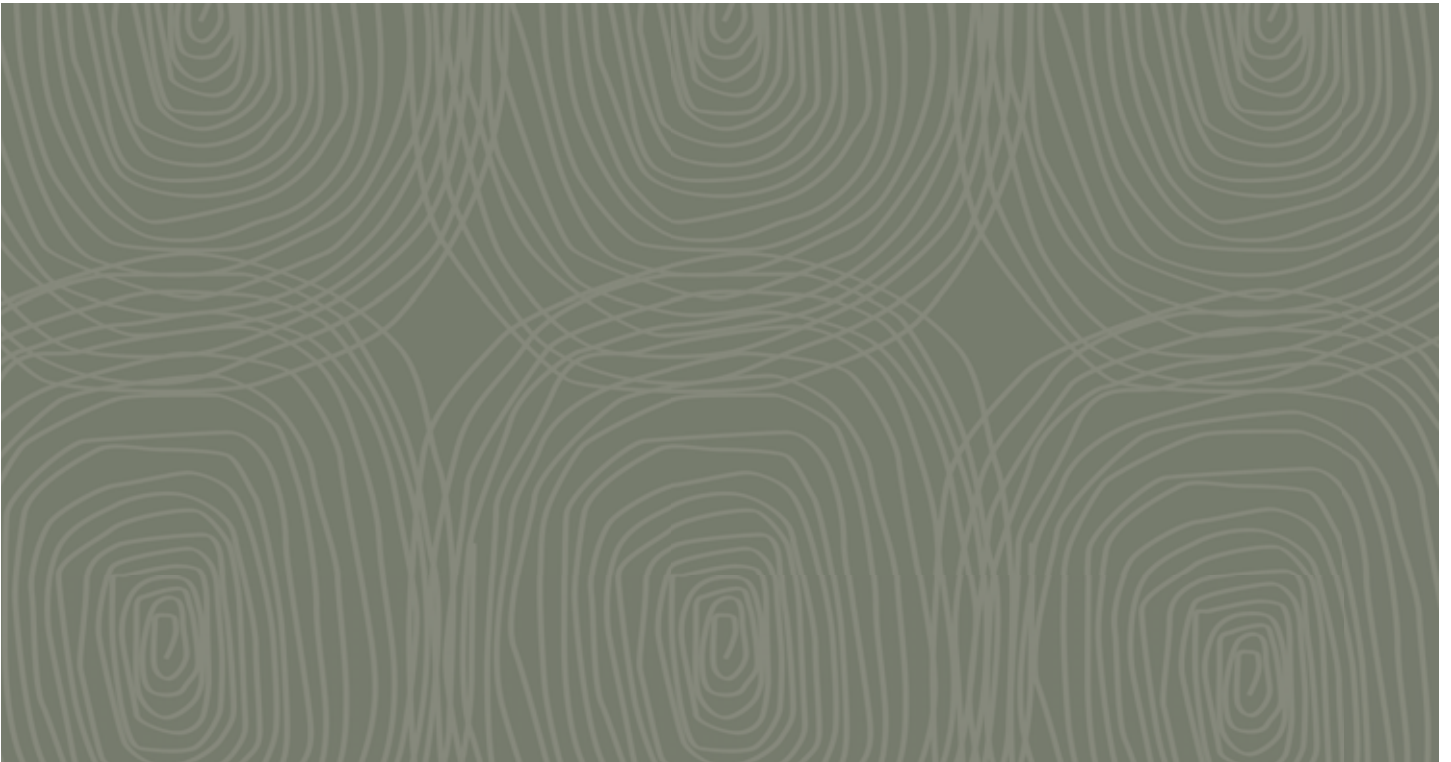


04 | Geology





Section 04 Geology

The Proponent is developing the Kevin's Corner Project through its Hancock Galilee Pty Ltd (HGPL) subsidiary. HGPL proposes to establish a mine in the Galilee Coal Basin, Central Queensland, to service international export energy markets for thermal coal. The project will consist primarily of three underground longwall operations, supplemented in the early years with two opencast pits. It is planned that the Project will link in with the rail line currently being proposed by the Alpha Coal Project.

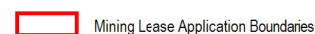
The geology environment associated with the proposed project is discussed in this section.

4.1 Tenure

Kevin's Corner is covered by granted tenure mineral development licence (MDL) 333. The title has been affected to HGPL. MDL 333 was granted on the 27th September 2007, and is due for renewal on the 30th September 2012. In December 2007, the Proponent obtained another exploration permit for coal (EPC) 1210. The MDL 333, a section of the EPC 1210 and the MDL 285 (Alpha Coal Project) have been regrouped to form the new mining leases currently under application. HGPL has applied for mining lease application (MLA) 70425, which is a combination of a portion of EPC 1210 and MDL 333 (Figure 4-1).

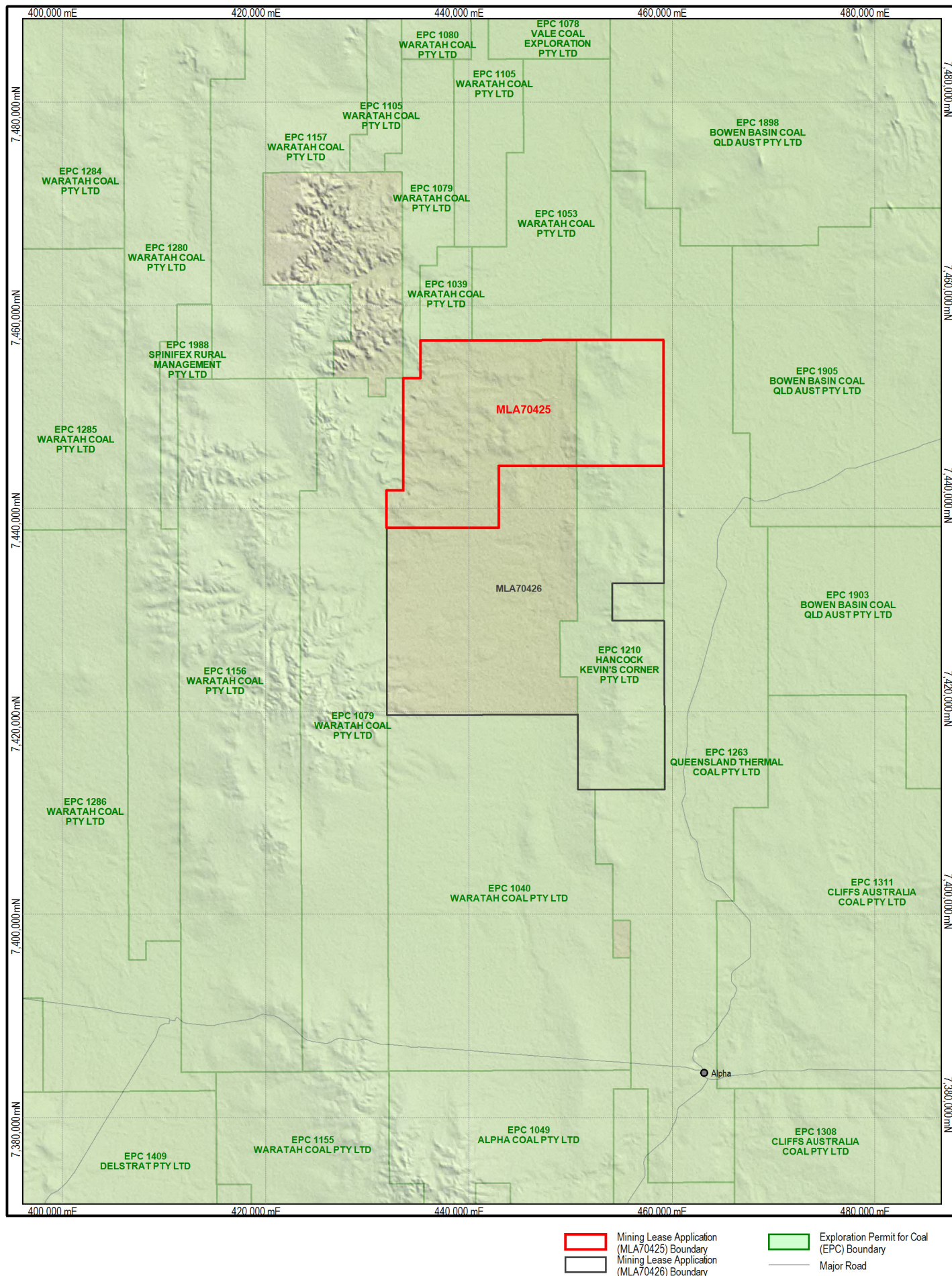
Figure 4-2 shows the location of the leases that make up the Kevin's Corner Project plus neighbouring EPCs 1053, 1079, 1040 of Waratah Coal Pty Ltd to the north, west and south, and EPC 1263 of Queensland Thermal Coal Pty Ltd to the east.

MDL 333 is over-pegged by the petroleum exploration permit, ATPA 744, held by Comet Ridge Ltd, as shown in Figure 4-3 below.



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Datum: GDA94, MGA Zone55



THE KEVIN'S CORNER PROJECT WITH SURROUNDING EPCs

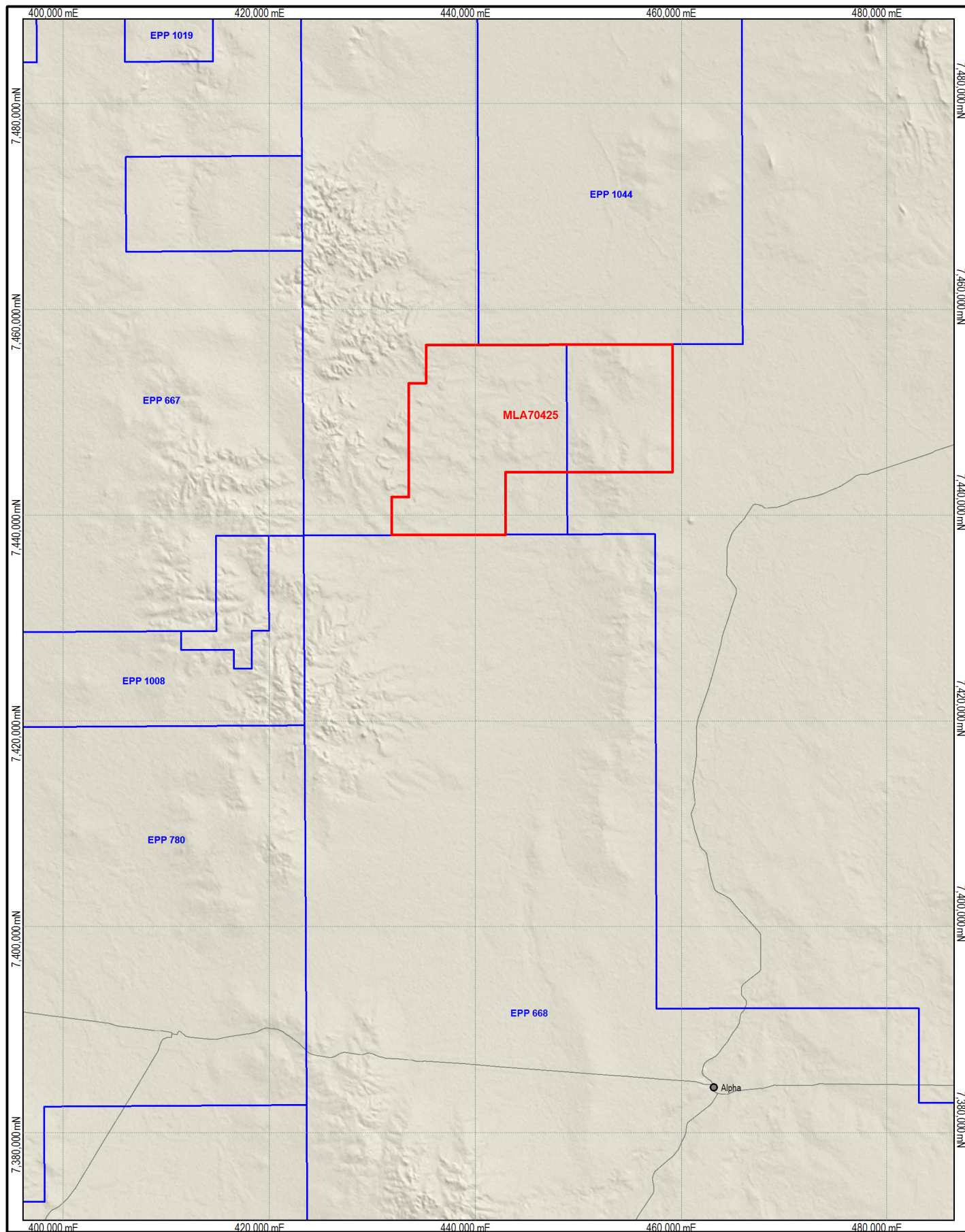
Job Number | 4262 6660
Revision | C
Date | 12-09-2011

Figure: 4-2

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- Mining Lease Application (MLA70425) Boundary
- Mining Lease Application (MLA70425) Boundary
- Major Road

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0 5 10Km
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Datum: GDA94, MGA Zone55



**Kevin's Corner Project
Environmental Impact Statement**

THE KEVIN'S CORNER PROJECT WITH OVER-PEGGED ATPs

Job Number | 4262 6660
Revision | B
Date | 12-09-2011

Figure: 4-3

File No: 42626660-g-1093.wor

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4.2 Regional geology

The Kevin's Corner Coal deposits occur within the Galilee Basin, a sequence of Late Permian to Early Triassic sedimentary rocks, exposed in a linear belt between the towns of Pentland in the north and Tambo in the south (Figure 4-4).

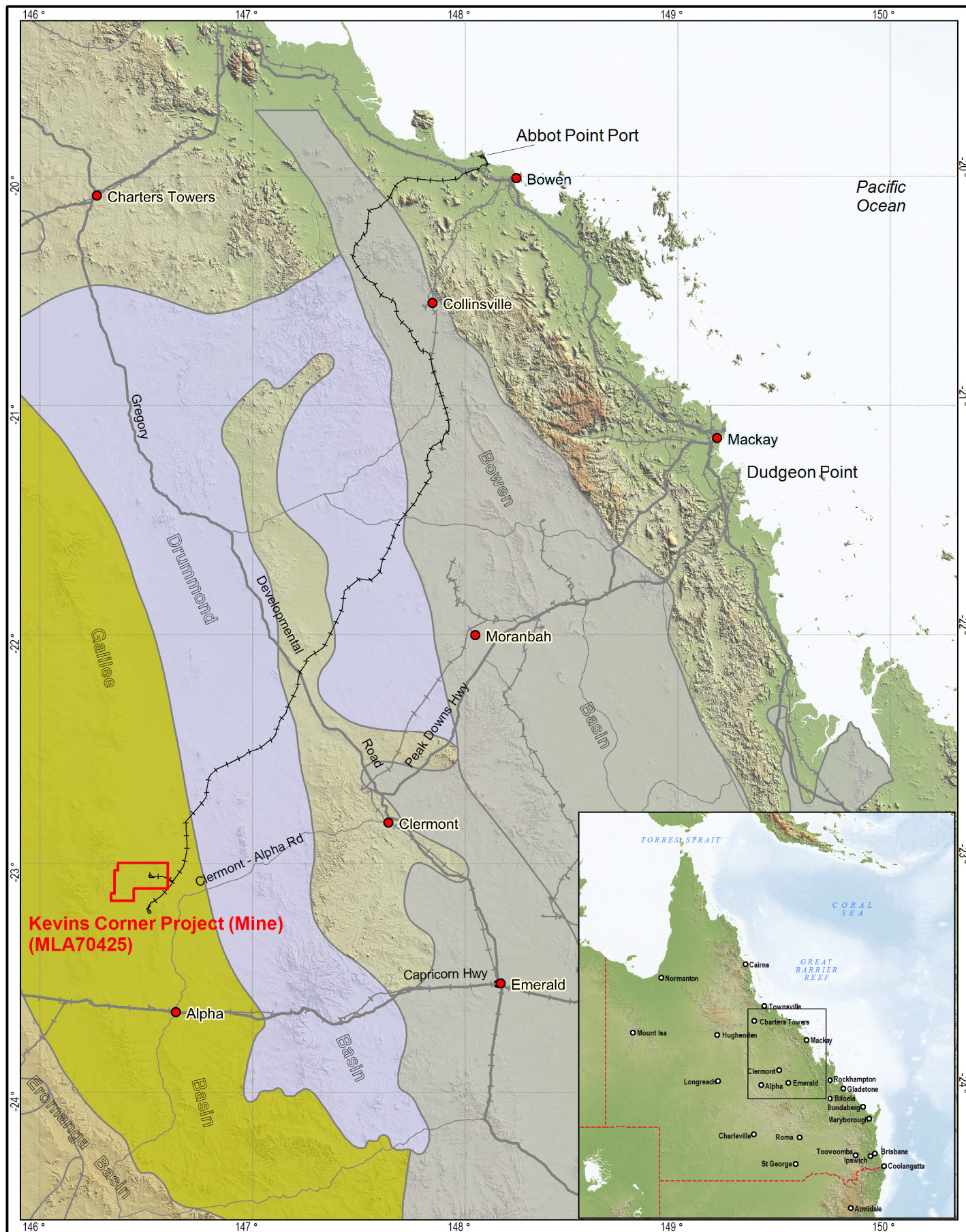
The rocks of the Galilee Basin are of similar age to those of the Bowen Basin (Late Permian), which is exposed to the east of the Drummond Basin (Figure 4-4). The Bowen and Galilee coal basins are separated by a north-trending structural ridge between Anakie and Springsure, referred to as the Springsure Shelf. Much of the western portion of the Galilee Basin is interpreted as occurring beneath Mesozoic sediments of the Eromanga Basin. The Anakie Inlier comprises older Palaeozoic rocks.

Late Permian, coal-bearing strata of the Galilee Basin sub-crop are found in a linear, north-trending Belt in the central portion of the exposed section of the basin and are essentially flat lying (dip 1 to 2° to the west). No major, regional scale fold and fault structures have been identified in regional mapping of the Project area (Golder, 2007a and Bridge Oil, 1994).

The stratigraphy of the Galilee Basin in the Kevin's Corner area is described in Table 4-1.

Table 4-1: Galilee Basin Stratigraphy – Kevin's Corner Area

Era	Period	Basin	Unit	Rock Types
Cainozoic	Quaternary	-	-	Alluvium
	Tertiary	-	-	Argillaceous sandstone and clay
Mesozoic	Triassic		Rewan Formation	Green-grey mudstone, siltstone and labile sandstone
Paleozoic	Permian	Galilee	Bandanna Formation	Coal seams A and B, labile sandstone, siltstone, and mudstone
			Colinlea Sandstone	Coal seams C, D, E, and F, labile and quartz sandstone
	Late Carboniferous to Early Permian		Joe Joe Formation	Mudstone, labile sandstone, siltstone, shale and thin carbonaceous beds
	Early Carboniferous	Drummond		



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0 25 50km
Scale 1:2,500,000 (A4)
Projection: Geographic (GDA94)



Datum: GDA94, MGA Zone55

HANCOCK GALILEE PTY LTD
Kevin's Corner Project
Environmental Impact Statement

GALILEE BASIN
CENTRAL QUEENSLAND

Job Number 4262 6660
Revision B
Date 12-09-2011

Figure: 4-4

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The site lithostratigraphy, including the site-specific coal seam information, is presented in Table 4-2.

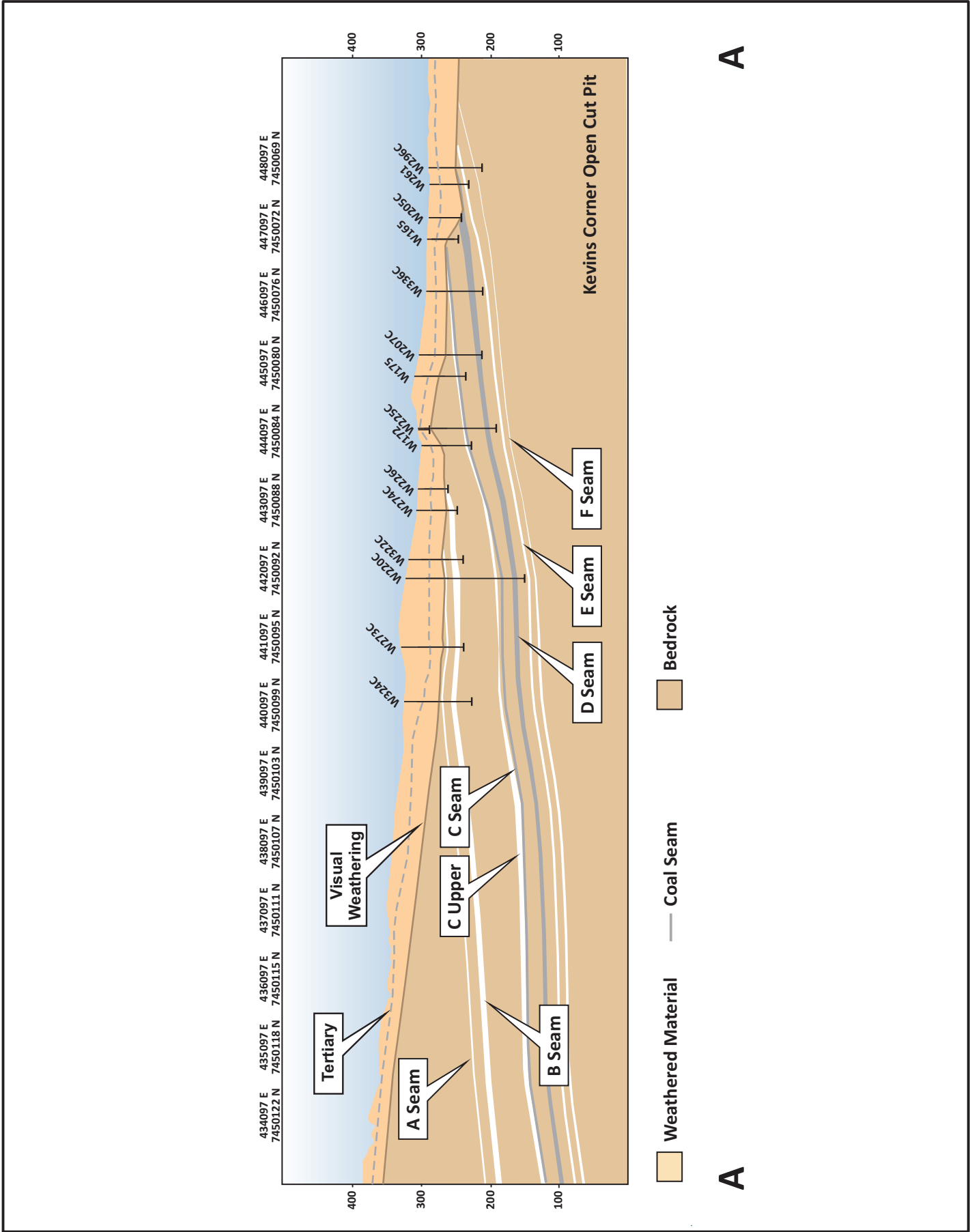
Table 4-2: Late Permian Coal Measure Stratigraphy - Galilee Basin

Age	Lithology	Stratigraphic Unit	Thickness	Comments	
Quaternary	Sand, fine gravel, clay		Average 40 m	Alluvium	
Tertiary	Saprolite, laterite and remanent red mudstone and white / beige sandstone		5 - 60 m	Clay-rich	
Triassic	Green brown-purple mudstone, siltstone and labile sandstone	Rewan Formation	175 m	In far west	
Late Permian	Sandstone	Bandanna Formation	30–50 m		Increasingly argillaceous
	Coal Seam A. Seam contains thin stone bands that thicken from south to north		1 - 2.5 m		
	Labile sandstone, siltstone and mudstone		10 m		
	Coal Seam B. Seam contains numerous dirt bands that constitute between 15 and 30% of seam. Variable in quality.		6 - 8 m		
	Siltstone and mudstone		60–70 m		
	Coal Seam C. Inferior C upper seam C Seam	Colinlea Sandstone	2 - 5 m		Increasingly arenaceous
	Siltstone and sandstone		3 – 4 m		
	Coal Seam D. Stone bands present with seam thickening westward, upper section splits off main seam to north west		2 – 20 m		
	Sandstone		4.5 - 6 m		
	Coal Seam E		30 m		
	Sandstone		0.5 m		
	Coal Seam F		15 – 20 m		
	Sandstone		1 - 3 m		
	Unknown				
Early Permian	Labile and quartz sandstone	Undefined	Transition to Joe Joe Formation		

A diagrammatic cross-section is presented in Figure 4-5 indicating the coal seams within the project area.

4.3 Project Specific Geology

The Kevin's Corner Coal Deposit (MDL 333) occurs within the Galilee Basin (Figure 4-6), a sequence of Late Permian to Early Triassic age. The geology consists mainly of sediments dipping 1 - 2° westward, which is unconformably overlain by Tertiary and Quaternary sediments (Table 4-2). The thickness of Tertiary and Quaternary sediments varies from 5 m to 60 m (average 40 m) across MDL 333. There are six coal seams in the project (mine) area designated as A, B, C, D, E, and F.



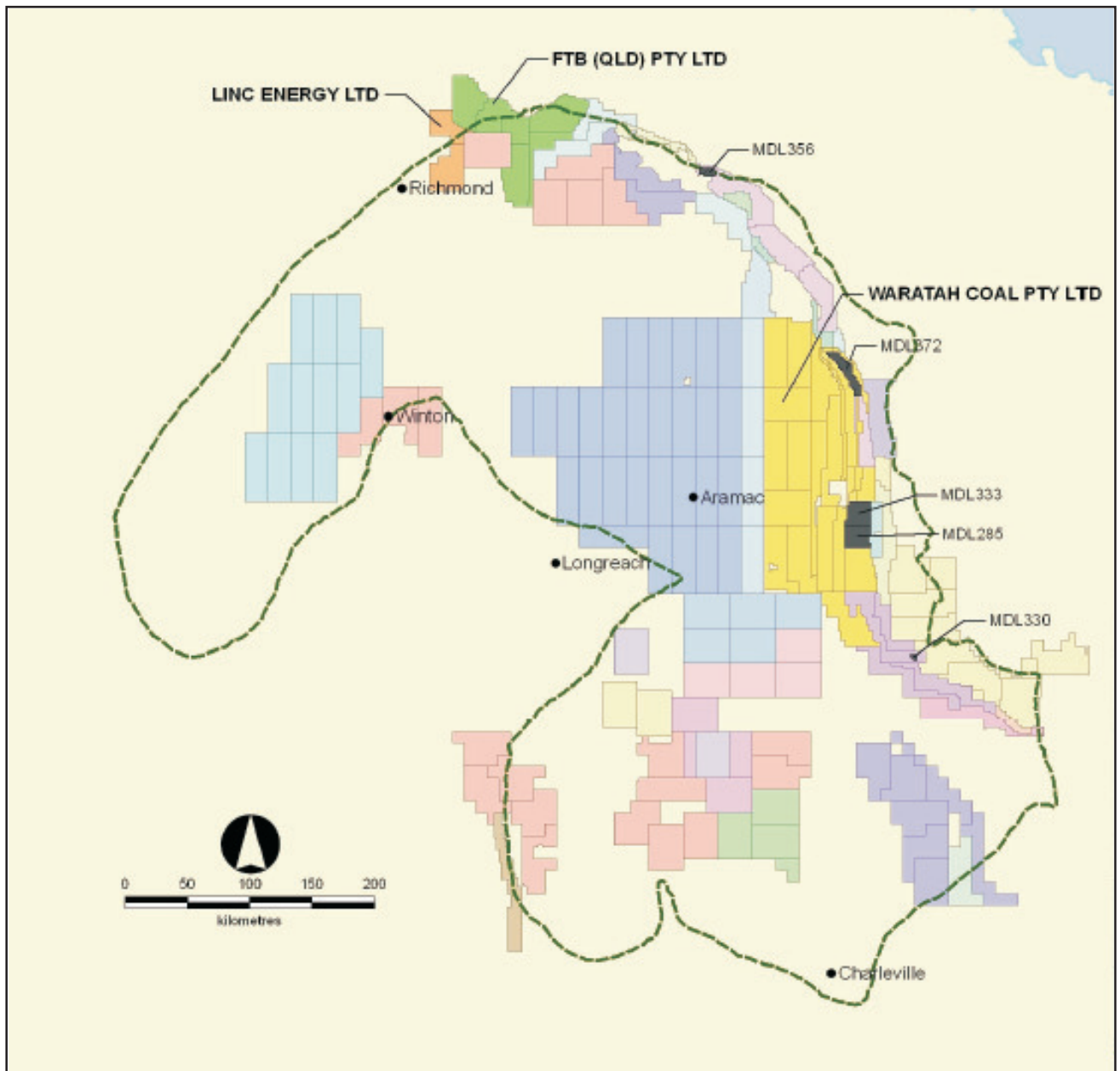
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DIAGRAMMATIC WEST-EAST CROSS-SECTION THROUGH THE PROJECT AREA

Job Number | 4262 6660
Revision | B
Date | 12-09-2011

Figure: 4-5



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4.3.1 Cainozoic

A sequence of sand, fine gravel and minor clay horizon covers the project study area. This cover has an average thickness of 40 m, thickest in the eastern and central regions and thinning towards the high-lying areas to the west (< 5 m thick). Saprolite and lateritic horizons are recorded along with mottled clay paleosols. Minor localised perched groundwater was recorded on the clay saprolite during exploration drilling within the Cainozoic.

The Cainozoic unconformably overlies the Triassic Rewan Group and Permian units.

Weathering of the Mesozoic / Palaeozoic occurs at the base of the Cainozoic. The depth to the base of weathering in the Mesozoic is enlarged at Kevin's Corner due to the accumulation of a recent Cainozoic layer over the top of the ancient weathered layers.

Tertiary intrusive and extrusive rocks (e.g. Tertiary basalts) have not been encountered on site.

4.3.1 Rewan Group

The Rewan Group outcrops only in the far west of MDL 333. This group comprises mudstone, siltstone, and lithic sandstone of fluvial, lacustrine, and aeolian origin, and is of low porosity and permeability (Butcher, 1984). The maximum encountered thickness of the Rewan Group is 1,363 m in the Bowen Basin (DME, 1997) but it is suspected that the Rewan Group can reach a maximum thickness of 3,500 m. Exploration drilling in the area immediately surrounding MLA 70425 indicates an average horizontal thickness of 175 m (Table 4-2).

The base of the Rewan Formation is located some 30 to 50 m above the uppermost A seam coal ply.

The confined aquifers of the Great Artesian Basin (GAB) are bounded below by the Rewan Group (Habermehl, 2000), indicating that the proposed Kevin's Corner mining activities will occur in older formations below and to the east of the GAB and separated from the oldest GAB aquifer, the Clematis Sandstone, by the thick Rewan Group, which is a regional aquitard.

4.3.2 Permian

The Permian is represented by the Bandanna Formation and Colinlea Sandstone.

The Bandanna Formation comprises grey siltstone, sandstone, mudstone, and hosts the A and B coal seams.

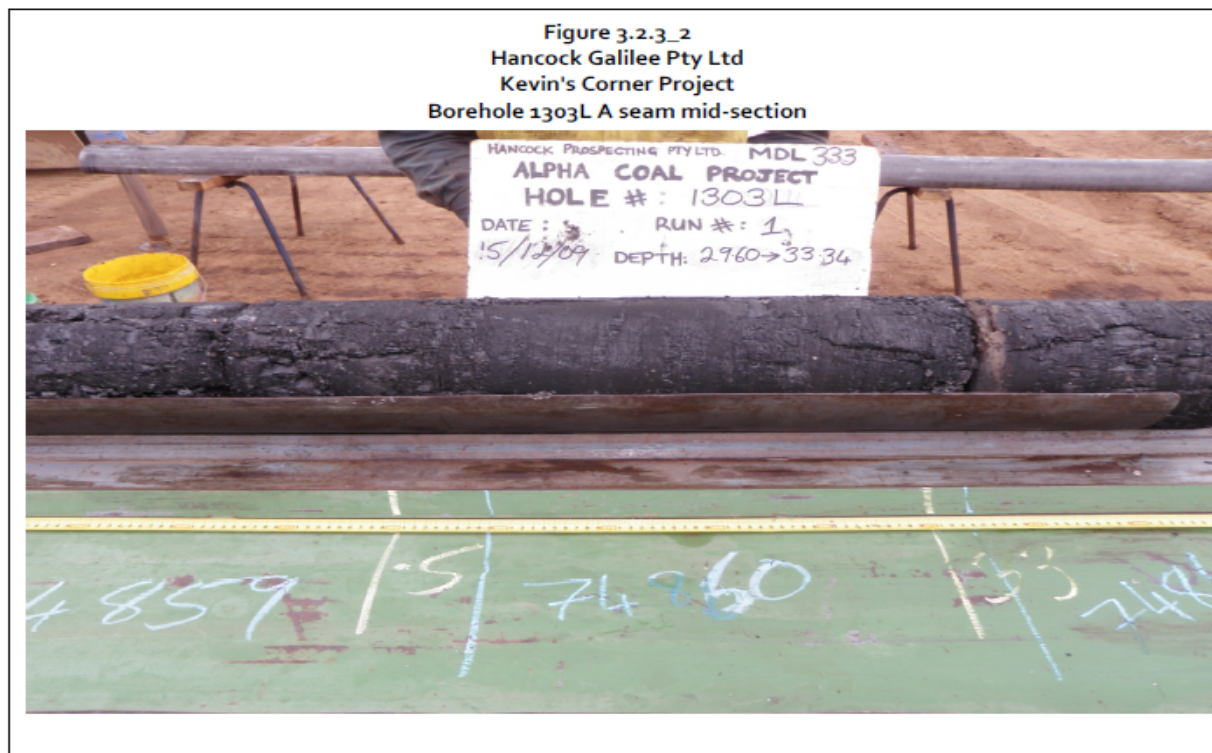
The Colinlea Sandstone contains the C to F coal seams (Figure 4-5). The unit is dominated by medium to coarse sandstone, which is labile and displays a clayey matrix in places. The seams are conformable and dip (1 - 2°) to the west.

A Coal Seam

The A Seam has an average thickness of 2.5 m within the project area and is described as a dull to bright coal (Plate 1). The A seam comprises three plies, A1, A2 and A3. The combined A seam can produce good quality coal with a minimum of 10% raw ash but in general the full seam ranges between 15% and 20% of raw ash. The A seam sits below the Rewan Formation or Cainozoic cover (where missing) and 15 to 25 m above the B seam.



Plate 4-1: A coal seam



B Coal Seam

The B seam composes six plies (B1 to B6), which are consistent and correlatable in MDL 333. In terms of coal quality, the B3-B4 plies have an average raw ash of about 25%. The upper plies (B1 and B2) have higher ash contents, greater than 30%. B5 and B6 are both of high ash. The coal plies are separated by soft tuffaceous claystone (Plate 2).

Plate 4-2: B coal plies





B-C Interburden

The interburden between the B and C coal seams is generally greater than 80 m. The sediments above the C Seam comprise labile sandstone with a clayey matrix and subordinate siltstone. Drilling has intersected an area of puggy claystone or clay matrix sandstone mid way down into the C Seam interburden. The coal quality of the C and D Seams is generally much better than that of the A and B.

C Coal Seam

The C Seam is made up of two distinct zones:

The C Upper Unit (CU) is characterised by interbedded stony coal, puggy clays and carbonaceous shale. The majority of this coal is not economic due to inferior coal and ash content greater than 70%. In addition, this coal seam sequence includes puggy clays, which reduces economic value. This coal seam is not considered as part of the current resource for Kevin's Corner.

- The *Lower C Seam* (C Seam) comprises dull to dull banded coal with some claystone partings. It is generally greater than 20% ash, but in places it can contain plies of less than 10% ash. The C Seam splits into 3 separate plies (C1, C2, and C3). The cumulative thickness is generally between 2 and 3 m and is best developed in the central-south of MDL 333 (Plate 3).

Plate 4-3: C Seam





C-D Interburden

The interburden between the C and D Seams is generally composed of competent sandstone, interlaminated with silty bands and carbonaceous wisps, with occasional coaly traces and in places can grade into siltstone.

D Coal Seam

The D Seam comprises four correlatable seam plies:

- The *D Upper Seam* (DU), a dull to dull and bright ply of coal, ranging from 0.3 to 2 m thick. It is commonly separated from the rest of the D Seam by a layer of coaly shale and sits contiguously on top of the other plies of the D Seam.
- The *DLM1 ply* is a low ash (approximately 13%) ply of dull coal to coaly shale. It is often < 1 m thick.
- The *DLM2 ply* is a consistently thick (2.5 – 3 m) section of dull to dull and bright coal. It is consistently underlain by a band of siltstone/sandstone that separates it from the DLL (D Lower) ply. It has an average raw ash of 21%.
- The *DLL* (D Lower) commonly has a raw ash of 25% and an average thickness of approximately 2 m.

D-E Interburden

The D to E interburden can range from a fine to coarse sandstone and becomes pebbly toward the top of the E seam. The interburden and is 5 to 30 m (average 14 m) thick.

E and F Coal Seams

The E Seam is present as two 0.2 m thick clean coal bands (E1 and E2) below the D Seam. The F Seam displays patchy development and the full geological section can reach in excess of 5 m in isolated areas. However, excessive banding with non-coal parting, excessive separation (high incremental ratio) and poor coal quality makes the F Seam sub-economic. The F Seam sits around 30 m below the D Seam floor.

No resource potential by current practices and economy is currently attributed to either E or F Seams within MDL 333.

4.4 Proposed mining method

4.4.1 Underground

Three underground longwall operations are proposed in three independent mines. Each longwall panel will have an independent set of mains for access, coal clearance and ventilation.

The Northern Underground will be developed first, being the shallowest access point and having the shortest initial panel length. The Southern and then Central Underground will be developed sequentially (on the basis of depth of access and available reserves), with access construction occurring immediately following completion of the previous mine's access drifts.

4.4.2 Open-cut

The open-cut mine layout consists of 2 pit areas, extending over a total strike length of 11 km. Mining will commence at the seam sub-crop, and progress down dip. The open-cut operation commences as a truck-shovel operation, after which it will evolve into a dragline stripping operation. The pre-strip fleet will mine all of the weathered tertiary overburden. At peak production, there will be 2 draglines operating, and up to 5 waste truck-shovel / excavator fleets. Almost all of the waste will be used to backfill the pit, although an initial out-of-pit dump will be required for the box cut. The maximum backfill height will be around 30 m above the natural surface.

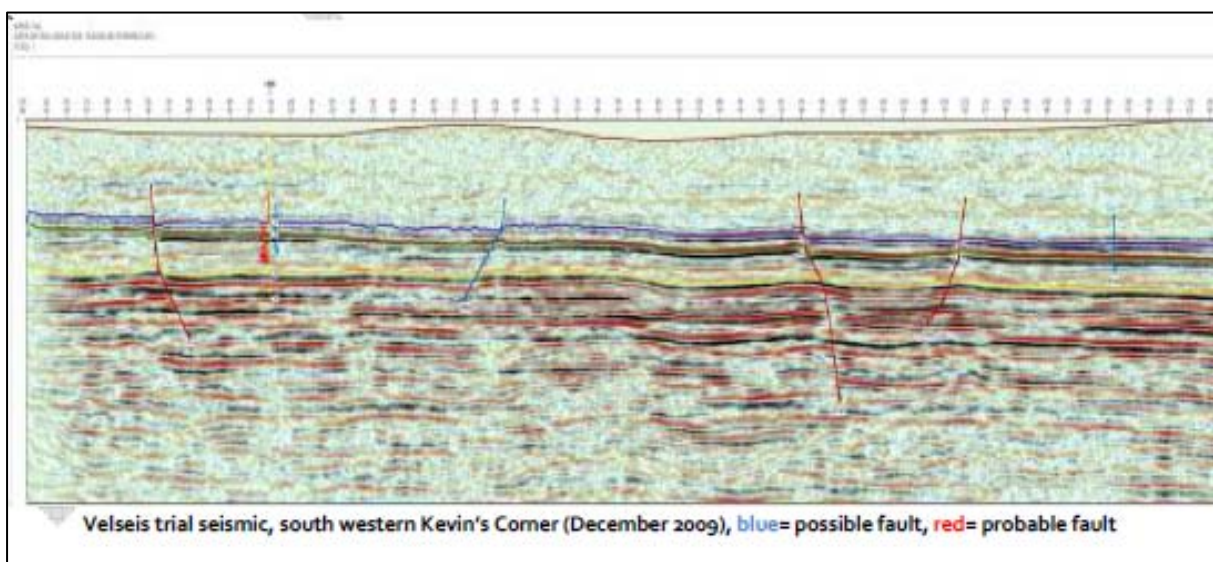
4.5 Geological structures within the area of disturbance

Minor and localised faults have been identified in exploration core, with the presence of calcitic healed faults, small breccia zones, and small scale fault offsets. On a regional scale, drilling within MDL 333 does not indicate any major fold and fault structures. There is little seam conflict to indicate the presence of large scale faulting.

Although the seam structure has been defined in terms of parent seams and plies (Section 4.3), the plies are a continuous feature over the whole deposit, colloquially known as a "layer cake".

A trail 2D seismic survey was conducted in the south-west of Kevin's Corner to assess underlying geological structures. The seismic exploration covered a distance of 6 km and suggests probable and possible faults (Figure 4-7).

Figure 4-7: Trail 2D Seismic stack



The presence of broken seismic reflectors (as recognised in Figure 4-7) and the record of fault indicators in the exploration drilling core indicates the existence of faults at Kevin's Corner. The seismic data suggests 2 to 3 km spacing of faults with throws up to 3 times the seam height.

4.5.1 Slope stability

During the historical geotechnical investigations some bedding parallel shear zones were detected in the sediments overlying the C seam. These appear to be persistent. It is noted that the dip of the



strata will be into the walls at a low angle, which is a more favourable orientation for the shears in terms of slope stability.

Some weathering and erosion effects are expected on slopes containing these overburden materials, however, they are not expected to unduly affect the stability of the landform.

4.6 Geological factors that may influence ground stability

4.6.1 Geology

The Permian coal seams dip gently to the west at an angle of 1 to 2°. Six seams have been intersected in the actual mining lease (MDL 333): the A, B, C, D, E and F Seams. The D Seam is the most economic target at Kevin's Corner as the D Seam contains good quality thermal coal. For export coal, all coal will require washing prior to export.

Tertiary and Quaternary deposits overlie the coal seams (Figure 4-5). Of significance is the depth of weathering (average 40 m) and the relatively soft Tertiary deposits which, although generally soft and diggable, often contain harder, iron-cemented, laterite bands. These are significant because they may prevent the economic use of a bucket wheel excavator and may provide resistance to ripping.

The Tertiary strata and some of the Permian deposit contain mudstone, claystone and sandstone, which have a clayey matrix. Sections of the sequence are prone to slaking and thus often rapidly degrade on exposure to weathering conditions. Below these sections, the rock grades into more sandy and generally more competent rock types towards the top of the C Seam.

4.6.2 Roof Behaviour

Strata Control Technology (SCT) undertook assessments including but not limited to the D Seam roof behaviour to assess primary support requirements for the proposed underground mine, stress field characterisation, caving characterisation, and secondary support requirements.

Roadway stability on development, in unstructured roof, is expected to be good in the shallower areas of the mine. Roof stability is expected to be maintained until the horizontal stress exceeds ~ 5 MPa. Above this stress level increased roof movement would be anticipated and roof stability reduced. This can occur in roadways developed "across" the maximum horizontal stress at depths beyond ~ 150 to 200 m. Roof bolts will be required to maintain roof integrity in these areas.

Structural features, such as local faults, are expected to locally reduce the stability of the roof such that increased roof deformation will be initiated at lower stress levels.

Good caving conditions are expected for longwall operations.

4.6.3 Groundwater

The depth of the groundwater table varies between 10 and 75 m, with a gradient from south-south-west to north-north-east. Air lift flow rates during exploration have been found to be generally low. It is anticipated that groundwater ingress into the underground workings will be considerable¹, based on the aquifer potential of the sandstone units and increased inter-aquifer connection due to goaf. The groundwater will be handled using dewatering schemes within the mine (EIS Volume 1 Section 12).

¹ Predictive modelling indicates a volume of 125 GL over the 30 year life of mine, some 11 ML/day (127 L/s)



Coal mining operations will be carried out below the groundwater table and some wet blast holes are anticipated. It is also noted that blast hole stability will be variable, with stability issues in the Quaternary/Tertiary and some swelling rocks within the Permian sequence.

Inflows

Groundwater inflows into the underground mine can occur through:

- The C-D sandstone aquifer, which has the potential for extensive inflows where coarse sands occur in the hanging wall; and
- The foot wall floor from the D-E sands aquifer.

Predictive groundwater numerical modelling predicts that an average pumping rate of 127 L/s will be required to manage, dewater and depressurise the D-E sands aquifer to a level below the D coal seam, i.e. an active dewatering system ahead of mining is required to reduce the pressure and risks associated with pit floor ingress.

4.6.4 Subsidence

The potential subsidence characteristics resulting from the proposed longwall mining at Kevin's Corner was assessed by SCT Operations Pty Ltd (SCT). The preliminary assessment (SCT, 2010) indicates that the proposed longwall panels at the Kevin's Corner Project are of supercritical width in subsidence engineering terms with maximum subsidence developed over the central part of each panel.

Maximum subsidence is expected to be generally less than 2.9 m in the majority of the proposed mining area with 2 m maximum subsidence expected in the north beyond the D Seam split.

Cracks are expected to be temporary (self heal in the clay-rich Tertiary) and generally less than 100 mm at 300 m overburden depth and 300 mm at 100 m overburden depth. The largest potential cracks are expected to develop parallel to the longwall face at the start of each panel.

The proposed longwall mining is expected to cause fracturing of the overburden strata above most of each longwall panel. The hydraulic conductivity of the fracture network developed depends on the particular characteristics of the overburden stratigraphy and individual units within it. In general, a significant increase in hydraulic connectivity with the surface is typical of fully subsided tertiary overburden strata and would be expected at this site.

4.7 Geochemical information for the area to be mined

4.7.1 Coal quality testing

Coal quality data stored into an Oracle based Minescape GDB database has been composited to a seam basis. Since some of the samples were analysed on a parent seam rather than split basis, the data has been processed to validate the parent seam quality to each of its splits, in order to create a quality model on the same basis as the structural model (Salva, 2010).

Coal quality data consists of:

- Raw Proximate Analysis, Specific Energy, Total Sulphur and Relative Density; and
- Float 1.50 and float 1.60 product proximate analyses.

Drill hole statistics for key raw parameters are listed in Table 4-3.



The total sulphur content of the target coal is typically around 0.6%, which is similar to that found at the Alpha Coal Project, where approximately half (0.3%) was present as pyritic sulphur. Geochemical information on coal and mining wastes and environmental management strategies for these materials are described in Volume 2 Section 16.

Table 4-3: Drill hole statistics raw coal quality (Salva, 2010)

Seam	IM % ad				Ash % adb				RD g/cc adb				GCV kcal/kg adb				TS % adb			
	No.	Minimum	Maximum	Mean	No.	Minimum	Maximum	Mean	No.	Minimum	Maximum	Mean	No.	Minimum	Maximum	Mean	No.	Minimum	Maximum	Mean
A1	7	6.8	10.7	8.3	11	15.5	69.22	36.94	6	1.43	2.3	1.71	5	3240	5525	4502	6	0.17	0.54	0.32
A12	2	11.1	11.3	11.2	2	15.9	17.2	16.55	2	1.45	1.46	1.46	0	-	-	-	1	0.41	0.41	0.41
A2	9	6.8	12.8	9.38	15	13.5	79.71	42.61	11	1.43	2.3	1.84	7	2053	5630	4453	7	0.17	0.57	0.35
A23	1	10.9	10.9	10.9	1	13.1	13.1	13.1	1	1.42	1.42	1.42	1	5733	5733	5733	1	0.78	0.78	0.78
A3	18	6.7	13.7	10.33	18	8.4	38.8	18.04	15	1.38	1.69	1.47	12	3666	6180	5400	14	0.3	0.58	0.4
A	35	4.26	12.3	8.44	37	8.3	57.83	23.99	37	1.35	2.3	1.56	5	5259	6130	5746	5	0.31	0.63	0.41
B1	58	4.6	10.8	7.83	61	20.67	64.7	38.21	54	1.51	1.94	1.68	17	1486	4593	3440	19	0.12	0.66	0.33
B2	59	3.3	11.92	7.81	64	17.4	68.58	35.9	56	1.42	2.06	1.65	17	1262	5793	3655	20	0.18	1.07	0.36
B3	64	1.6	23.6	8.29	70	16.7	79.45	33.28	63	1.45	2.3	1.64	16	2210	5422	4087	18	0.15	0.59	0.4
B41	5	9.2	10.4	10.1	7	19.6	61.3	36.97	5	1.47	1.79	1.55	5	2722	5303	4607	5	0.22	0.46	0.36
B42	4	8.2	9.9	9.3	7	26.5	62.5	40.58	4	1.52	1.8	1.6	4	2911	4765	4277	4	0.36	0.5	0.46
B43	2	9.2	10	9.6	3	25.2	38.77	30.49	2	1.52	1.54	1.53	1	4667	4667	4667	2	0.39	0.46	0.42
B4	63	5.1	11.5	8.33	67	16.8	71.48	32.18	63	1.46	2.3	1.63	10	3184	5425	4553	13	0.27	0.61	0.43
B5	8	6.3	10.4	8.78	12	26.3	75.98	48.69	10	1.54	2.3	1.83	6	1950	4708	3609	8	0.25	0.76	0.43
B6	2	8.6	9.6	9.1	2	40.9	59.36	50.13	2	1.7	1.97	1.83	1	1950	1950	1950	2	0.39	0.76	0.57
C1	20	5.2	11.3	8.19	24	19.2	78.66	33.42	19	1.46	2.3	1.64	15	2511	5736	4709	14	0.42	1.48	0.65
C12	2	7.1	8.1	7.6	3	23.5	63.67	43.52	2	1.53	1.72	1.63	2	1068	5160	3114	2	0.34	0.66	0.5
C	48	2.2	9.7	6.81	49	9.9	64.29	29.36	39	1.38	2.04	1.63	5	1825	5382	3499	8	0.25	0.74	0.49
C2	22	4.45	11.3	7.85	25	17.4	66.2	34.64	21	1.46	2.3	1.68	17	1434	5736	4353	16	0.21	0.76	0.53
C3	25	5	11.3	7.95	27	12.6	80.03	32.79	24	1.42	2.3	1.63	21	1434	6046	4545	19	0.21	1.61	0.59
DU	80	4	12.2	7.07	89	5.5	67.33	28.53	80	1.34	2.3	1.61	24	3623	6453	5260	28	0.36	1.07	0.6
DLM1	77	2.69	13.9	8.41	78	6.1	42.8	13.08	70	1.31	1.7	1.42	23	4691	6453	5973	22	0.36	1.2	0.72
DLM	21	5.7	10.4	8.18	21	12.7	33.3	20.58	21	1.4	1.61	1.49	16	1907	6233	5080	18	0.41	1.03	0.59
DL	1	9	9	9	1	20.5	20.5	20.5	1	1.52	1.52	1.52	1	5253	5253	5253	0	-	-	-
DLM2	87	2.4	12.3	7.53	92	8.2	80	21.17	82	1.38	2.3	1.53	21	3085	5846	5424	21	0.4	1.82	0.79
DL1	34	3.6	9.7	6.86	36	14.2	80	26.07	33	1.45	2.3	1.59	11	4413	5752	5080	10	0.38	1.39	0.65
DLL	80	2.38	11.3	7.08	84	9.2	61.41	24.91	75	1.42	2.3	1.58	25	1888	6240	4744	27	0.26	0.99	0.54

IM – Inherent Moisture

RD – Relative Density

GCV – Gross Calorific Value

TS – Total Sulphur



4.7.2 Coal quality

The Kevin's Corner mine ROM coal consists of coal from the A, B, C and D seams in an approximate ratio of 1/3/4/92. The quality of the ROM coal is as follow

- A Seam: 24% ash
- B Seam : 35% ash
- C Seam : 34.7% ash
- D Seam : 21.9% ash

The D seam is the most economically attractive seam in the deposit as described above with product ash below 10% at F1.6.

Mean total sulphur levels in the product are approximately 0.55% (air dried basis).

The coal present is a high moisture, high volatile (> 40% DAF) and low to medium rank thermal coal. The average air dried moisture is estimated to be approximately 8.34%.

4.7.3 Coal quality and environmental characterisation

4.7.3.1 Mineralogy

The mineralogy of 2,972 samples from 32 bores on site was undertaken using visible, near infrared, short wavelength infrared (vis-NIR-SWIR) reflectance measurements using the HyChips system. The minerals observed included kaolinite, montmorillonite (Al smectite), nontronite (Fe smectite), and white mica.

In addition the study considered iron oxide intensity. Both hematite and goethite were observed in the samples in distinct intervals down the holes. Iron oxide intensity drops markedly at depth in all holes. This may be associated with the base of weathering or a redox boundary.

4.7.3.2 Geochemical characterisation

Geochemical assessment of geological units underlying the proposed mining area allowed for the determination of the potential for:

- Release of salinity;
- Generation of acid and metalliferous drainage (AMD); and
- Dispersivity.

Samples representative of overburden, raw and product coal, and coal washery wastes (coarse rejects and fine tailings) were characterised. In addition, an extensive range of static and kinetic reference (geochemical) data from the adjacent Alpha Coal Project was available for similar test materials.

Overburden

Static test results indicate that the bulk overburden material is non acid forming (NAF) and a minor amount of overburden typically associated with economic and uneconomic coal seams may be potentially acid forming (PAF), although most is likely to have a low capacity to generate acid. Overburden materials with a significant capacity to generate acid will require environmental management strategies to prevent acid generation as described in Volume 2 Section 16. Neutral waters contacting the bulk overburden would remain circum-neutral. Salinity release would be expected to occur over the short term and diminish with time. Metal and metalloid concentrations of waters contacting the bulk overburden are not expected to increase significantly.

Dispersivity test results indicate that for overburden, the claystone, mudstone, and clay rock types are dispersive or potentially dispersive. The fresh siltstone and sandstone are slightly dispersive and is more amenable for use along with topsoil in rehabilitation activities.

Coal and Coal Washery Waste

Raw and product coal is currently geochemically classified as uncertain, but based on comparable Alpha Coal Project data and kinetic leach column tests some may have a very low capacity to generate acid.

The coal washery coarse reject waste is expected to be PAF and the fine tailing is currently classified as uncertain. Based on comparable Alpha Coal Project data some may have a low capacity to generate acid. The coarse rejects will require measures to prevent or control acid generation involving compaction, lime amendment, and encapsulation in NAF overburden materials.

Implications

The bulk overburden can be managed as NAF material. However, a small amount of overburden typically associated with economic and uneconomic coal seams may be PAF, although most is likely to have a low capacity to generate acid. Overburden materials with a significant capacity to generate acid will require environmental management strategies to prevent acid generation as described in Volume 2 Section 16. Precautions will be taken to prevent water flow over the dispersive materials of overburden dumps by avoiding placement at the final top surface of the outer slopes and batters.

Coarse reject material are expected to be PAF and will require measures to prevent or control acid generation involving compaction, lime amendment, and encapsulation in NAF overburden materials as described in Volume 2 Section 16. Coal and fine tailings will require management to control the pH of any contained contact water with application dependent upon ongoing geochemical and water quality monitoring test data.

Management of any poor quality runoff from overburden emplacements, coal stockpiles, coarse reject storage areas and the tailings storage facility, and disturbed areas is detailed in EIS Volume 2 Section 11 and Section 16.



4.7.3.3 Spontaneous Combustion Propensity

A preliminary investigation of the spontaneous combustion propensity of coal from the study area was conducted by the University of Queensland's Spontaneous Combustion Testing Laboratory (UQSCTL) using an adiabatic oven test procedure that is routinely used by the coal industry to obtain the R70 self-heating rate of the coal. This test also produced a value for the relative ignition temperature of the coal. A large database of R70 and relative ignition temperature values is held by UQSCTL, therefore comparisons between the Project and other previous studies was used to obtain a relative indication of the propensity of the coal to spontaneously combust.

The samples tested in the adiabatic oven indicated that the R70 values are 3.55 °C/h and 6.70 °C/h for ash contents of 25.9% and 18.7%, respectively, on a dry basis. In addition, the relative ignition temperatures range between 132 °C and 110 °C. These values indicate the coal has a high intrinsic spontaneous combustion propensity based on Queensland conditions. While these results are not ideal, spontaneous combustion can be managed successfully by using appropriate mining planning techniques.

4.8 Summary of exploration process

The following description of the historical exploration of the Kevin's Corner project is partially sourced from Golder (2007a).

4.8.1 1970 to 1979

Coal exploration commenced in the area in the 1970s, during which time four exploration permits were explored. Three of these covered the Kevin's Corner and Alpha tenements and the fourth covered an area a short distance to the north (Figure 4-8).

Available historical data suggests that intensive exploration was undertaken within EPC 245 (Alpha), covering the current extent of MDL 285. Work concentrated on the evaluation of thermal coal reserves.

Initial coal exploration was undertaken by the Queensland Department of Mines (QDM) from 1971 to 1972, with results for three drill holes reported in 1973. The drilling indicated the presence of a substantial resource of non-coking, sub-bituminous coal in structurally simple rocks of Late Permian age. The coal resources were identified below a thick Tertiary cover (up to 47 m).

EPC 136 was explored by Dampier Mining Company Limited (Dampier) and Queensland Coal Mining Company Ltd (Queensland Coal), both subsidiaries of BHP Limited. Some 148 drill holes were completed by BHP. Five seams were intersected and considered to occur within the Bandanna (A and B) Formation and Colinlea (C, D, E) Sandstone. Minor coal seams were also identified in deeper, older rocks assigned to the Late Carboniferous Joe Joe Formation. Coal resources identified during exploration of EPC 136 were considered to be uneconomic by Queensland Coal at the time the tenement was relinquished (14 February 1975).

EPC 137 was granted to a joint venture between Shell Development (Aust) Pty Ltd (Shell) and Western Mining Corporation Ltd (WMC) for three years on 15 February 1974. The exploration permit

was relinquished at the end of the second year of tenure upon completion of some fifty drill holes, including five large diameter cored holes. Five seams were identified in the permit area and assigned by Shell geologists to the Late Permian Colinlea and Bandanna Formations. The coal intersected was classified as sub-bituminous, low sulphur, moderate ash (15.5% to 25.8%) coal, with moderate specific energy (22.4 MJ/kg). Bedding was interpreted to dip at between one and two degrees to the west and no major faults were proposed within the Project area. An Indicated Resource of 4.7 billion tonnes was estimated to a maximum depth of 250 m, with little coal being present within 90 m of surface due to the presence of thick Tertiary cover.

EPC 244 was granted to the Proponent in 1978. Some 82 of the 148 holes drilled by BHP under EPC 136 occur within EPC 244, providing a substantial technical basis for selection and initial exploration of the area. The coal measure stratigraphy defined in the Golder Associates report (Golder, 2007a), supplemented with a description of the individual coal seams by BHP.

Exploration in the 1970s focused on establishing the 300 m depth structure contour for the floor of Seam D in order to focus on the evaluation of resources potentially amenable to open-cut and shallow underground mining.

EPC 245 was granted to Bridge Oil Limited over 230 sub-blocks for three years on 14 December 1978. The EPC was subsequently reduced in area by relinquishment to 150 sub-blocks on 14 December 1979 and to 120 sub-blocks on 14 December 1980. A further twenty sub-blocks were relinquished on 14 December 1982, at which time EPC 245 was renewed for a further three years.

4.8.2 1980 to 1989

Limited coal exploration occurred during this decade. AP17CR was a retention authority granted to Bridge following the conditional surrender of EPC 245 on 14 December 1988. This was subsequently converted to EPC 484 following the introduction of new Queensland mining legislation in 1990.

Bridge Oil Limited (Bridge) explored EPC 245 until June 1981 when it entered into a Joint Venture with Australian subsidiaries of Cogema, Total and Charbonnage de France, with Bridge continuing as the Project Manager. The French partners withdrew from the Joint Venture in July 1992 and Bridge resumed sole ownership of the project.

4.8.3 1990 to 1999

Coal exploration in the Galilee Basin continued to be subdued during the 1990s with the only activity remaining focused on the Alpha MDL area. EPC 484 was relinquished by Bridge on 5 September 1993 (Bridge, 1993). Bridge concluded at this time that a large scale thermal coal mine developed on the site could not compete with mines being developed in the Bowen Basin, further to the east, with better access to coal haulage railway infrastructure and closer to coal export terminals on the coast.

EPC 570, the precursor title to MDLA285, was subsequently granted to Hancock over a similar, slightly larger area (Figure 4-9).

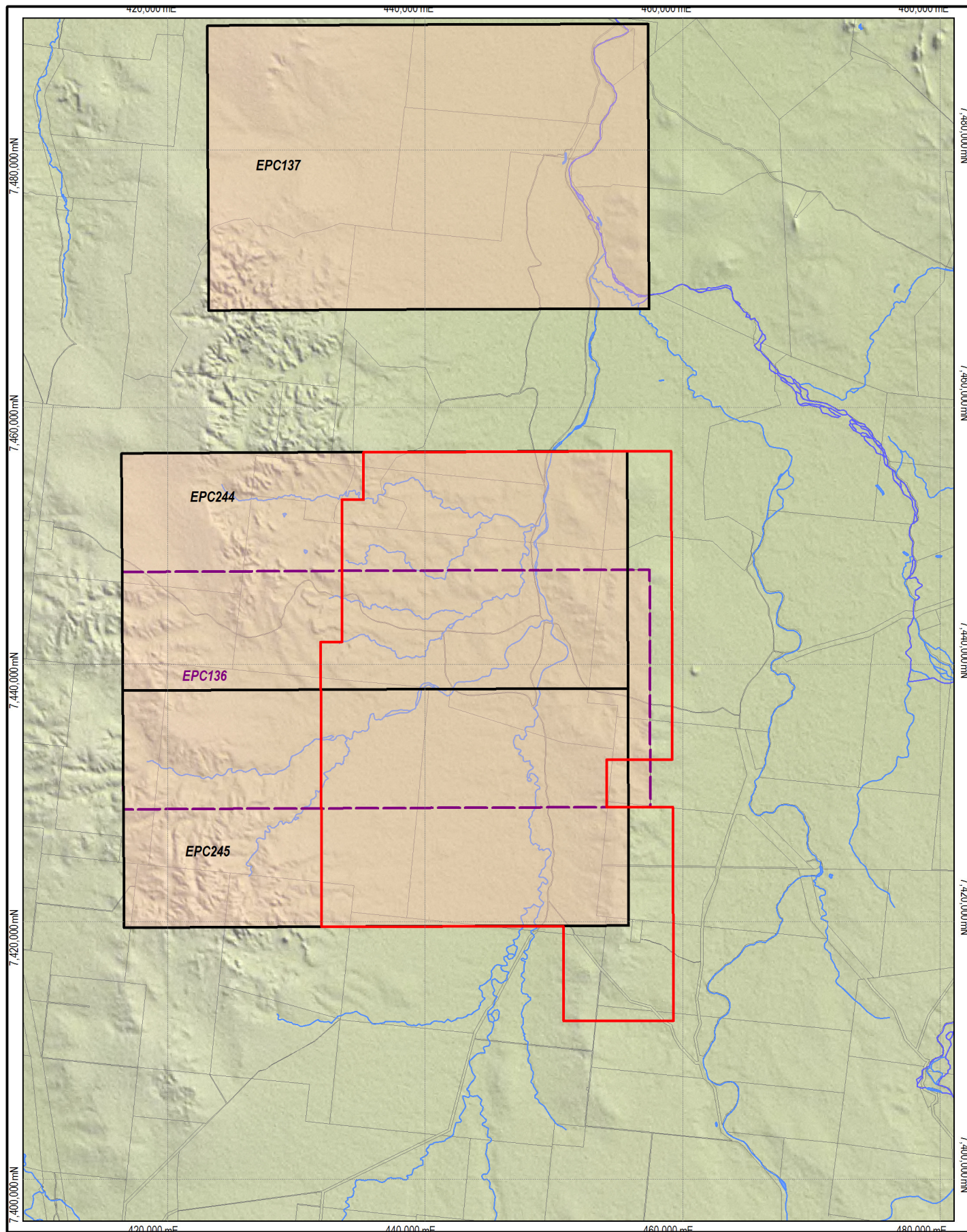


4.8.4 2000 to Present

There has been a rapid upsurge in Galilee Basin coal exploration in recent years. Most emphasis has been placed on coal resources to the north of the Capricorn Highway and along the southern edge of the Galilee Basin.

EPC 854 was granted to Linc Energy (Linc) in August 2004. The exploration target in EPC 854 is reported to be coal forming the A and B seams. A MDL application has been lodged by Linc for land within EPC 854.

Waratah Coal Inc. (Waratah) holds significant tenure in the Galilee taking up three coal exploration permits, and a multiple adjacent applications in the mid 2000's. Waratah holds EPC 1039, EPC 1079 (Figure 10) and EPC 1053 (Table 4-4) on the northern and western boundaries of Kevin's Corner. Public announcements by Waratah included total resources of approximately 5Bt with 0.98Bt bordering with the Kevin's Corner tenure.



- Extent of Hancock Prospecting Tenements - December 2008
- Exploration Permit - Coal (1970-1979)
- Exploration Permit - Coal (1970-1979)

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COAL EXPLORATION PERMITS 1970 - 1979

Job Number 4262 6660
Revision B
Date 12-09-2011

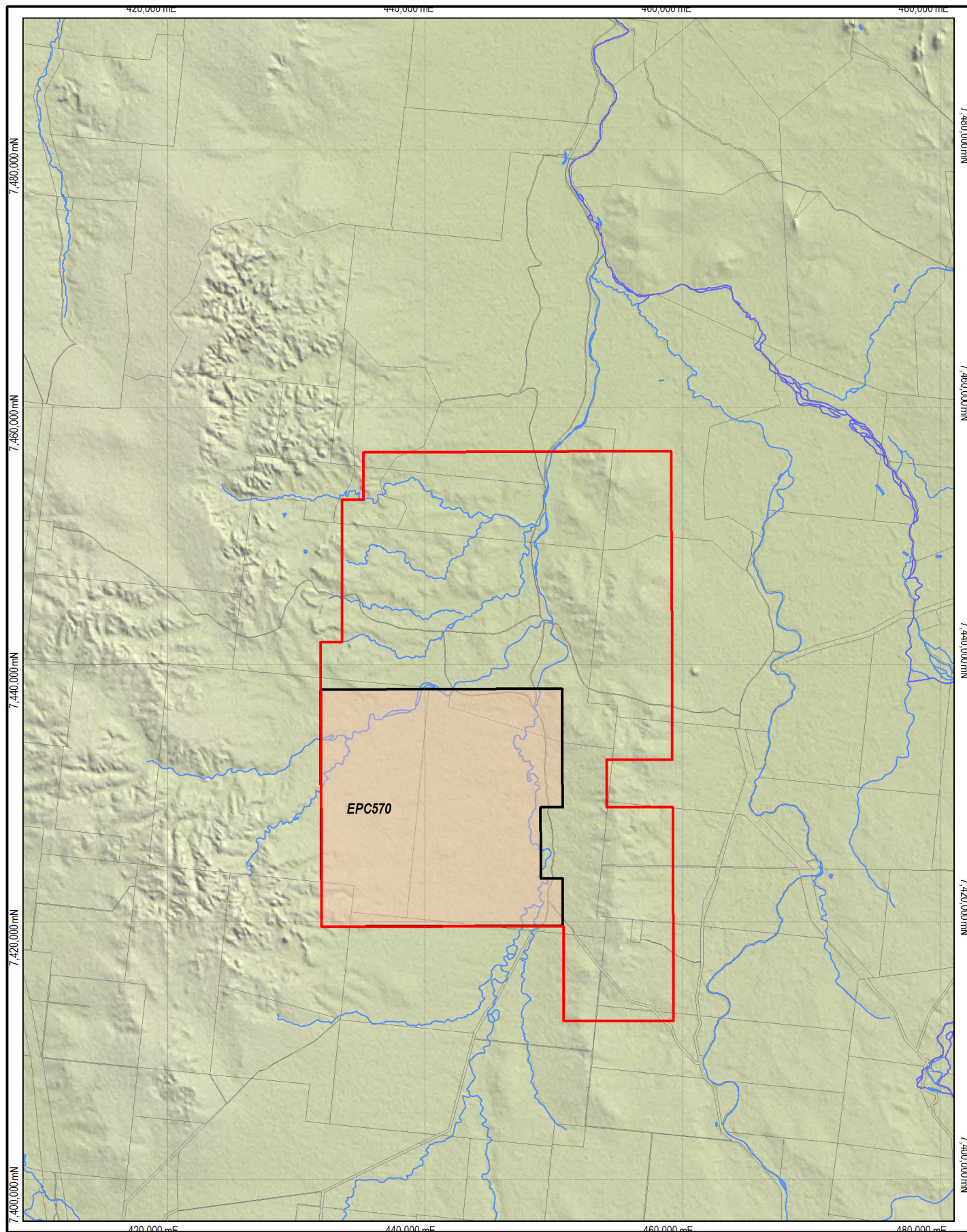
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Datum: GDA94, MGA Zone55

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Extent of Hancock Prospecting Tenements - December 2008
 Exploration Permit - Coal (1990-1999)

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HANCOCK GALILEE PTY LTD
Kevin's Corner Project
Environmental Impact Statement

COAL EXPLORATION PERMITS 1990 - 1999

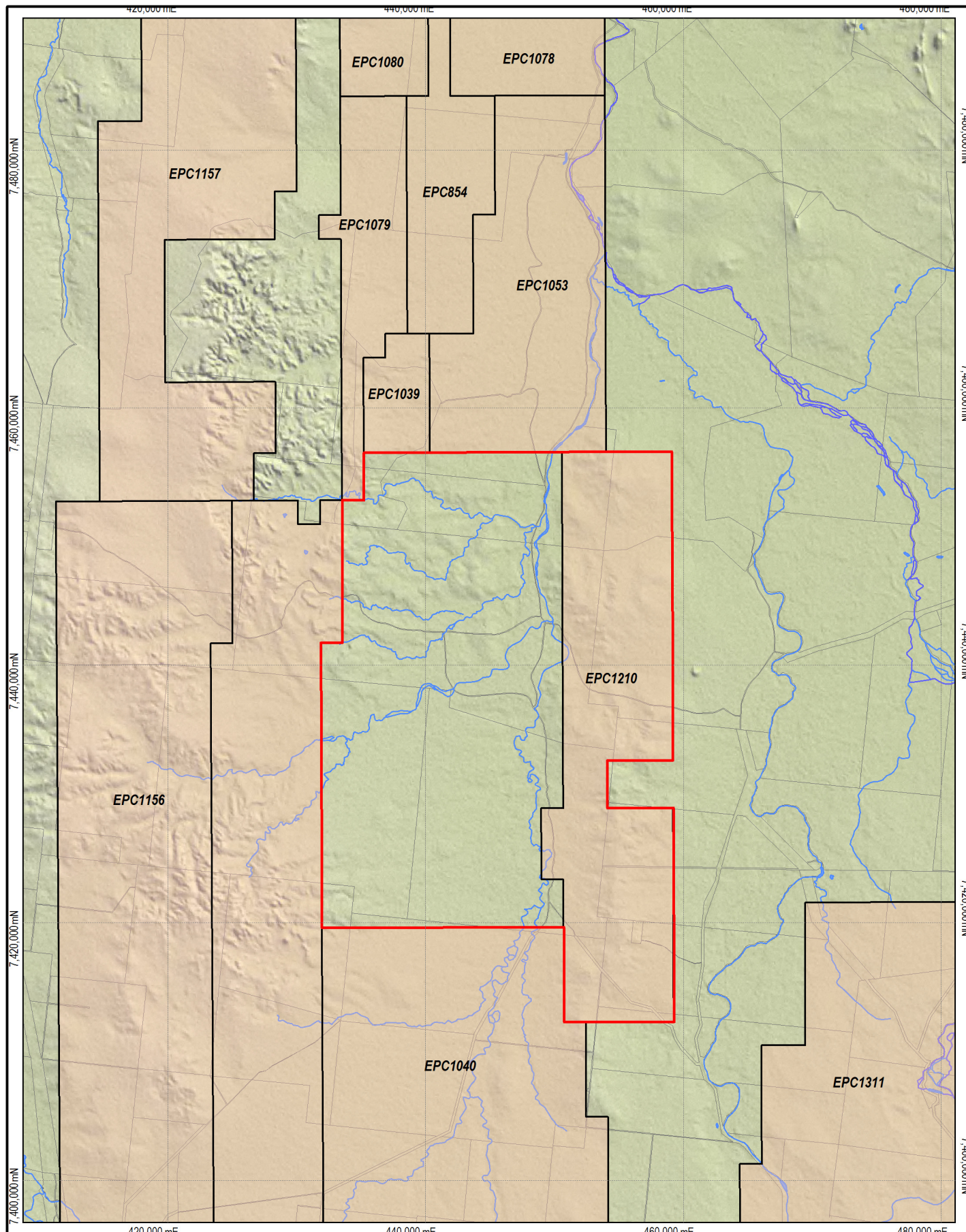
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Revision	B
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Extent of Hancock Prospecting Tenements - December 2008
 Exploration Permit - Coal (2000-2010)

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0 3.75 7.5km
 Scale: 1:400,000 (A4)



 **HANCOCK GALILEE PTY LTD**
Kevin's Corner Project
Environmental Impact Statement

COAL EXPLORATION PERMITS
2000 - 2010

Job Number | 4262 6660
 Revision | B
 Date | 12-09-2011

Figure: 4-10

Datum: GDA94, MGA Zone55

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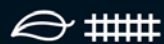


Table 4-4: Coal Exploration Permit Summary - 2000 to present

Tenement	Name	Holder	Granted	Expired	QDEX Company Reports
EPC854	Galilee	Linc Energy Ltd	30 Aug 2004	29 Aug 2007	44671
EPC1039	Pucky Creek	Waratah Coal Pty Ltd	8 Mar 2007	8 Mar 2012	No company report information available
EPC1040	South Alpha	Waratah Coal Pty Ltd	22 June 2006	21 June 2011	
EPC1048		Linc Energy Ltd	16 Nov 2006	15 Nov 2011	
EPC1053	Alpha North	Waratah Coal Pty Ltd	30 Aug 2007	29 Aug 2012	
EPC1079	Alpha Extended	Waratah Coal Pty Ltd	6 Aug 2006		Application
EPC1080	Laglan	Waratah Coal Pty Ltd	6 Aug 2006		Application

4.8.5 Mineral and Petroleum Exploration

Waratah has lodged a number of minerals exploration permit applications over-pegging coal exploration permits held by both Waratah and competitors surrounding the two Hancock MDLs. Golder Associates (Golder, 2007b) suggests that these tenements have been applied for to remove potential for interference in coal exploration and development activities by third parties.

Most of the remaining permit applications covering the Galilee Basin have been lodged by Drummond Uranium Pty Ltd.

The Hancock MDLs are currently over-pegged by a petroleum exploration permit granted to Tri-Star Petroleum Company (EPP 668) current until 30 April 2019, and a petroleum exploration permit application lodged by Comet Ridge Ltd (EPP 744).

The nearest petroleum well in the area, Jericho 1, drilled in June 1965 and approximately 20 km to the south of Jericho, is more than 50 km from the Hancock MDLs. Only limited seismic surveying has been undertaken in the vicinity of the Hancock MDLs limiting the amount of information available relating to the stratigraphy and structure of the basin in this area.

A single coal seam gas well has been drilled in the area (Splitters Creek 1), approximately 32 km to the east of Aramac.

4.9 Coal resources

4.9.1 Geological Modelling

The Mincom Stratmodel was used for the geological modelling. The model, based on an assessment of geological information, included all available information regarding the coal on site. Coal resource estimation approach

4.9.1.1 JORC Code requirements

The resource estimates are based on the requirements of the JORC Code as described below.



4.9.1.2 JORC Code Requirements

The JORC Code provides minimum standards for public reporting of Resources and Reserves to the investment community. For coal deposits, the JORC Code is supplemented by the Australian Guidelines for Estimating and Reporting of Inventory Coal, Coal Resources and Coal Reserves (referred to as 'the Guidelines').

The Code and the Guidelines provide a methodology which reflects best industry practice to be followed when estimating the quality and quantity of Coal Resources and Reserves. A Coal Resource is defined as that portion of a coal deposit in such form and quantity that there are reasonable prospects for economic extraction. The location, quantity, quality, geological characteristics and continuity of a Coal Resource are known, estimated or interpreted from specific geological evidence and knowledge. Coal Resources are divided into three categories:

- Measured – for which quantity and quality can be estimated with a high degree of confidence. The level of confidence is such that detailed mine plans can be generated, mining and beneficiation costs and wash plant yields and quality specifications can be determined;
- Indicated – for which quantity and quality can be estimated with a reasonable degree of confidence. The level of confidence is such that mine plans can be generated and likely product coal quality can be determined; and
- Inferred – for which quantity and quality can be estimated with a low degree of confidence. The level of confidence is such that mine plans cannot be generated.

Resources are estimated based on information gathered from Points of Observation. Points of Observation include surface or underground exposures, bore cores, geophysical logs, and drill cuttings in non-cored boreholes. It should be noted that Points of Observation for coal quantity estimation need not necessarily be used for coal quality estimation.

The estimate is calculated using the area, thickness and in situ density of the coal seam. The basis from which the in situ density is derived should be clearly stated. It is important to note that in situ density is not the same as the density reported by the standard laboratory measurement.

The Guidelines suggest distances that should be used between Points of Observation when estimating resources:

- Measured – Points of Observation no more than 500 m apart;
- Indicated – Points of Observation no more than 1 000 m apart; and
- Inferred – Points of Observation no more than 4 000 m apart.

4.9.1.3 Coal resource estimation points of observation

Salva Resources have, in May 2010, calculated a resource estimate based on all available exploration drilling data (Salva, 2010). The Points of Observation used to define the Coal Resources at Kevin's Corner are the drill holes with a reliability type of 1, 2, or 3 (Table 4-5).



Table 4-5: Points of Observation categorisation (Salva, 2010)

Type	Point of Observation Description	Value and Use of Point of Observation			
1	Cored and analysed intersection of seam with wireline log, may or may not have lithology log	TYPES 1-3 Reliable for structure and thickness		TYPES 1-2 Required for quality confirmation	
2	Cored and analysed intersection of seam without wireline log, may or may not have lithology log				
3	Non cored intersection of seam with wireline log, may or may not have lithology log				TYPE 3 May support quality
4	Non cored intersection of seam without wireline log, may or may not have lithology log		TYPE 4 Supportive of structure and thickness		

The drill hole spacing for structure and for quality used to define the coal resources were as follows:

- MEASURED - Structure points of observation less than 500 m apart
 - Quality points of observation less than 1 000 m apart
- INDICATED - Structure points of observation less than 1 000 m apart
 - Quality points of observation less than 2 000 m apart
- INFERRED - Structure points of observation less than 2 000 m apart
 - Quality points of observation less than 4 000 m apart

The distances chosen are in line with those suggested in the guidelines.

The Kevin's Corner Project resource has been classified as containing Measured, Indicated, and Inferred coal resources based on the assessment of geological interpretation and coal quality data.

4.9.1.4 Kevin's Corner Project resource estimate March 2010

The Kevin's Corner resource estimate is outlined in Table 4-6. It is estimated that the total resources for A, B, C, and D seams are 4.269 billion tonnes (Bt), of which 229 million tonnes (Mt) are Measured and 1 040 Bt are Indicated.

These resources are currently being upgraded in the 2010/2011 exploration program due 2nd half 2011. These will not upgrade the quantity of the resource, but categories of measured and indicated will be increased substantially.

Table 4-6: Kevin's Corner coal resources March 2010

Resource category	Value	Seam Group				Tonnes Total (Mt)
		A	B	C	D	
Measured	Volume (Mm3)	7	79	7	67	
	Area (Ha)	284	1 031	569	1 658	
	Thickness (m)	2.5	6.5	1.24	4	
	In situ density (t/m3)	1.33	1.49	1.49	1.42	
	Sub total Tonnes (Mt)	10	114	10	96	229
Indicated	Volume (Mm3)	142	444	36	149	
	Area (Ha)	5 514	7 149	2 342	3 496	
	Thickness (m)	2.5	6.2	1.57	4.2	
	In situ density (t/m3)	1.35	1.50	1.49	1.44	
	Sub total Tonnes (Mt)	190	600	50	200	1 040
Inferred	Volume (Mm3)	279	602	444	874	
	Area (Ha)	10 076	8 663	19 774	18 697	
	Thickness (m)	2.5	6.9	2.2	4.6	
	In situ density (t/m3)	1.37	1.49	1.45	1.43	
	Sub total Tonnes (Mt)	300	900	600	1 200	3 000
Grand Total Tonnes (Mt)						4 269

Notes: Volumes, areas and tonnages have been rounded and may not total. Coal masses are in situ estimates based on application of in situ moisture model from ACARP C10042 and Preston Sanders formula to adjust density.

4.9.2 Model Audit

Hancock engaged IMC Pty Ltd (IMC) to undertake a model audit and review. IMC used Mark Briggs from Moultrie Group Pty Ltd to execute the actual audit activity. The audit review took place during March 2010. The audit conclusions were that the JORC resource statements were probably acceptable, but had less confidence in reserve statements. The bulk of the Kevin's Corner estimation is an Inferred resource, which is subject to variation by virtue of data density and quality. This will be upgraded with further drilling.

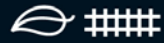
4.10 Mining

The development of the Project and associated mine plan have been based on a production of up to 42 Mtpa of ROM coal to produce up to 30 Mtpa of thermal coal product.

Table 4-7 details the expected ROM tonnage for each of the mining areas within Kevin's Corner.

4.10.1 Excavation Characteristics (Surface mine)

The excavation characteristics are influenced by the depth of weathering and hence rippable rock that extends to an average of 40 m across the deposit:

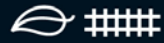


- The upper weathered zone is of variable thickness from < 12 m to 65 m (average 35 m), capable of being ripped by large dozers and removed by scrapers. It is currently planned to remove this weathered zone with truck and shovel.
- Drilling and blasting may be required below the weathered zone.
- Weak tertiary materials and the generally soft overburden will permit the use of large blast holes and relatively low powder factors.
- Estimated swell factors are buckets 35% and waste dumps 25%.

Mining is currently planned to commence in the open cast mines by truck and shovel, and this affords considerable flexibility, particularly in respect of external waste dump construction.

Table 4-7: Expected ROM Tonnes

	Year of Operation	Mine Plan Throughput by Source (Mt/a (as))				Total Feed
		Underground North Mine (ROM)	Underground South Mine (ROM)	Underground Central Mine (ROM)	Open Cut Mine (ROM)	
2014	1	35,092	/	/	2,145,853	2,180,945
2015	2	575,287		70,099	4,129,236	4,774,621
2016	3	4,495,745	128,271	794,838	6,251,771	11,670,626
2017	4	8,158,099	922,506	5,025,991	6,748,028	20,854,624
2018	5	9,144,543	3,859,148	9,245,209	3,089,695	25,338,596
2019	6	9,487,804	9,654,289	9,527,297	4,854,644	33,524,034
2020	7	12,890,487	9,500,317	9,663,456	3,766,704	35,820,965
2021	8	11,950,652	9,526,063	9,639,695	3,258,861	34,375,271
2022	9	11,934,890	9,774,432	9,632,971	2,547,026	33,889,320
2023	10	12,616,748	9,221,396	9,690,840	2,584,395	34,113,380
2024	11	12,405,211	9,858,322	9,836,190	2,629,556	34,729,280
2025	12	12,942,478	9,285,119	9,561,022	2,518,175	34,306,794
2026	13	12,746,494	9,374,338	9,619,773	2,582,849	34,323,455
2027	14	12,308,033	9,681,864	9,407,940	2,912,940	34,310,778
2028	15	11,819,427	9,378,623	8,623,349	2,745,662	32,567,061
2029	16	11,635,232	9,545,166	9,456,223	2,939,881	33,576,501
2030	17	12,497,316	9,384,087	9,587,992	3,421,510	34,890,904
2031	18	12,547,962	9,333,523	9,614,910	3,984,758	35,481,153
2032	19	11,453,031	9,782,309	9,565,263	3,638,978	34,439,580
2033	20	10,536,857	9,234,356	9,486,185	3,452,045	32,709,443
2034	21	8,604,148	9,659,877	9,488,075	4,107,170	31,859,270
2035	22	8,555,602	9,271,023	9,366,760	4,862,533	32,055,917
2036	23	8,675,802	8,162,935	9,374,625	4,607,758	30,821,120
2037	24	8,556,851	9,398,188	9,002,126	4,396,348	31,353,512
2038	25	8,450,534	8,994,937	9,325,173	5,606,847	32,377,491
2039	26	7,970,997	9,566,162	9,012,644	5,216,380	31,766,183
2040	27	7,847,072	9,024,301	9,227,995	5,440,373	31,539,741
2041	28	7,188,503	9,508,959	9,246,607	5,613,573	31,557,642
2042	29		9,022,893	9,132,914	4,841,289	22,997,096
					Total	854,205,302



4.10.2 Overburden removal

For the two open cut pits, the topsoil is to be stripped using a front end loader and stockpiled for reuse.

The tertiary and weathered Permian overburden will be excavated by large rope shovels and backhoe excavators. Overburden material will be hauled to out-of-pit dumps. Much of the material will be free-dig but some blasting may be required.

All coal will be exposed by excavator and trucks until shovel, electric rope and draglines are introduced.

In regards with the underground longwall operations minimum amount of topsoil and Cainozoic overburden will be removed within the adit access areas.

4.10.3 Blasting

Blasting will be carried out using ammonium nitrate/fuel oil (ANFO) or emulsion based explosive.

4.10.4 Overburden and waste disposal

All CHPP coarse rejects will be hauled into the designated overburden emplacements by rear-dump trucks.

Rejects

Waste material from the CHPP comprising coarse reject and tailings will be deposited back into the open pit once sufficient space is available. The fine rejects will be pumped to an initial out-of-pit tailings storage facility (TSF) located to the west of the open-cut mining.

Coarse Reject Handling

Haul trucks will transfer coarse rejects to the reject emplacement area.

The proposed reject emplacement area is in the overburden southern pit emplacement area with minor initial coarse rejects being trucked to the northern emplacement areas.

Reject placement will be sequenced such that capping of the reject will be completed progressively as the working face progresses down dip.

Additional details regarding mine waste management is presented in EIS Volume 1 Section 16.

In simple terms for every 100t of ROM coal, the CHPP will on average produce approximately 75t of product coal, 17t of coarse reject and 8t of tailings.

4.11 Infrastructure area geology

Details regarding the mine plan and infrastructure are presented in the Project Description, EIS Volume 1 Section 02. The mine infrastructure is located mainly on non-coal bearing strata, overlying the Colinlea Sandstone immediately to the east of Sandy Creek.

The Joe Joe Formation, further to the east, underlies the LIA, Accommodation Village, Airport, Mine Access Road and Rail spur.

Figure 4-11 indicates the mine plan and coal outcrop. Figure 4-12 presents the mine plan and areas of sterilised coal. It is noted that the majority of coal to be sterilised comprise the uneconomical E and F coal seams.

It is important to note that the C seam coal, although not mined in the current Longwall mining plan, has not been sterilised and could be mined in the future.



4.12 Potential impacts and Mitigation

Based on the compilation and review of available geology data and mining activities, an impact assessment has been conducted. The evaluation of available geological information indicates the potential for environmental impacts associated with the nature and characteristics of the geological resources, these include:

- The D-E sandstone unit below the D Seam;
- The nature of the overburden within the open-cut pits, which may affect Highwall stability;
- The AMD potential of the units;
- The sandstone unit between the C and D coal seams, the C-D aquifer;
- Resource sterilisation due to mine plan and infrastructure;
- The coal seam propensity for spontaneous combustion;
- The potential impacts of blasting using ANFO;
- The management of Fossils;
- The management of fine rejects, tailings; and
- The geological implications for rehabilitation and mine closure planning.

These matters are discussed in more detail below

4.12.1 D-E Sands

The floor of the D Seam comprises relatively competent rock, identified to have rock of medium to high strength. Thus the floor should not pose significant instability concerns. However, aquifer pressures (confined D-E sandstone aquifer) have the potential to cause floor heave.

Mitigation

Active depressurisation of the D-E sands aquifer will be required to reduce the pore pressures and minimise the risk of uncontrolled inflows. Dewatering systems and impacts have been detailed in EIS Volume 1 Section 12).

4.12.2 Highwall interburden stability (open-cut pits)

The thick (60 to 70 m) interburden between the B and C coal seams comprises labile sandstone with a clayey matrix and subordinate siltstone. Puggy claystone or clay matrix sandstone is logged within the interburden.

Geochemical studies indicate that the clay-rich sediments are dispersive or potentially dispersive. In addition, this material can have slaking properties, which effects open pit wall stability. The clayey materials have the potential to slake on exposure.



The slake-prone strata have clays of high to extremely high plasticity; as such these clays are not suitable for road building (pavement construction) and will tend to adhere to machinery and conveyor belts once they have been exposed to the weather.

The B-C interburden material may, therefore, be of importance to highwall and waste stability considerations.

Mitigation

Good surface water drainage control will be essential to prevent ponding of water as well as trafficability and handle-ability problems. Consideration of the puggy claystone or clay matrix sandstone within the interburden must be given when considering high wall slope angles.

Precautions should be taken to prevent water flow over the dispersive materials of overburden emplacements.

4.12.3 AMD

Preliminary geochemical assessments regarding the potential for the generation of acid and metaliferous drainage (AMD) have been conducted (EIS Volume 1 Section 16). The preliminary results indicate the potential for acid mine drainage, which has implications in terms of waste management, rehabilitation and backfilling.

Mitigation

The geochemical nature of the coarse and fine rejects has been considered in the Mine Waste section of the EIS. Mitigation and management measures are included in Volume 2 Section 16

4.12.4 C-D Aquifer

An aquifer unit on site within the Bandanna Formation comprises the C coal seam, underlying D coal seam, and interburden sediments, referred to as the C-D sands aquifer (JBT, 2010a). The coal seams and interburden are in hydraulic connection and effectively form one hydrostratigraphic unit.

The C-D sandstone aquifer is recognised, from aquifer tests at the adjacent Alpha Coal Project, to have moderate to high groundwater potential due to variable hydraulic conductivity and relatively high storage (average transmissivity of 4 m²/day and storage of 1.3 x 10⁻³).

Longwall mining will have the potential to impact on the C-D sands aquifer, resulting in induced groundwater migration from the C-D sands into the mine.

Mitigation

In order to ensure a "dry" safe working environment active dewatering will be required within the C-D aquifer, as well as the D-E sands. Dewatering using production bores will be required to remove an average 127 L/s over the life of the mine. EIS Volume 1 Section 12 provides details of the required dewatering.

4.12.5 Resource sterilisation

Resource utilisation

The mine plan is designed to recover between 25 Mtpa and 30 Mtpa of coal to 2042. In this period approximately 900 Mtpa of ROM coal is planned to be mined. Substantial mining reserves will remain after this period, thus the closure planned date of 2042 is only indicative.

The mine can be economically operated as an open-cut operation in the Northern Open pit area. In this surface mine both the C Seam and D Seam will be mined using truck-shovel open pit methods. This coal is too shallow for longwall mining with fresh stable ground being limited in thickness immediately above mining operations.

The area around the Southern Open pit has the ability to be mined by open-cut or underground methods. The C Seam is not an economically recoverable unit in its own right, i.e. it would not be mined without the D Seam. For underground operations the C Seam is unable to be recovered due to its proximity to the D Seam.

For much of the remaining area of the mine longwall reserves have focused on the D Seam. The D Seam can be competitively recovered and washed to an export grade coal. The C Seam is higher in ash with a burden too thin to be mined separately by underground, and strip ratio is too high for economic open cut operations, thus for underground areas of the deposit the C Seam is not recovered and left in-situ.

A and B Seams

The A and B seams exist to the west. The A Seam has low ash coal but the thickness is too thin and variable to mine either by open pit or underground mining (except for an area to the south of the deposit which could be considered for Bord and Pillar operations in the future).

The B Seam is a higher ash coal. It is also too deep to be economically recovered by open cut methods based on current marketability. There is, however, the potential for underground operations in the future should markets be able to accept the higher ash product.

E and F Coal Seams

As per Section 4.3.3 these seams are not economically recoverable and have to be excluded from the JORC RS.

Section 4.3 details the geology underlying the proposed mine area and Figure 4-12, the mine plan, indicates the location of ancillary mine infrastructure. The infrastructure located on the east of Lagoon Creek, on the sub outcrop of the Bandanna Formation and Colinlea Sandstone, are underlain by the E and F coal seams.

The E Seam is present as two 0.2 m thick clean coal bands (E1 and E2). The F Seam displays patchy development and the full geological section can reach in excess of 5 m in isolated areas. However, excessive separation (high incremental ratio) and poor coal quality makes the F Seam sub-economic. No resource potential by current practices and economic is currently attributed to either E or F Seams



within the Kevin's Corner Coal Project area (Section 4.11). The sterilised resources are indicated in Figure 4-12.

Petroleum and mineral exploration permits have been granted (over-pegged) on the Hancock MDLs. It is considered that shallow surface mining would not sterilise deep petroleum reserves, should they exist, and that access to these resource would be feasible.

4.12.6 Spontaneous combustion

These coals are known internationally to display spontaneous combustion.

Mitigation

The deposit ROM, product and working places will require appropriate management systems to prevent spontaneous combustion (Salva, 2010). This can include active watering, orientation of stock and waste piles based on wind directions, and wind breaks.

4.12.7 Blasting

Blasting will be carried out using ammonium nitrate/fuel oil (ANFO and HANFO) explosive.

The impacts of blasting using ANFO / HANFO can include increased fracturing and the increase in nitrate concentrations within the groundwater and pit water.

Mitigation

Blast using water tolerant explosives in wet holes to avoid dissolving and dewatering. Groundwater movement will be towards the mine during mining thus preventing ammonia rich groundwater migrating off site. Final voids at Kevin's Corner and Alpha Coal Projects will alter the groundwater flow patterns post mining. These final voids will act as sinks, due to high evaporation compared to ingress (rainfall, groundwater, and runoff), such that groundwater will, on a local scale, drain towards the final voids. Plume migration in groundwater will thus not occur.

4.12.8 Fossils

Based on the age and depositional nature of the sediments located within the proposed mining area, there is the potential for fossil specimens to be uncovered during construction and operations. However, no records of fossils have been recorded in the exploration data.

Management

Should significant fossil specimens be identified within the mine then steps will be taken to secure and protect the fossils. The Queensland Museum will be notified to allow for the identification and correct preservation and removal.

4.12.9 Tailings

Dilution materials in mining operations include mudstone, claystone and sandstone, which have a clayey matrix. These materials, if associated with the coal processed in the CHPP, can result in:



- Increased fine rejects (tailings);
- Reduced volume of coarse material;
- Difficulties in transport and deposition; and
- Reduction in water recovery due to high water takes (interstitial water).

LIMN Sim and additional tests have been carried out to determine tailings characteristics for handling, processing and storage.

Mitigation

EIS Volume 1 Section 16 details the management and disposal of tailings on site. Initial tailings deposition will comprise disposal on an out-of-pit tailings Storage facility (TSF), which overlies the clay-rich weathered Cainozoic sediments. The design and management of the TSF will ensure little or no impacts on the environment. Once sufficient void space is available within the Northern Open pit then tailings will be co-disposed with backfill and coarse rejects.

4.12.10 Rehabilitation and closure

Mining will permanently impact on the geological resources within the MDLs. Coal, interburden, and overburden will be removed and rehabilitation (backfilling) will result in the alteration to the pre-mining geology. Underground operations will permanently subside undermined areas and result in increased hydroconnectivity.

The mine will develop a closure plan to minimise the impacts and rehabilitate the overburden and soils to allow for pre-mining land use.

The details regarding decommissioning and rehabilitation is presented in EIS Volume 1 Section 26.