5.0 LAND

5.1 METHODOLOGY

The method for conducting the EIS for the land section of this report was in two stages; a literature review and a field investigation.

The following literature applicable to the site was identified and reviewed:

- Spatial data sources (GIS framework provided with Searle *et al*, 2007; Maher, 1996) were reviewed to consider topographic, geologic and soils characteristics likely to exist on site;
- Maher 1996 and Searle et al, 2007 were reviewed for factors which were likely the major issues such as sodicity and salinity;
- A search of the DERM Interactive Resource and Tenure Maps for active mining or exploration leases; and
- A search of the Environmental Management Register/Contaminated Land Register (EMR/CLR) database to check if lots on the project site are registered as contaminated.

A field investigation was undertaken during the 9th, 10th and 11th of September by a Soil and Hydrology Scientist. The investigation included:

- A reconnaissance of the entire project site looking for variation in soils characteristics based on surface condition and comparing the site with mapping;
- An inspection of the site for any likely contaminating activities (existing and historic) i.e. old cattle dips, land fill sites etc;
- Strategic soil sampling to test for sodicity and nutrient status to inform rehabilitation/revegetation; and
- Analysis of soils results to determine requirements for soil amelioration rates (e.g. gypsum to counteract sodicity and fertiliser rates for revegetation).

5.2 TOPOGRAPHY/GEOMORPHOLOGY

5.2.1 Existing Environment

The project site is on a flat elevated plain that falls uniformly from North to South, with an average slope of less than 0.5%. The site at its highest point has an approximate elevation of 336m AHD in the North-East corner, and at its lowest, 325m AHD in the South-East corner. Slopes increase in the South-East corner of the site up to 2.5%, sloping South-East (see Figure 5.1).

During the field investigation the site was observed to be poorly drained, most likely outwash plains derived from laterised sandstone (Maher, 1996), with poorly developed drainage lines. There are no permanent watercourses on the project site however, there is a poorly defined drainage line in the South-East corner named Paddy Gully (see Figure 5.1). This drainage line was not observed to have bed or banks within the extents of the project site. Paddy Gully drains east from the site approximately 2.5km to join Kogan Creek, a tributary of the Condamine River; which flows northwards into the Condamine River, below the junction with Cooranga Creek.

5.2.2 Potential Impacts

Levelling of the substation platform and associated infrastructure will result in minimal changes to the topography of the Project site as the site is already very flat and will require minimal earthworks.

Major diversion of water is unlikely however there may be minor changes to drainage patterns on the site to divert water flows around the substation platforms. However, as the existing drainage lines are poorly defined, minor diversion of waters are unlikely to change geomorphologic processes. Potential impacts on water flows and hydrology are further discussed in Section 7.0.

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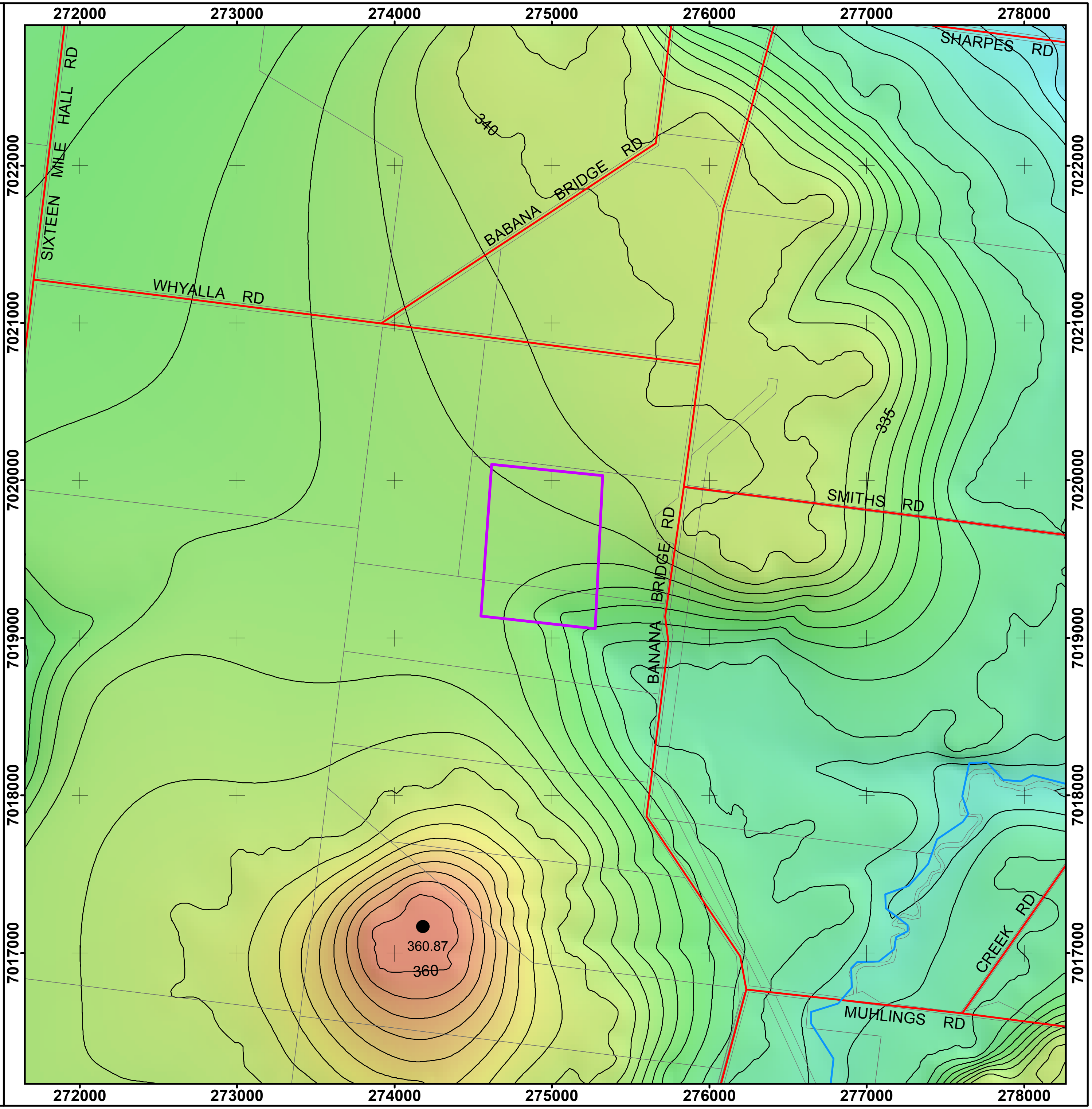
Topography

Figure 5.1

- Spot Height
- Contour
- Road
- Watercourse
- Cadastre
- Sub-station

Contours and spot heights generated from 25m DEM. Contour interval 2.5m.



0 125 250 500 750 1,000 1,250 1,500 Meters

Scale 1: 35 000
Datum / Projection: GDA94 MGA Zone 56

terranean mapping technologies

CONICS

24 September 2009

09-3084-003

5.3 GEOLOGY AND SOILS

5.3.1 Existing Environment

5.3.1.1 Geology

The site is located entirely on Kurbarilla sandstone geology (Digital 1:250,000 Geology Data Base, Geosciences Australia 2005). These sandstones which date from Mesozoic times (most likely Jurassic to Lower Cretaceous), contain mainly clayey labile to quartoze sandstone with some siltstone, mudstone and polymictic conglomerates materials (Maher, 1996). These sandstone formations were significantly eroded in the period following Tertiary times as this site is contained within the ironbark/bull oak Land Resource Area (LRA) (Maher, 1996) this indicates that the rocks were harder than other sandstones in the region and hence have been left as low hills.

5.3.1.2 Soils

The site is completely contained within an ironbark/bull oak forest LRA (Maher, 1996) (Figure 5.2). An LRA contains a number of different soils that vary according to site within the landscape unit. At this time, the different soils that occur within LRAs in this area have not been mapped separately. However, the common soils that could be expected to occur within the ironbark/bull oak LRA include:

- Braemar - moderately thick (20 to 40 cm), bleached sandy surface, over mottle, yellowish brown to greyish brown clay subsoil derived from sandstone; and
- Cutthroat - thick (>30cm) bleached loose sandy surface, over mottled, yellowish brown sand clay subsoil overlying sandstone; and surface, over red brown clay overlying sandstone.

Whilst not identified on the site, Channing soils could also be present. Braemar, Cutthroat and Channing soils however are all treated in a similar fashion from a management perspective.

These soils are all similar in that they are both texture contrast soils and they can be considered to be very similar from an agronomic and soil chemistry perspective (see Table 5.1). The soils tend to be acid, have very low plant available water capacity (PAWC), have low salinity in the surface increasing with depth in the subsoils and are sodic in the surface and sodic to strongly sodic in the subsoils. Bleaching tends to occur in the lower parts of the surface layer, indicating periodic waterlogging.

TABLE 5.1 IMPORTANT AGRONOMIC CHARACTERISTICS OF THE SOILS (SOURCE: MAHER, 1996)

SOIL	PH	SALINITY	SODICITY	EFFECTIVE ROOTING DEPTH (CM)	PAWC IN ROOT ZONE (MM)
Braemar					
Surface soil	5.6	Low	Sodic	30	36
Upper subsoil	6.6	High	Stongly sodic		
Lower subsoil	5.0	Very high	Stongly sodic		
Cutthroat					
Surface soil	5.4	Very low	-	60	8
Upper subsoil	7.8	Low	Sodic		

SOIL	PH	SALINITY	SODICITY	EFFECTIVE ROOTING DEPTH (CM)	PAWC IN ROOT ZONE (MM)
Lower subsoil	8.8	Medium to high	Sodic		
Channing					
Surface soil	5.5	Very low	Sodic	20	24
Upper subsoil	5.1	Very high	Stongly sodic		
Lower subsoil	4.5	Very high	Stongly sodic		

During site investigation a number of shallow soil holes (up to 0.5m) were dug to investigate soil characteristics of the site (see Figure 5.2 for sampling locations). These indicated that the soils on the site are likely to be mainly Channing soils with minor occurrences of Braemar soils occurring along the poorly defined drainage lines. These soils are defined as Sodosols (Isbell et al, 1997). Samples were taken for each soil type and sent to a laboratory to be tested for their sodicity and nutrient status. Table 5.2 summarises these results. This data has been used to inform the EMP in regards to quantities of soil ameliorants that may be required for soil stabilisation (gypsum to counteract sodicity), and revegetation (fertiliser rates).

TABLE 5.2 SUMMARY OF SOILS SAMPLE RESULTS FROM THE PROJECT SITE

SITE	EC (DS/M)	PH	CEC	NA	K	CA	MG	AL	P (MG/KG)	EAT	ESP (%)	TEXTURE
Site 8 Surface 0-10cm	0.05	5.6	6.3	0.6	0.2	1.8	2.4	<0.1	2	3(1)	10.5	Sandy loam
Site 8 Subsoil 10-30cm	0.29	5.9	12.0	2.8	0.1	1.4	6.9		1	2(3)	4.3	Sandy clay loam
Site 10 Surface 0-20cm	0.05	6.8	10.7	0.4	0.3	71	2.1		4	3(1)	26.75	Sandy loam
Site 10 Subsoil 25-40cm	0.19	6.3	13.1	2.9	0.1	1.3	7.4		1	2(3)	4.5	Sandy clay loam

These results suggest that:

- The soils have low salinity in the surface, increasing with depth;
- Have low nutrient status; and
- Are sodic in the surface and strongly sodic in the subsoils.

The Gypsy program was used to calculate the rates of gypsum application that would be required to counteract the sodicity levels for these soils based on the soils results from Table 5.2. Calculations were also made of the rate of fertiliser application to assist in the establishment of vegetation in those areas of the site to be revegetated. The area of the substation site that has been left exposed post construction should be treated with soil ameliorants and the following rates are recommended:

- Gypsum at 15 t/ha; and
- MAP fertiliser at 45 kg/ha.

5.3.1.3 Existing soil erosion

A site investigation found that there was some existing gully erosion adjacent to the project site. The area of erosion is about 200m to the east of the North-East corner of the site (refer to Figure 5.2 for identified erosion areas). The erosion is likely to have formed due to the exposure of sodic subsoils in this area. To ensure the area of erosion does not expand and comprise the project site in the future the erosion should be stabilised as part of the site development. Recommendations have been provided as part of the EMP (see Appendix E).

Management recommendation for erosion sites on sodic soils are provided in Section 5.3.3.1.

5.3.1.4 Salinity

A review of mapping developed as part of the Strategic Salinity Risk Assessment in the Condamine Catchment (Searle et al, 2007) shows that there are no existing salinity locations within the Project site. At a larger landscape scale, there are also virtually no existing salinity locations in all of the Kumbarilla sandstones in the Condamine Catchment. While subsoils are saline (see Table 5.1), this is mainly a function of low permeability of these subsoils and the accumulation of salts within the profile over geological time.

Searle et al (2007) concludes that there is a moderate salinity risk for the subcatchment in which the project site is located; but that this is not relevant to the Kumbarilla landscape on which the site is located.

5.3.1.5 Acid Sulphate Soils

Acid sulphate soils (ASS) are unlikely to be present at the Project site as the site is higher than AHD 100m. There are no characteristics of the site that would indicate that it is subject to ASS.

5.3.1.6 Good Quality Agricultural Land

A review of the GQAL data for the region shows the site is not classified as having agricultural value (see Figure 5.3).

5.3.1.7 Mining and Petroleum

The Queensland Government Department of Mines and Energy's, Interactive Resource and Tenure Maps (IRTM), were accessed (17 September 2009) to determine any registered exploration permits, leases, licenses and permits within or immediately adjacent to the study area, and the results are shown in Figure 5.4a - Figure 5.4d. In summary:

- There is a Petroleum leases held by Linc Energy Ltd directly to the west of the site;
- Aberdare Collieries Pty Ltd hold a Mineral Development License over the eastern part of the site;
- Australian Cbm Pty Ltd currently hold an EPP over the block. The current EPP has expired however a renewal has been lodged.
- Linc Energy Ltd holds a current exploration permit Coal (EPC) for the western part of the site; and
- The site is not on a coal resource area. The closest coal resources to the site are Kogan Creek to the East and Chinchilla to the West.

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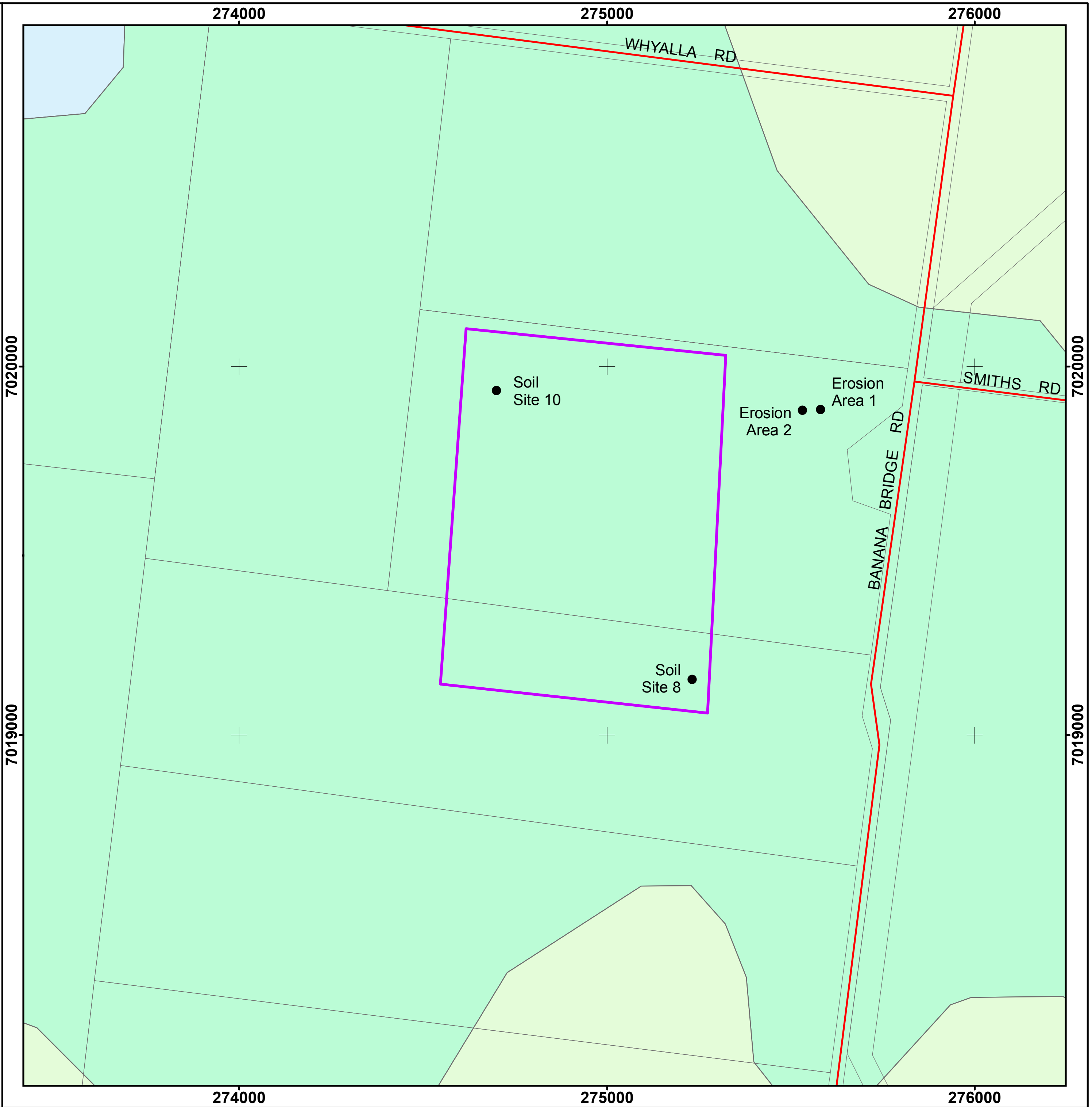
Soils Mapping

Figure 5.2

Watercourse
Road
Sub-station
Cadastre
Soil Site

Land Resource Area

Brigalow Plains
Ironbark/Bull Oak Forests
Light Forests



Scale 1: 15 000
Datum / Projection: GDA94 MGA Zone 56

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Agricultural Land Quality

Figure 5.3

- A
- B
- C
- D
- Watercourse
- Road
- Sub-station
- Cadastre

Land Classifications:

A: 'A' land system, Slope < 8% and cropping land use.
B: 'A' land system, Slope < 8% and grazing land use or 'B' land system, Slope < 8% and crop or grazing land use or 'C' or 'D' land system, Slope < 8% and crop land use.
C: 'C', 'D' or unspecified land system, Slope < 8% and grazing land use. Grazing land with 'C' land system. Areas of forestry where land system is 'A', 'B' or 'C'.
D: All other land systems / land use or Slope > 8% where land use is not grazing and land system is 'C'.

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Scale 1: 35 000
Datum / Projection: GDA94 MGA Zone 56

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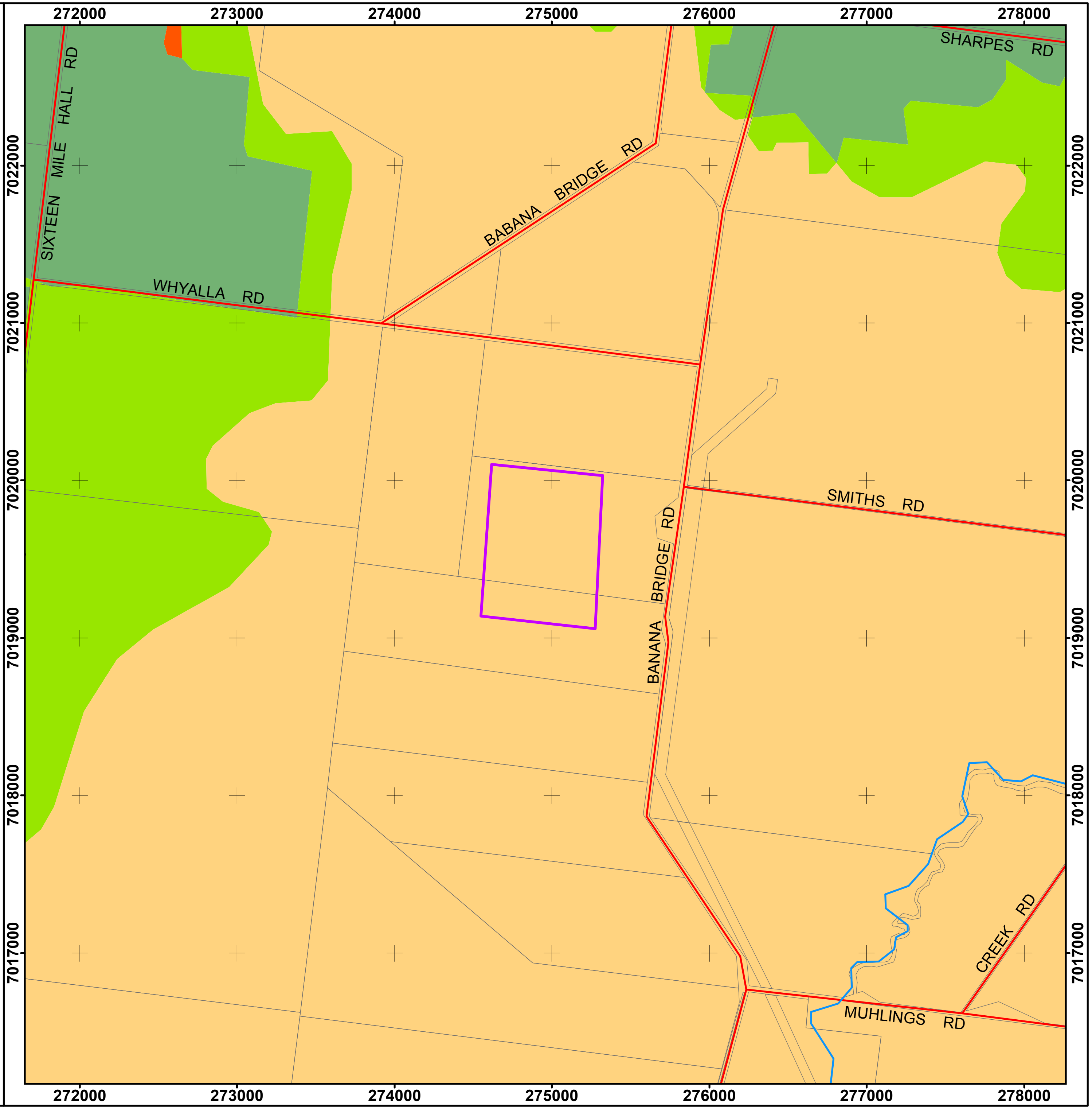

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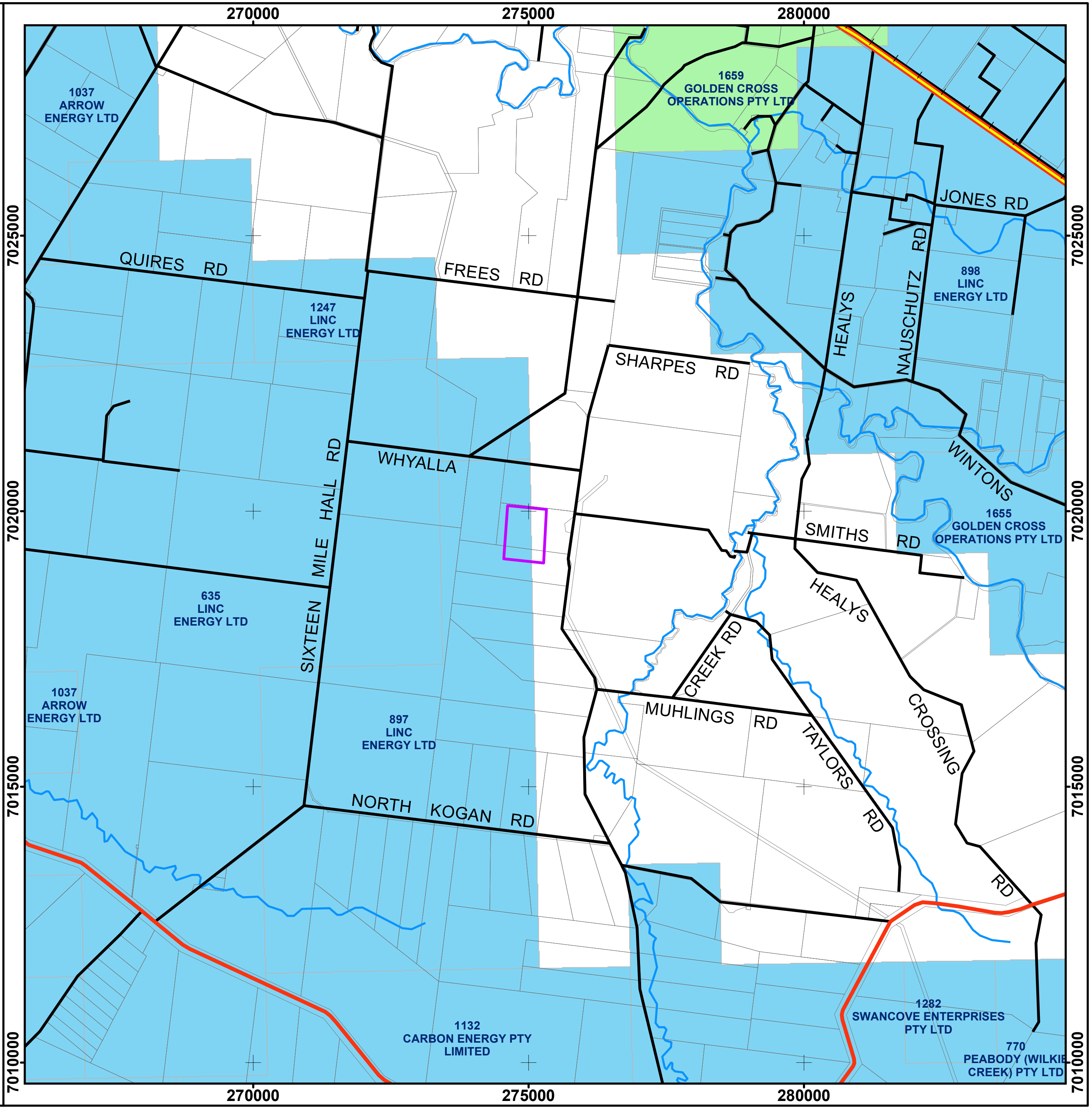
Coal Exploration Permits

Figure 5.4a

- Highway
- Major Road
- Local Road
- Watercourse
- Sub-station
- Cadastre

Exploration Permits (Coal)

- APPLICATION
- GRANTED



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Scale 1 : 100 000
Datum / Projection: GDA94 MGA Zone 56

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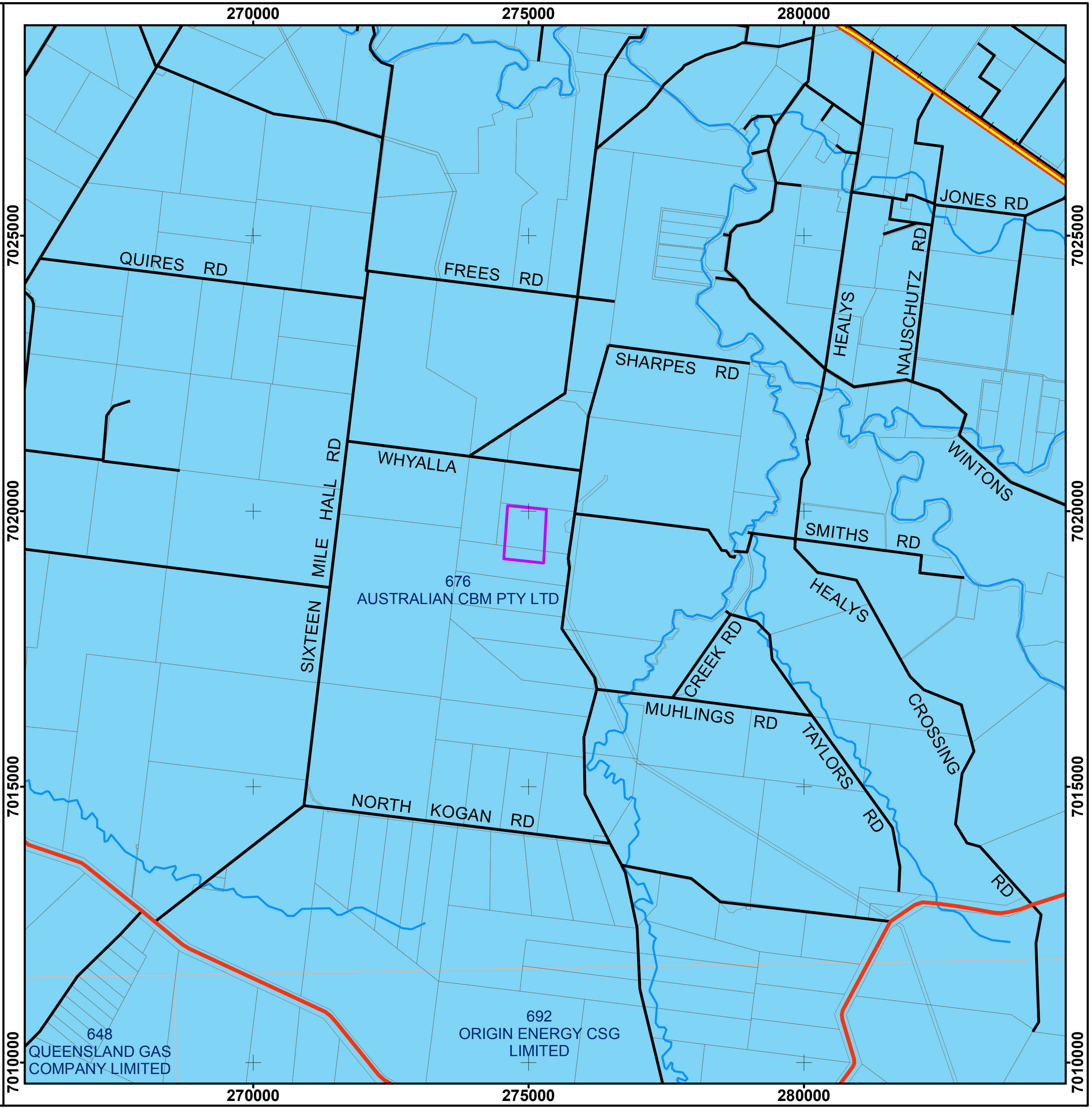
Petroleum Exploration Permits

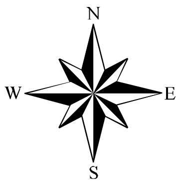
Figure 5 .4b

Highway
Major Road
Local Road
Watercourse
Sub-station
Cadastre

Exploration Permits (Petroleum)

APPLICATION
GRANTED





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Scale 1 : 100 000
Datum / Projection: GDA94 MGA Zone 56

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09-3084-005

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Petroleum Lease Applications

Figure 5.4c

- Highway
- Major Road
- Local Road
- Watercourse
- Sub-station
- Cadastre

Petroleum Lease Application

- APPLICATION
- GRANTED

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Scale 1 : 100 000
Datum / Projection: GDA94 MGA Zone 56

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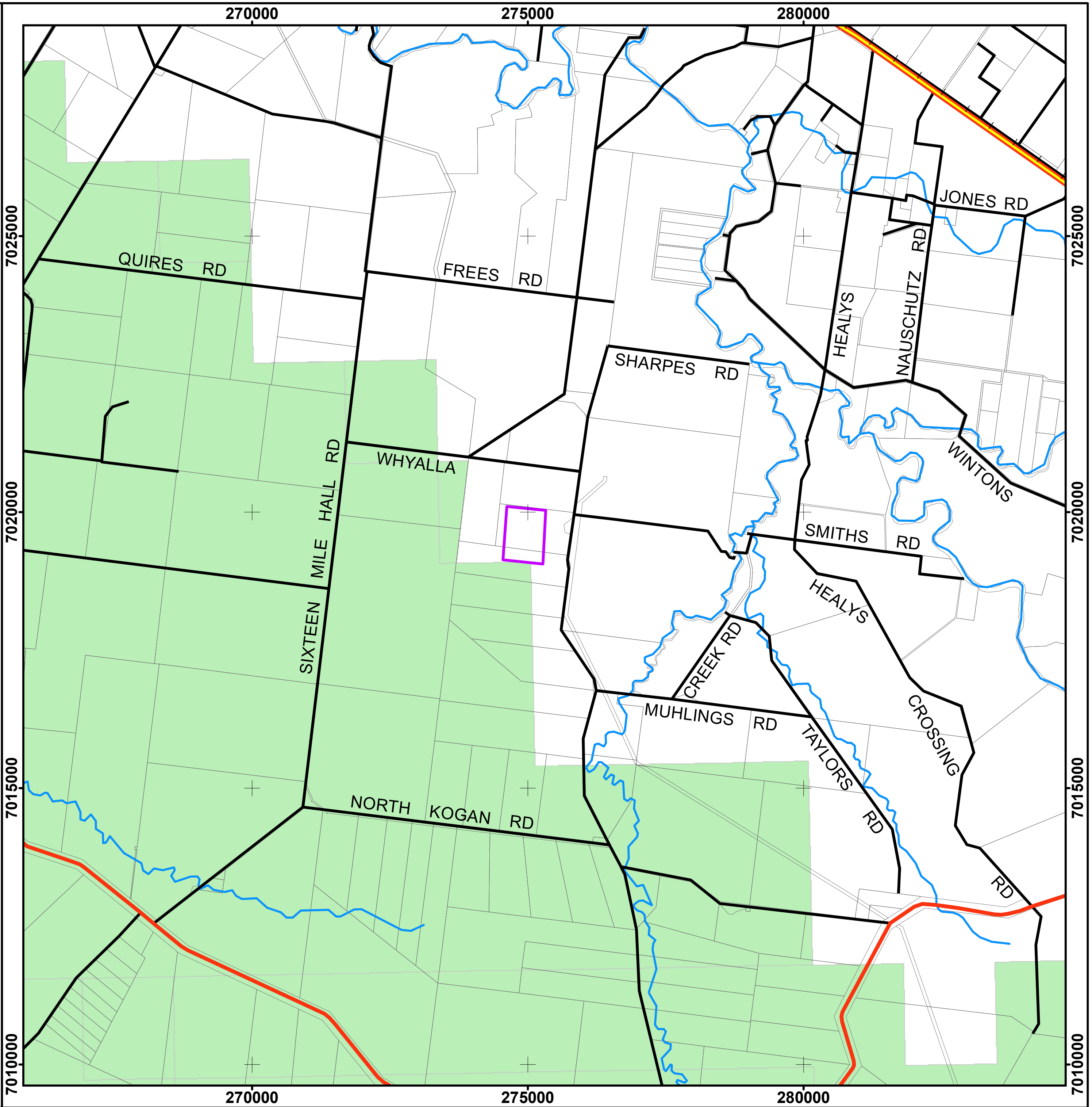

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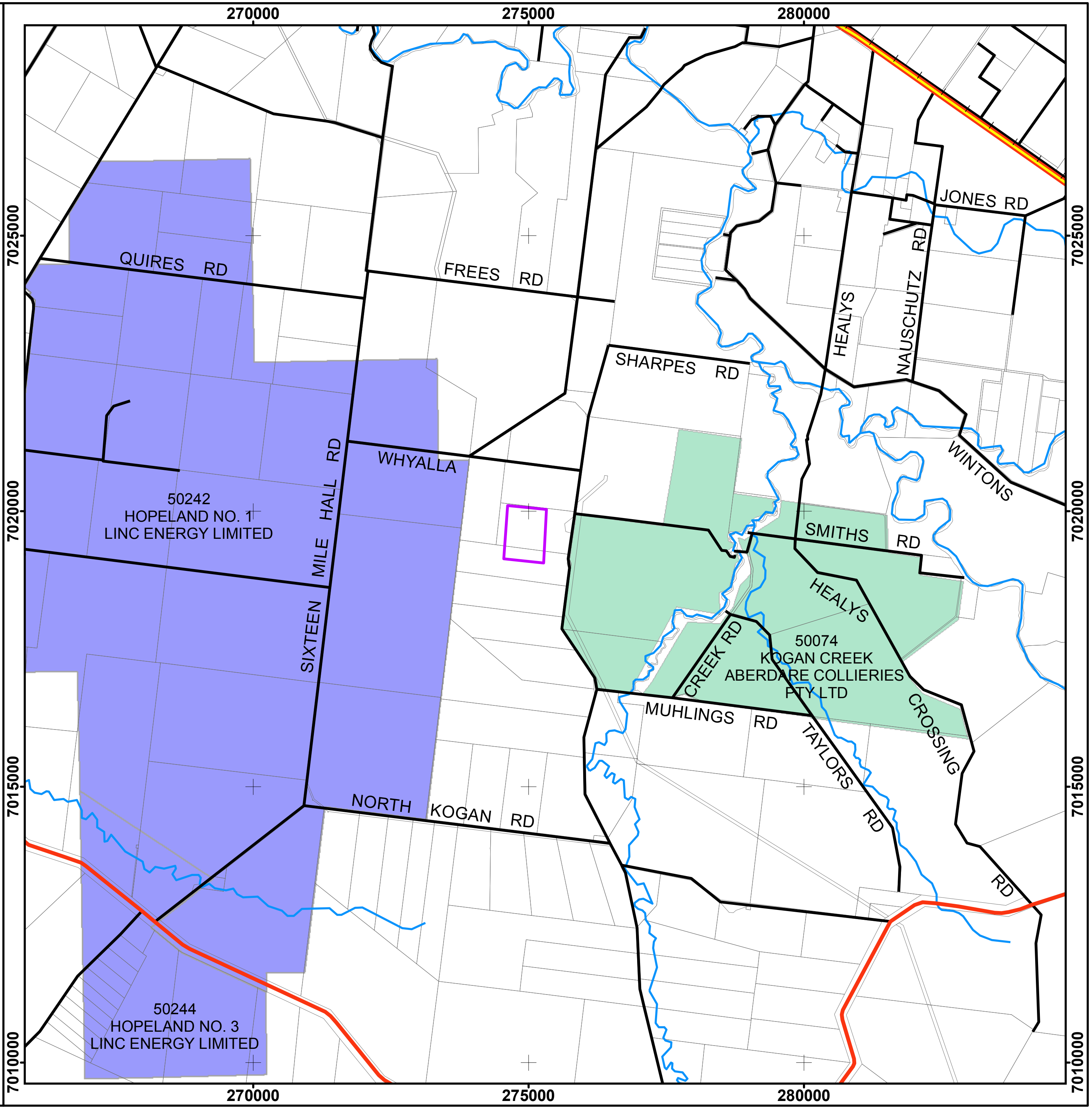
Mining Tenements

Figure 5.4d

Highway
Major Road
Local Road
Watercourse
Sub-station
Cadastre

Mining Leases

APPLICATION
GRANTED



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Scale 1 : 100 000
Datum / Projection: GDA94 MGA Zone 56

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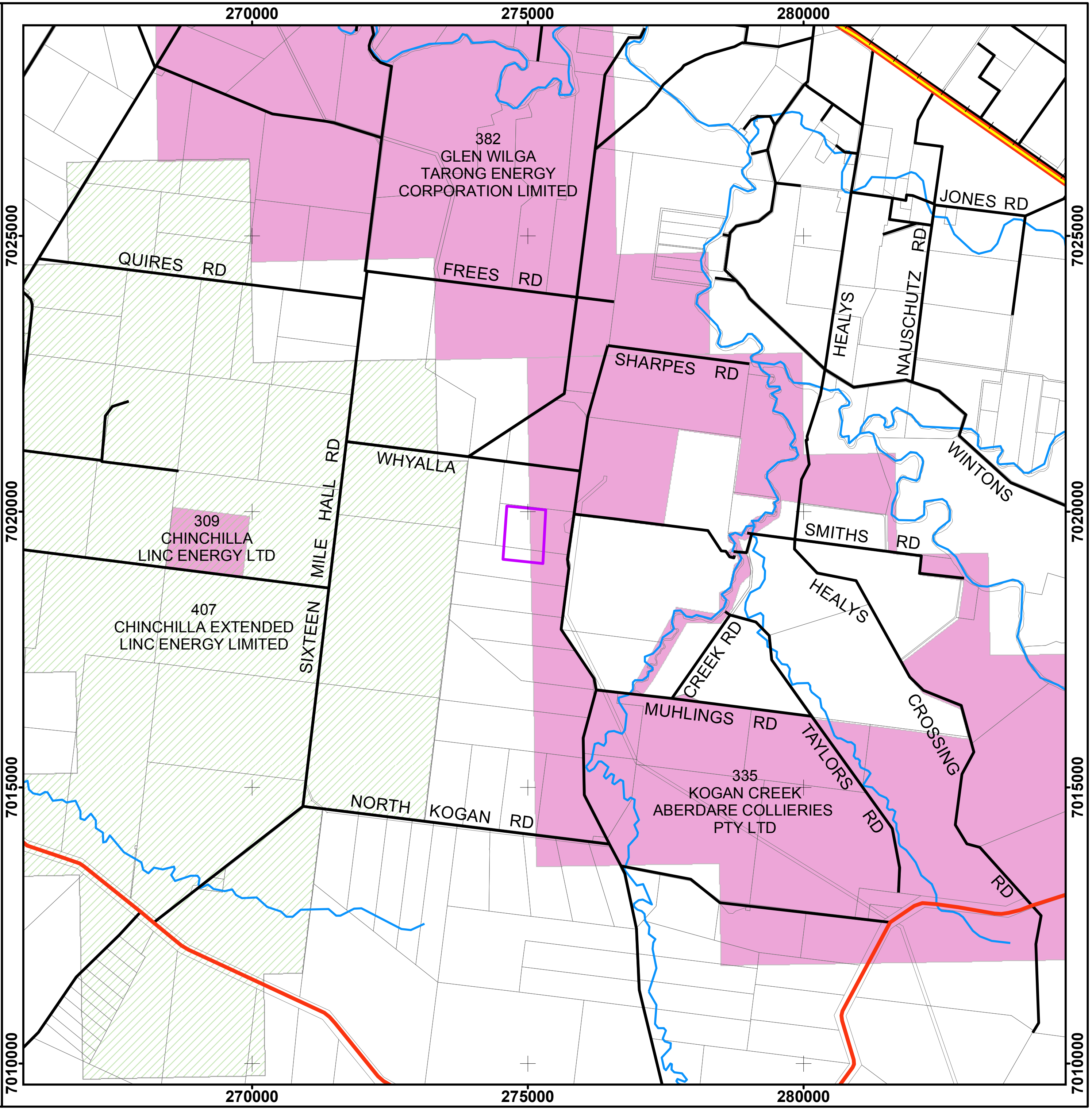
Mineral Development Licences

Figure 5.4e

- Highway
- Major Road
- Local Road
- Watercourse
- Sub-station
- Cadastre

Mineral Development Licenses

- GRANTED
- APPLICATION



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Scale 1 : 100 000

Datum / Projection: GDA94 MGA Zone 56

terranean mapping technologies

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25 September 2009

09-3084-005

5.3.2 Potential Impacts

5.3.2.1 Soil Erosion

Due to the site having low slopes and a sandy loam soil surface, the project site is not considered to have a high risk of water erosion while the soil surface is intact. However, texture contrast soils with sodic subsoils are prone to tunnel erosion, and the problem occurs when the subsoils are exposed. Tunnels generally form under the surface and eventually cave in to form gullies. The rehabilitation of tunnel eroded areas can be difficult and expensive to repair (Maher, 1996).

Potential for erosion of susceptible saline/sodic subsoils is a key concern during the construction phase. This will only be of concern where subsoils are exposed when these soils are excavated as a result of construction works.

There is potential for erosion on the site if water flows are concentrated therefore impedance of flows across the site should be minimised and sheet flow conditions, as would naturally occur, should be maintained as much as possible. The minor floods that can be expected to traverse the site will need to be directed around critical equipment, therefore requiring some local drainage channels and drains to divert this water (see Section 7.2.1).

5.3.3 Mitigation Measures

5.3.3.1 Soil Erosion

There are two primary issues that need to be dealt with in regards to soil erosion due to sodic soils on the project site. Firstly, there is a need to reduce the risk that erosion of the subsoils occurs due to construction activities. This will be achieved by ensuring that earthworks are conducted in a manner which limits the exposure of sodic subsoils to water flow where practicable. In conjunction, sodic spoil soils (i.e. in excess soil post construction) will be treated with gypsum and spread across the disturbed site. Secondly, there is a need to repair the erosion that already exists on the site. This may be achieved through the use of deep ripping, application of gypsum, and where required the filling of gullies using soil that is non-sodic.

In order to minimise flow concentration, levelling of the site should be conducted in a fashion as to maintain sheet flow of water across the site. Possible impediments to flows such as roads should either be constructed flat with ground level or constructed of coarse gravel to allow water to flow through.

Where bunding and drainage channels are required to direct water away from areas with critical equipment, or where chemical or hydrocarbon storage is required, the bank will be pushed up from the back so not as to expose the sodic subsoils to water flows. The material used to construct the bund and drainage channels should be treated with gypsum, fertilised and seeded with grass to stabilise them as soon as possible after construction.

Where concentration of water flows does occur due to the construction of drainage channels, the discharge points should be on a soil not susceptible to tunnel erosion and be well grassed.

Best practice on managing these soils will be employed and all earthworks to level pads for substation platforms will ensure:

- Subsoils are not exposed to water flows;
- High levels of surface cover are maintained to reduce erosion potential;
- Water flows are kept distributed and not channelized to reduce erosion potential; and
- Any banks that are required to be constructed are formed from the lower side as not to expose the subsoil in the bank channel.

Where tunnelling and gully erosion exist (or in the event are created due to earthworks on site) the following practices will be used to stabilise the site:

- Divert water from the top of the eroded area; it is vital to find a safe disposal area, otherwise the problem is being shifted from one place to another. The disposal site must be well grassed and on a soil not susceptible to tunnel erosion;
- If the tunnels are close to the surface and shallow (less than 60 cm to the bottom of the tunnel) intensive cross ripping may succeed The first ripping should be up and down the slope and subsequent ripping at right angles to the first;
- If the tunnels are deeper than 60 cm, the tunnels can be filled with soil. This should be done when the soil moisture conditions are fairly high and it is vital the area is well compacted. The soil used as fill should be sourced from an area not susceptible to tunnel erosion;
- The effected area should be treated with gypsum, fertilised and sown to grasses suitable for the area; and
- Ongoing regular monitoring is vital.

In addition to the above recommendations, the *Best Practice Erosion and Sediment Control* (IECA 2008) outlines best practice sediment and erosion control measures in Queensland. These measures must be implemented in all disturbance areas as identified in the EMP (see Appendix E).

5.4 Land Contamination

An EMR/CLR search was conducted for the Project site (Lot 3 and Lot 4 on RP176346). The search results indicated that the land is not currently listed on the EMR.

A visual site inspection of the project site was conducted on 10 September 2009. The observation made during the inspection was that there appeared to have been no contaminating activities conducted on the land parcel at the time of inspection.

Results of a search of the Department of Defence (DoD) Unexploded Ordnance (UXO) website indicate that the land is located in an area unaffected by UXO.