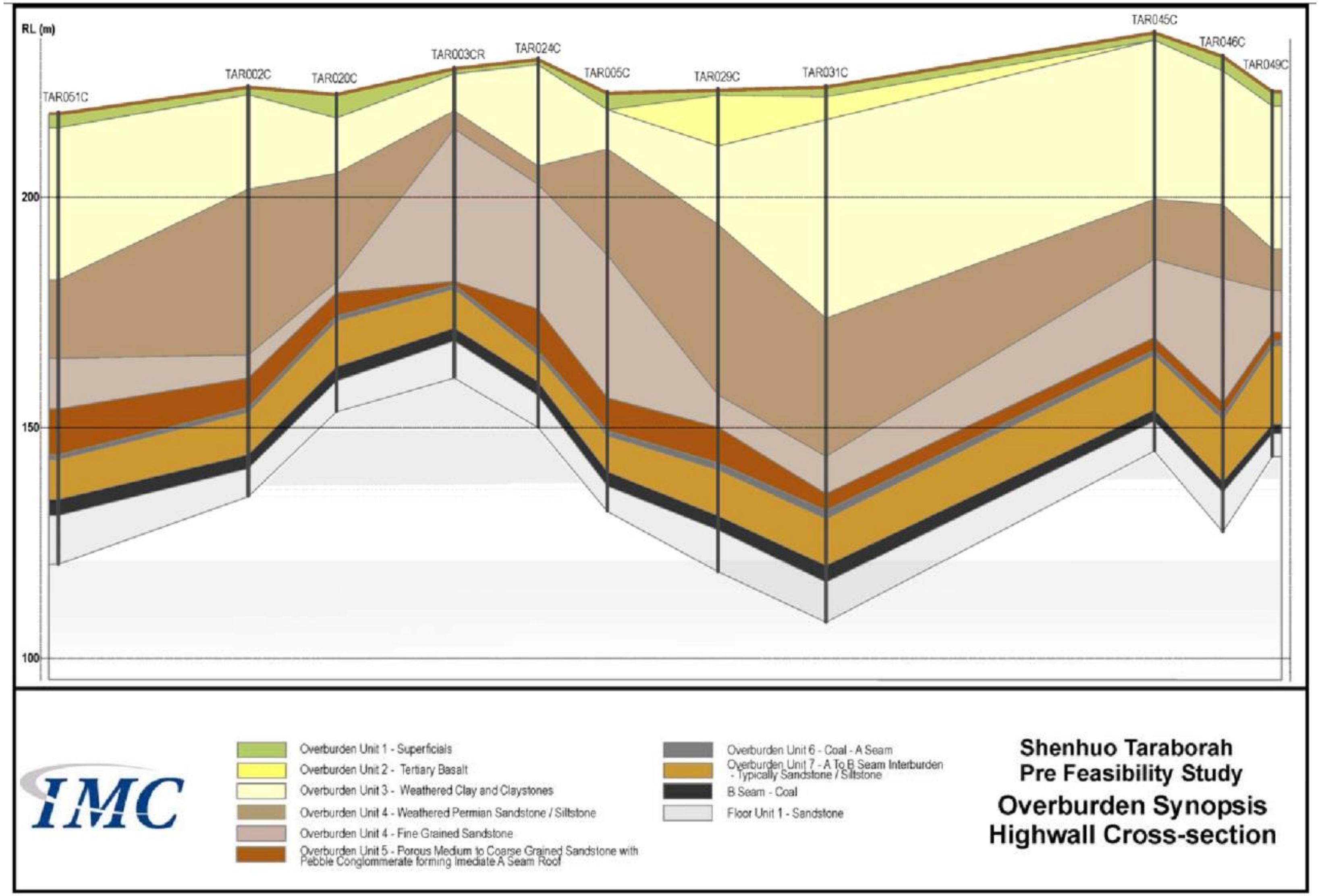


Figure 4.23 Cross Section of Overburden and Interburden Units

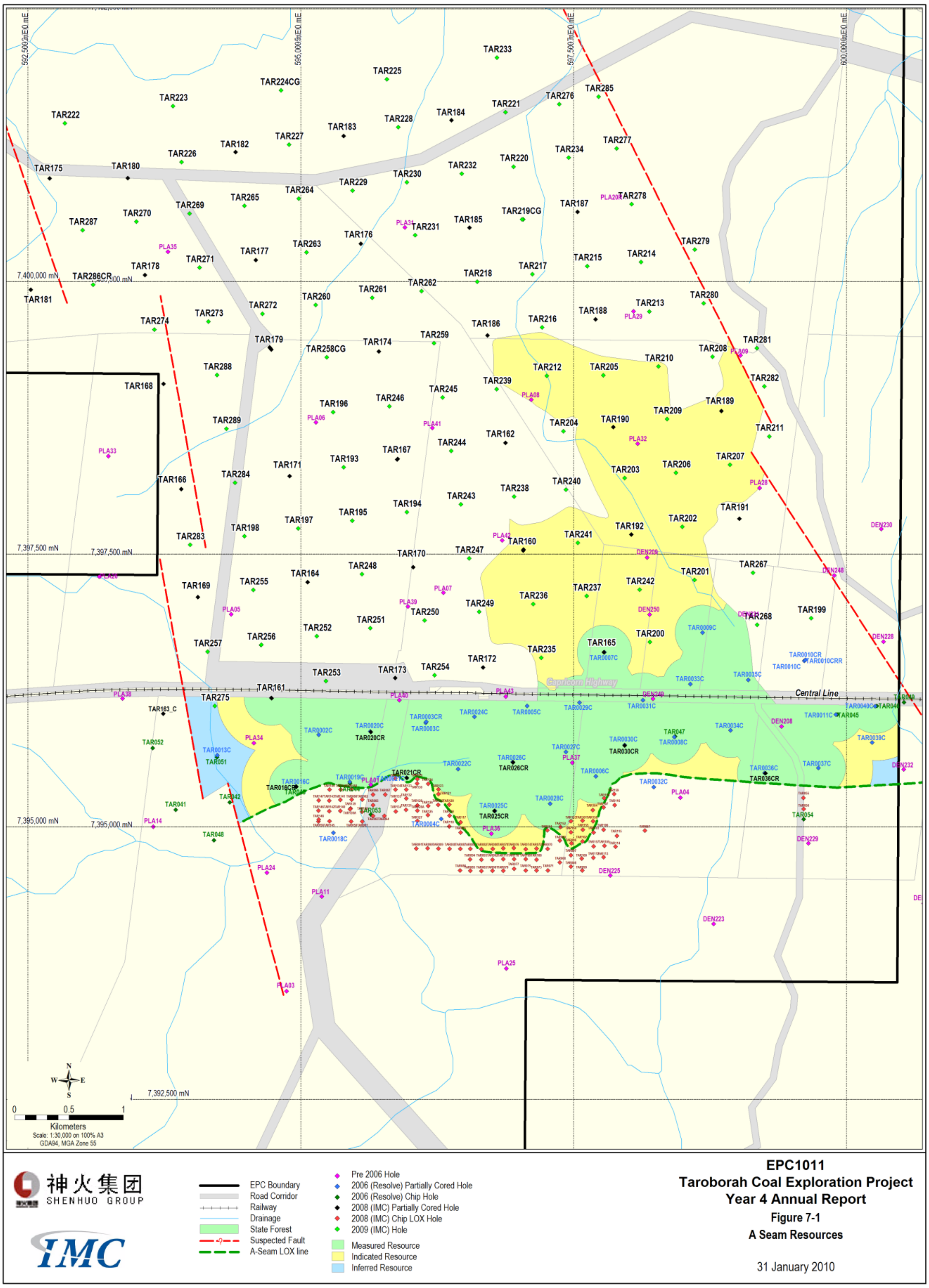


Figure 4.24 A Seam Resource Area

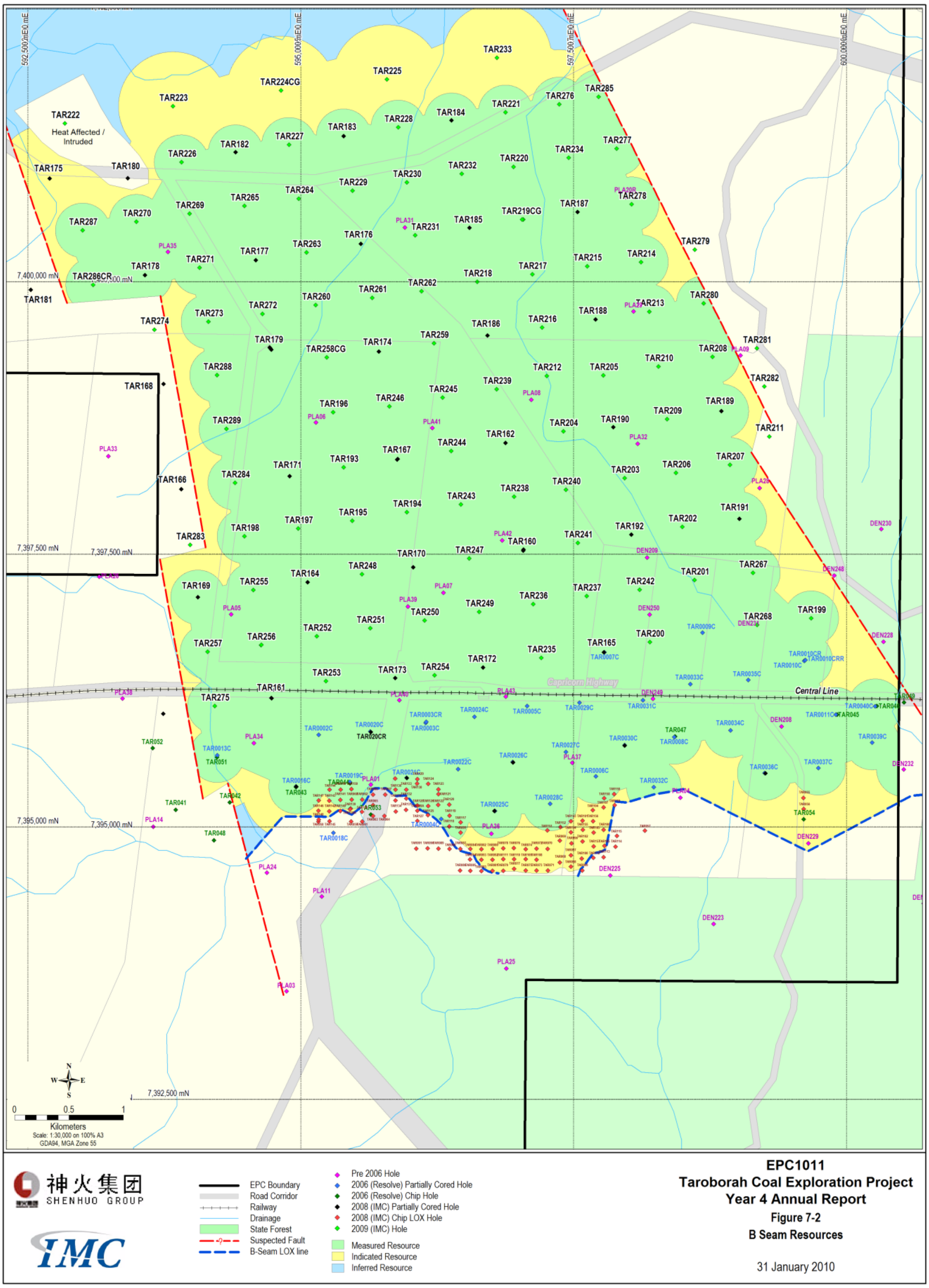


Figure 4.25 B Seam Resource Area

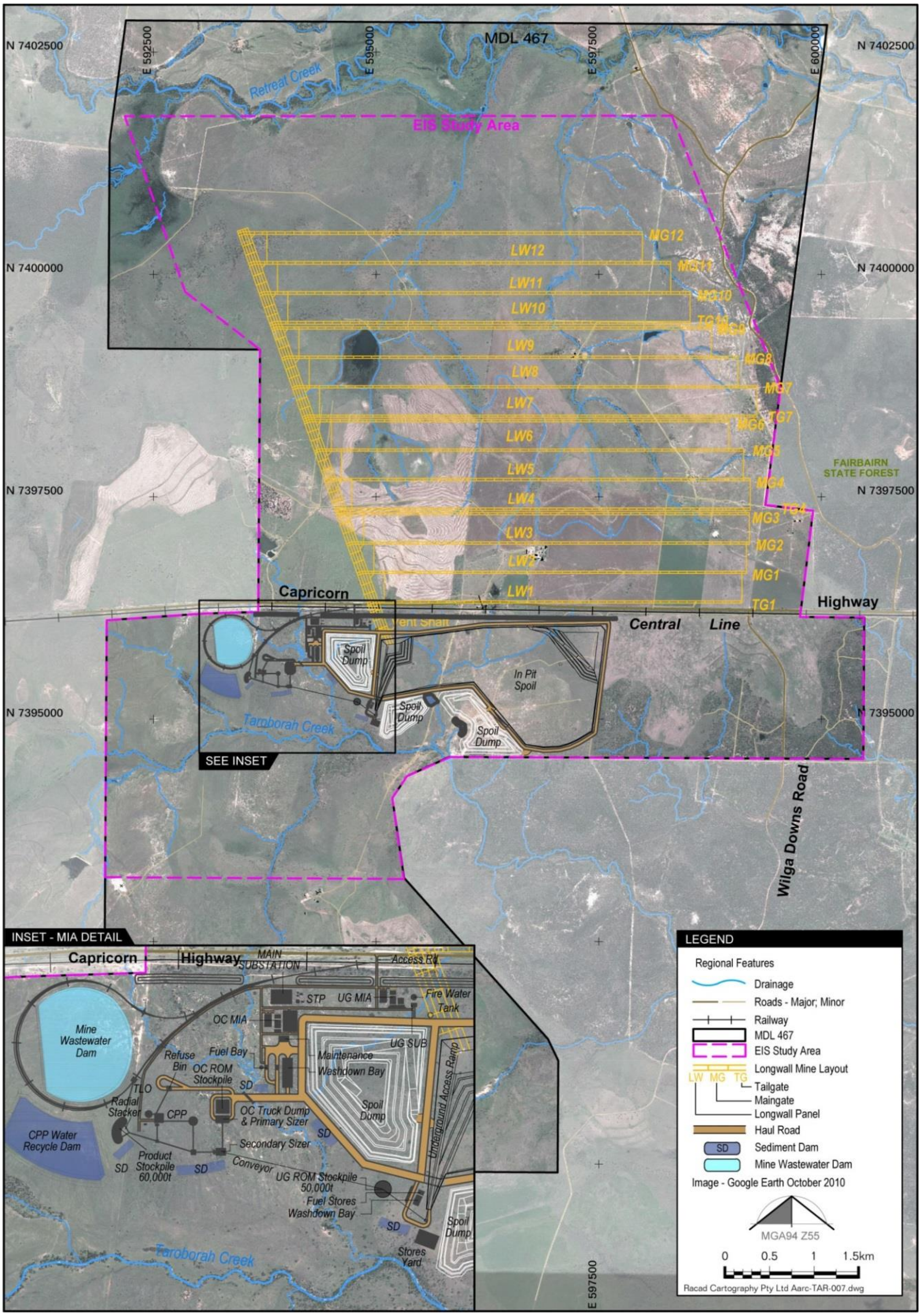


Figure 4.26 Planned Extent of Mining

4.2.1.5 Soils

A soil and land suitability assessment was conducted for the Project during 2011 and 2012 and the results of this assessment presented in Appendix 7. The following sections summarise the findings of the soil and land suitability assessment.

Soil Management Units

Field surveys were conducted in order to attain a visual assessment of soils and to describe their morphological characteristics. Soil samples were taken at representative sites across the study area and sent to a laboratory for assessment of their physiochemical properties.

Soil sampling was conducted at a predetermined intensity across the Project site, utilising a grid of 62 soil sampling locations in the form of either a soil core or hand augured hole (refer to Figure 4.27 for soil sampling locations). Soils were sampled down to a maximum depth of 1.5m below ground level where possible, and described and sampled. Secondary visual assessments were conducted continuously across the study area, while traversing the landscape. Check holes were judiciously used to confirm major soil types and determine soil boundaries.

Soil sampling strategies and survey plans were developed in accordance with the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques* (herein referred to as the *Technical Guidelines*) (DME 1995) and the *Guidelines for Surveying Soil and Land Resources* (Mckenzie *et al* 2008) (herein referred to as the *Blue Book*).

The survey effort involved the undertaking of detailed profile descriptions with profiles sampled at 62 locations within the 5195 ha study area. This intensity of test pits is within the recommended range in accordance with the *Blue Book* for mapping at a high intensity of 1:25 000. Additionally, mapping observations were taken in the field at regular intervals by the soil scientist undertaking the primary sampling program while traversing from sample site to sample site. Although not always formally annotated, these observations served to confirm mapping boundaries, soil-type distributions and areas subject to cultivation. These observations contributed to completing the 1:25 000 scale requirements. This results in an approximate area of 25 ha or less per observation.

Eight soil management units (SMU) were identified within the Taroborah MDL developed from field and laboratory data. The SMUs were classified using similar nomenclature used to describe soils in the region by a previous soil report undertaken by the Department of Primary Industries in 1993 called *"Understanding and Managing Soils in the Central Highlands".* The SMUs classified in this soil assessment include the Orion/Jimbaroo, Adelong, Adelong/College, Rolleston/Glengallan, College/Lascelles, Glengallan, Glen Idol and Jimbaroo soil types. Table 4.10 provides a description of the dominant soil types that were identified in each management unit. Where more than one soil type makes up a particular SMU this unit is considered to be a soil association. These units are considered to be too complex to be described by one soil type. An association is made up of a dominant soil type and a sub-dominant soil type.

An additional, but minor, SMU has also been mapped for the Project site. However, for the purposes of the land suitability study this SMU has been absorbed into a larger over-arching SMU of similar character. This SMU is called the Picardy and is essentially a red variant of the Orion/Jimbaroo SMU.

The area covered by each SMU within the Project site is presented in Table 4.11 together with approximate Project disturbance areas for both the opencut and underground mines. The distribution

of soil management units on the Project site is shown in Figure 4.28.

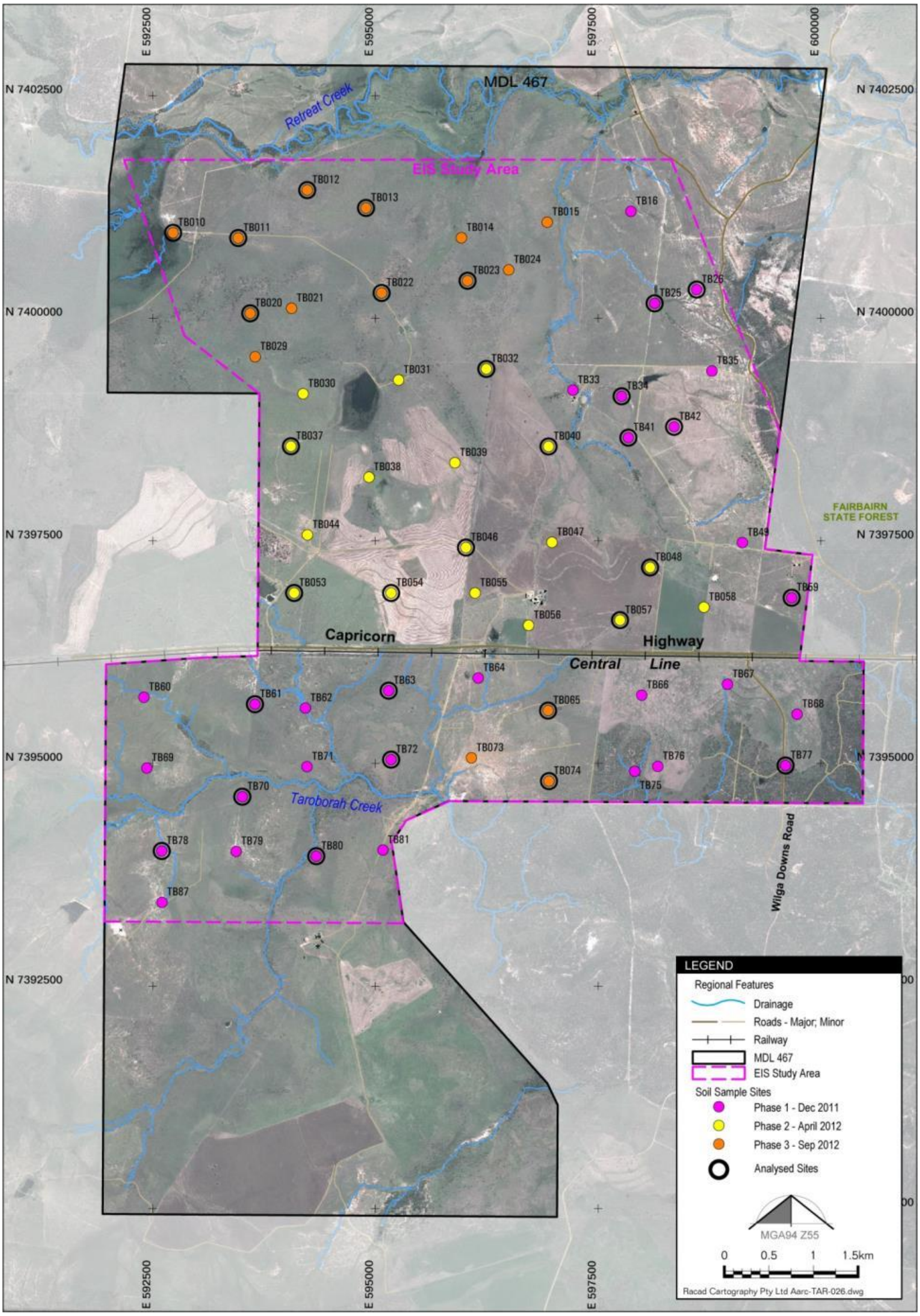


Figure 4.27 Soil Sampling Locations on the Project Site

Table 4.10 Summary of Soil Management Units Identified on the Project Site

Soil Management Unit	Australian Soil Classification	Brief Description
Orion/Jimbaroo	Black/Brown Vertosols	The Orion/Jimbaroo SMU is an association of deep and shallow black or brown, self-mulching and cracking medium to heavy clay soils. These soils possess strong lenticular structure and may have some carbonate nodules at depth. The heavy clay nature of the soil makes it difficult to work when wet. Effective rooting depth and hence, Plant Available Water Content (PAWC) is governed by the depth of soil to parent material. Soils formed in areas of higher relief and steeper slopes are generally shallower than their counterparts on flatter terrain. These soils are imperfectly drained with a low to moderate soil permeability. These soils are used extensively for agriculture.
Adelong	Brown/Grey Sodosols, Vertosols	Grey/brown or black uniform heavy cracking clay surface soil grading into a greyish/yellow brown colour at depth. Soil depth is typically greater than 150 centimetres (cm). These soils have a self-mulching to a weak crusting surface and are difficult to work when wet and are very hard when dry. If cultivated at the right moisture content these soils can have favourable soil physical characteristics.
Adelong/College	Dark, Grey or Brown Vertosols or Dermosols	The Adelong/College SMU is comprised of two soil types differentiated on the basis of soil colour and the condition of the surface soil material. The College soil type has a potentially crusting and sealing surface which can affect seedling establishment and cultivation. These soils are difficult to work when wet. The College soils have restricted permeability and poor drainage with restricted rooting depths as a result of high sodium levels. Both soils have heavy clay textures and high cation exchange capacities due to the presence of 2:1 lattice clays such as montmorillonite. Both soils have strong blocky or lenticular structure.

Soil Management Unit	Australian Soil Classification	Brief Description
Rolleston/Glengallan	Brown/Grey Sodosols, Vertosols	The Rolleston/Glengallan Soil Management Unit is an association of grey/brown cracking and non-cracking soils with minor areas of grey and brown duplex soils. The grey clays have developed from finer material associated with the Alderbaran sandstones whilst texture contrast soils which possess sandy loam topsoils over medium to heavy clay subsoils have developed from coarser sedimentary parent material. The grey clays and texture contrast soils have low to moderate levels of salts and are sodic to strongly sodic at depth. The grey clays possess melon holes that are less than 40 cm deep; however, they remain wet for extended periods. These soils are poorly drained and have slow infiltration and permeability. The effective rooting depth is a function of the sodium bulge at 50 cm. These soils are moderately dispersive below 0.5m. The texture contrast soils have severe soil physical properties such as hard setting, structure-less surface horizons, and very low infiltration and drainage. Effective rooting depth is less than 20 cm due to the soil being strongly sodic below this depth. Sodicity predisposes the subsoil to erosion due to its highly dispersive behaviour. The texture contrast soils are strongly sodic at depth and possess low PAWC. Most water infiltration ceases within the contact zone of the subsoil. Upon hitting the impermeable subsoil water tends to move laterally in the landscape. This hydrological process leads to the formation of bleached horizons which sit directly above the subsoil.
College/Lascelles	Grey/Brown Vertosols and Dermosols	The College/Lascelles soil association is made up of coarse self-mulching or crusting, grey and brown cracking and non-cracking clays on alluvial plains and levees with minor areas of hard setting, yellow-brown sandy duplex soils with hard impervious clay subsoils.

Soil Management Unit	Australian Soil Classification	Brief Description
Glengallan	Brown Sodosols	The *Land Management Manual* for the Central Highlands presents the Glengallan soil as the most likely fit for the soils encountered on these Permian sandstones. The Glengallan SMU has shallow, loamy sand to sandy loam surface lying directly above hard decomposing sandstone parent material. These soils have hard setting surface horizons with massive structures with some coarse fragments found within the profile. Due to the nature of the parent material these soils have low nutrient levels including deficiencies of Copper, Zinc and Boron, low levels of soluble salts and low to moderate Ca/Mg ratios. These soils are all non-sodic within the topsoil material sampled for analysis. At the two logged sites subsoil material was not encountered in the field due to the presence of parent material close to the surface, hence sampling of subsoil material was not possible. However, it is likely that this soil type is a texture contrast soil which could be sodic, saline or both. Soil textures would likely be medium to heavy clays with very low permeability and drainages and low PAWC due to sodic or saline salt bulges at depth.
Glen Idol	Red Chromosol	Red-brown, loose, loamy sand surface over a brown to reddish brown sandy clay. At 70 cm grey clay is present with prominent orange and red mottles overlying a horizon with weak basalt rock fragments. Texture increases with depth as the soil grades back into a coarse sandy clay with grit. These soils are low in soluble salts and are non-sodic. These soils are extremely low in levels of nitrate nitrogen, phosphorus and potassium whilst also being deficient in some trace elements. These soils are magnesic with high levels of magnesium relative to calcium. pH is generally slightly acid to mildly alkaline. The presence of mottles in the subsoil indicates that soil wetness issues may be a problem.
Jimbaroo	Black Vertosol/Dermosol	Shallow phase of the Orion/Jimbaroo SMU. Similar physically and chemically to this unit but has a curtailed soil depth to 30 cm above parent material

Table 4.11 Summary of SMU and Disturbance Areas

Soil Management Unit	Total Project Site Area (ha)	Approximate Disturbance Area from Mining Activites (ha)		Percentage of Total Disturbance Area
		Underground Mine	Opencut Mine	
Orion/Jimbaroo	1,831	1010.7	173.3	46.1
Adelong	55.04	54.9	0	2.1
Adelong/College	1,028.1	390.5	100.8	19.1
Rolleston/Glengallan	1,245.8	531.8	178.9	27.7
College/Lascelles	488	0	0.2	0.01
Glengallan	357.6	79.1	15.0	3.7
Glen Idol	153.6	4.3	0	0.17
Jimbaroo	39.55	0	28.4	1.11
Pickardy	30.74	0	0	0.0
		2,071.3	**496.6**	
Total	**5,229.43**	**2,568**		**100**

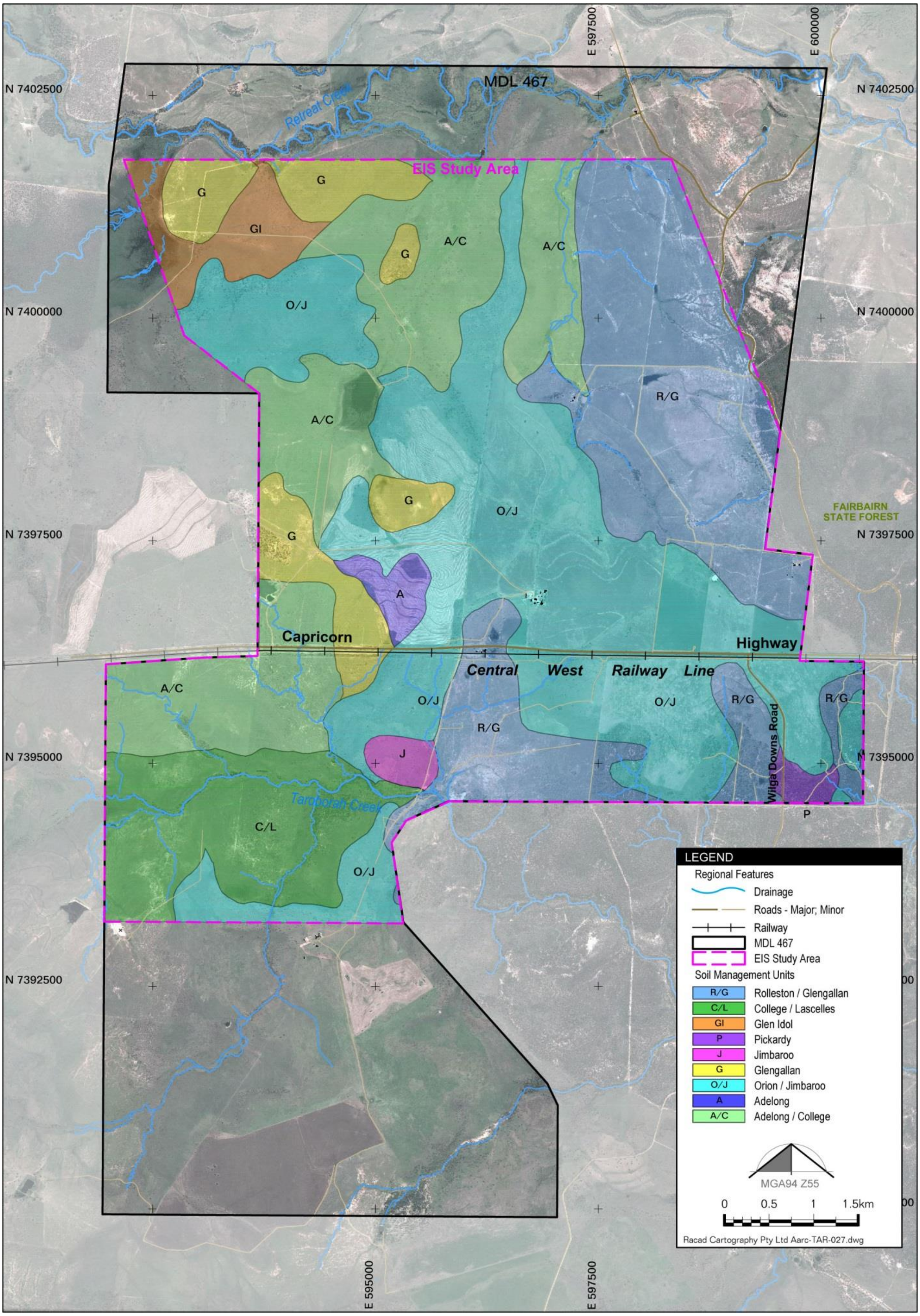


Figure 4.28 Distribution of Soil Management Units across the Project Site

4.2.1.6 Land Suitability

The pre-mining land suitability for the Project site was assessed on the basis of the physical, chemical and nutritional characteristics of the soils. The classification system used is that provided in the "*Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques"* (DME 1995). This methodology can be applied to both beef cattle grazing and rainfed broadacre cropping.

The following classes of land suitability (DME 1995) were employed for the suitability assessment:

Class 1 Suitable land with negligible limitations which is well suited to a proposed use.

Class 2 Suitable land with minor limitations which is suited to a proposed use but which may require minor changes in management to sustain use.

Class 3 Suitable land with moderate limitations which is moderately suited to a proposed use but which requires significant inputs to ensure sustainable use.

Class 4 Marginal land with severe limitations which is marginally suited for a proposed use and would require major inputs to ensure sustainability. These inputs may not be justified by the benefits to be obtained in using the land for a particular purpose and is hence considered presently unsuitable.

Class 5 Unsuitable land with extreme limitations which preclude its sustainable use for the proposed purpose.

The following conclusions were derived from the Project's pre-mining land suitability assessment:

- Suitability for beef cattle grazing is mostly limited by nutrient deficiencies (low levels of N, P, and some trace elements), soil pH, flooding and erosion. The Orion/Jimbaroo, Adelong, Adelong/College, College/Lascelles and Glen Idol SMUs are considered to be suitable land areas for grazing with moderate limitations (Class 3). The Rolleston/Glengallan and Jimbaroo SMUs are considered Class 4 land as it is marginal land with severe limitations, whilst the Glengallan SMU has been classified as Class 5 land which is unsuitable land with extreme limitations to grazing;

- Notwithstanding the classification derived from this assessment, grazing within the Central Highlands is most often limited by rainfall trends. Grazing as a land use is more suitable and carrying capacities higher in wetter years associated with climatic La Nina events;

- Rainfed broadacre cropping is mainly limited by the PAWC for crop growth. PAWC is impacted by subsoil constraints such as sodicity, salinity, and extremely alkaline pH. These constraints reduce the water storage potential of the soil, restricting the depth to which plant roots can draw water. Soil fertility (most sites possess low levels of N and P) and soil erosion (either due to their position in the landscape or nature of their soil material) are also major limiting factors. SMUs located in steeper areas are prone to erosion, whilst units based on alluvial plains are at risk from flooding. Overall, the Orion/Jimbaroo, Adelong/College, and College/Lascelles SMUs were considered suitable for cropping with moderate limitations (Class 3). The Adelong, Rolleston/Glengallan and Glen Idol SMUs were considered to be marginal land with severe limitations (Class 4), whilst, the Glengallan and Jimbaroo SMUs were assessed to be unsuitable land with extreme limitations (Class 5); and

- Notwithstanding this assessment, cropping in the Central Highlands can be severely limited by rainfall. Soils that possess subsoil constraints cannot fully take advantage of this rainfall due to the limited plant rooting depths associated with these constraints.

A summary of the pre-mining land use suitability's for each Project SMU together with the key suitability limitations of each unit is presented in Table 4.12. The spatial distribution of these land suitability classes are presented in Figure 4.29 and Figure 4.30.

Table 4.12 Pre-Mining Land Use Suitability Classes

Soil Management Unit	Important Limitations for either Suitability Category	Agricultural Suitability	
		Beef Cattle Grazing	Rainfed Broadacre Cropping
Orion/Jimbaroo*	pH, erosion and nutrients	3	3
Adelong	pH, nutrients and flooding	3	4
Adelong/College*	PAWC, nutrients, physical factors, soil workability, pH and flooding	3	3
Rolleston/Glengallan*	PAWC, nutrients, physical factors, soil workability, salinity, microrelief and pH	4	4
College/Lascelles*	PAWC, physical factors, soil workability, salinity, pH, erosion and flooding	3	3
Glengallan	PAWC, nutrients and water erosion	5	5
Glen Idol	PAWC and pH	3	4
Jimbaroo	PAWC, soil depth, nutrients	4	5

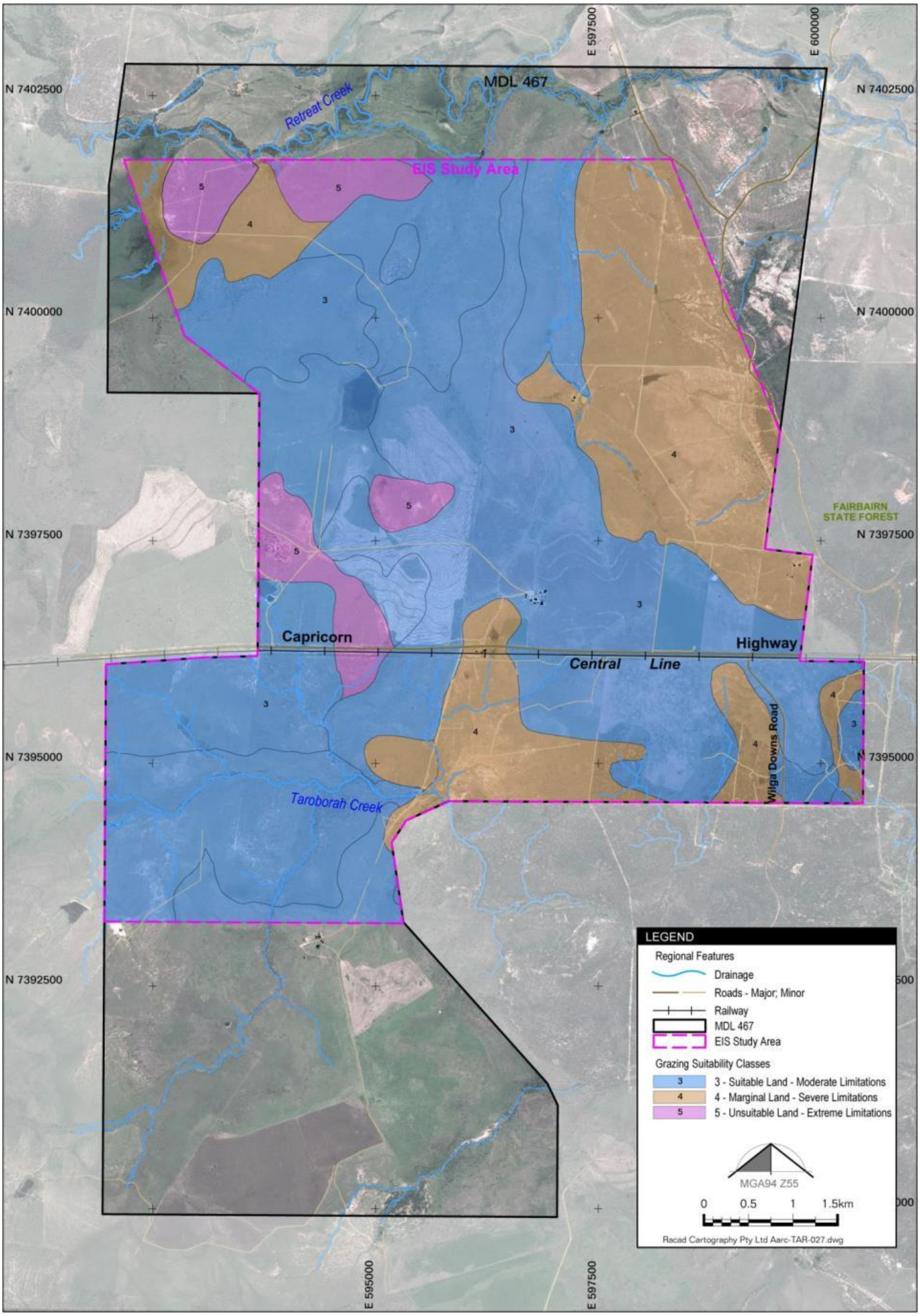


Figure 4.29 Land Suitability Class Map for Beef Cattle Grazing

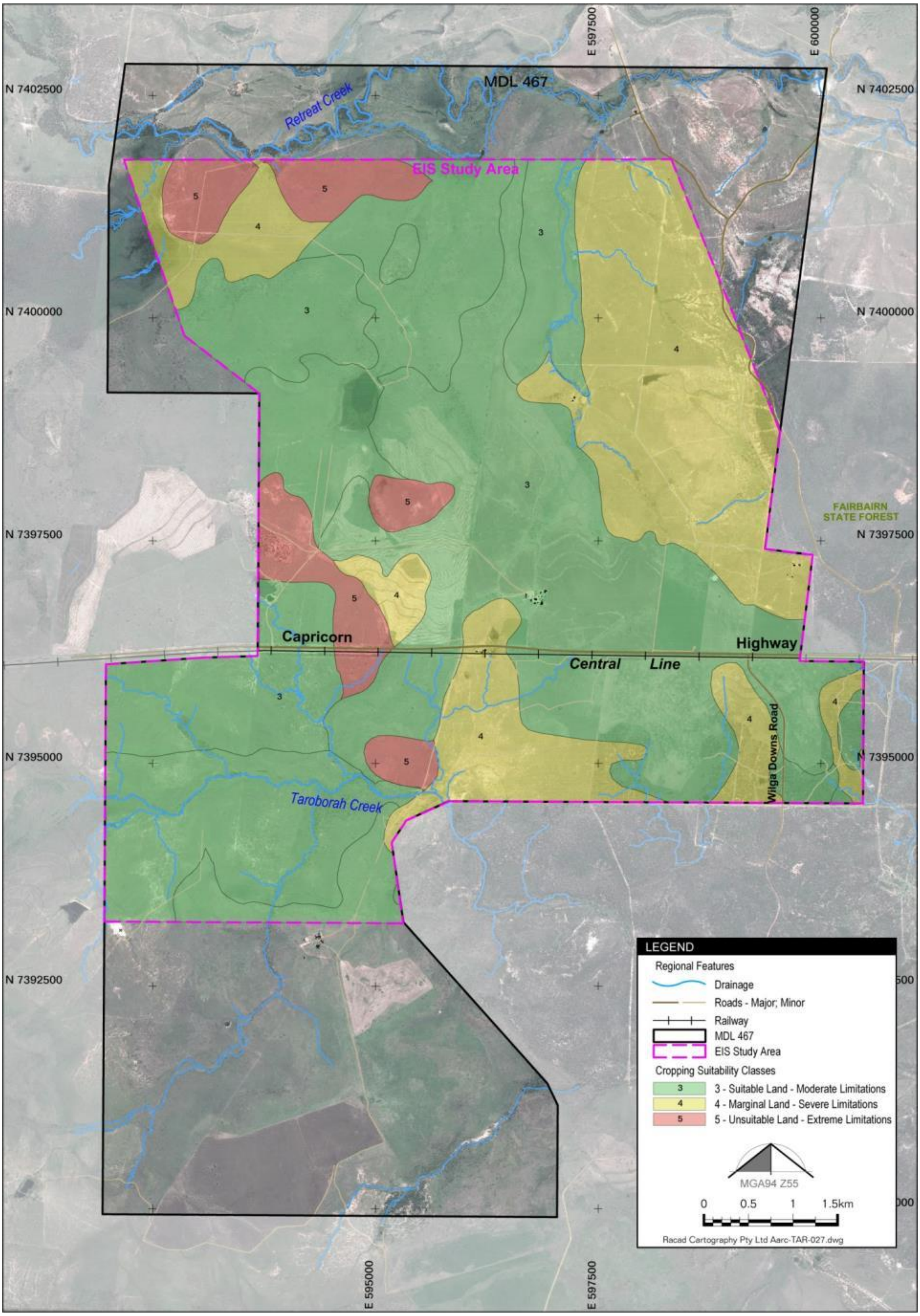


Figure 4.30 Land Suitability Class Map for Rainfed Broadacre Cropping

Good Quality Agricultural Land (GQAL)

The quality of agricultural land within the Project boundary was assessed via "*Planning Guidelines: The Identification of Good Quality Agricultural Land"* (herein referred to as the Planning Guideline) (DHLGP 1993) and the "Good Quality Agricultural Land" mapping as described by the EHP (formerly DERM) Land Classification System (DERM 2010). The Good Quality Agricultural Land classification indicates the quality of the land required to maintain a sustainable level of productivity of a particular land use with acceptable limitations (DHLGP 1993).

GQAL is categorised in The Planning Guideline (DHLGP 1993) as follows:

Class A CROP LAND

Land suitable for current and potential crops

Limitations to production range from none up to moderate levels.

All crop land is considered to be good quality agricultural land.

Class B LIMITED CROP LAND

Land marginal for current and potential crops; and suitable for pastures

Land which is marginal or unsuitable for most current and potential crops due to severe limitations. Further engineering and/or agronomic improvements may be required before land would be considered suitable for cropping.

Land marginal for particular crops of local significance is considered to be good quality agricultural land.

Class C PASTURE LAND

Land suitable only for improved or native pastures

Limitations preclude continuous cultivation for crop production but some areas may tolerate a short period of ground disturbance for pasture establishment.

In areas where pastoral industries are the major primary industry, land suitable for improved or high quality native pastures may be considered to be good quality agricultural land.

Class D NON-AGRICULTURAL LAND

Land not suitable for agricultural uses

This may be undisturbed land with significant habitat, conservation and/or catchment values. Severe limitations preclude any interference with land or biological resources for the production of agricultural goods.

The agricultural land assessment did not identify any Class B land on the Project site. The majority of land was found to be comprised of Class A land. SMUs classified as Class A contained soils that were predominantly found to be developed on basalt parent material or alluvium derived from basaltic sediments, thereby supporting broadacre cropping and improved pastures for beef cattle production. In addition, significant areas of Class C1, Class C2 and Class C3 land were also recorded (based upon sandstones of the Aldebaran formation), which facilitate native pasture production and light grazing land uses.

Note that within the Emerald Shire Local Government Area (now the Central Highlands Regional

Council), Class A, Class B and Class C1 classified land are all considered to be 'good quality agricultural land' (Agricultural Land Class Overlay, Emerald Shire Planning Scheme, 2006).

In order to identify the potential impacts that the Project may have upon GQAL, the proposed Project disturbance areas have been superimposed upon the GQAL map within the EIS study area (refer to Figure 4.32 for the location of these potential impacts). The following Project infrastructure will impact GQAL:

- Opencut pit, spoil piles, coal handling and preparation plant (CHPP), offices, roads and rail infrastructure – are likely to disturb Class A, C2 and C3 land; and
- Underground mining activities - Class A, C1, C2 and C3 land north of the highway will be at risk of subsidence.

A comparison of the land suitability and agricultural land quality for each SMU, determined as a result of this study, is presented in Table 4.13.

Table 4.13 Pre-Mining Land Use Suitability and Agricultural Land Quality Classes

Soil Management Unit	Important Limitations for either Suitability Category	Agricultural Suitability		Good Quality Agricultural Land Class
		Beef Cattle Grazing	Rainfed Broadacre Cropping	
Orion/Jimbaroo*	pH, erosion and nutrients	3	3	A
Adelong	pH, nutrients and flooding	3	4	C1
Adelong/College*	PAWC, nutrients, physical factors, soil workability, pH and flooding	3	3	A
Rolleston/Glengallan*	PAWC, nutrients, physical factors, soil workability, salinity, microrelief and pH	4	4	C2
College/Lascelles*	PAWC, physical factors, soil workability, salinity, pH, erosion and flooding	3	3	A
Glengallan	PAWC, nutrients and water erosion	5	5	C3
Glen Idol	PAWC and pH	4	3	C1
Jimbaroo	Soil depth, PAWC, nutrients	4	5	C2

* =soil associations

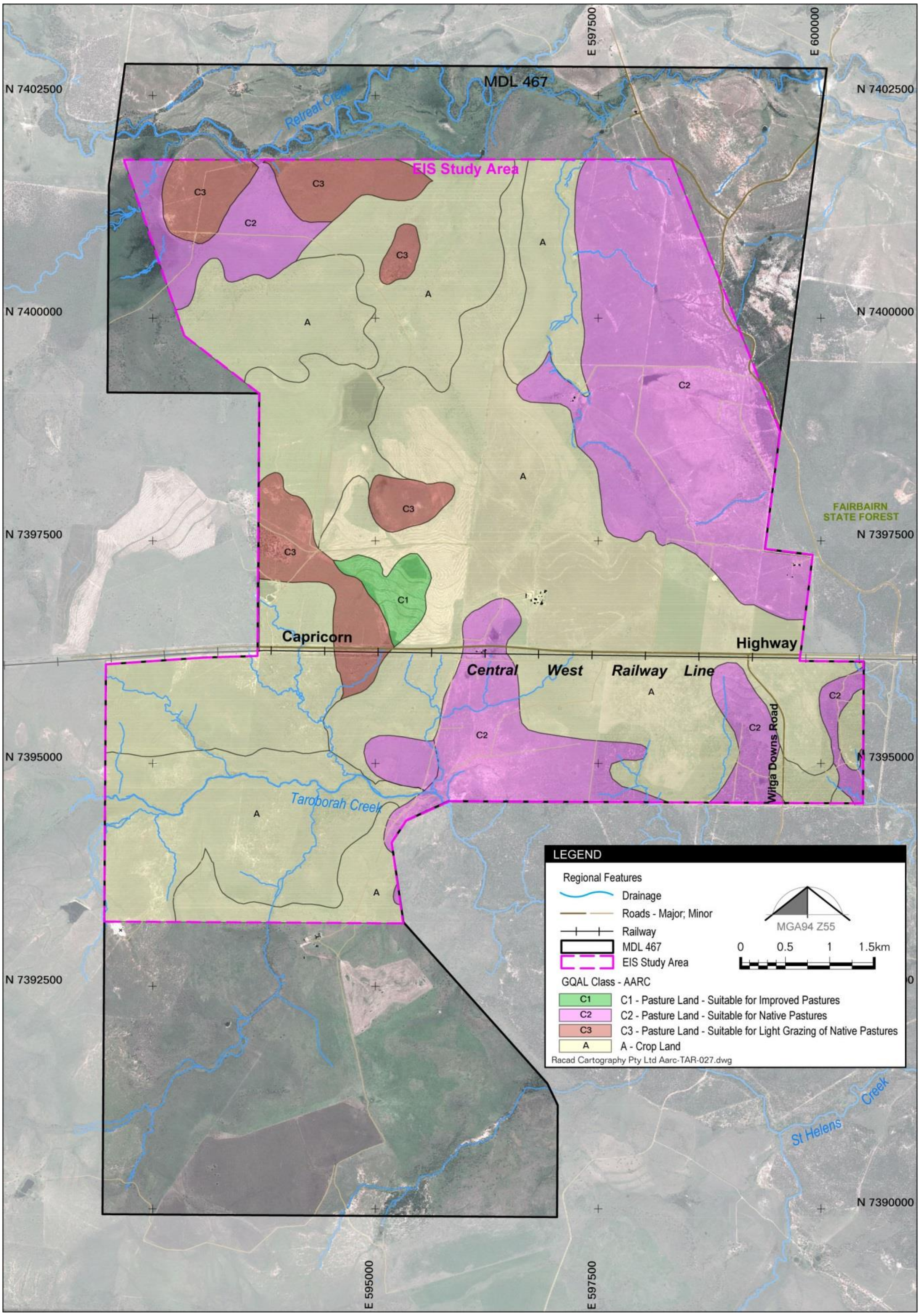


Figure 4.31 Classification of Good Quality Agricultural Land Mapped by AARC

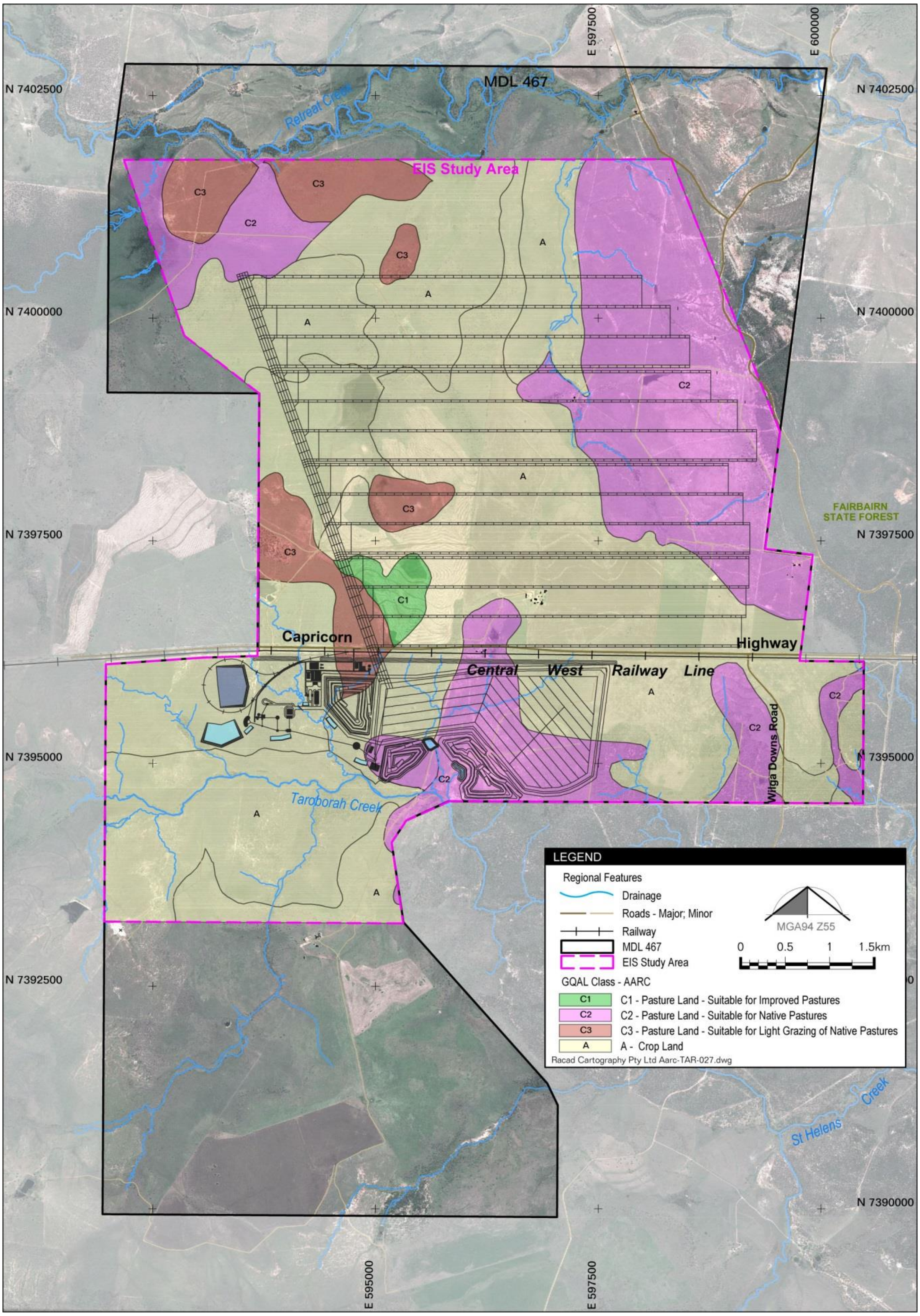


Figure 4.32 Potential Project Impacts upon GQAL

Strategic Cropping Land

The *Regional Planning Interests Act 2014* (RPI Act 2014) aims to protect agricultural land resources that are deemed important to Queensland. It is designed to ensure that planning and development assessment under local government planning schemes includes appropriate consideration of strategic cropping land (SCL). The RPI Act came into effect on 3 June 2014, and replaced the Strategic Cropping Land Act 2011 that commenced on 30 January 2012.The policies under the RPI Act 2014 provide local government guidance for the management of Priority Agricultural Area and Strategic Cropping Area. Strategic Cropping Area is defined in the RPI Act 2014 as those areas identified as strategic cropping land (SCL) on the SCL Trigger map, whereby strategic cropping land means land that is, or is likely to be, highly suitable for cropping because of a combination of the land's soil, climate and landscape features.

The presence of Strategic Cropping Area (SCA) on the Project site was assessed via an initial review of the EHP SCL trigger maps (EHP 2012 – as shown in Figure 4.33), followed by assessments of field observations, including soil morphological characteristics, and soil physiochemical properties determined by laboratory analysis of sampled soil material.

Since the project site is located within the "Western Cropping Zone Management Area", adjacent to the Priority Agricultural Area (PAA) (refer to Figure 4.33 for SCA and PAA location details), the SCL criteria for this zone were employed to determine whether or not the mapped SCL trigger areas can be validated as true SCL. The results of this review found that approximately 2,050 ha of the Project site is mapped as SCA, whilst the area of validated SCA is 1,766 ha. Refer to Figure 4.34 for the validated SCL trigger map, SMUs and proposed mine infrastructure disturbance areas and Table 4.14 for the results of this assessment.

The disturbance areas potentially created by Project activities for each SMU and SCL area (both trigger and validated areas) are presented in Table 4.15.

Table 4.14 Summary of SCL Status of each SMU

	Orion/Jimbaroo				Rolleston/Glengallan			Adelong/College			College/Lascelles				Glengallan		Adelong	Glen Idol	
Criteria	TB40	TB48	TB58	TB57	TB59	TB33	TB41	TB37	TB60	TB61	TB70	TB78	TB80	TB69	TB12	TB44	TB54	TB10	TB11
Slope	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Not SCL**	**Not SCL**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Rockiness	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**			**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Gilgai Microrelief	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**			**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Soil Depth	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**			**Not SCL**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Soil Wetness	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Not SCL**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**				**Not SCL**	**Not SCL**	**Yes**	**No analytical Data**	**No analytical Data**
Soil pH	**Yes**	**Yes**	**Yes**	**Yes**	**Not SCL**		**Not SCL**	**Yes**	**Yes**	**Yes**	**Yes**						**Yes**	**No analytical Data**	**No analytical Data**
Salinity	**Yes**	**Yes**	**Yes**	**Yes**				**Yes**	**Yes**	**Yes**	**Not SCL**						**Yes**	**No analytical Data**	**No analytical Data**
Soil Water Storage	**Yes**	**Yes**	**Yes**	**Yes**				**Yes**	**Yes**	**Yes**							**Yes**	**Not SCL**	**Not SCL**
Minimum Area	**Yes**	**Yes**	**Yes**	**Yes**				**Yes**	**Yes**	**Yes**							**Yes**		
Outcome	**SCL**	**SCL**	**SCL**	**SCL**				**SCL**	**SCL**	**SCL**							**SCL**		

Yes = sample passes SCL criteria

Table 4.15 SMU and SCA Disturbance Areas for the Opencut and Underground Mines Project Site

Underground Mine Disturbance Areas (ha)			
SMU	**SMU Area**	**SCL Trigger Area**	**Validated SCA**
Orion/Jimbaroo	1010.7	741.8	691.6
Adelong	54.9	54	54.0
Adelong/College	390.5	70.8	28.2
Rolleston/Glengallan	531.8	139.4	41.8
Glengallan	79.1	9.9	14.1
Glen Idol	4.3	0	0
Total	**2071.3**	**1,015.9**	**829.7**
Opencut Mine Disturbance Areas (ha)			
SMU	**SMU Area**	**SCL Trigger Area**	**Validated SCA**
Orion/Jimbaroo	173.3	5.3	5.3
Adelong/College	100.8	99.7	99.7
Rolleston/Glengallan	178.9	0	0
College/Lascelles	0.2	0	0
Glengallan	15.0	0.7	0.7
Jimbaroo	28.4	0	0
Total	**496.6**	**105.7**	**105.7**

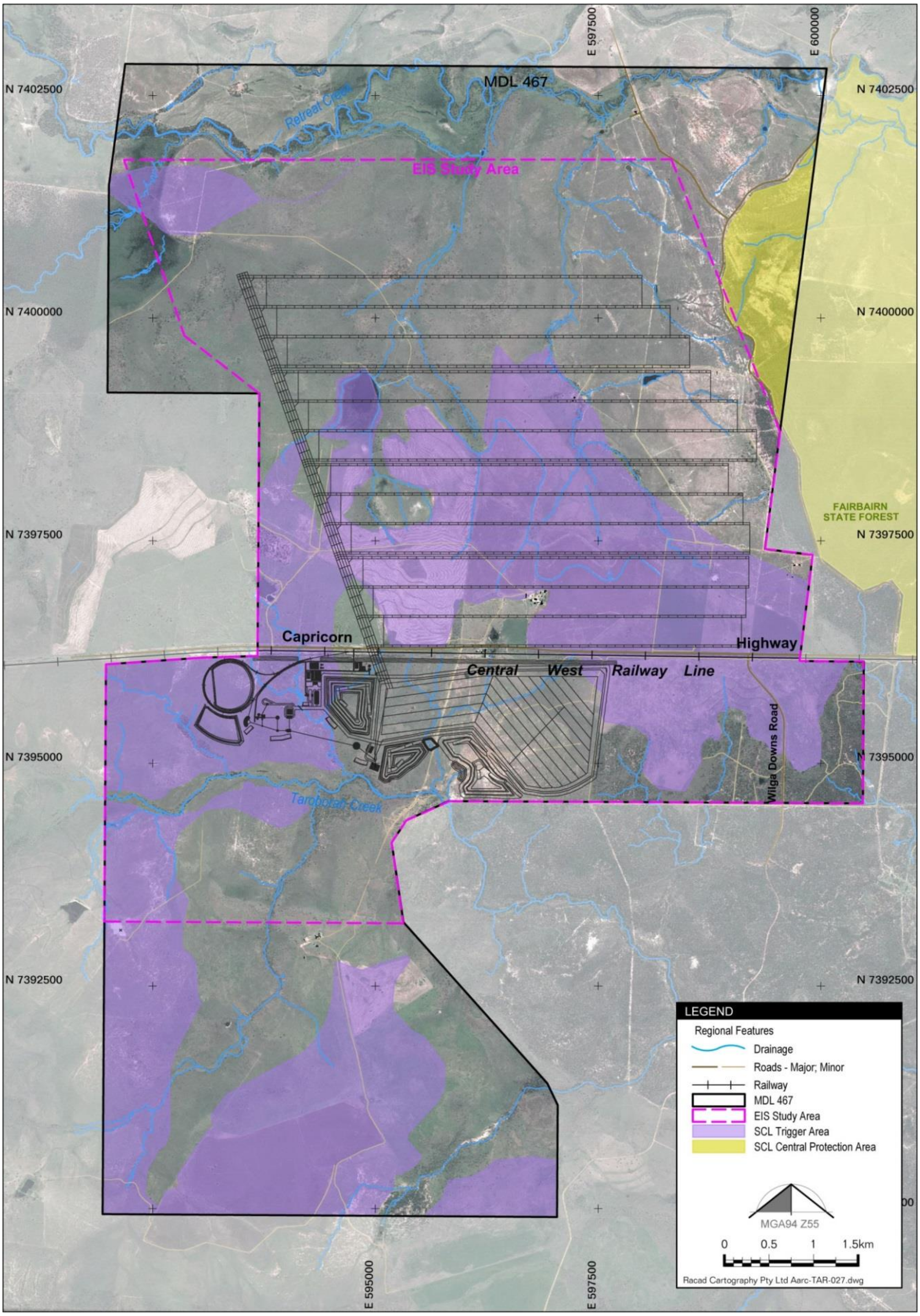


Figure 4.33 Strategic Cropping Land Trigger Map for Potential SCL and Proposed Mine Disturbance Areas

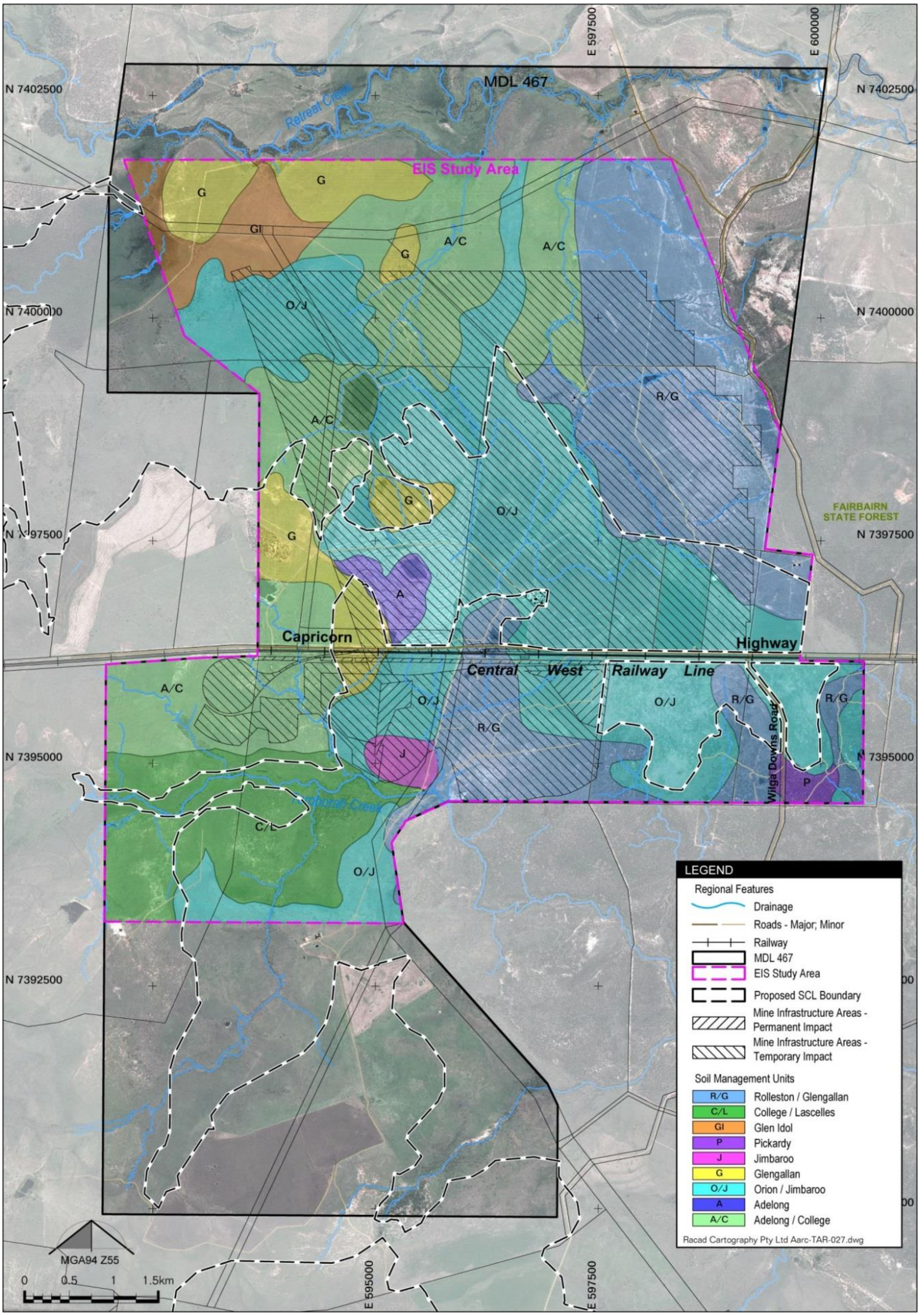


Figure 4.34 Validated SCA, SMUs and Proposed Mine Infrastructure Disturbance Areas

4.2.1.7 Contaminated Land

Preliminary Site Investigation

An assessment of the potential for contaminated land to occur within the Project site was conducted during 2011 and 2012. Details of the contaminated land assessment are presented in Appendix 8, and address the potential for both historical and current land contamination.

The preliminary site investigation (PSI) consistent with the Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland (Department of Environment 1998) was undertaken to determine background (pre-mining) contamination on the Project site.

Historical Landuse

A landuse history for the Project site was generated from both historical landownership titles, interviews with land holders and three sets of historical aerial photographs that were obtained from the QLD Government Land Office.

The general area was first sighted by Leichhardt in 1844 and pastoral runs were taken up in the 1850s and 1860s. Since this time, the main landuse has been wheat and sorghum cropping and low-intensity cattle grazing. No known commercial or industrial activities have occurred on the Project site.

An assessment of historical landuse via aerial photography has been conducted and summarised as follows:

- 1946 aerial photographs – the local landscape appears largely undeveloped with relatively low anthropogenic impacts within the Project area. Cleared agricultural and pastoral paddocks are evident, concentrated around the Taroborah Station;

- 1964 aerial photographs – by 1964, an expansion of agricultural activities had occurred across the Project site with fragmentation of large, intact stands of vegetation. Agricultural activity intensified around both the Taroborah Station and St Helens homestead. Several tracks intersected the landscape, leading to dams and other agricultural areas; and

- 1983 aerial photographs - further fragmentation of the local vegetation was evident in the 1983 aerial photographs, particularly in the northern and western sections of the Project site. Broad-scale vegetation clearing and development of agricultural land across the majority of the site north of the Capricorn highway is apparent, including clearing for a number of additional tracks and fence lines throughout the site. The vegetation located to the east of the Project site does not appear to have undergone significant clearing and represents a large patch of consistent vegetation, within in a fragmented landscape.

In order to determine the potential for historical land contamination, a review of the available aerial photography, interviews with land holders and Queensland (QLD) land register searches were conducted.

Regional and Local Hydrogeology

In terms of regional hydrogeology, the Project site lies within the Fitzroy Basin and the Nogoa River subarea, a major inland river system which drains through the Great Dividing Range to the east central coast of Queensland.

Most of the land in the region (approximately 90%) is used for agriculture, with significant areas of

state forest and national park; the remainder of the basin is used for irrigation, grazing, mining, power generation.

Groundwater in the Fitzroy Basin generally falls into two major chemical categories as follows, although other minor water types also occur locally in the Fitzroy Basin:

- Alluvial sequence – characteristic of both alluvial groundwater and surface waters along the eastern coastal and western areas of the Fitzroy Basin; and

- Sodic sequence – associated with older sedimentary rocks and mainly present in deep aquifers (also occasionally in shallow groundwater). The major ion balance of this groundwater approaches that of sea water and has been identified in the central and southern sections of the Fitzroy basin.

The local hydrogeology of the Project site is characterised by three local aquifer types as follows:

- Tertiary basalt (Tb) - mainly found in the western portion of the Project site, directly overlying the underground mine workings and within the opencut area;

- Aldebaran Sandstone (Pb) - outcropping over the eastern portion of the Project site. This aquifer may act as a recharge area for the regionally extensive Aldebaran Sandstone aquifer; and

- Quaternary alluvium (Qa) - associated with streams that drain to the south of the Project site, with a potential connection to Lake Maraboon.

Note that the north-west trending graben faults. Also a major south-west trending basement structure which lies across the Project site, potentially complicates the local hydrogeology.

Several Project exploratory and groundwater monitoring bores have been installed across the Project site, in addition to bores that have been registered with EHP and local, private landholder bores.

A local groundwater bore census has been conducted both within and around EPC1011 (AGE 2011 and AGE 2013) to identify the position, status, standing water level and water quality (pH and electrical conductivity) of both the EHP registered and private groundwater bores. Groundwater quality and yield assessments were also conducted in 2008 and 2009 (Matrix Plus 2008, 2009a and 2009 b).

Local groundwater was found to be of adequate quality and is utilised by surrounding landholders for both stock and domestic uses.

Potential Contaminants of Concern

Livestock dips – only one livestock dip has been identified on the Project site. Since this dip was buried about 4m below ground level, the risk of contaminants impacting the local environment and human health are considered to be limited. Potential impacts upon local groundwater have yet to be determined:

- Chemical storage and handling - chemical drums in various states of decay were observed on the Project site at various homesteads. Minor product dispensing spills were observed at some of these locations;

- Hydrocarbon spills – un-bunded above-ground fuel storage tanks were recorded at various

homesteads, with minor product dispensing spills observed at some of these locations;

- Sewage Treatment Plants – no sewage treatment plant malfunctions were reported by local landowners; and

- Asbestos fibres (un-bonded and exposed) – two fibro properties structures which that were built with asbestos fibre re-enforced cement sheeting were observed on the Project site (an abandoned and dilapidated house at Yarrawonga Station and the house at Taroborah Siding – refer to the Taroborah Historic Heritage Management Plan (Converge, 2012) for further details). Although these properties represent a potential source of land contamination, such field observations are anecdotal and do not represent a full asbestos-survey of buildings and land within the Project area.

Contaminated Land, Unexploded Ordnance and Underground Services Registers

A search of both the Environmental Management Register (EMR) and Contaminated Land Register (CLR) for EPC1011 identified only one landholding (Lot 223 on FTY1531) on the EMR, where Notifiable Activity 22 - Livestock Dip or Spray Race had been conducted. However, although this Lot lies within the former EPC1011, it does not underlie MDL467 and therefore, the livestock dip in question has not been considered in this report.

None of the Lots which lie within MDL467 are recorded on the Contaminated Land Register.

The presence of unexploded ordnance within the former Emerald Shire boundary was not identified during a search of the unexploded ordnance register and therefore, the risk of unexploded ordnance being present on the Project site was considered to be low.

The only underground services that were identified for the Project site were underground Telstra and NextGen cables which run parallel to the Capricorn Highway.

Sources of Contaminated Land

A preliminary site investigation was conducted for the Project site and the following potential sources of land contamination identified:

- Livestock dips – only one decommissioned livestock dip was identified on the Project site, buried underground to a depth of approximately 4m below ground level (bgl). However, since it was buried at a reasonable depth and it does not lie within the Project disturbance area, the risks of contaminants impacting the local environment and human health are considered to be low, since Project activities will not bring any soil contamination to the surface (refer to Figure 4.35 for location details of this dip); and

- Chemical storage and handling –at a number of homesteads on the Project site, used and decaying chemical drums were observed, with minor product dispensing spills in shallow topsoil at some of these locations. However no visual evidence of significant dispensing spills was evident;

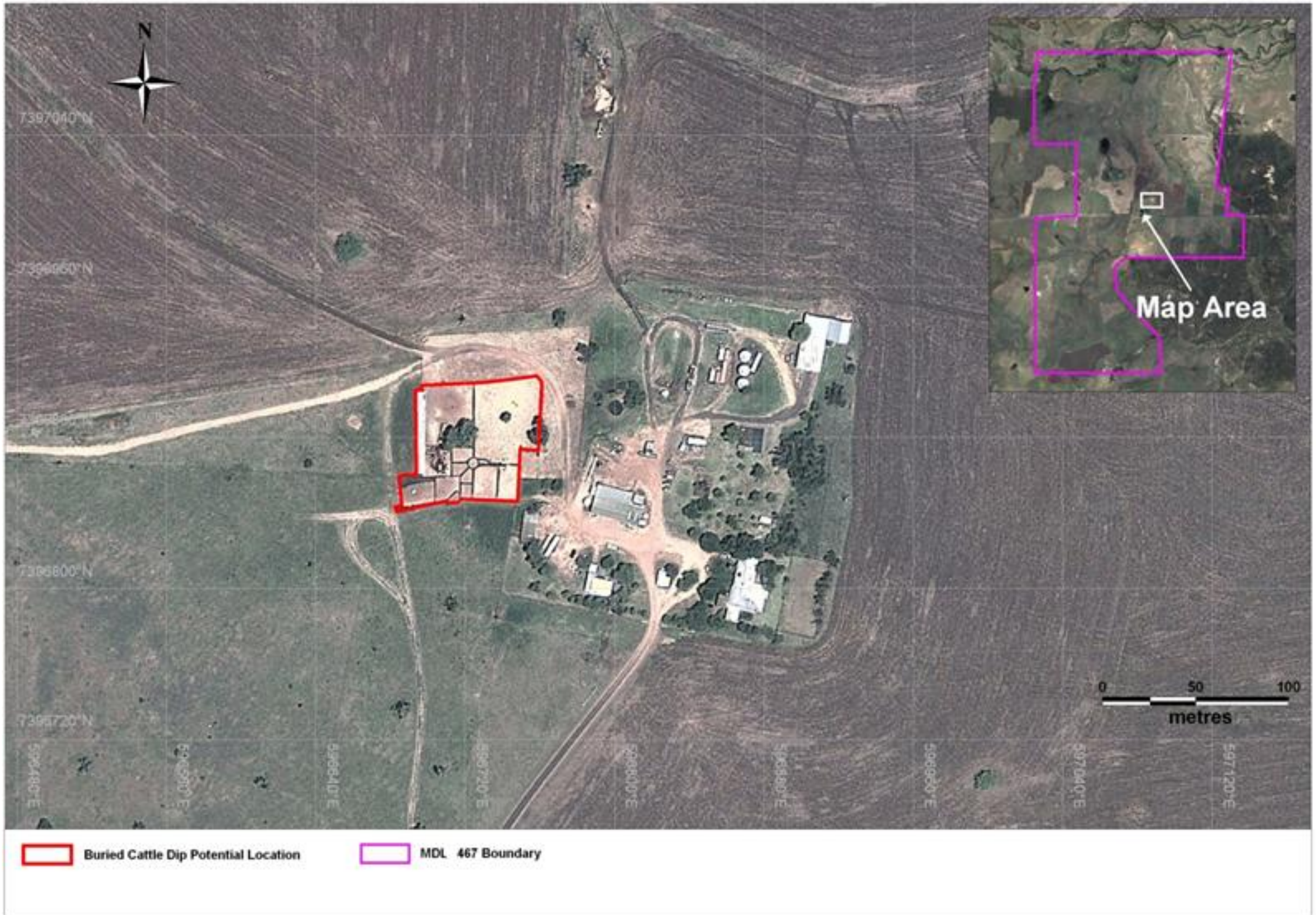


Figure 4.35 Location of Buried Livestock Dip on the Project Site

- Hydrocarbon spills – above-ground fuel storage tanks with no bunds were recorded at various homesteads. Once again minor product dispensing spills in shallow topsoils were observed at some of these locations, but no visual evidence of significant hydrocarbon spills were evident;

- Domestic Sewage Treatment Plants – no domestic sewage treatment plant malfunctions were reported by local landowners; and

- Asbestos fibres (un-bonded and exposed) – two fibro properties which were built with asbestos fibre re-enforced cement sheeting were observed on the Project site (an abandoned and dilapidated house at Yarrawonga Station and the house at Taroborah Siding. Although these properties represent a potential source of land contamination, such field observations are anecdotal and do not represent a full asbestos-survey of buildings and land within the Project area.

Contaminated Surface Water and Sediment

The chemical analytical data that has been produced to date for local surface water and sediments has not indicated any significant contamination. However, contamination from hydrocarbons and agrichemicals has not been assessed for these particular environments.

Surface water or sediment samples which have exceeded guideline trigger values for electrical conductivity, Al, Cr, Cu, Mn, Ni, ammonia nitrate / nitrite and phosphorus are assumed to exhibit naturally-elevated concentrations of these elements / compounds.

In addition, no visual contamination of local surface waters was recorded during the field surveys.

Contaminated Groundwater

Although somewhat saline at certain locations, the local groundwater is currently used on site for both livestock and domestic consumption, with no recorded ill-effects, therefore, there is currently no anecdotal evidence to suggest that local groundwater is contaminated.

However, groundwater sampling and analysis has been conducted as part of the Environmental Impact Statement studies and no contamination of the local groundwater identified.

4.2.1.8 Infrastructure

The Queensland Stock Route Network and underlying properties are illustrated in Section 3.1.2.1 and the telecommunications network is depicted in Section 3.5.6. Infrastructure to be developed on the Project site is described below and illustrated in Figure 4.36:

- In-pit and out-of-pit spoil dumps;

- Opencut and underground MIA (includes coal transfer and laydown areas, site offices, stores yard, workshops, change rooms, administration office, mine office, maintenance areas, washdown bays, parking areas, fire water tank, vent fans etc.);

- Primary and secondary sizers;

- CPP and refuse bin;

- Site access and haul roads;

- Main and underground substations;
- Fuel, oil and chemical storage areas and vessels;
- Opencut and underground ROM, CPP feed, product and topsoil stockpiles;
- Clean and dirty water management and drainage systems including sediment dams;
- Mine wastewater dam;
- CPP water recycle dam;
- Water storage system (200 kilolitres (kL));
- Potable water treatment facility for staff use and consumption;
- Visual amenity bunds;
- Sewage treatment plant;
- Overhead feeder power line;
- Electrical substation; and
- Radial stacker, train load-out system and rail balloon loop.

4.2.1.9 Environmentally Sensitive Areas

A search of the Department of Environment and Heritage Protection (DEHP) Environmentally Sensitive Areas mapping service indicates areas of Endangered Regional Ecosystem (ERE) are located within the Project site in both the northern and southern sections of the Project site (as shown in Figure 4.37). However, when this area was ground-truthed (refer to Figure 4.38 for ground-truthed vegetation community details), the actual extent of the ERE was found to be considerably less. Therefore, EREs will not be significantly disturbed during opencut construction and operations.

The mapping indicates that the Project site does not contain conservation parks, declared fish habitat areas, wilderness areas, aquatic reserves, heritage or historic areas, national estates, world heritage listings, sites listed by international treaties or agreements or areas of cultural significance relating to biodiversity and scientific reserves.

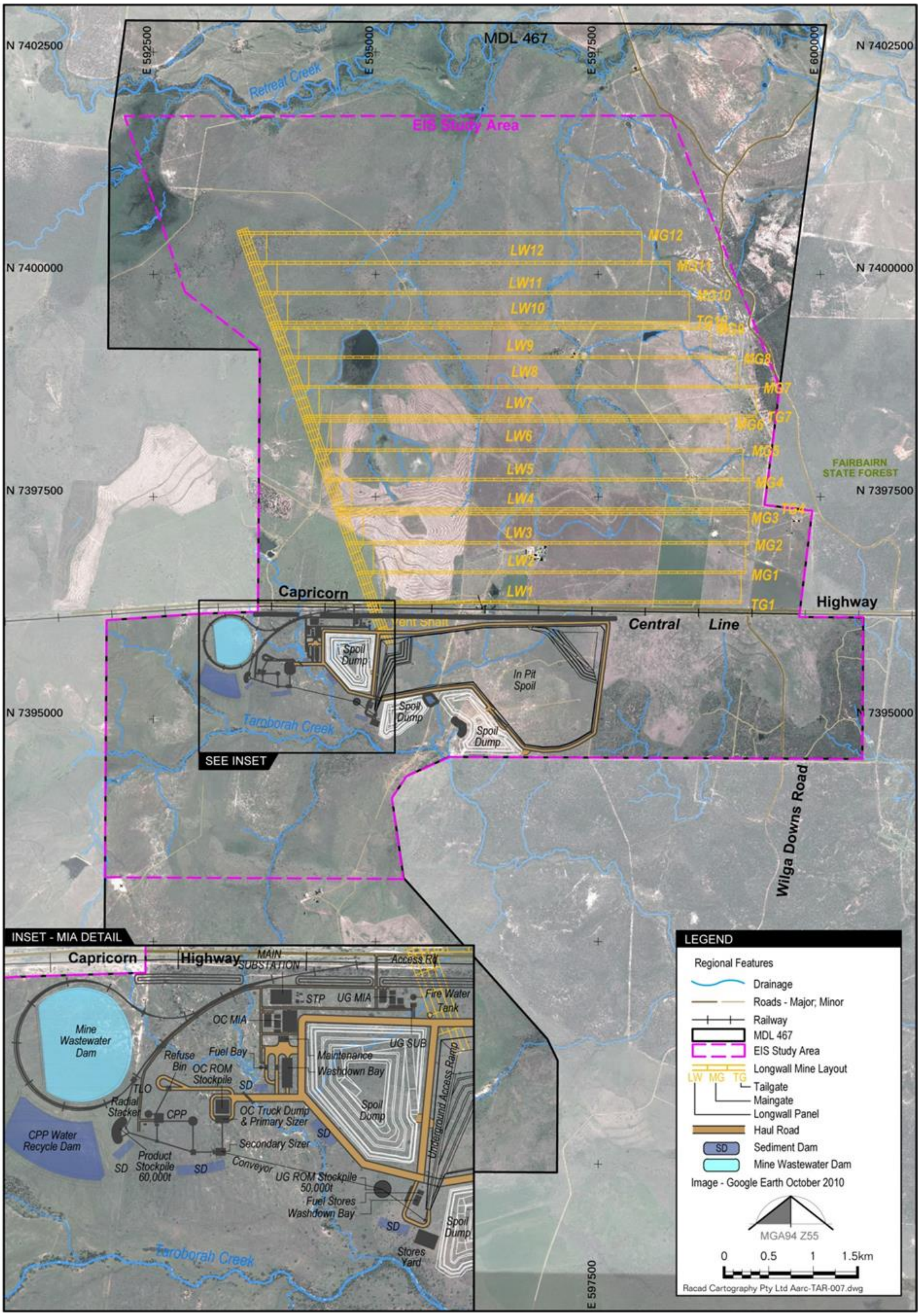
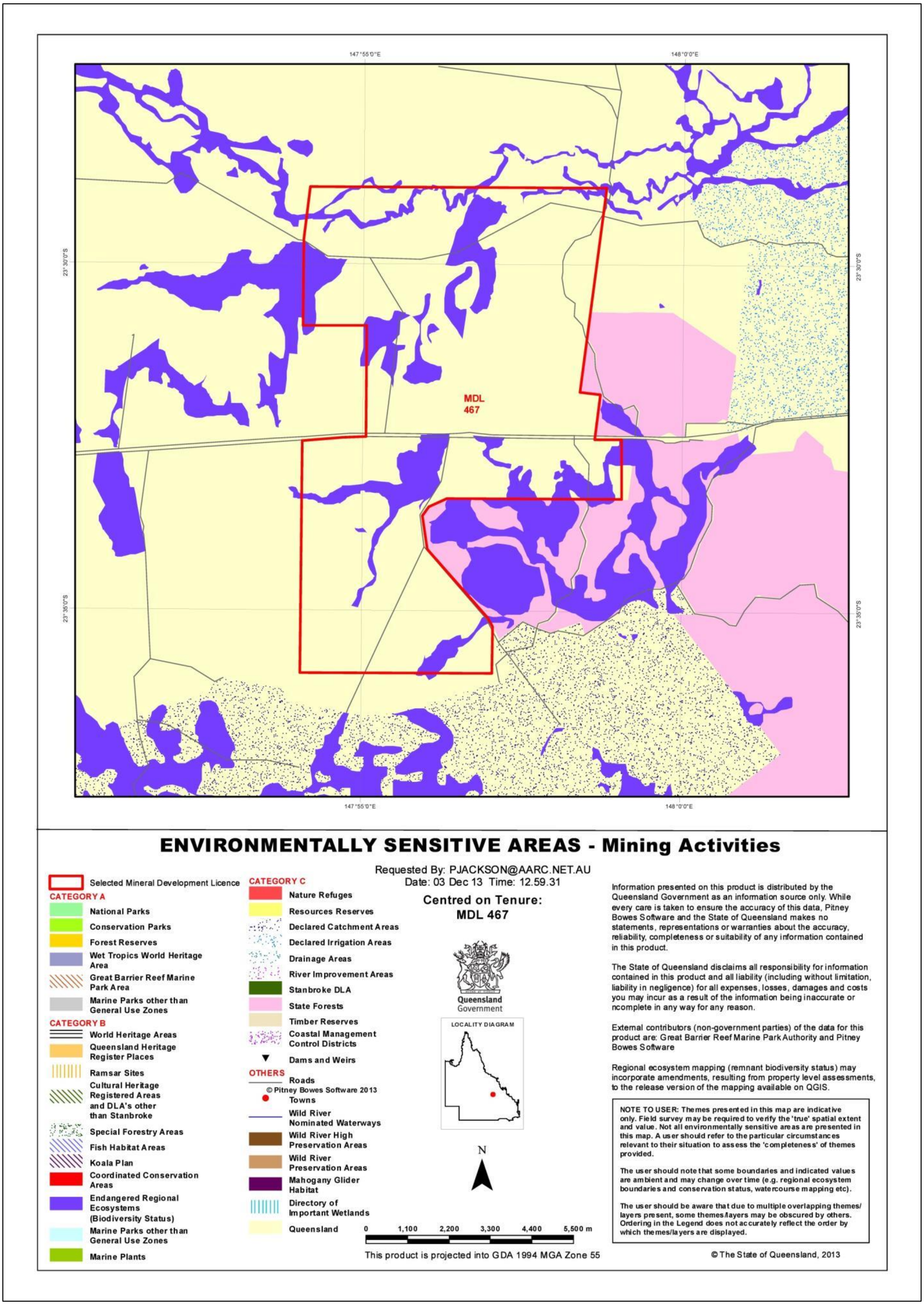


Figure 4.36 Project Infrastructure Layout



Source: QLD Government 2013

Figure 4.37 EHP Mapped Environmentally Sensitive Areas

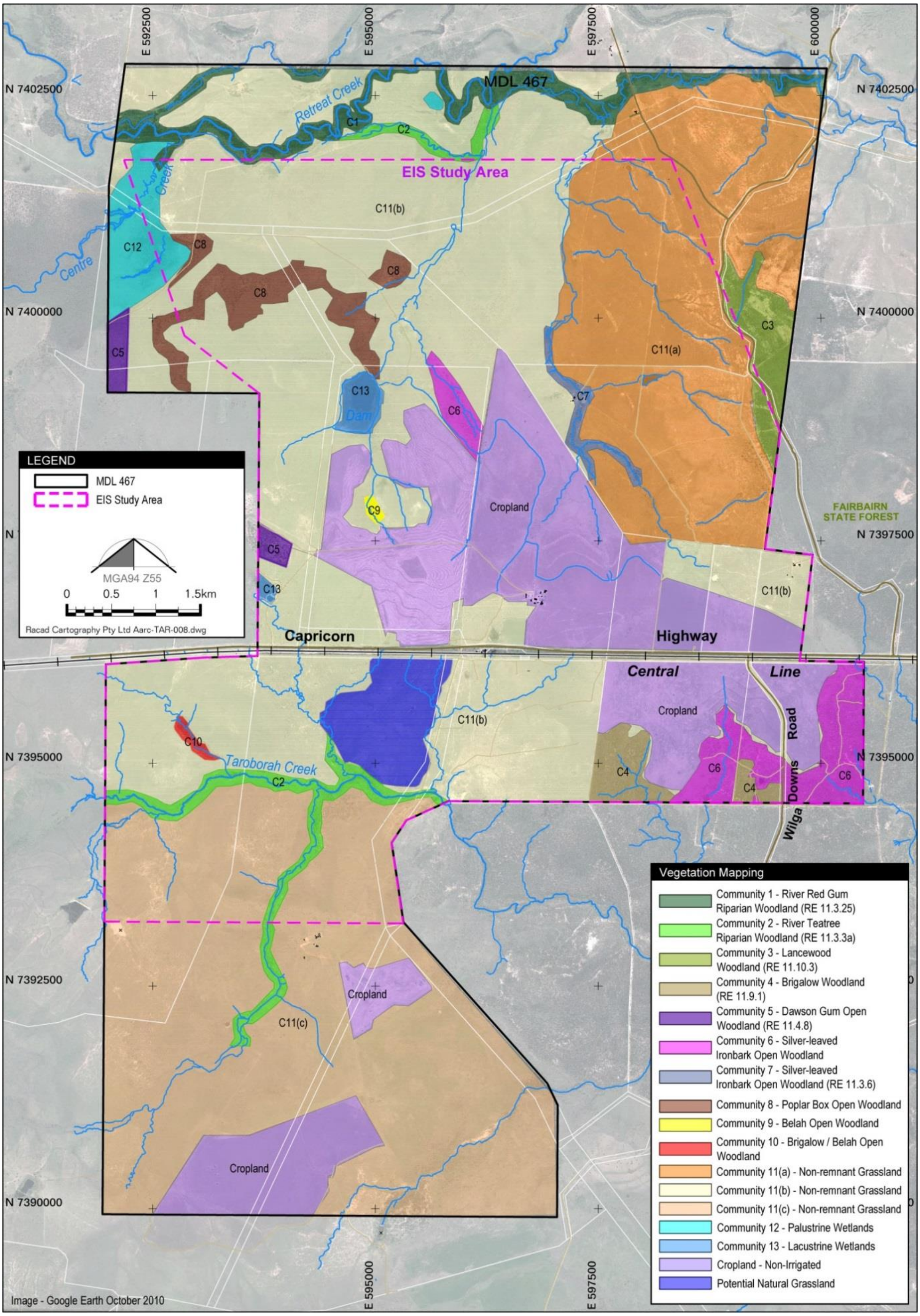


Figure 4.38 Ground-truthed Vegetation Communities

4.2.1.10 Landscape character

Landscape character refers to the defining physical characteristics of an area including the vegetation, topography, waterways and the extent of anthropogenic disturbance that a landscape has undergone including built structures, agricultural and farming activities.

The Emerald Downs area has been subject to early pastoralism since 1854, which involved the clearing of vast tracts for grazing of livestock and agricultural cultivation. Remnant vegetation remains intact in the south, east and north east of the Project site associated with the Fairbairn State Forest while the remainder of the site is highly fragmented.

The Project site is predominantly used for low to medium intensity cattle grazing on native and improved pastures and broadacre dryland cereal cropping with vegetation found in sporadic patches across the majority of the site. The site is predominantly flat with undulating alluvial plains, gently undulating rises and low hills. Elevation ranges from approximately 200m AHD to 280m AHD, with an average elevation of approximately 240m AHD. The most elevated areas of the Project site occur in the north east, adjacent to Fairburn State Forest, with the lowest elevations encountered around Retreat Creek in the north of the site. The Capricorn Highway also runs in an east west direction through the centre of the site.

The majority of modification adding to the landscape character is in the form of broad scale clearing associated with the cattle grazing and agricultural cropping as well as the necessary built structures, access roads and stock tracks to facilitate these activities.

4.2.1.11 Visual amenity

The assessment of visual amenity values, or defining the impact of visual change, is typically a subjective process. Each individual will generally place a different perception of the value of a view or landscape. Generally it is expected that the higher the proportion of human-made features, the less appealing the view. Variation in vegetation type also provides a significant visual influence. The more diverse or 'green' the landscape, the more visually appealing it usually becomes.

Existing Environment

The region's undulating slopes are formed on the Permian sediments of the Bowen Basin. The dominant land uses around the project site are low intensity cattle grazing and agricultural cropping.

The topography of the site is generally flat with gentle hills and undulations, with changes in elevation on the site within a range of 50 m. There are no distinctive viewpoints surrounding the Project site.

Although the majority of vegetation is sparse due to historic land uses, buffers do exist and surround various extents of the Project site. Predominately, topography and vegetation provide the greatest buffers south and west of the Project site (benefiting those looking north and east onto the Project site), while other residences located near the northern extents and outside the MDL boundary are buffered by topography and distance.

Figure 4.39 shows the visual observation points. The views associated with these ground observation points are displayed in Photo Plate 4.1 through to Photo Plate 4.12.

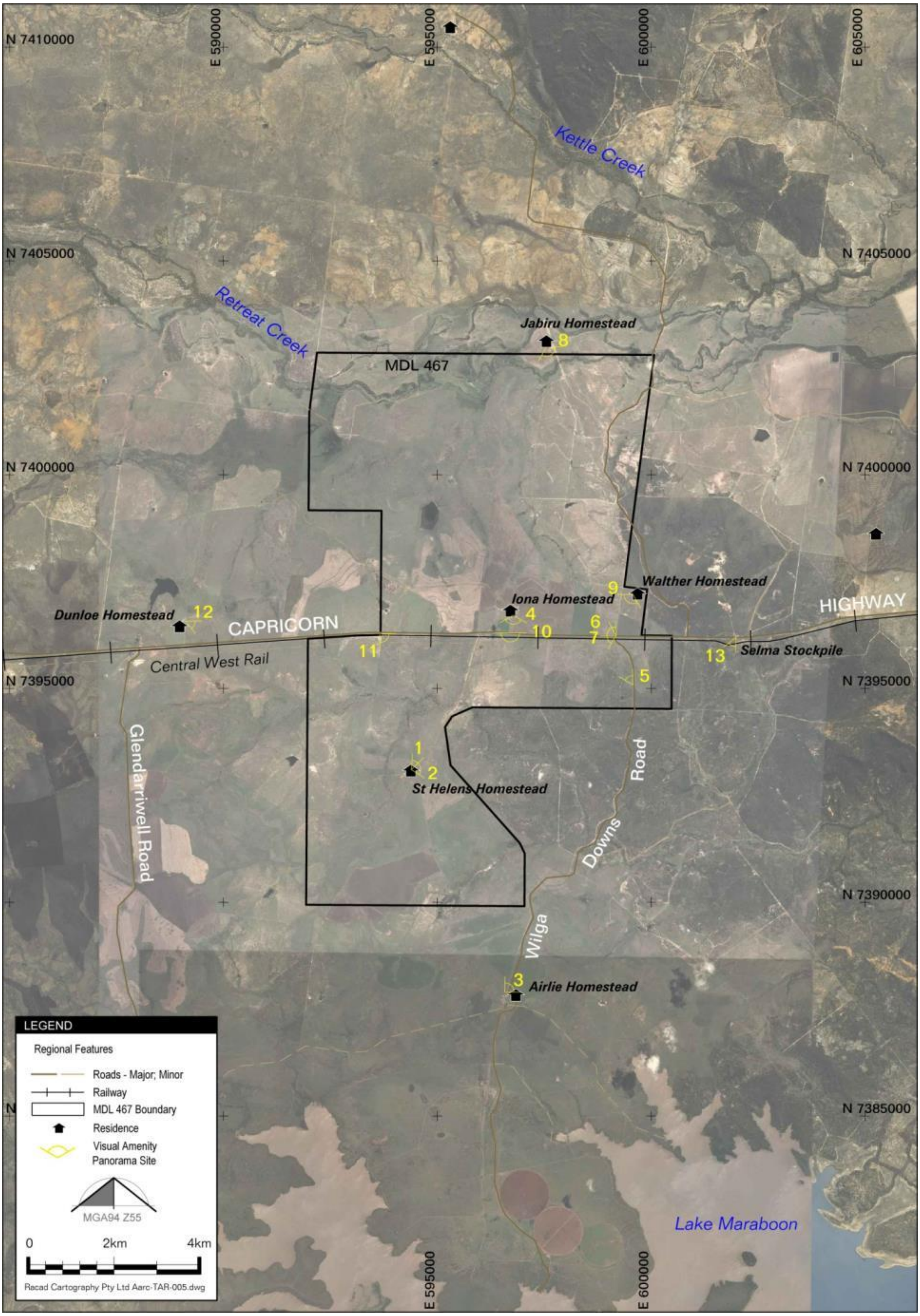


Figure 4.39 Photo Site Location and Panoramic Direction

Photo Plate 4.1 Visual Assessment Site 6: View from Capricorn Highway at the Wilga Downs intersection, looking westward and panning north.

Photo Plate 4.2 Visual Assessment Site 4: Iona homestead facing south panning south-east to south-west, directly in front of homestead by 50 metres.

Photo Plate 4.3 Visual Assessment Site 10: Capricorn Highway from Iona property gate facing south. Encompasses view of mine infrastructure area from the road.

Photo Plate 4.4 Visual Assessment Site 8: Photo taken in front of Jabiru Homestead looking south.

Photo Plate 4.5 Visual Assessment Site 13: Capricorn Highway near Selma Stockpile outside of MDL467, near the eastern boundary looking west.

Photo Plate 4.6 Visual Assessment Site 9: Walther Property on the eastern margin of the MDL467 panning south-east to west from the western side of the homestead.

Photo Plate 4.7 Visual Assessment Site 7: Southern side of the Capricorn Highway at intersection with Wilga Downs panning south-west to west.

Photo Plate 4.8 Visual Assessment Site 5: Wilga Downs Road on eastern side of MDL467, panning north-west to north.

Photo Plate 4.9 Visual Assessment Site 1: St Helens property, view panning north to northeast.

Photo Plate 4.10 Visual Assessment Site 3: Airlie property taken 50 meters in front of the homestead, panning from north to east.

Photo Plate 4.11 Visual Assessment Site 11: Capricorn Highway from western edge of MDL467, panning east to south from the south side of the road.

Photo Plate 4.12 Visual Assessment Site 12: Dunloe property on the western edge of MDL467. Taken from the south eastern corner of the homestead facing east.

4.2.2 Potential impacts and mitigation measures

4.2.2.1 Resource Utilisation

A pre-feasibility study was carried out by IMC Mining Solutions Pty Ltd (IMC) in 2009 to assess the viability for opencut and underground mining within the Taroborah resource area.

Within the Taroborah lease, sandstones and mudstones hosting the coal seams dip from a relatively shallow depth in the south to a deeper depth in the North. To maximise resource utilisation, opencut mining will be initiated in the early phase of resource extraction targeting the two shallowest seams (A and B) within the Permian sedimentary parent material. Underground mining will commence five years from the Project's commencement and will occur north of the Capricorn Highway and QR rail line targeting only the lower of the two seams (B seam), as the A seam is generally 1.5m thick or less and of poor quality (high ash and high sulphur), and therefore, not economically extractable by underground methods.

There are no other occurrences of economically extractable coal within MDL467.

Opencut Operation

The opencut production schedule assumes that the A seam and the upper portion of the B seam (B tops) will be selectively mined and washed to reduce sulphur levels. The lower portion of the B seam (B bottoms) does not require washing to deliver a suitable export quality thermal coal. The B bottoms represent 58% of the in situ coal and 68% of the product coal. This leaves 42% of the in-situ coal being the A seam and B tops, which when washed provides a product averaging 6.6% ash and 2.2% sulphur at a yield of 68.4%.

Production will steadily ramp up over 2 years to a maximum coal production rate of approximately 2.28 Mtpa ROM. Over seven years, a total of 11.11 Mt of ROM coal is mined. The volumes of waste produced per annum increases to around 30M loose cubic metres (lcm) and reach a maximum of 32M lcm by 2023.

On average, 1.59 Mtpa opencut ROM will be mined, delivering 1.07 Mt of bypassed raw product from the B bottoms and 0.51 Mtpa of washed product from the A seam and B tops.

It should be noted that the pre-feasibility study considered a larger opencut pit that extended eastward from the current pit boundary to around Wilga Downs road. However, the SCL legislation that was introduced after the pre-feasibility study was completed has resulted in the removal of this resource from the opencut mining plan as this area has been validated as SCA.

Underground Longwall Mining Operation

In the underground resource area at Taroborah, mining of only the B seam is contemplated due to the general thinness (<1.5m thick) and poor quality of the A seam together with its close proximity (<10m separation) to the underlying B seam. It is envisaged that the majority of the underground resource coal can be mined and sold as a <1% sulphur product without the requirement of beneficiation. This would be accomplished by selectively mining only the B bottoms section.

The proposed longwall mining layout is based on maximising the extraction of coal north of the highway. Thus, the main entries are located on the western side of the resource area adjacent to a postulated fault location, with the longwall panels laid out east-west and extending across to the postulated eastern boundary fault. The longwall mine plan contains 4.3 Mt ROM of development coal and 64.3 Mt ROM longwall coal (total underground ROM coal = 68.6 Mt). As minimal coal requires

washing due to the premises of selecting a <1% sulphur seam section, total washing yield averages 99.3% for a recoverable saleable coal total of 68.1 Mt.

It should be noted that potentially extractable coal exists to the north of the present underground mining limits, as well as in the area underlying the SCL south of the Capricorn Highway. Further feasibility assessment of the Project will consider extraction in these areas.

Coal Quality and Marketability (Efficiency and Waste Generation)

Thermal coal product with a sulphur content of less than 1% is saleable into any world market. The coal also has a favourable fuel ratio (Fixed Carbon % Volatile Matter %), meaning the products are high in volatile matter and suitable for use in modern power stations fitted with low NoX burners. This new burner design is widely used in Japan, Taiwan and Korea, which are traditional markets for Australian thermal coals.

Another property that will benefit the marketing of the Taroborah coal is the low ash content, which would aid sales to some utilities, particularly in Japan, where ash storage is restricted, and in some cases not allowed. These companies face very high charges from cement companies who take the ash away for use in clinker production.

Coal with sulphur content greater than 1% and less than around 5% is marketable in places such as Chile, Korea and in the Japanese industrial market, where power stations are fitted with sulphur scrubbers. However, selling this high sulphur quality coal is not guaranteed and will take significant market effort.

Higher sulphur levels in Seam A and B tops coal also have a relatively high amount of iron present in the ash. This iron is in the form of pyrite which cannot be removed by the washing process. The high iron in the ash may restrict its use as a cement additive due to its discolouration effect.

Waste from the opencut pit will be deposited above ground level for the first three years of operation, with backfilling of the void created by MDL467 opencut operations commencing in year 2.

Based on extraction techniques utilised in the underground operations, waste is not expected to be produced in large volumes with the majority of spoil produced in the opencut operations during the first 7 years of the Project.

Opencut production is anticipated to steadily ramp up over 2 years to a steady production rate before reaching a maximum ROM coal production rate of approximately 2.28 Mtpa. The underground operation is expected to reach a maximum ROM coal production of 5.75 Mtpa.

The magnitude of disturbance areas within MDL467 should be largely confined to the area located south of the Capricorn Highway consistent with the area necessary to accommodate the opencut pit, spoil dumps, ROM coal haulage, ROM stockpiling, rail load out facility and associated mine infrastructure. The disturbance areas for the Project become significant by year 2, with waste dumping expected to reach up to 20 million cubic metres and the majority of land clearing being undertaken during the construction period to accommodate mine infrastructure.

4.2.2.2 Land Use And Suitability

The suitability of the Project site to pre-mine land uses such as beef cattle grazing and rainfed broadacre cropping has been assessed. In most areas the land is suitable for beef cattle production with rainfed broadacre cropping areas mainly restricted to areas where soils have developed from

basalt.

Opencut mining in the south of the Project Site will have a permanent impact on the land, particularly the soils occupying this area. Topsoil will be stripped and stockpiled and used in other areas of the Project site.

It is expected that for all temporary disturbance occurring within the Project site the land be returned to primary production. In instances where this is not possible the land should be returned in a condition that will regenerate over time and be designated as a "Conservation" area until the land has sufficient time to maintain equilibrium within the landscape.

Good Quality Agricultural Land will be disturbed by mining operations south of the Capricorn Highway. Although not currently used for cropping, Class A land which has the potential to support broadacre dryland cropping will be affected by temporary and permanent impacts caused by mine infrastructure. In areas of temporary disturbance it is expected that the post mine land use will be similar to that of pre-disturbed areas of land. This means that all potential reserves of topsoil will need to be re-distributed and seeded to stabilise these disturbance areas.

SCA south of the highway that has been cropped in the past will not be impacted by mine infrastructure due to the selective location of infrastructure to avoid this SCA. A large tract of land north of the highway will be temporarily disturbed due to proposed underground mining in this area as discussed below in Section 4.2.2.3. This area of temporary disturbance will most likely cause the above ground surface to slump which in turn will affect the hydrology of this area. Modelling has been carried out to determine the extent of this slumping based on a Longwall underground mining methodology. It is envisaged that this temporary impact will have a minimal disturbance on soil material and likely post mine land use.

Mitigation of disturbed SCA zones will require topsoil to be replaced within the landscape. This means that prior to the installation of infrastructure, stripping of recommended levels of topsoil and other surface materials should be undertaken. Exposure of dispersive subsoils should be avoided where possible to reduce any erosion and hence loss of soil in runoff water. Riparian zones bounding Retreat and Taroborah Creeks should be preserved to act as buffers against the movement of any sediment that may be generated during the life of the mine.

Stripped topsoil should be removed in such a way that there is no exposure of constrained subsoil material to the atmosphere. Soil should be stockpiled in a way that preserves the original attributes of the soil. This means that nutrient levels, soil structure and soil biological material including organic matter is maintained. These stockpiles should be bunded to reduce soil loss. A soil ameliorant such as lime or gypsum may be applied to assist in the maintenance of soil physical properties.

Subsidence due to underground mining may impact on the local surface hydrology. Soil attributes such as wetness may be affected due to a change in the surface hydrology. Water may pool in areas of subsidence leading to anaerobic and water logging conditions in the subsoil. This may affect the suitability of these areas for post mine land uses. The free drainage of surface water courses will be maintained by the limited excavation of sediment in areas where creek flows are impeded.

The shallow slopes caused by underground mine subsidence will not have a significant impact upon SCA, however any tension cracks and soil erosion will be addressed via filling in of the cracks and / or the application of topsoil to sectors of SCA which have lost their soil surface layer.

With a typical differential subsidence of 0.8m over 110m in the current cropping areas (and maximum of 1.1m over a distance of 130m), post-completion slope above the underground operations will

remain fundamentally similar to the existing conditions, and appropriate mitigation measures as discussed above will ensure drainage is unaffected, with the result that there should be no long-term impact on agricultural yields. Based on evidence and research at Crinum and Kestral mines, located approximately 50km north-east of Taroborah, as well as in the Illinois Basin in the USA, where incidentally the land in both areas is much flatter than at Taroborah, it is expected that all currently cropped land will return to production at 90% or greater of its existing yields at the completion of the project with little or no effect to soil fertility.

Residual features in the landscape include the two final voids and three spoil dumps, which will persist following mine closure. Realistic gradients and slope lengths must be developed for spoil material so that the redistributed topsoil and re-established vegetation have a chance of stabilising these landforms. Soil loss mitigation strategies will be carried out to minimise soil loss using sediment retention ponds, landforms that follow natural contours, stepped slopes that have been ripped and seeded and utilising landform designs that encourage natural drainage of water in lower areas within the landscape. Designs that reduce the velocity or volumes of runoff water have the potential to reduce the erosivity of the water leading to favourable soil loss outcomes. Landscape/landform designs will be built so that after significant rainfall events, runoff and any suspended sediments are able to be captured before they leave the Project site.

While the opencut will unavoidably result in a final void being left behind, this will be on some of the least productive area of the tenement, and one which is not currently used for cropping, and has not been used for this purpose previously. The grazing characteristics of the land south and north of the highway will be largely unaffected on those tenements falling within the Project area. Careful consideration will be given to improving stocking rates on these properties through reticulation of excess water.

The Proponent will seek to minimise the impact of mining operations on agricultural production during and after the life of the Project. Cropping and grazing will continue on as much of the land as possible during mining. Where properties are purchased to enable the project to take place, the Proponent will seek to keep unaffected areas of those properties in production during the life of the project. Consideration will also be given to reticulation of excess water from mine dewatering for agricultural purposes, where possible, to improve productivity.

4.2.2.3 Subsidence

This section provides an assessment of the predicted subsidence as a result of underground longwall mining at the proposed Taroborah Coal Project. Longwall mining involves the progressive extraction of blocks of coal in panels. The longwall extraction method causes the roof above the seam to collapse or cave. The caving of the immediate strata causes the lowering of the overlaying strata and results in surface subsidence. Mining related subsidence is relatively predictable and is based on modelling the site specific geological data and interpretation of the overburden strata (refer to Section 4.2.1.3 for details of the local geology).

The Surface Subsidence Assessment for the Taroborah Project is provided in Appendix 10.

Subsidence Modelling

Subsidence prediction was conducted using Surface Deformation Prediction Software (SDPS), a software package that utilises the Influence Function method. The Influence Function method calculates a number of surface deformation indices based on the digitised mine plan and digitised cover depth contours. The model was calibrated using research and data from the Goonyella

Extension Project, and recent documented industry experience, yielding subsidence predictions that are considered credible.

Model Parameters

The maximum subsidence factor, expressed as Smax/m, represents the maximum vertical displacement of the profile per metre of extraction height. The SDPS model includes this as a function of the width-to-depth ratio and the percentage of hard rock in the overburden, as indicated in Table 4.16.

All panels on the Taroborah Project are considered ‘supercritical’, with width-to-depth (W/h) ratios of approximately 1.6 for the northern area of the mine layout, and >2 for the southern and central sections. Supercritical extractions typically result in flat-bottomed subsidence troughs.

The angle of influence represents the angle between the horizontal and the line that connects the projected inflection point position of the subsidence trough at coal seam level to the surface point of ‘zero subsidence’. The angle of influence for the Project was set at 56° based on experience of adjoining mining operations.

A default SDPS strain coefficient of 0.35 was used due to the lack of detailed subsidence data.

Table 4.16 SDPS Maximum Subsidence Factors for Longwall Panels

	Percent Hardrock in the Overburden							
W/h	10%	20%	30%	40%	50%	60%	70%	80%
0.6	0.64	0.59	0.51	0.42	0.34	0.26	0.21	0.16
0.7	0.69	0.63	0.55	0.46	0.36	0.28	0.22	0.18
0.8	0.71	0.65	0.57	0.47	0.38	0.29	0.23	0.18
0.9	0.72	0.66	0.58	0.48	0.38	0.30	0.23	0.19
1.0	0.73	0.67	0.58	0.49	0.39	0.30	0.24	0.19
1.1	0.74	0.68	0.59	0.49	0.39	0.31	0.24	0.19
1.2	0.74	0.68	0.59	0.49	0.39	0.31	0.24	0.19
1.3	0.74	0.68	0.60	0.49	0.40	0.31	0.24	0.19
1.4	0.75	0.69	0.60	0.50	0.40	0.31	0.24	0.19
1.5	0.75	0.69	0.60	0.50	0.40	0.31	0.24	0.19
1.6	0.75	0.69	0.60	0.50	0.40	0.31	0.24	0.19
1.7	0.75	0.69	0.60	0.50	0.40	0.31	0.24	0.19
1.8	0.75	0.69	0.60	0.50	0.40	0.31	0.24	0.19
1.9	0.76	0.69	0.60	0.50	0.40	0.31	0.24	0.19
2.0	0.76	0.69	0.60	0.50	0.40	0.31	0.24	0.19

Source: IMC 2013

Limitations

The SDPS model has a number of limitations; however these are not considered likely to generate material difference to the predicted outcomes and impacts. The SDPS model assumes symmetrical panels, however, as all undermined panels for the Taroborah Project are of a similar width, this assumption is valid. Further, incremental or dynamic subsidence effects are not modelled in the SDPS approach. This is not considered a significant issue, as the final modelled subsidence impacts will be greater than any incremental impacts. Finally, anomalous subsidence effects, such as subsidence associated with faulting, are not accounted for in this model. However, experience from other Bowen Basin longwall mines indicates that subsidence associated with, for example, faulting, is typically

localised and easily mitigated or rehabilitated.

Subsidence Predictions

Contours of modelled subsidence parameters following extraction are indicated in Figure 4.40 to Figure 4.43 and discussed below.

Magnitude of Subsidence

An overall lowering of the surface profile, shown in Figure 4.40, is expected to occur following B seam extraction by longwall mining. In the central and southern areas, subsidence is predicted to reach a maximum of approximately 1.9m, which is equivalent to 63% of the extraction thickness. Modelled subsidence in the northern section (where the B seam thickness reduces to 2.5m) is predicted to reach a maximum of approximately 1.4m, equivalent to 56% of extraction thickness.

Strain Predictions

Predicted strain following B seam extraction is shown in Figure 4.41. Strain, either tensile or compressive, is a result of differential horizontal movement. Areas of tensile strain are predicted to reach a maximum of 12 millistrains (mm/m) and are associated with the interface of the longwall panel edge and chain pillar. Modelling indicated compressive strains in panels up to a maximum of approximately -8 mm/m. Compressive strain does not equate to 'supersidence' (positive subsidence).

Tilt Predictions

Tilt represents the difference in subsidence between two points, divided by the distance between the points. Tilt variations are reflective of predicted maximum strains at the interface of the longwall panel edge and chain pillar. Predicted maximum tilts, expressed as percentages, around the perimeter of longwall panels are typically approximately 1.2%, as shown in Figure 4.42.

Curvature Predictions

Curvature, expressed in hundreds of ppm, represent the rate of change in tilt. Predicted curvatures for the Taroborah Project are indicated in Figure 4.43. The highest curvatures typically occur in high strain zones adjacent to the longwall panel edge and chain pillar interface, and near the maximum subsidence trough. Typical maximum curvatures are predicted to range from approximately -260 ppm in roadways and periphery of panels and approximately 160 ppm around panel centres.

Pre and Post Mining Topography

The pre and post mining topography of the Project site are presented in Figure 4.44 and Figure 4.45, respectively. The topography of the site is gently undulating, with elevation ranging from RL240 in the south and along the eastern and western boundaries, to RL200 towards the north of the site. Minor differences in elevation are evident in the post mining topography. General drainage patterns will not be significantly affected by subsidence, indicated by the small difference between subsidence amounts at the panel centres compared to over the chain pillars between panels.

Two cross sections (LS1 and LS2) have also been developed along creeks that will be subjected to subsidence and run tangentially to the lines of subsidence (refer to Figure 4.46 for details of these cross sections). These cross sections demonstrate that the land subsidence created by underground mining will not significantly alter the topography of these creeks and only limited potential for ponding will arise.

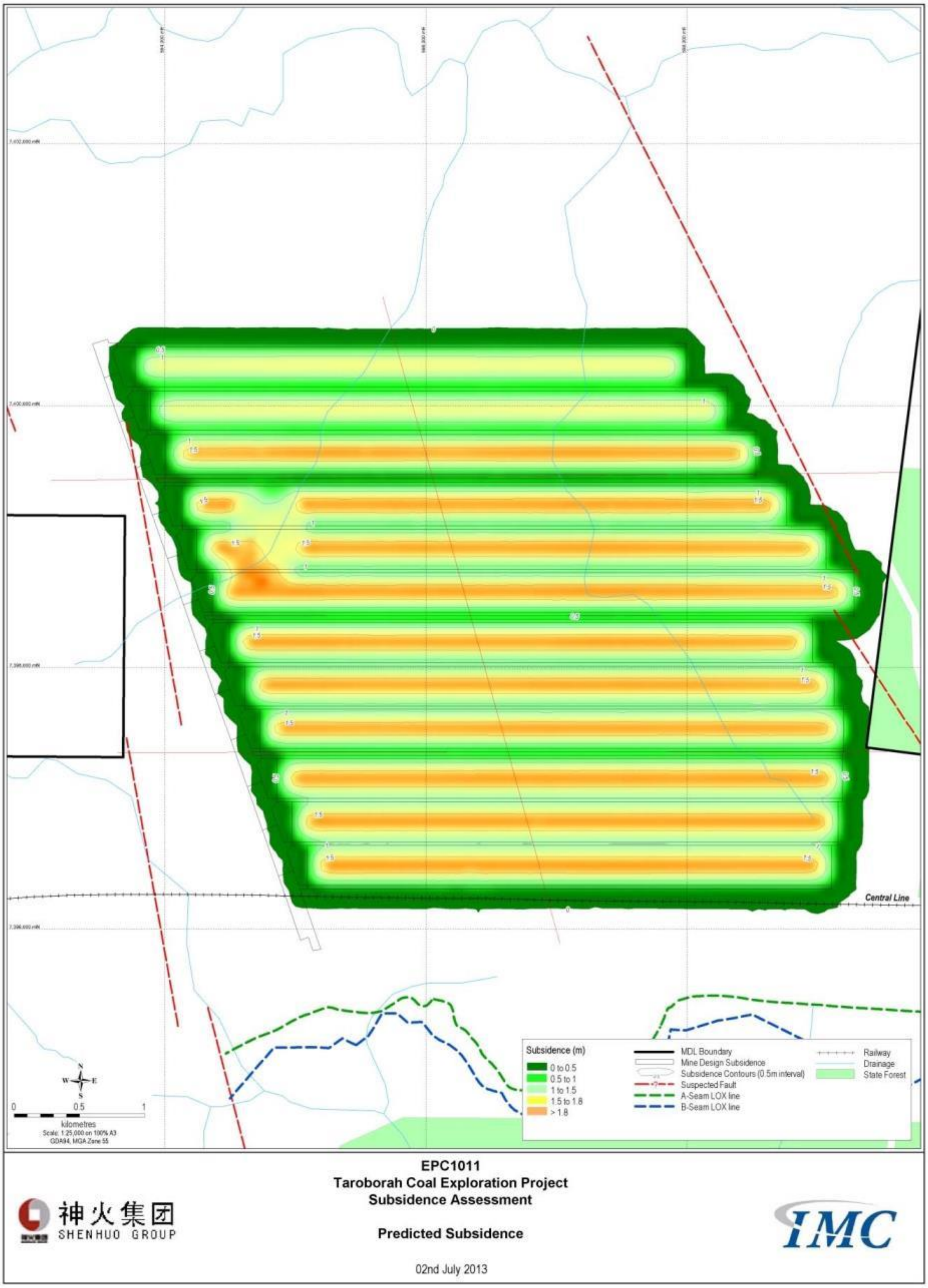


Figure 4.40 Predicted Subsidence for the Taroborah Mine Layout

Figure 4.41 Predicted Strain for the Taroborah Mine Layout

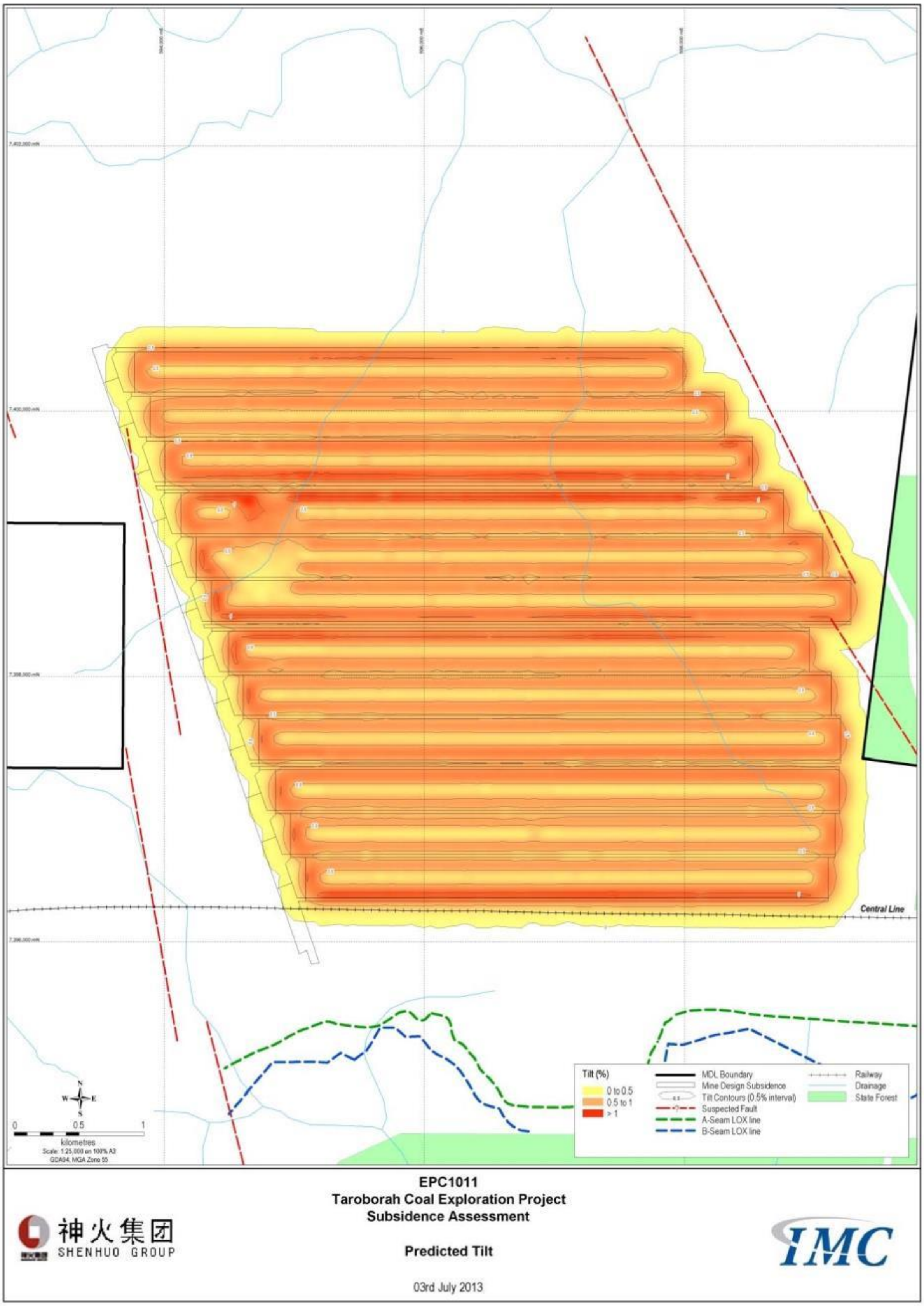


Figure 4.42 Predicted Tilt for the Taroborah Mine Layout

Figure 4.43 Predicted Curvature for the Taroborah Mine Layout

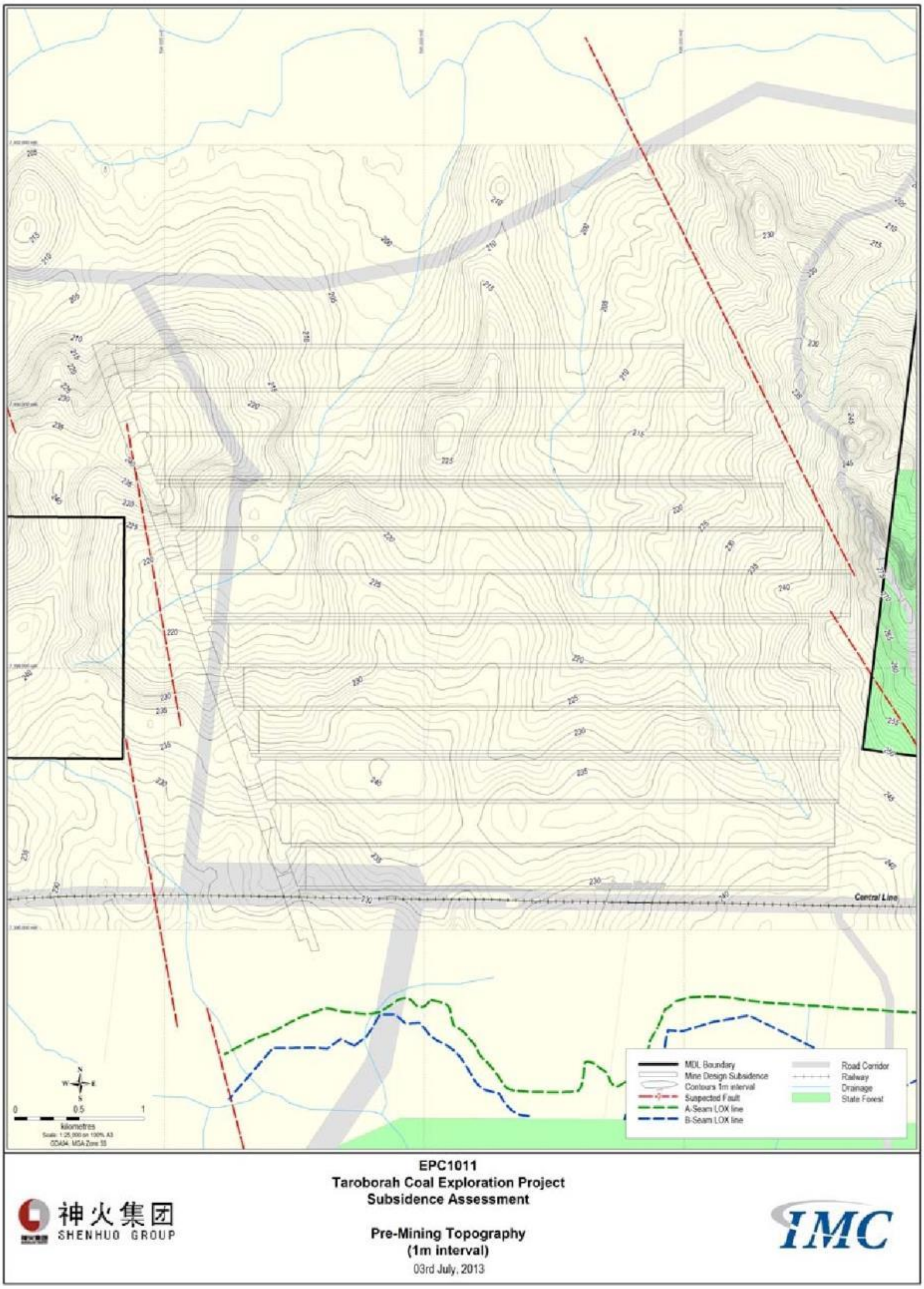


Figure 4.44 Pre Mining Topography

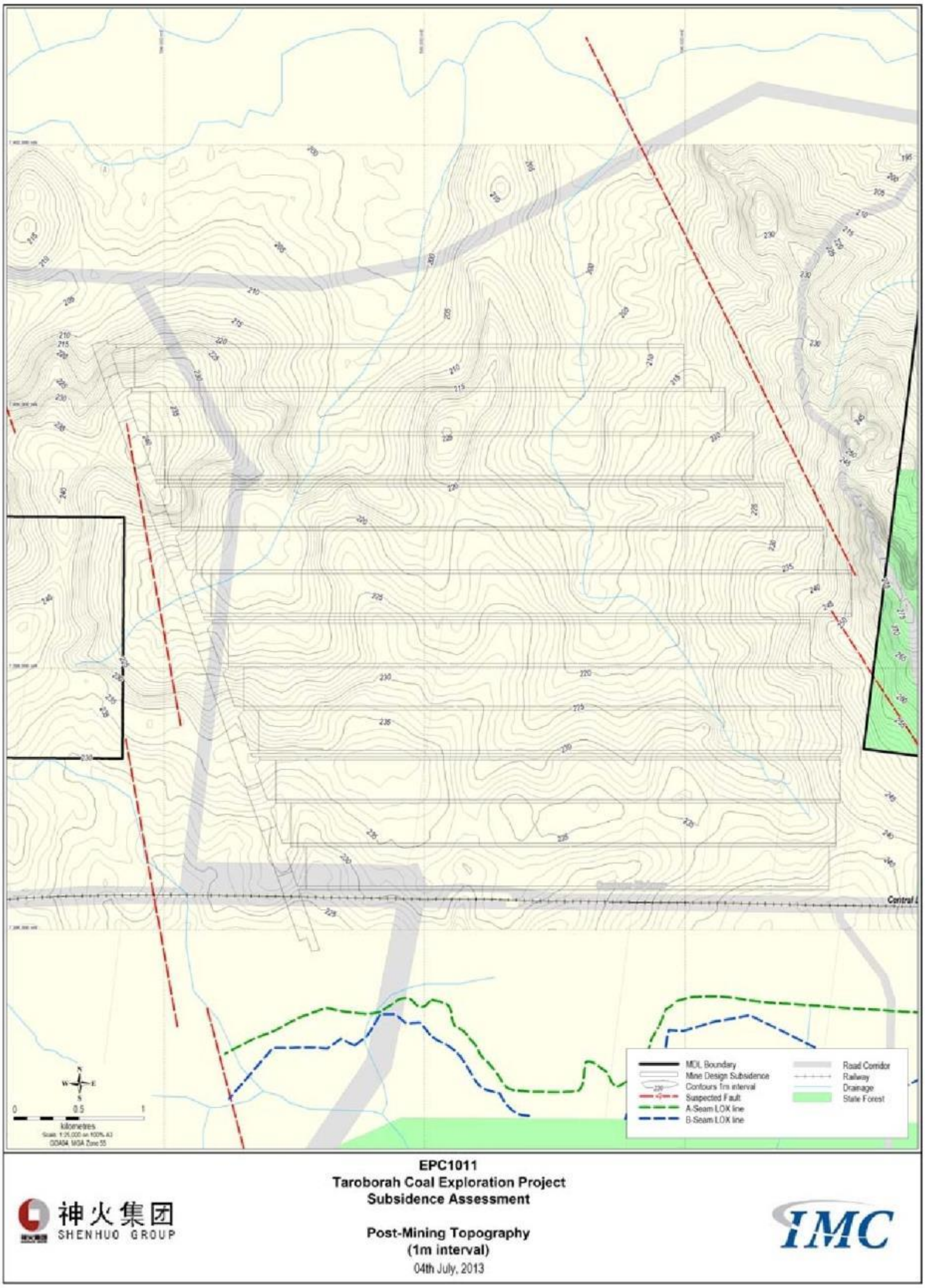


Figure 4.45 Post Mining Topography

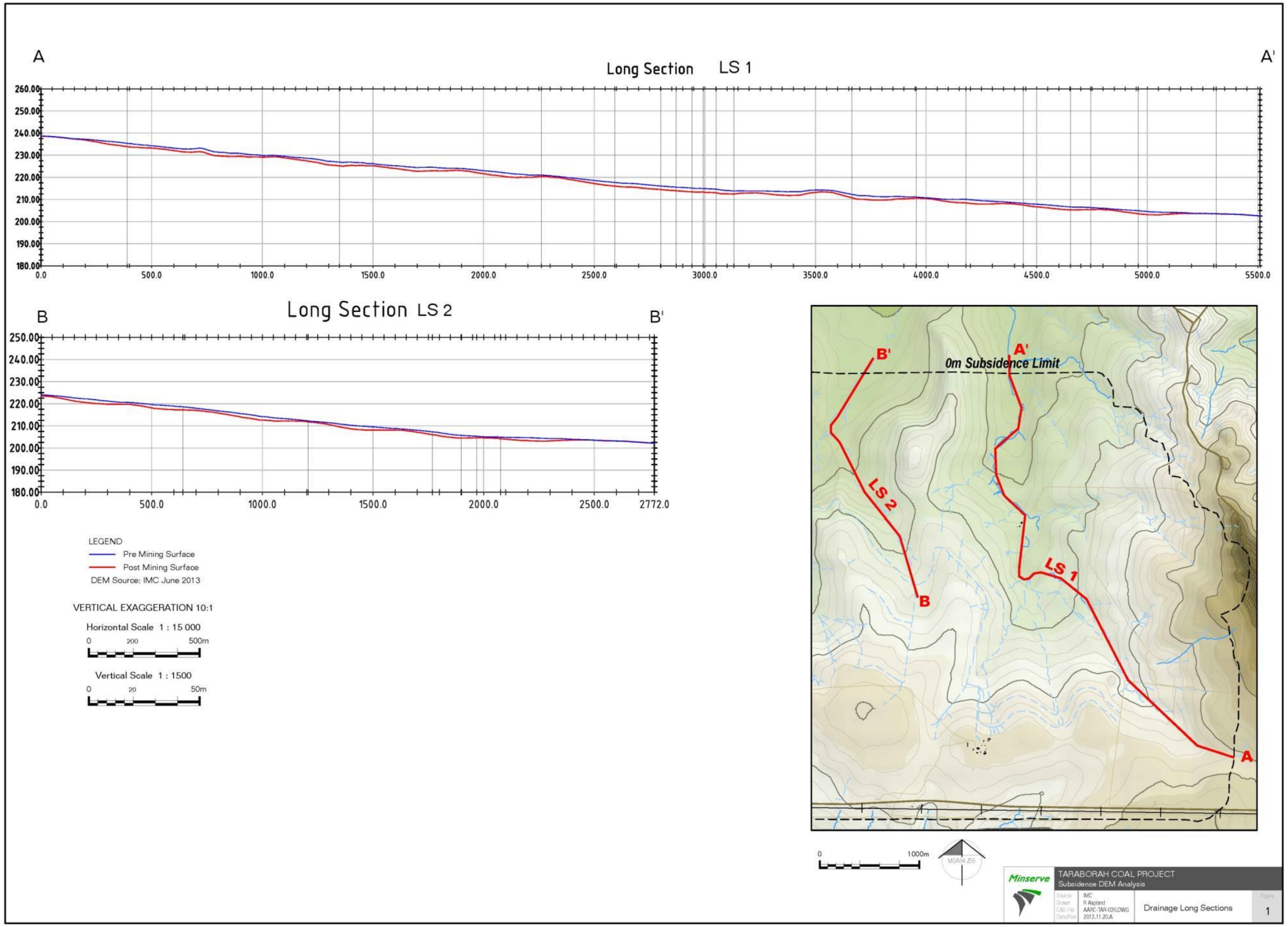


Figure 4.46 Pre and Post Mining Creek Cross Sections

Subsidence Impacts

The predicted subsidence and strain described above are likely to have some impact on the surface landscape. Following undermining of the seam, a zone of surface tension over the chain pillars is expected to result in surface cracking, extending approximately 35m either side of the chain pillar centreline. Cracks with a maximum width of 0.2 – 0.3m and maximum depth of 5m are considered a worst case scenario. Rehabilitation of these tensile cracks will be required, and will consist of remedial earthworks and sealants.

Compressive strains over the central area of the longwall panels are anticipated to occur. Compression may manifest as humping on the surface, likely requiring minor remedial earthworks should it occur.

Subtle alterations to the Project site's drainage profile are predicted to occur as a result of subsidence (see Figure 4.43) and are discussed further in Section 4.5.2.1 of this EIS. Subsidence management strategies will be implemented to mitigate impacts to surface drainage and sensitive surface features. Subsidence impacts on watercourses are addressed in further detail in Section 4.5.2.1 of the EIS.

Transport Infrastructure

The initial proposed longwall panel at Taroborah runs parallel to, and immediately north of, the Capricorn Highway and Central West railway line corridor. As such, and due to the relatively conservative angle of draw assumed for the subsidence modelling, this transport infrastructure is predicted to be minimally impacted by subsidence from the longwall mining operation. Figure 4.47 provides a plan view of the location of the Capricorn Highway and Central West railway line in relation to the planned longwall panels at Taroborah and also illustrates the magnitude of predicted subsidence following extraction of the initial longwall panel.

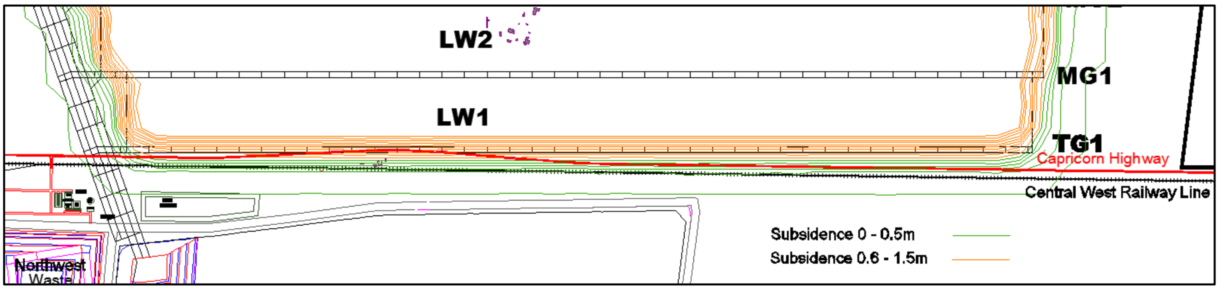


Figure 4.47 Predicted Subsidence Along the Capricorn Highway and Central West Railway Line

As projected, the Central West railway line is anticipated to undergo a maximum subsidence of approximately 0.3m at the western extent of the subsidence area, but will generally experience subsidence of 0.2m or less. Being located further northward and closer to the longwall panel, the Capricorn Highway will experience subsidence of up to 0.9m, but will generally experience subsidence of 0.6m or less. The gentle angle of the predicted subsidence trough as well as the orientation of the transport infrastructure in relation to the trough means that the maximum grade change (tilt) that the railway line will undergo is approximately 0.3-1.0% (i.e. subsidence of 0.1m over a distance of 35m horizontally and 11m laterally), while maximum strain is predicted at <4mm/m. The maximum grade change for the highway is in the range of 0.5-1% with similar strain. This level of tilt and strain is not expected to result in significant cracking or damage to the highway surface or the railway track based on experience in NSW, and therefore should not represent a significant hazard to vehicular or rail traffic or require extensive remedial works. As an additional precaution, the railway line will be

engineered to undergo twice this level of strain and tilt during the necessary upgrades required to service the mine.

Due to the orientation of the longwall panels to the Capricorn Highway and Central West railway line, the expected subsidence will be a one-time event that will occur over a period of approximately 12 months, with the leading edge of the trough advancing from east to west as the longwall panel is mined at a rate of approximately 15 - 18m per day. In general, the subsidence will be gradual with the full extent along the transport corridor expected to occur within approximately 3 weeks of undermining.

Prior to longwall mining, a comprehensive Subsidence Management Plan (SMP) will be developed and compensation agreements put in place with the DTMR to mitigate any damage from subsidence. As part of the SMP, during extraction of the first longwall panel, suitable warning signage and speed limit reduction will be posted along the highway, and the highway will be monitored daily for significant cracking should it occur and repaired accordingly.

4.2.2.4 Land disturbance

The construction and operational phases of the Project necessitates the disturbance of approximately 2,693 hectares of grazing land and natural habitat within the MLA areas. Table 4.11, previously presented, outlines the mining activities that will cause land disturbance to some extent and the maximum expected area of disturbance resulting from the Project. The mine stage plans included in Section 3.3.4.1 show land disturbance changes over the life of the Project.

Land disturbance on the Project will be a temporary impact only during the construction and operational phases of the Project. All land disturbances on the Project will be rehabilitated either progressively if possible, or on decommissioning to minimise potential environmental impacts from land disturbance. The two final voids will be the main areas of land disturbance that cannot be rehabilitated.

Land disturbance on the Project may result in the following potential impacts:

- The temporary reduction of habitat for flora and fauna;
- Potential to impact on areas of cultural heritage importance or nature conservation;
- Topsoil removal, loss, compaction and diminished viability;
- Increased soil erosion (wind and water)
- Diversion of overland flow and catchment redefinition;
- Vegetation clearing; and
- A reduction of the land suitability of the Project site.

Management strategies will be implemented to minimise the amount of land disturbance on the Project, these strategies include:

- The minimum amount of land that is required in order to construct and operate the Project safely will be cleared at any one time;

- Progressive rehabilitation will be conducted on the Project where possible where the aim is to reduce water erosion, emissions of dust and to gain a better understanding of effective rehabilitation and revegetation methods prior to the decommissioning of the Project;

- On decommissioning of the Project, all land disturbance areas no longer required will be rehabilitated as per the methodology outlined in EIS Section 3.7;

- Soil erosion control strategies will be implemented for all land to be disturbed or cleared as discussed in Section 3.7.6;

- A system of permits to authorise land disturbance on the Project will be implemented during the construction and operational phases to ensure all land disturbance: has been authorised by management, is conducted in a manner as to create the least environmental impact in regards to clearing of vegetation and impact on fauna, is subject to erosion control measures, includes topsoil stripping and stockpiling; and

- Topsoil stripping will be conducted to ensure that the maximum volume of topsoil is recovered during land clearing and that it is stockpiled and utilised in rehabilitation in a manner to ensure its viability while preventing erosion and compaction. Methods of topsoil stripping and stockpiling on the Project are summarised below.

Topsoil Management

Prior to the development of any infrastructure on the Project, topsoil and vegetation will be removed from the footprint area and stockpiled. Stockpiled vegetation may be chipped or used whole in revegetation works at a later date. Smaller vegetation and grasses will be removed with the topsoil.

In order to maintain the fertility of any topsoil excavated on the Project site (in terms of seed-stock viability, healthy micro-organism populations and nutrient values) recommended maximum stripping depths for each SMU have been developed as follows, including reasons for each of the selected stripping depths (refer to Table 4.17 for details of these maximum stripping depths).

Table 4.17 Soil Management Units (SMU) and their Stripping Depths

SMU	Stripping Depth (cm)	Limitation
Orion/Jimbaroo	60	No limiting physiochemical properties Depth to parent rock variable
Adelong	30	Extreme pH Moderate sodium levels
Adelong/College	30	Extreme pH Sodic subsoil
Rolleston/Glengallan	10 *	Moderately saline and sodic
College/Lascelles	30	Highly alkaline pH High soluble salts and sodium
Glengallan	10 *	Shallow parent material
Glen Idol	30	Alkaline
Jimbaroo	20	No limiting physiochemical properties

* note that this thickness is too thin for practical soil stripping and therefore, soil horizons below this SMU will inevitably be included in the stripping process.

The volumes of soil available from each SMU (based upon the recommended SMU maximum stripping depths) are summarised in Table 4.18 and discussed in more details below.

Assuming a material handling loss of 10%, the estimated volume of soil that would be available for re-use in post mining rehabilitation is approximately 1,594,460m^3.

Table 4.18 Approximate Volumes of Topsoil Available for Rehabilitation on the Project Site

Soil Management Unit	Approximate Surface Area to be Disturbed (ha)	Stripping Depth (m)	Approximate Volume of Topsoil Available for Rehabilitation (m^3)
Orion/Jimbaroo	173.3	0.6	1,039,800
Adelong/College	100.8	0.3	302,400
Rolleston/Glengallan	178.9	0.2 *	357,800
College/Lascelles	0.2	0.3	600
Glengallan	15.0	0.2 *	30,000
Jimbaroo	28.4	0.2	56,800
Total	**496.6**		**1,787,400**

* note that the recommended thickness is too thin for practical soil stripping and therefore, a thickness of 0.2m has been used for estimating volumes.

Topsoil will not be stripped during wet conditions as this may cause significant compaction of the topsoil stockpile, destroy the natural structure of the soil and reduce oxygen diffusion into the stockpile.

Topsoil material stockpiles will be located in areas away from drainage lines, roads, machinery, transport corridors and stock grazing areas. Topsoil stockpiles will be managed in order to maintain the viability of the seed bank and microorganisms within the stockpile.

Stockpiling of soils, should ensure that slope angles are relatively shallow and that slope lengths are relatively short. These two management strategies should assist in reducing soil erosion and decreasing runoff. Where possible, topsoil stockpiles will be located on relatively flat areas and will not be located on steep slopes. Rainfall run-off will be directed away from stockpile areas, and runoff from the stockpile area itself will be controlled with either a small earthen bund or sedimentation dams downstream of the stockpiles.

The stockpiles may need to be ripped and seeded with a quick establishment pasture, to limit erosion and maintain a viable seed bank if the period of stockpiling is greater than one growing season or six months. Topsoil stockpiles will be clearly signposted for easy identification and to avoid any inadvertent losses or disturbance. Establishment of weeds on the stockpiles will also be monitored and controlled.

Rehabilitation Success Criteria

The rehabilitation works at the Project site will aim to achieve the rehabilitation goals and return all land disturbed at the Project site to a state that is:

- Safe to humans and wildlife;

- Non-polluting;
- Stable, and
- Able to sustain the agreed post mining land use.

EIS Sections 3.7.3 and 3.7.5 provide further details of the post mine land use for individual mine areas and domains.

Preliminary completion criteria have been developed for the Project site to provide standards for determining successful rehabilitation for each domain at the mine site. Completion criteria take the form of a set of measureable benchmarks against which the rehabilitation indicators can be compared to determine if the chosen objectives are met.

Evidence of the completion criteria having been addressed will be collected as part of the rehabilitation monitoring program to assist in determining rehabilitation success. The domains within the Project site are deemed to be successfully rehabilitated when completion criteria for each rehabilitation goal and objective have been met over a long term period determined appropriate to the level of environmental risk presented by the final landform.

The preliminary completion criteria against which rehabilitation monitoring is to be judged are as follows:

- Evidence that all safety precautions have been taken in accordance with the relevant legislation;
- Certification that final landform is structurally sound and safe to people and animals;
- Evidence that post closure monitoring (air, soil, water, stream sediments) shows the final landform is compliant with limits in the relevant Environmental Protection Policies or other agreed limits;
- Evidence that all exploration sites have been cleaned up and rehabilitated to an acceptable standard;
- Evidence of remediated landform in a contaminated land assessment report;
- Evidence that monitoring data is meeting specified contaminant and trigger levels that ensure environmental values are not being compromised;
- Certification that the waste disposal site has been clearly covered to prevent any release or seepage of hazardous or contaminated material;
- Evidence that monitoring data demonstrates the cover is functioning in preventing any release or seepage of any hazardous or contaminated material;
- Evidence of geotechnical studies to determine whether final landform is stable and structurally sound;
- Evidence that appropriate risk assessment and control measures have been undertaken;

- Evidence that required sediment control structures are in place and functioning correctly;
- Certification that infrastructure sites (both remaining and decommissioned) have the required structures to control water flow and runoff;
- Evidence of geotechnical studies to determine whether the final landform is stable and material is competent; and
- Evidence that all soil chemical, physical and biological properties are within acceptable limits that ensure soil is able to support post-mining land use.

Details of the decommissioning and rehabilitation of the Project are described in Section 3.7

The long term stability of the final landforms, including spoil dumps and final voids, and the associated residual risks will be assessed as part of the Project's rehabilitation and decommissioning strategy. The safety of the final void will be assessed by a suitably qualified geotechnical engineer as described in Section 3.7.8.

Water resources and drainage across the Project site is discussed in Section 3.5.3 and Section 3.5.4. Ongoing monitoring of water quality, as part of the rehabilitation strategy discussed in Section 3.7.10, will assist in identifying landform stability, seepage and water quality issues.

4.2.2.5 Land Degradation Or Contamination

The risks of land degradation or contamination have been assessed for the Project and summarised as follows;

- Dam failure – release of contaminated water and sediment from the mine waste water, CPP recycle or sediment dams as a result of dam wall failure;
- Dam pipeline failure – leakage of contaminated water from dam pipelines;
- Dam flooding – overtopping of dam during storm periods resulting in contamination of land by dam water;
- Fuel spillage – vehicle / equipment filling spillages, ruptures in fuel storage tanks, ruptures in vehicle fuel storage tanks;
- Bulk chemical storage – dispensing spillages and tank ruptures;
- Spoil dumps and ROM stockpiles – surface water runoff and leachate seepage;
- Coal conveyors - spillage of coal as it is being transported from stockpiles to the CPP;
- Operation of light / heavy vehicles, machinery and equipment – leakage of hydrocarbons from fuel tanks, resulting in subsequent land contamination;
- Washdown bay – release of contaminated water and sediment from vehicle washdown bays;
- Workshops – release of hydrocarbons from workshops via accidental spills and release of hydrocarbon-contaminated sediment;

- STP – release of untreated sewage from the STP either via STP overflow or tank rupture;
- Floods – soil erosion as a result of excess surface water runoff;
- Haul truck accidents – loss of ROM material onto the ground in the event of a haul truck accident; and
- Rail transport of coal – spillages of coal from rail wagons.

Mitigation Strategies

In response to the above contamination risks, the following contaminated land mitigation strategies have been generated:

- Dam failure – annual dam inspections will be conducted in order to mitigate the risk of dam failure and any necessary remedial actions conducted as soon as possible, to ensure that minor dam problems do not develop into significant dam structural issues;
- Dam pipeline failure – visual inspection of dam pipelines should be conducted on a regular basis in order to identify any initial pipeline leakages that may arise;
- Dam flooding – the dam should be designed so that its storage allowance can accommodate most flooding situations;
- Sedimentation Dams or Stormwater Dams - will be installed for all catchment areas downstream of the mine infrastructure area, spoil dumps and processing infrastructure to contain any spills or contaminated stormwater runoff;
  - Detailed design of all designated hazardous dams at the Project site will adhere to the design parameters that have been determined in accordance with the DERM *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams* (2012), which will ensure such facilities are very unlikely to overflow; and
  - All sediment dams have been designed to hold 1 in 10 year Annual Recurrence Interval runoff.
- Fuel spillage – fuel dispensing areas and storage tanks should be constructed to the necessary standards, in order to avoid spillages All chemical and hydrocarbon storage and handling facilities will be appropriately bunded, spill kits available, and spills cleaned up immediately;
- Bulk chemical storage – in order to avoid chemical spillages, chemical dispensing areas and storage tanks should be constructed to the necessary standards;
- Spoil dumps and ROM stockpiles – the drainage system which is installed around spoil dumps and ROM stockpiles should be maintained, in order to minimise the risk of surface water runoff and leachate seepage resulting in contaminated land;
- Coal conveyors - regular visual inspections of coal conveyor systems should be conducted, to identify any spillages of coal and remediate such spillages as soon as possible;
- Operation of light / heavy vehicles, machinery and equipment – vehicles, machinery and

equipment must be properly maintained, in order to reduce the risk of hydrocarbon leakage;

- Washdown bay –vehicle washdown bays must be maintained correctly, in order to minimise contaminated water and sediment release;

- Workshops – the drainage system surrounding the workshops must be properly maintained to reduce the risk of hydrocarbon release, The maintenance of workshop equipment and machinery must be conducted on a regular basis, in order to reduce the risk of hydrocarbon spillage;

- STP – correct maintenance of the STP is required in order to minimise the risk of sewage spillage The sewage treatment plant will be designed to cater for the maximum number of personnel that can be accommodated on the site at one time;

- Haul truck accidents – loss of ROM material onto the ground must be removed and remediated as soon as possible;

- Rail transport of coal – spillages of coal from rail wagons on-site will be removed and remediated;

- Local groundwater **–** potential contaminants of concern will be included in future rounds of groundwater monitoring and chemical analysis, particularly in areas where livestock dips have been buried, drum stores and above-ground storage tanks exist. Additional down hydraulic-gradient groundwater bores may be required in order to assess such impacts;

- Once the project is operational, a register and map of all potentially contaminated sites and any remediation details, will be kept on site and updated regularly;

- Any Notifiable Activities will be recorded on the Environmental Management Register;

- A Spillage Management Plan and an Emergency Plan for all hazardous materials stored on-site, together with a description of suitable equipment and training will be developed for the Project; and

- Rubbish disposal areas and sewage treatment sites on the Project will be rehabilitated so as to remove any surface land contamination, and provide for safe, stable and self-sustaining landforms.

4.2.2.6 Erosion and Stability

Landform Stability

Results of exchangeable cation testing indicate most overburden/interburden materials are unlikely to be sodic. However, clay and soil within 12m or so of the surface may be partly sodic and subject to surface crusting and high erosion rates if placed on the surface of the dumps and exposed directly to rainfall. Materials with sodic potential should be treated (with gypsum or lime) if exposed on dump surfaces or used in engineered structures. Section 3.6.3.2 describes the method employed for spoil disposal which considers the handling of dispersive material. This method will ensure long-term stability of the spoil dumps over the life of the project.

Revegetation and natural sedimentation have been identified during the concept designs as being key

features in ensuring landscape stability.

Section 3.7.8 proposes management techniques to ensure long-term stability of the final landforms post decommissioning. Additionally, the long term stability of the landforms, including spoil dumps, and final voids and the associated residual risks will be assessed as part of the Project's rehabilitation and decommissioning strategy.

Erosion Management

The SMUs whose physicochemical properties indicate that they are susceptible to dispersion under adverse conditions are as follows:

- Glengallen;
- Rolleston / Glengallen; and
- College / Lascelles.

Field surveys have identified localised erosion in the Glengallan and College / Lascelles SMUs in the form of moderate sheet and gully erosion throughout minor drainage lines. For these SMUs, sodic and or saline layers exist in relatively close proximity to the surface and are prone to sheet, rill and gully erosion if disturbed.

Due to their position within the landscape (rises and low hills) the Orion / Jimbaroo SMUs may be prone to erosion on steeper slopes. These soils possess superior physiochemical properties and do not exhibit any chemical indicators of erosion potential. Where these soils have been exposed by cultivation, they are more likely to be susceptible to sheet, rill, or gully erosion due to loss of soil cohesion and strength.

In disturbed areas, uncontrolled surface-water runoff from exposed constrained subsoils could result in erosion. In response to the potential risk of significant soil dispersion in susceptible SMUs, the following erosion mitigation strategies will be implemented:

- Land area – land clearance will be limited to the minimum area required for the safe operation of the Project;
- Land surveying – land clearance areas will be surveyed, marked out and signed off by an authorised person to ensure that only the land required for Project operations is in fact cleared;
- Runoff – undisturbed area runoff will be diverted around disturbed areas and stockpiles in order to avoid surface water contamination;
- Stockpiles– if stockpiles are stored for one growing season or six months, they will be ripped and seeded with a rapidly establishing pasture species, in order to minimise erosion and maintain a viable seed bank;
- Overburden– will be progressively rehabilitated, in order to minimise the total disturbance area that exists at any one time. Deep ripping will be employed for this material, in order to maximise rainfall infiltration and therefore minimise runoff;
- Rehabilitated slopes – in order to minimise slope lengths and runoff velocities, both contour

and collection drains will be constructed around rehabilitated slopes. These drains will also help to remove suspended sediments, prior to the discharge of surface water from the Project site;

- Disturbed areas – where possible, progressive rehabilitation will be employed to minimise areas of disturbance on the Project site, at any one time;
- Mine rehabilitation – the land will be returned to pre-mining land suitability wherever possible;
- Sediment / stormwater dams – will be installed for all disturbed areas on the Project site; and
- Topsoil stripping – the stripping depths identified in Section 4.2.2.4 of this EIS will be employed and stockpiles developed to accommodate the soil that will be re-used.

Erosion Monitoring

Erosion monitoring on the Project will be conducted at a number of locations, focusing on constructed landforms with steep outer slopes that provide the greatest erosion risk. Permanent photographic points will be established to monitor slope areas of the following landforms on an annual basis:

- Spoil dumps;
- ROM pads and product stockpiles;
- Embankment walls of the reject dams; and
- Mining void walls.

Photographs will be taken following each wet season to capture potential erosion caused by runoff. More than one photographic point will be required for some of these landforms to provide good photographic coverage of all slopes. The photographs will be compared to the previous years to determine any large areas of erosion that are increasing in size and may require remedial works. The photographs will also provide a good record of remedial works conducted and the success of these works.

Remedial works will generally be required for any erosion that is increasing in size from one year to another (i.e. has not established on its own) or if the erosion is deeper than 1m in depth or wider than 1m width. In some cases, if an erosion feature is more than 1m depth or 1m width but has vegetation established and stabilising the erosion feature, it may not require remedial works immediately because vegetation destruction to conduct works can be counterproductive.

Specific monitoring of the water control dams will be undertaken to ensure the stability of the embankment walls is maintained. Regular inspections will be carried out, and instrumentation, including survey monuments, piezometers and boreholes for sampling groundwater for water quality testing, will be installed and monitored.

4.2.2.7 Landscape character

The existing nature of the Project site is open scale pastures with areas of dryland broadacre cropping on the better soils of the MDL. The landscape is made up of various components ranging from alluvial plains with creeks and swamps to gently undulating rises and low hills made up of basaltic and sandstone parent rock. With the exception of areas of remnant vegetation, which may be able to be utilised as screens, the site lacks landforms which have the capacity to block visual outlines of mine

infrastructure. However, the visual impacts for sensitive receptors that are located some distance from mine infrastructure (such as spoil dumps) are minimised.

Areas of the Project site landscape which possess the capacity to absorb land-use changes are mainly associated with dense stands of vegetation. No significant ridge lines or hills exist locally that could fulfil this function.

The Emerald area landscape is comprised of older sandstones and coal bearing deposits that have been flooded with Tertiary Basalt. After subsequent weathering and leaching, soils have developed *in-situ* where areas of basalt remain. Basaltic derived alluvium is also a feature of the region especially near larger creeks and rivers. The relatively gently undulating landscapes that we see today are a result of these geomorphic processes. Any landform with significant relief stands out within the landscape due to relatively flat nature of the terrain. Therefore, any changes to the landscape by mining activities will be magnified by any "vertical" disturbance. The change in character of the landscape will depend on the sensitivity of the receivers and the distance between them and the disturbance.

Although the majority of vegetation is sparse (due to historic land uses), visual buffers or screens do exist, which surround various sectors of the Project site. Topography and vegetation provide the main buffers for residents and visitors who are located in the north and east of the Project site and look to the south and west. The visual amenity of other residences that are located near the northern extents of the Project site and outside the MDL boundary is buffered by both topography and distance.

In terms of built form, homesteads and farm buildings are the predominant man-made structures that have been developed in the local area. Traditional designs have been employed to construct these buildings and therefore, none of these structures pose a significant visual impact upon the local landscape.

The topography of the site is generally flat with gentle hills and undulations. Variations in land elevation range up to 50m. There are no distinctive viewpoints, landmarks, large perennial waterways, gateways or focal points surrounding the Project site, and no specific features which contribute to the visual amenity of the local area. Most of the major views assessed in this particular study are associated with local homesteads and local roads, since these locations represent the most significant sensitive receptors.

4.2.2.8 Visual amenity

Mine components are not homogenous; therefore potential impacts can vary considerably. The main factors in terms of visual amenity values at this site will be vertical profile and magnitude or extent of change from associated disturbances.

Many of these mine components will change throughout the life of the Project as will the associated impacts. Spoil dumps will be at their greatest extent at the end of mine life. These dumps will be progressively rehabilitated reducing their visual impact over time.

A summary of the Project's major infrastructure and its potential to pose visual impacts during operations is provided as follows:

- Opencut pit – since this pit will be below ground level, its visual amenity impact is low, except for people passing close to the pit;
- Surface infrastructure and associated facilities – will create a moderate visual amenity impact

since these structures will be visible from limited viewpoints to the south;

- Mine Infrastructure Area – the workshops, offices and laboratory will not pose a significant visual amenity impact, since they will not be multi-story structures;
- Site transport - mine site access and haul roads will only cause a visual amenity impact for people who travel on or near this infrastructure;
- Underground longwall mining – the limited land subsidence that will occur within the longwall mining area will pose low visual amenity impacts;
- Spoil dumps - out-of-pit spoil dumps will pose the greatest visual amenity impact since they will be constructed up to 90m above ground level;
- Water storage and treatment – the water storage tanks and potable water treatment system will be part of the limited visual amenity impact created by the Mine Infrastructure Area; and
- Train load-out facilities and rail loop – will pose limited visual amenity impacts and are part of the impacts created by the surface infrastructure.

Mining Areas, Final Voids and Extraction

Two final voids will remain on the Project site and have relatively small disturbance areas. However, due to the close proximity of the opencut pit to the Capricorn Highway there is potential for the final voids to have a visual impact, although this should be minimised by the proposed construction of a visual amenity bund along the highway.

The Project mine plan indicates that up to 3315 ha may be disturbed for the purpose of mine excavations and activities associated with coal mining. Mining areas will be a dynamic component of the Project and will move as the mine progresses. Progressive rehabilitation of land to its pre-mine land suitability will reduce the visual impacts of the in-filled pits.

Progressive rehabilitation will limit visual impacts to short time frames until the end of mine life stage. At the end of mine life stage, bunds will be constructed around all final voids, consistent with the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland.* For safety reasons, the guidelines stipulate that the bund wall should be a minimum of 2m in height. However, as rehabilitation progresses, the bund walls will also provide a buffer and reduce potential visual impacts.

Heavy machinery needed for extraction may be visible from particular vantages around the site. Sharp contrasts will arise from dark coloured coal against the existing natural colours of the environment. This sharp contrast will create potential impacts on visual amenity values.

Therefore, it is noted that opencut extraction and voids in particular will have significant impacts when they are within line-of-sight for sensitive receivers. However, these potential impacts will be limited by the dynamic nature of these disturbances and the construction of bunds along the Capricorn highway and surrounding the final voids.

Spoil Dumps

Spoil dumps will likely become the foremost feature of the Project site. Like the mining pits, they will be dynamic and will mirror mine progress. The greatest total disturbance area will be at end of mine

life and although they will be sizeable features, progressive rehabilitation will limit the duration of impacts. Note that rejects from the CPP will be co-disposed with overburden and interburden in the out-of-pit and in-pit spoil.

Mine staging will have a considerable bearing on the severity of impacts from spoil dumps. Spoil will be initially stored in out-of-pit spoil dumps, during the initial 3 years of mine operations. Three spoil dumps will be located in close proximity to the opencut pit spanning west to east.

Spoil dumps have been designed at an overall slope angle of 30^o with dump heights expected to reach up to 90m above the original topography before progressive rehabilitation commences. In-pit dumping will begin during the third year of operations when the void from previous mining operations is large enough, reducing overall disturbance areas and blending the surface into the surrounding environment. In-pit spoil dumps are not expected to be elevated more than 5m above the existing topography, and will be virtually un-visible from sensitive receivers due to bunding.

Mine Infrastructure Area

The Mine Infrastructure Area (MIA) is located approximately 22 km west of the Emerald Township and contains a range of structures. The MIA should not conflict with regional outlooks from the Emerald Township as distance and current vegetation provide efficient buffering against any visual impacts associated with infrastructure areas. The visual amenity bund will shield the MIA from the Capricorn Highway and views of the MIA from the St Helens Homestead will be partially obscured by vegetation.

The final building design specifications particularly the colours chosen for the exterior of the buildings will lessen building impacts. It is recommended that building exteriors should be earthy / natural colours to help blend with the surrounding natural environment.

Operations will run 24 hours a day; therefore, artificial lighting will be used throughout the night. This lighting may cause impacts during night time hours at the homesteads that are located in close proximity.

Haul Roads

The main haul roads associated with the Project site are in close proximity to the opencut pit itself, thereby reducing truck haul distances and areas of disturbance. Haul roads and access roads will not be visible, due to the presence of a visual amenity bund along the Capricorn Highway and their lack of vertical profile. Therefore, this infrastructure is not expected to have a significant impact on visual amenity values.

Fugitive lighting has the potential to cause an impact from haul roads. The effects of fugitive lighting will be restricted to night time hours and by factors such as house orientation, vegetation and topography. Lighting from vehicles will also be limited to short time frames.

An increase in Project traffic has the potential to also impact upon visual amenity, however, traffic is likely to only produce a low impact due to the utilisation of the rail line for product coal haulage and a Bus In/Bus Out system for the Project workforce.

Rail Loading Facilities

The rail load out facility is situated adjacent to the CHPP area, connects to the proposed rail balloon loop which then spans approximately 4 km north connecting to the Queensland Rail Central West system. Rail loading facilities have a low vertical profile and are likely to be visible from only the St

Helens homestead. Existing vegetation, the proposed visual amenity bund and spoil dumps are likely to screen the rail loading facilities from other receivers.

Vegetation Clearance

Vegetation clearance will have both primary and secondary impacts. Primary impacts describe the loss of vegetation which will decrease existing visual amenity values and secondary impacts occur because the vegetation may no longer be able to shield other disturbances from view of sensitive receivers. Vegetation clearance will also change the colour of the surface structure and will create a colour contrast in the landscape. Many vegetation cleared sites, particularly voids and spoil dumps, will be rehabilitated progressively. Progressive rehabilitation will reduce the contrast between existing landscapes and future landscapes and will return the colours and tones of the environment to a similar pre-mining state. Vegetation will play a vital part in mitigating the Project's potential impacts.

Lighting from the Project

Artificial lighting will be used at night around certain infrastructure primarily within the MIA, CHPP, loading facilities, power generating sites and about vehicles. Potential impacts will also be influenced by the prevailing climatic conditions. It is likely that lighting will be visible from surrounding residences.

Mine Staging

Mine staging will have a significant influence on the magnitude and extent of landscape change. Disturbance areas, spoil dumps and voids will increase and change location as production rates increase. Production is proposed to start with the opencut operations, with underground operations not beginning until year 5 of the Project. Opencut production is anticipated to steadily ramp up over 2 years to a steady production rate before reaching a maximum ROM coal production rate of approximately 2.28 Mtpa. The underground operation is expected to reach a maximum ROM coal production of 5.75 Mtpa.

Based on extraction techniques utilised in the underground operations, waste is not expected to be received in large volumes, and the spoil (rejects) produced deposited in-pit. The majority of visible, out-of-pit spoil will be produced in the opencut operations during the first 2 years of the Project, and by Year 3 this spoil will begin the process of rehabilitation.

The magnitude of disturbance areas within MDL 467 should be largely confined to the area located south of the Capricorn Highway consistent with the area necessary to accommodate the opencut pit, spoil dumps, ROM coal haulage, ROM stockpiling, rejects impoundment, rail load out facility and associated mine infrastructure. The disturbance areas for the Project become significant by year 2, with waste dumping expected to reach up to 20 million cubic metres and the majority of land clearing being undertaken during the construction period to accommodate mine infrastructure.

Schedules of land clearing and mine rehabilitation are provided in Section 3.2.1, 3.2.2 and 3.3.41 respectively.

Sensitive Receivers

The location and proximity of receivers associated with the Project is shown in Figure 4.48 and summarised in Table 4.19. For sensitive receivers located outside of the Project site, their proximity to the site has been measured to the MDL boundary and the distance to actual disturbance will be more in reality with the majority of above ground operations being confined to the area south of the Capricorn Highway (refer to Figure 4.48 for the locations of sensitive receivers).

Table 4.19 Number of Residencies and Distance to the Project boundary

MDL467	
Buffer Distance from Project Boundary	**Number of Residences**
Less than 1 km	1
1 km – 3 km	3
3 km – 5 km	2
5 km – 10 km	4
Total	**10**

Note that the above table excludes the four sensitive receivers that exist within MDL467

Visual Effects Simulated

This section presents the visual impacts of the Project from key vantage points in the form of panoramic photographs. These photographs have been taken from points that best summarise the Project site. Aerial photographs, contour maps, road maps and vegetation maps were assessed (together with receiver locations) in order to identify sites that would best summarise local visual amenity receivers, thereby capturing potential visual impacts from each side of the Project.

Photographic panoramas have been taken to record current landscape conditions and animations have been generated from the same locations to portray the potential visual impacts of the Project. Animations have been generated for periods during the mine life, which are presented in Figure 4.49, Figure 4.50, Figure 4.51 and Figure 4.52.

Spoil dumps and bunds will have the greatest impacts when they are earthy brown, however, these areas will have been rehabilitated for several years by the end of mine life. The animations have been rendered spoil dumps and bunds in light brown before any slope re-grading or re-vegetation is conducted, since dumps in this state create the most significant visual amenity impact (refer to Figure 4.49, Figure 4.51 and Figure 4.52 for details of the visual amenity impacts of non-rehabilitated infrastructure). Following progressive rehabilitation, by Year 5 these dumps will be vegetated and will revert back to more the colour of the surrounding landscape and therefore, their visual amenity impacts will reduce (refer to Figure 4.50 for an example of the visual impacts of post rehabilitation infrastructure).

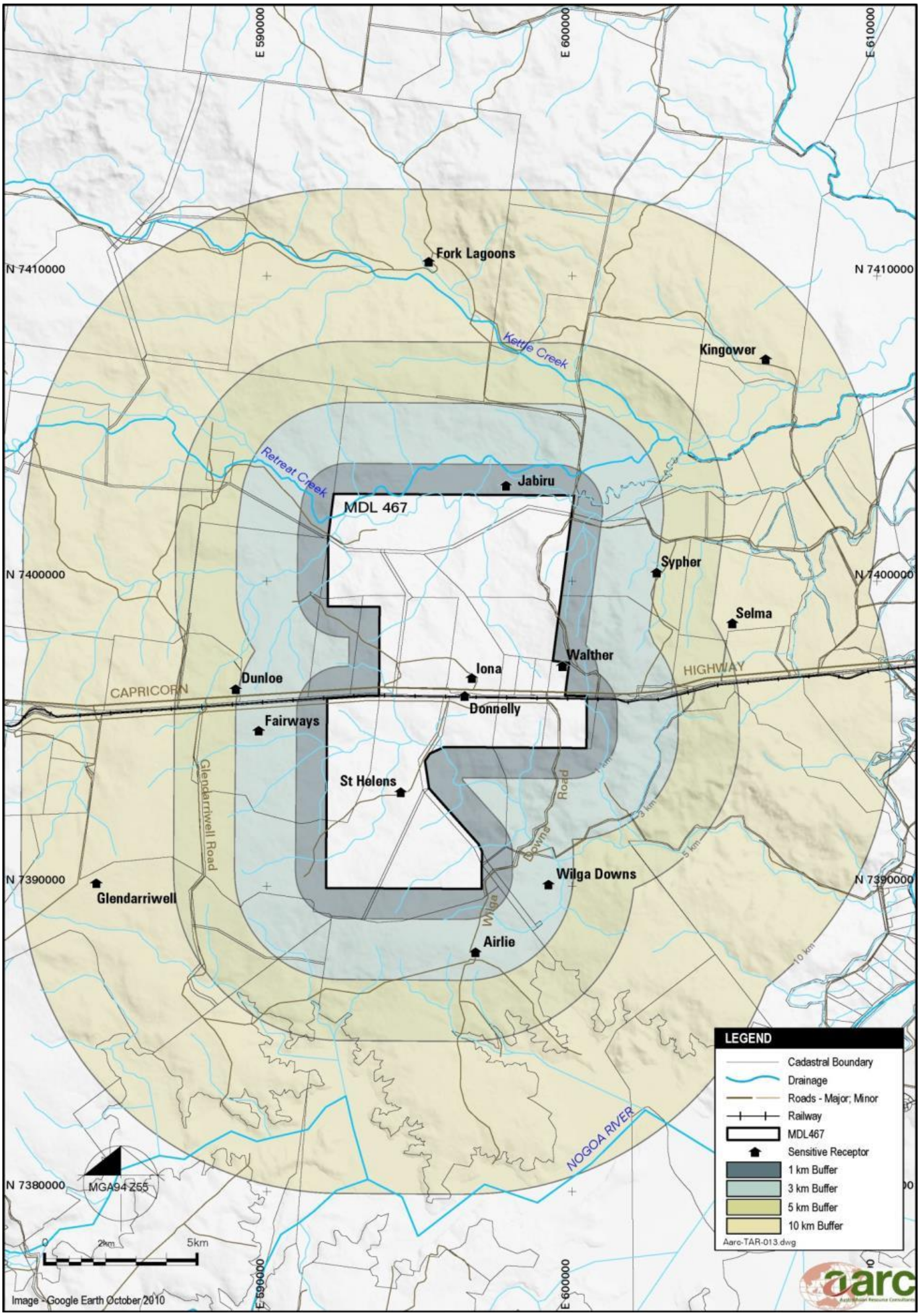


Figure 4.48 Location of Sensitive Receivers and Buffers

Visual Amenity Site 4 - Iona Homestead

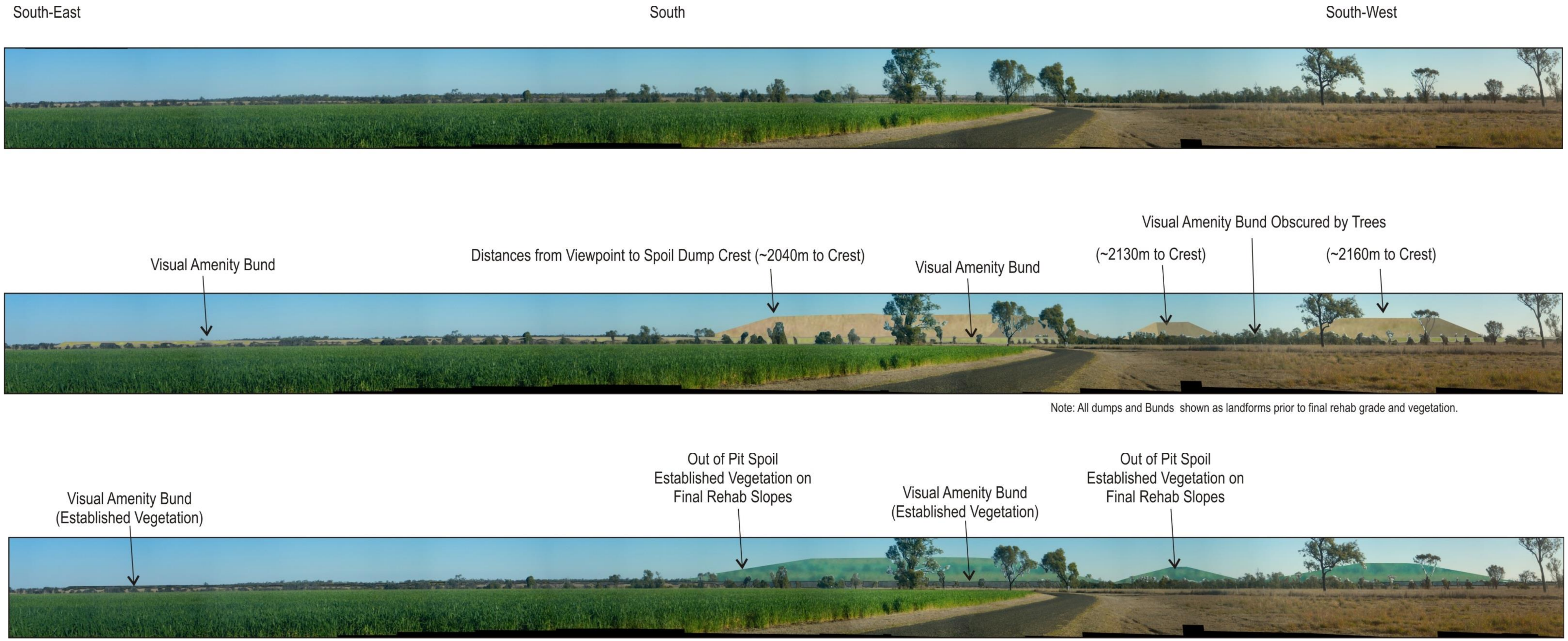


Figure 4.49 Visual Amenity Impacts from Iona Homestead

The Iona homestead will be impacted most heavily by the Project, largely due to its close proximity to the opencut operations and sparse vegetation between it and the proposed spoil dumps. The impacts on visual amenity from parts of the Capricorn Highway, which is located just to the north of the visual amenity bund running east to west through the image, will be similar but slightly less impacted due to the close proximity of the bund obscuring more of the dumps. The visual impacts of the spoil dumps are highlighted by the sparsely vegetated foreground, which is currently utilised for agricultural cropping purposes. A view of the rehabilitated spoil dumps is also presented for this viewpoint.

Visual Amenity Site 11- Western Extent of MDL467

Figure 4.50 Visual Amenity Impacts from Western Side of MDL467 on Capricorn Highway

Visual impacts from the western extent of the MDL are alleviated by the presence of vegetation and the visual amenity bund, obscuring the view to the main infrastructure area and spoil dumps of the Project. The Capricorn Highway can be seen to the left of the image indicating that in parts of the highway vegetation helps obscures the visual impact of the Project. The spoil dump and visual amenity bund is shown in this figure as rehabilitated structures.

Visual Amenity Site 1 – St Helens Homestead

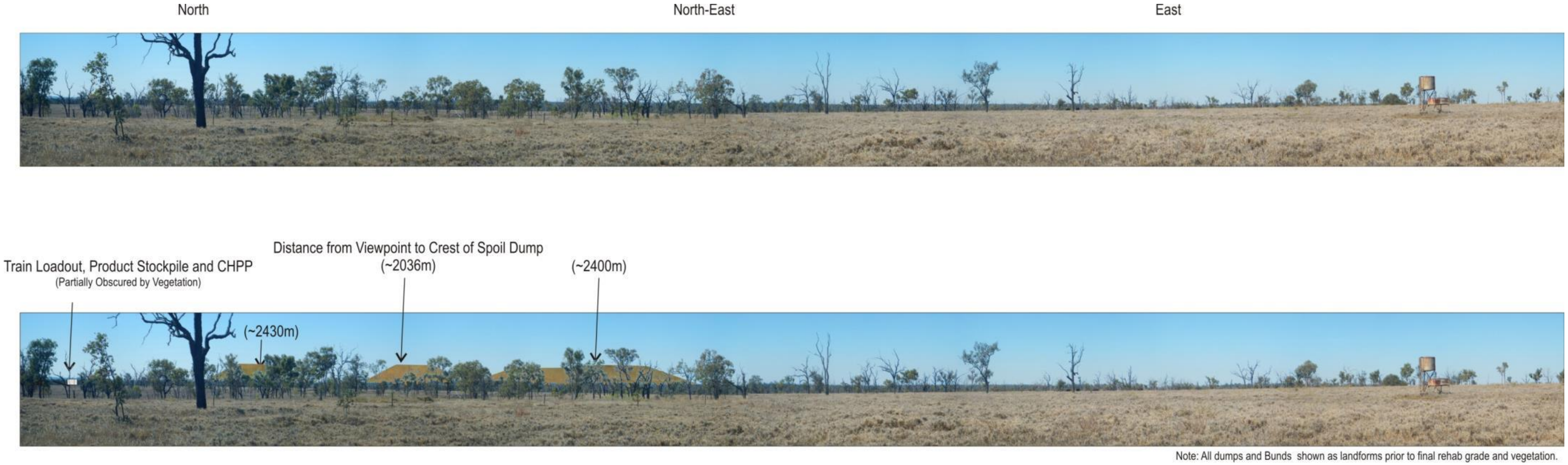


Figure 4.51 Visual Amenity Impacts from St Helens homestead

The visual impacts of the Project from the St Helens homestead, located to the south of the Project, will be partly obscured by vegetation and also alleviated through distance to the main spoil dumps. Spoil dumps will be the most pronounced of the visual impacts but during the operational phase of the mine, the ROM piles will also be visible from the homestead.

Visual Amenity Site 9 – Walther Homestead

Figure 4.52 Visual Amenity Impacts from the Walther Homestead

The spoil dumps present a significant visual impact from the Walther homestead, particularly prior to rehabilitation. Although partly obscured by vegetation, the visual impacts on the horizon are pronounced. Impacts at the Walther homestead are similar to those encountered at the Iona homestead, albeit to a slightly lesser degree.

Visual Management Units

The Project site incorporates a variety of different landscapes and values. To provide a more consistent assessment of the visual amenity values associated with the Project site, Visual Management Units (VMUs) have been developed for this visual amenity assessment. VMUs were created by grouping landscapes with the same broad characteristics (vegetation, land use etc.) within the Project site. Utilising VMUs will allow the site to be broken down and analysed at a more manageable and accurate scale and outcomes will be more detailed.

Landscapes with distinctive landscape characteristics will be categorised into VMUs to assess the potential impacts on the surrounding landscape and to determine the ability of certain landscapes to absorb impacts associated with the Project. Landscape VMUs differ with diversity of the range of features and patterns present, and consequently in their ability to accommodate different types of development. Some areas may be particularly sensitive to development and others more resilient. Landscape sensitivity will have a bearing on the overall level of significance of the impact on visual amenity values. Further discussion of magnitude of change and sensitivity assessment criteria for key landscapes associated with the Project is provided in Appendix 7.

Sensitive receivers will also be categorised into VMUs to determine how significant potential impacts on particular groups of receivers are likely to be. This will involve determining the receiver's location and the duration of exposure to a disturbance associated with the Project. A crucial aspect of assessing a VMU's sensitivity is their distance to disturbances. For this Project the defined distance levels have been determined by assessing the topography. The level of sensitivity and magnitude of change will be determined to assess the overall level of significance of potential impacts.

Landscape VMUs are essentially what a receiver is looking at and Receiver VMUs are essentially how many people are viewing a landscape, their distance to it and for how long they view it. The Landscape VMUs for this site are presented in Table 4.20. The Receiver VMUs are presented in Table 4.21.

Table 4.20 Landscape VMU Characteristics

VMU	Project Specific Characteristics
Rural/Grazing	Predominantly cleared areas of improved pasture. Scattered trees or clumps of trees present, many fences and unformed roads/tracks.
Remnant Vegetation	Patches of forest/woodland with relatively large or mature trees and a characteristically intact appearance. Grazed understorey typical.
Main Roads / Highways	The Capricorn highway which provides a route from east central Queensland to the western areas of Queensland.
Railways	The Queensland Rail Central West system rail line runs parallel with the Capricorn highway and connects western Queensland with the eastern areas of central Queensland.
Residential Roads	Constructed and unconstructed roads that provide access to residences surrounding the Project.
Residences	Existing residences close to the MDL467 that are within 10 km.

Table 4.21 Receiver VMU Characteristics

VMU	Project Specific Characteristics
Homesteads and places of work	Limited number of receivers with propriety interest and prolonged exposure durations
Main public roads or highways	Many receivers with intermittent or short term exposure durations and momentary interest
Railways	Very few receivers with intermittent or short term exposure durations and momentary interest
Lookouts and scenic routes	Few receivers and moderate exposure durations with moderate interest
Constructed roads	Few receivers and intermittent or short term exposure durations with momentary interest
Non-constructed roads	Very few receivers and intermittent or short term exposure durations with momentary interest
Broad-scale rural land uses	Very few receivers with moderate exposure durations with moderate interest

Significance Assessment

Residential receivers are deemed to have the greatest sensitivity as a result of their proprietary interest and their prolonged exposure. Although recreational receptors have a shorter exposure to potential impacts they are also considered to be sensitive due to the aesthetic value they place in the landscape. Transient users, users of trains or roads, are considered to have moderate sensitivity because they pass through the Project area only intermittently. The least sensitive groups are those already affected by a similar type of visual impact, for example users of the land such as agricultural croppers.

Homesteads in the vicinity of the Project area have the potential to be significantly impacted. Receivers using main roads and in particular the Capricorn Highway and Wilga Downs Road have the potential to be moderately impacted on by the Project as well as those receivers using the QR Central West system. Receivers using minor roads and tracks in close proximity to the Project site have an intermittent exposure to disturbances. However, minor roads involve a lower number of receivers and represent a moderate impact potential. Other roads users and rural graziers have a slight potential to be impacted by the Project.

Factors taken into account when determining the level of significance are the total number of receivers, their distance to the disturbance, the magnitude or extent of landscape change and the sensitivity of receivers. Full details of the evaluation undertaken to determine the level of significance for impacts on receivers and landscapes is provided in Appendix 7.

Summary of Impacts

The Project's spoil dumps will be the most substantial component and will likely cause the most significant impacts on visual amenity values. Areas lacking vegetation buffering will also create intermittent exposures to receivers. Residences located in close proximity to the Project, such as the Iona, St Helens and Walther homesteads, are those most likely to be exposed to significant impacts.

Receivers using the Capricorn Highway and Wilga Downs Road will be exposed to disturbances associated with the Project intermittently and will be subject to moderate impacts. Visual impacts along Wilga Downs Road (Visual Impact Site 5) are not considered to be significant since only intermittent exposure to receivers will occur and site infrastructure is located at least 2 km from this road.

Receivers situated more than 5 km from the Project site are likely to experience only slight impacts.

Although the MIA will be visible from one of the receivers, it is unlikely to produce a significant impact because of its vertical scale, the amount of vegetation present and distance. To residential receivers to the north and receivers using main roads in the Project area, the MIA will be screened by the visual amenity bund.

Artificial lighting is likely to be utilised during the Project. Light will be visible from certain vantage points but it is expected that at this time potentially affected receivers are likely to be indoors and the impacts will be limited. The amount of surrounding vegetation and positioning of the visual amenity bund and spoil dumps between the closest receivers will also limit the potential impact from artificial lighting.

Mitigation of Potential Impacts

The analysis conducted as part of this report predicts that the potential impacts of the Project on visual amenity values are likely to be significant, due to the close proximity of the Project site to existing homesteads. However, the gently undulating topography does not provide any views that overlook the Project and because of this the components of the mine appear on the horizon and are limited to predominantly the spoil dumps. The existing surrounding environment, particularly the vegetation, may mitigate the impacts. It is recommended that vegetation should remain intact along important buffer zones to alleviate any potential visual impacts.

Roads

Although the proposed mine site is in close proximity to the Capricorn Highway it was identified that the high number of short term, or intermittent receivers, will experience moderate impacts on the values associated with the highway as a result of the Project. The visual amenity bund will limit views of mine infrastructure from the Capricorn Highway except for the spoil dumps.

Although no dense vegetation buffers were consistently observed along the highway, all existing intact vegetation buffers will remain intact throughout the life of the Project to reduce any potential visual impacts from intermittent highway use.

Wilga Downs Road is also located approximately 2 km from the nearest edge of the pit and 3 km from the nearest spoil pile and therefore, will not be significantly visually impacted by the proposed spoil dumps being constructed. Due to the intermittent impacts on a low amount of receivers, visual impacts were assessed as low. Trees that could provide screening from Wilga Downs Road visual impacts will not be removed.

Mine Components

Spoil dumps are one of the major features of the Project that may potentially impact on visual amenity values. As discussed previously, it is likely the spoil dumps will reach a peak of 90 m with a 30 ^{o} angle of repose (slope plus benches) during the early years of operation. The close proximity of the Project to the Iona, Walther and St Helens Homesteads, has resulted in visual impacts being unavoidable and the location of the spoil dumps have been located to maximise energy efficiency by locating them as close to the opencut pit as possible. The spoil dumps will be flattened during rehabilitation with the angle of repose reduced and height slightly reduced, allowing them to blend into the surrounding topography as well as the ripping, seeding and planting of the spoil with suitable native plants. Vegetative cover on the spoil piles will reduce their visual impact and will be carried out by Year 5 of the Project.

In-pit dumping of spoil will decrease the height of these dumps, and they should not extend more than 5m above the exiting topography following rehabilitation. In-pit spoil dumps are to be progressively rehabilitated in line with mine progress. Progressive rehabilitation using local vegetation will aid the dumps to merge into the surrounding landscape comparatively quickly. The likelihood that receivers are exposed to potential impacts will be limited by the visual amenity bund and progressive rehabilitation.

Due to the close proximity of the final void to the Capricorn Highway, it is unlikely the existing landscape will be able to filter out the visual impacts, aside from sporadic stands of vegetation located on the highway which intermittently obscure the view. However the visual amenity bund will obscure the final void from the highway. As part of the site rehabilitation process, the final voids will be surrounded with small-scale bunds of approximately two meters in height, which will also help to screen the voids from view.

The MIA is not expected to have significant impacts on any of the receivers due to it being obscured to the north by the visual amenity bund and spoil dumps and by existing vegetation to the south.

Public Viewing Outlooks

There are no existing viewing outlooks associated with the Project area. The primary land use of the surrounding environment is low intensity cattle grazing and cropping, which is unlikely to be disrupted by the Project. The topography of the site only varies in elevation by approximately 50 m from the highest rises to the flat ground and is mainly comprised of gentle undulations. The majority of the raised land forms are on private land, inaccessible to the general public and as such it is unlikely that these are used for scenic purposes.

Waterways

The visual amenity values of local creeks may be temporarily altered as a result of subsidence cause by underground mining. Remedial actions will be required in order to maintain creek flows and fill in tension cracks which will arise as a result of land subsidence.

Existing Residencies

Animated panoramas were constructed from residences that were located within 3 km of the opencut operations, spoil dumps and MIA area located south of the Capricorn Highway, as this will be the concentration of visual impacts.

Currently, four residences are located within the Project boundary and levels of sensitivity have been

assigned to the residences in relation to their proximity. One residence is located within 300m of the northern extent of the opencut pit and is considered highly sensitive. However, the visual amenity bund will significantly reduce visual amenity impacts for this residence. One residence is located less than 1 km from the Project's opencut area and is also considered highly sensitive. The remaining two residences are located 2 km – 3 km from the opencut area and are also considered highly sensitive due to their proximity. The remaining seven residences are located more than 3 km from the Project's opencut area and major above ground operations and have moderate to low sensitivity to the Project.

Places of Work

No places of work in the region are predicted to be impacted by the visual impacts of the Project, with the nearest town or centre located at Emerald, approximately 20 km to the east.

Existing Features' Ability to Absorb Components of the Project

The existing character of the site is open scale pasture with occasional stands of vegetation along roads and sporadic patches of vegetation in grazing areas. The area where the Project is proposed is not densely vegetated and the ability of the existing site to absorb the visual impacts of the Project is limited. Post-mining land forms will be elevated from existing levels, but will be returned to a similar pre-mining condition once the Project enters into decommissioning and rehabilitation phases. Existing vegetation buffers surrounding the Project site will help the existing environment to absorb some of the change from the Project.

There are a number of exploration and mining leases surrounding the Project, which will desensitise certain viewers to the Project. Coal operations are common in the region and provide a valuable economic input into the community.

Post rehabilitation, the modified landscapes should blend into the surrounding environment and have a similar final appearance all be it at a slightly raised level to the surrounding topography. Vegetative cover should also help to alleviate the visual impacts of the spoil dumps post mine. For functional reasons much of the infrastructure, including dams, have been located in low points around the Project but this will also alleviate their visual impact.

Buffer Zones Surrounding the Project

Planting of buffer zones along boundaries, especially on the visual amenity bund along the Capricorn Highway, will help to alleviate potential impacts on visual amenity values. Allowing existing buffer zones to increase in density will work to either interrupt views or fully screen receivers from the potential to view the Project. Revegetation can take up to 20 years to reach maturity, but after 10 years they will begin to disrupt views of the Project. As the Project has a life span of approximately 22 years, a revegetation strategy could be beneficial for the later stages of the Project.

4.2.2.9 Lighting

Since it is intended that the mine will operate 24 hours per day, artificial lighting will be employed at specific locations around the Project site, during hours of darkness. These lights will mainly be installed around the opencut pit, spoil dumps, CHPP, train loading facilities and office areas.

The majority of these light sources will not be directly visible from either the Capricorn Highway or the surrounding residences once the mine is constructed and operating due to the presence of the visual amenity bund. However, potential visual amenity impacts will also be influenced by the prevailing climatic conditions, such as the intensity of moonlight and presence of fog or haze, such that a lit up sky will be prevalent at times. It is likely that such a lit up sky will be visible from surrounding

residences and the Capricorn Highway and therefore, while not a risk of causing glare, will impose some visual amenity impacts.

The potential for artificial lighting to cause a risk of glare to motorists on the Capricorn highway is considered very low due to the visual amenity bund, which will screen all but the highest portions of the northwest spoil dump from direct line of site to light sources.

In terms of fauna impacts, an increase in night time lighting may affect both nocturnal and diurnal fauna. Such lighting will attract insects and therefore lead to an increase in the night time foraging activities of amphibians, microbats and reptiles. The behavioural patterns of nocturnal animals may also be disrupted due to a change in local lighting patterns.

In order to mitigate the potential impacts of night time illumination upon sensitive receptors (flora, fauna and local residents), the following are recommended:

- use directional lighting which is pointed away from sensitive receivers;
- employ lighting hoods to focus light sources;
- selection of light sources whose intensity and wavelength distribution have minimal impact upon local receptors; and
- dipping of vehicle headlights in certain sectors of the mine site, in order to minimise the impact of artificial illumination upon sensitive receptors.

Note, specific mitigation strategies may be required to be developed for individual residences.