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Rod Doyle
Hume Coal Pty Limited, rdoyle@humecoal.com.au

Ben Fitzsimmons

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HUME COAL – AN OVERVIEW

Ben Fitzsimmons and Rod Doyle[1]

ABSTRACT: Hume Coal is a subsidiary of POSCO, the South Korean steelmaker. It maintains a 100% interest in the Coal Exploration Authorisation 349 (A349) in New South Wales near Sutton Forest. This paper describes the exploration activities undertaken to date both historic and more recent as well as how the results of those activities have assisted in developing the proposed mine plan. Land Access has proved to be difficult in places. Located near the south western edge of the Sydney Basin the stratigraphy is different to the normal sequence towards the centre of the basin.

Mining Lease Applications have been submitted to the NSW government and an Environmental Impact Statement (EIS) has been prepared and will be on Public Display early in 2017. Mining constraints and their impacts on the mine plan are also described.

INTRODUCTION

The paper summaries the current status of the exploration results to date in the Authorisation 349 - (A349), an exploration tenement in the Southern Highlands of New South Wales. Located near Sutton Forest and the Belanglo State Forest, A349 is situated astride the Hume Highway. An EIS has been prepared and describes the proposed underground mine. The proposed mining technique, mining area and other aspects e.g. hydrology, as well as the current status of the project, is discussed.

The Southern Highlands has been explored for generations and has had several underground operations, generally all small scale by today's modern standards. Nevertheless mines such as Erith Colliery within the Morton National Park represent a long and historic connection to coal mining in the region. The recently closed Berrima Mine is some 5 km kilometres to the NNW of A349.

In A349 there are some 164 historic holes and Hume Coal in the last five years has drilled some 146 drill sites, including, large diameter holes, slimline exploration holes, piezometers and open holes. Total exploration holes drilled in the area equals 346. Several remote exploration techniques have also been used including; seismic, aeromag and ground magnetometer surveys.

Geological structures located in the area have been identified from, surface mapping, from remote techniques and from exploration drilling. Some structures have been strongly defined with very high confidence and some structures are hypothesised and of much lower confidence. The landscape varies between flat lying to incised gorges in the area where the Hawkesbury Sandstone is present, to undulating grazing countryside where the Wianamatta Shales are located.

The target coal seam is the Wongawilli seam and the seam varies from being not present (eroded from the sequence) to its normal (i.e. coastal) 9m thickness. A unique aspect about the deposit is the removal or lack of deposition of the Narrabeen sequence which is not present on the tenement. In most places the Hawkesbury Sandstone has eroded into the Wongawilli seam. In addition many holes have intersected the American Creek and Tongarra seams.

LOCATION

Located in the southern portion of the Sydney Basin, A349 currently occupies some 89 square kilometres. Figure 1 highlights the area and the Mining Lease Applications. Interestingly, there are predominantly two types of land use in the area and these are more or less based on geology. The two main rock formations are the Hawkesbury Sandstone to the west and the Wianamatta Group, predominantly shales to the east of the Hume Highway. The Wianamatta Groups is represented by

[1] *Hume Coal Pty Limited Email: rdoyle@humecoal.com.au Tel: +61 2 4869 8222*

extensive (and expensive), predominantly cleared grazing land. The area of the Authorisation still has some minor pockets of the original flora which have not been completely cleared, i.e. the Southern Highlands Shale Woodlands. While the Hawkesbury Sandstone dominates the Belanglo State Forest an agricultural enterprise growing radiator pine trees on the sandy soils, but more infamous for the tragic murders that took place therein. An area managed by the State Forestry Department.

The landscape is generally speaking undulating countryside with a couple of creeks that have incised the area in the western fringe of the Authorisation. Some dominate igneous structures adorn the region with Mount Gingenbullen, in the north-east of A349. Joplin (1964) identified this structure as an ‘unroofed sill’. Other igneous activity has also had its impact on the environment with diatremes being identified by aero and ground magnetometer surveys and also exposed by cuttings of the Hume Highway. Basalt flows also form distinct exposed landforms on some of the properties in the area.

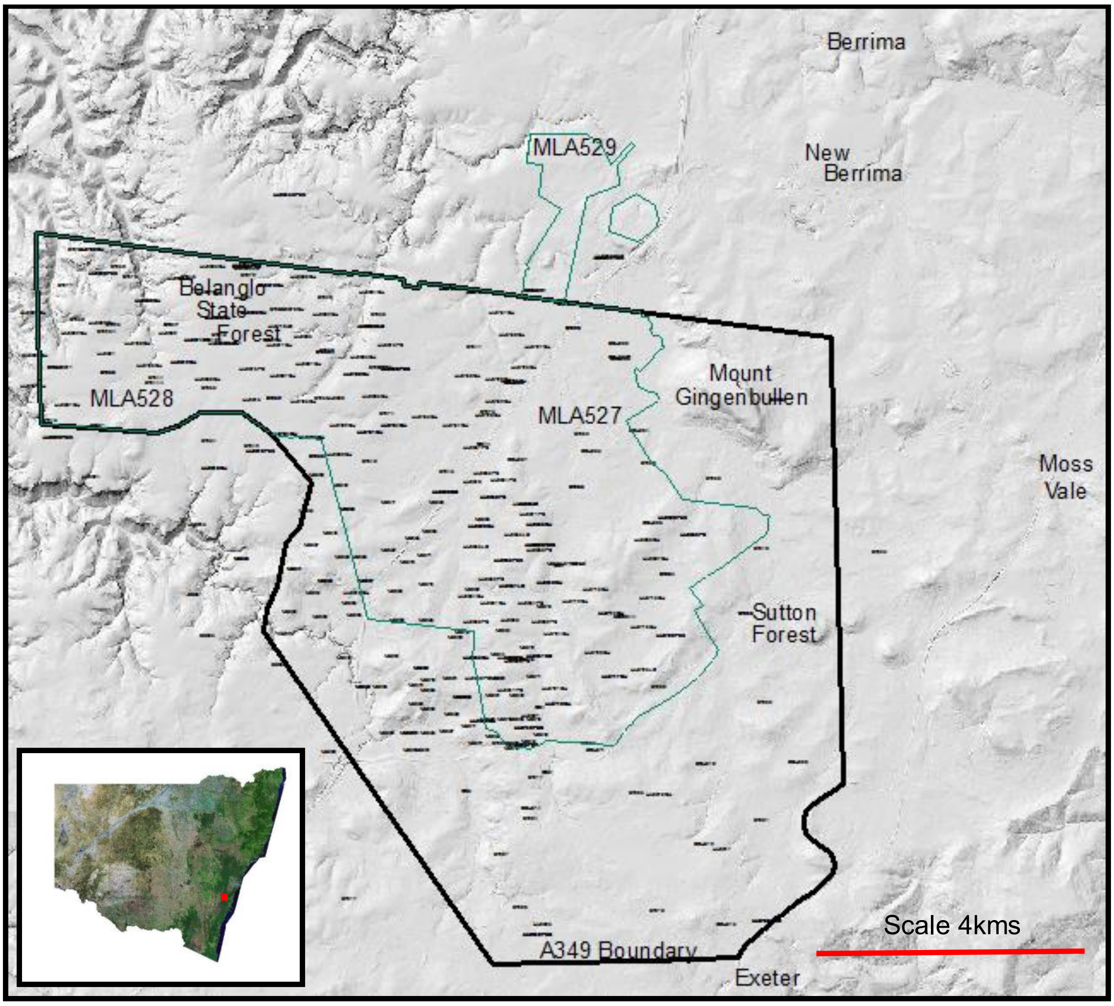

Figure 1: Location map of A349 and MLA527, 528 and 529 over a grey scale elevation grid

STRATIGRAPHY

The stratigraphy is depicted in Figure 2 below. The most distinctive thing to note is that there is no Narrabeen Group to be found in the area of the Authorisation. Indeed there are no upper units of the Illawarra Coal Measures present either. Over the authorisation an angular unconformity exists near the contact between the Hawkesbury Sandstone and the Wongawilli seam. However in places the seam has been completely eroded away by the erosive sandstone. There is some uncertainty associated with the nature of this scenario as the edge of the Sydney Basin is quite close. Because of the proximity to the edge of the basin there is a possibility that portion of the Upper Illawarra Coal

Measures and all of the Narrabeen Group were not deposited in this area, but developed deeper into the central part of the basin (to the east). Also given the deterioration of the Bulli seam in the south of the Illawarra (as noted in Harper, 1915) this lack of deposition has some merit.

In the, 'Explanatory Notes for the Moss Vale 1:100,000 Geology Sheet 8928', Trigg and Campbell (2016) note that there is only minor Narrabeen's which are present well to the south east of A349.

SYDNEY BASIN STRATIGRAPHY			
TYPICAL STRATIGRAPHY			A349 STRATIGRAPHY
TRIASSIC		Wianamatta Group	Wianamatta Group
		Hawkesbury Sandstone	Hawkesbury Sandstone
	NARRABEEN GROUP	Newport Formation	Absent
		Bald Hill Claystone	Absent
		Bulgo Sandstone	Absent
		Stanwell Park Claystone	Absent
		Scarborough Sandstone	Absent
		Wombarra Claystone	Absent
		Coalcliff Sandstone	Absent
PERMIAN	ILLAWARRA COAL MEASURES	Bulli Coal	Absent
		Loddon Sandstone	Absent
		Balgownie Coal	Absent
		Lawrence Sandstone	Absent
		Cape Horn Coal Member	Absent
		Hargrave Coal Member	Absent
		Woronora Coal Member	Absent
		Wongawilli Coal	Wongawilli Coal
		Kembla Sandstone	Kembla Sandstone
		American Creek Coal Member	American Creek Coal Member
		Darkes Forest Sandstone	Darkes Forest Sandstone
		Tongarra Coal	Tongarra Coal
		Wilton Formation	Wilton Formation
		Erins Vale Formation	*Only a few older (less reliable) holes have drilled below the base of the Tongarra Coal.*
		Pheasants Nest Formation	
		Shoalhaven Group	
		Talaterang Group	

Ply	Thick	Avg Ash	Section
UNM3	-	-	Unit eroded
R	0.35	-	
FCM	?	-	Only present in the North of A349
A	0.47	39.3	
B	0.50	33.1	
C	0.47	63.4	
D	0.45	35.7	
E	0.91	32.1	
F	0.37	33.7	
G	0.77	31.2	
H	0.34	35.0	
I	1.23	21.1	
J	0.35	41.0	Where Present

Figure 2: Stratigraphic table of the general Sydney Basin compared to A349 and WWSM detail.

In the A349 area there are only three coal seams that have been recognised, the Wongawilli, the American Creek and the Tongarra. The Wongawilli is the only economic coal seam. It ranges in thickness from 0.44 to 8.56 m, and averages 4.77 m. The Wongawilli seam will produce a 10% ash coking coal with good coking characteristics and a middlings thermal product. It is expected that a 3.50 m thick mining section will be extracted. The American Creek is too thin to be economic and ranges from 0.04 to 1.13 m in thickness and frequently splits into two parts. While the Tongarra ranges in thickness from 0.81 to 6.78 m averaging 3.64 m and is also split in places. Laboratory testing of ten Tongarra seam intersections averages 56% raw ash with a CSN of up to 1.5.

EXPLORATION ACTIVITIES AND RESULTS

There are 167 historic holes drilled in the A349 area. These holes were drilled in the 1970's. In addition Hume Coal has drilled 179 exploration and water piezometer holes. This combines to a total of 346 holes, in an area of about 89 square km. On average this represents about 4 holes per square kilometre or holes with a radius of influence of about 300 m, in other words a reasonably well drilled out resource on a well-known coal seam. However, some areas have a lack of holes and others are drilled at closer spacing than the above. This tends to reflect the difficulty in obtaining land access with current landowners.

As a general rule the Wongawilli Coal is thicker in the north of A349. While in the south and in particular the south-west of the authorisation the seam is subject to significant erosion and in some locations the seam has been eroded away altogether.

The Wongawilli Coal dips gently from the west to the east with 100 m elevation change over 10 km, a grade of 1 in 100. The seam outcrops in the west in Longacre Creek where there is an adit at about 50 m below the top of the Hawkesbury Sandstone cliffs at this location. While in the south east the seam is about 200m below the surface.

GEOLOGICAL STRUCTURES

There are numerous geological structures that have been identified in the region. The Mount Gingenbullen dolerite is the most dominant igneous feature within A349. A small quarry was mined on the mountain's north eastern flank. Further to the north near Bowral, Mt Gibraltar a micro-syenite intrusion occurs, while Mt Jellore similarly is a micro-syenite intrusion and is situated to the west of Bowral. There are also numerous Tertiary igneous flows (remnants of the Robertson Basalt) in the area. Diatremes are also well known in the area. Aerial magnetics were flown over A349 by Shell in 2002, this work was done at a scale that picked up numerous anomalies, but unfortunately was not able to identify dykes. Drilling targeted several diatremes which were proved up by drilling and surface mapping as a result.

Surface magnetics was undertaken on several properties over the authorisation during 2014 and 2015, this work provided significantly enhanced images, but again the surveys did not readily locate igneous dykes. Suggesting the dykes are either very thin or are essentially low in magnetic content. Figure 3 compares the same area with the 2002 aeromag survey image to the more recent 2015 ground magnetometer image. Borehole evidence has identified numerous igneous features. The scale (eg throw or thickness) of these features are largely open to interpretation.

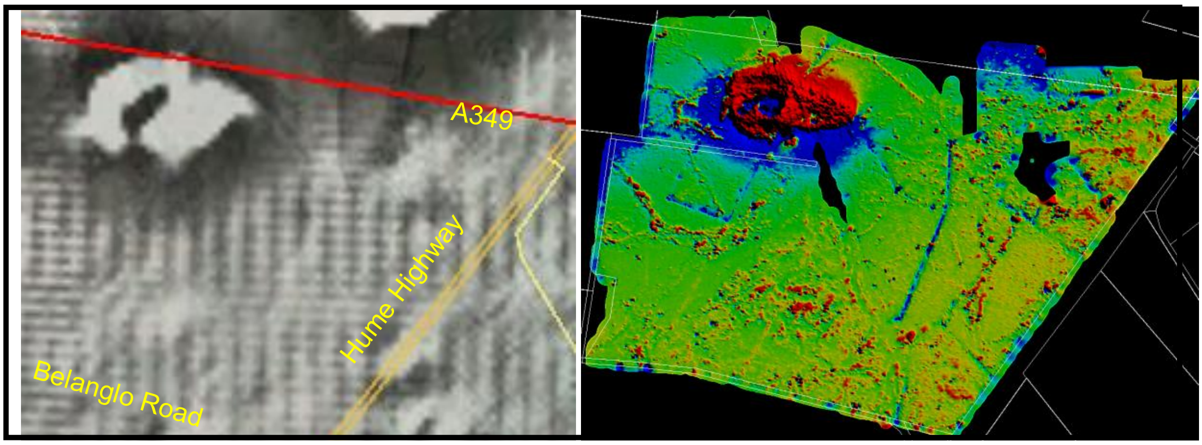

Figure 3: The 2002 aerial magnetics on LHS compared with 2015 surface magnetics on RHS

Using Minex software a geological model was initially developed, through which cross sections were sliced to determine the general nature of grades, points of inflexion or potential faulting within the Wongawilli Seam. In addition a review of all borehole logs was undertaken, which examined both historic and Hume Coal holes. This review also studied every core photograph to interpret possible structures. The process indicated a broad range of geological structures ranging from joint zones of diverse intensity to faulting and igneous intrusions. The interpretations were then compared to the remote sensing results such as seismic and magnetic data, as well as aerial and surface mapping work. Geological structures were interpreted and assigned different levels of confidence. The interpreted structures were then used to assist with designing the proposed mine plan. The result is a Mine Plan that recognises the potential for geological impacts.

LAND ACCESS

Following the government requirements for exploration activity and in an attempt to fulfil its licence conditions Hume Coal sought to undertake its legal exploration activities e.g. continued exploration drilling, geophysical logging and surface magnetic surveys. A Review of Environmental Factors (REF) was provided to the government for their approval. Following the REF being processed an opposition group took the Minister of Mines and Hume Coal to the Land and Environment Court (LEC) to appeal the approval. The decision was made in favour of the Minister and Hume Coal, citing that the exploration activities would not cause significant impact.

Under the approved REF three boreholes were drilled twoon private property and one on Hume Coal controlled land). Several landowners took Hume Coal to the LEC to appeal against already arbitrated land access, based upon the interpretation of 'significant improvements'. The LEC hearing initially found in favour of Hume Coal, however this decision was appealed and the decision was found to have erred in law so the original judgement was set aside. Since then the NSW government have revised the legislation in an attempt to clarify what 'significant improvements' were made (NSW Government revised legislation). Difficulties in obtaining land access has directly resulted in not being able to further improve the level of confidence in the Resource Assessment from Inferred to Indicated or to a Measured status.

WATER CONSTRAINTS UPON MINE DESIGN

The Hawkesbury Sandstone Formation a well known for its ground water systems and supplies water to many of the local farms. Some water bores are likely to be associated with joint zones or other geological structures. In an attempt to minimise harm to the ground water systems and to surface structures a decision to reduce the resource recovery and not to undertake longwall or shortwall mining, nor bord and pillar mining or any secondary extraction that might cause a goaf to be developed, was made. As a result an effective 'first workings' mine plan was devised with pillars left to ensure that subsidence impacts would be negligible.

This design will essentially retain the current levels of permeability within the strata, which will reduce the inflow of water into the underground workings. Had a longwall or similar goaf forming operation been designed greater inflows into the mine would have been experienced. To regulate water inflows into the mine, the older areas of the mine will be systematically sealed off from the active areas. The seals will be substantial enough to maintain the head of water and as such any impact upon the ground water table levels. As a result regeneration of the water table will be faster.

In the region surrounding the Hume Coal Mine, there are four main rock types. Starting from the top and working down – they are:

- Igneous rocks, flows such as the Robertson Basalt. In general, these rocks have reasonable groundwater.
- Rocks from the Wianamatta Group, which contain a mix of shales and sandstone. These rocks were originally deposited off shore in the ocean and hence have a high salinity, the water is unsuitable for most human and agricultural needs.
- Underlying this is the major sandstone formation known as the Hawkesbury Sandstone. This sandstone has significant fresh groundwater resources, although minerals such as iron and calcium impact on its quality.

- In the A349 area the Hawkesbury Sandstone lies immediately above the Wongawilli seam. The Wongawilli seam also contains groundwater of similar quality to the water in the Hawkesbury Sandstone.

There are numerous water bores in the area of the proposed Hume Coal Mine. Many people pump water from the Hawkesbury Sandstone and use it for both domestic and agricultural purposes, a few people also use the water for irrigation. Mining at Hume will have variable impacts on water bores within the mining area and to a much lesser extent outside the area of mining. The scale of impact will differ depending on where the bores are located relative to the mine. Hume Coal will develop a 'Make Good' programme to ensure that no landowner will be worse off with regard to groundwater as a result of mining.

Extensive water samples from numerous bores and surface sites have been gathered by Hume Coal over several years to develop an understanding of the 'baseline' groundwater conditions. In addition the levels of water in the various strata horizons have also been measured. This data has been used to develop a significant and sophisticated computer model of the groundwater behaviour and how it will react to Hume Coal's proposed mining.

In addition several specialists were engaged to determine how the interaction of mining and groundwater would be affected and how any impacts would be mitigated. One such study (RGS – Geochemical Assessment) involved considering the chemistry of the ground water and how it would be impacted at every stage of mining. These stages included;

- Raw and washed coal stockpiles - will have short term exposure for various parcels of coal, water from these stockpiles will be collected and monitored.
- Surface drift stone and surface reject stockpiles – will be covered with soil and grass. Water will be kept away from these areas although some rainfall may seep into the stockpile. Any run off will be collected, monitored and treated as required. Drift spoil materials (Hawkesbury Sandstone) will be pH neutral and are considered to be non-acid forming. They have a low sodicity and therefore have a low risk of dispersion or erosion. That is, they will remain intact on the surface until they are returned for backfilling in the underground environment.
- Rainfall remote from stockpiles etc – will be diverted away from mine collection.
- Underground coal reject emplacement - will be treated with 1% calcium carbonate ($CaCO3$) to neutralise the water. $CaCO3$ is an alkaline material which will offset the acidic nature of the rejects and bring it back into balance.
- Overall any water coming into contact with coal will not be released from site, without being treated in the Water Treatment Plant (WTP).
- Laboratory studies were undertaken on representative rock samples from boreholes. This included where;
- the drifts and shafts are planned to be mined,
- the coal being mined,
- the coal left unmined in-situ, and
- reject material (bands from the coal seam – non product) returned to the underground voids.

It's worth noting that despite the testing already undertaken, on-going monitoring will take place throughout the life of the mine. This will ensure that the ground and surface water systems will remain neutral, ensuring Hume Coal's aim of environmental sustainability.

MINE PLAN

Hume Coal is proposing an underground coal mine which will use a combination of traditional first workings drivages and an adaptation of high wall remote continuous mining techniques. The main driver for the design of the Hume Coal Project is the environmental constraints associated with the project setting. Hume Coal recognises the importance of the groundwater resource, and minimising the impact upon it by mining. Therefore, it was crucial to ensure the mine design allow for the safe extraction of coal while protecting the overlying strata and groundwater systems.

The underground mining operations will be accessed by two drifts, one of which will allow the entry and exit for personnel and equipment, and the second for the clearance of mined coal. Shafts will also be constructed to assist with the ventilation of the mine.

Main roadways and gate roads will be developed using continuous miners of conventional dimensions. The plunges to be developed sub-perpendicular to the gate roads on both the left and right sides are known as plunges. The plunges will be made with an approximate cross sectional area of 4 m wide by 3.5 m high by using remote control continuous miners. The depth of the plunge will vary throughout the mine; however they will extend on average, 120 m.

Each plunge will be separated by a long and slender coal pillar which will ensure adequate stability for the overlying strata, eliminating fracturing of the overlying rock mass and consequently limiting any long-term impacts on overlying groundwater systems and surface infrastructure. Plunges will be grouped into ‘panels’ which will be roughly 60 m wide and consist of approximately seven plunges and six long pillars. Each panel will be separated by a barrier pillar of approximately 16 m width. Plunges will be developed from the end of the gate road, retreating back toward the mains roadways. Coal will be cleared from the plunge using technology similar to Joy’s floor mounted Flexible Conveyor Train (FCT) back to the gate road. Once completed, bulkhead seals will be installed to seal off the mined-out area.

Exploration work has identified that there is little gas present in the authorisation. An average level of 0.3 m^3/t is present, of which some 95% is Carbon Dioxide with the remainder being methane. As such the level of gas underground is expected to be minimal.

Hume Coal will dispose of rejects into the underground mined out workings. The volume of rejects will equate to approximately 20% of all Run of Mine (ROM) production. Aside from the advantage of not requiring an extensive surface area to dispose of the reject materials, the mined-out areas will be partially filled, inbye of the bulkhead seals. This will allow for a more rapid recovery of groundwater levels as mining progresses.

Rejects which are produced through the processing of the coal will be transported to a reject material treatment plant which will crush the material and mix with water, resulting in a material similar to the consistency of toothpaste. Calcium Carbonate will also be mixed with the rejects to assist bringing the water into a neutral balance. The reject material will then be pumped underground for permanent storage.

The mine will aim to produce 3.5 million tonnes per annum (Mtpa) ROM, with a saleable product of 2.8 Mtpa. The ROM coal will be processed on site and produce two products, metallurgical coal with an average ash of 10% and industrial coal with an average ash of 22%. Processing of the coal will consist of crushing, gravity separation and floatation. The product coal will be stockpiled on site, separated into the two different products. Coal will be transported to Port Kembla using rail. The rail wagons will use covered coal wagons, which will ensure best practice techniques in the management of air quality.

It is because of Hume Coal’s desire to minimise the impact on the ground water that the mine is designed as a “Low Impact”, a first workings only underground coal mine. As a result of this there will be no goafing, and therefore no ground stability issues with surface subsidence being predicted to be less than 20 mm.

Figure 4 highlights the mine plan following numerous revisions and elimination of any goaf formation. There are several limitations on the nature of the mine plan, including; the thickness of the working section, geological washouts and structures as well as heritage properties (adjacent to Golden Vale Road), a dam notification zone and some surface infrastructure.

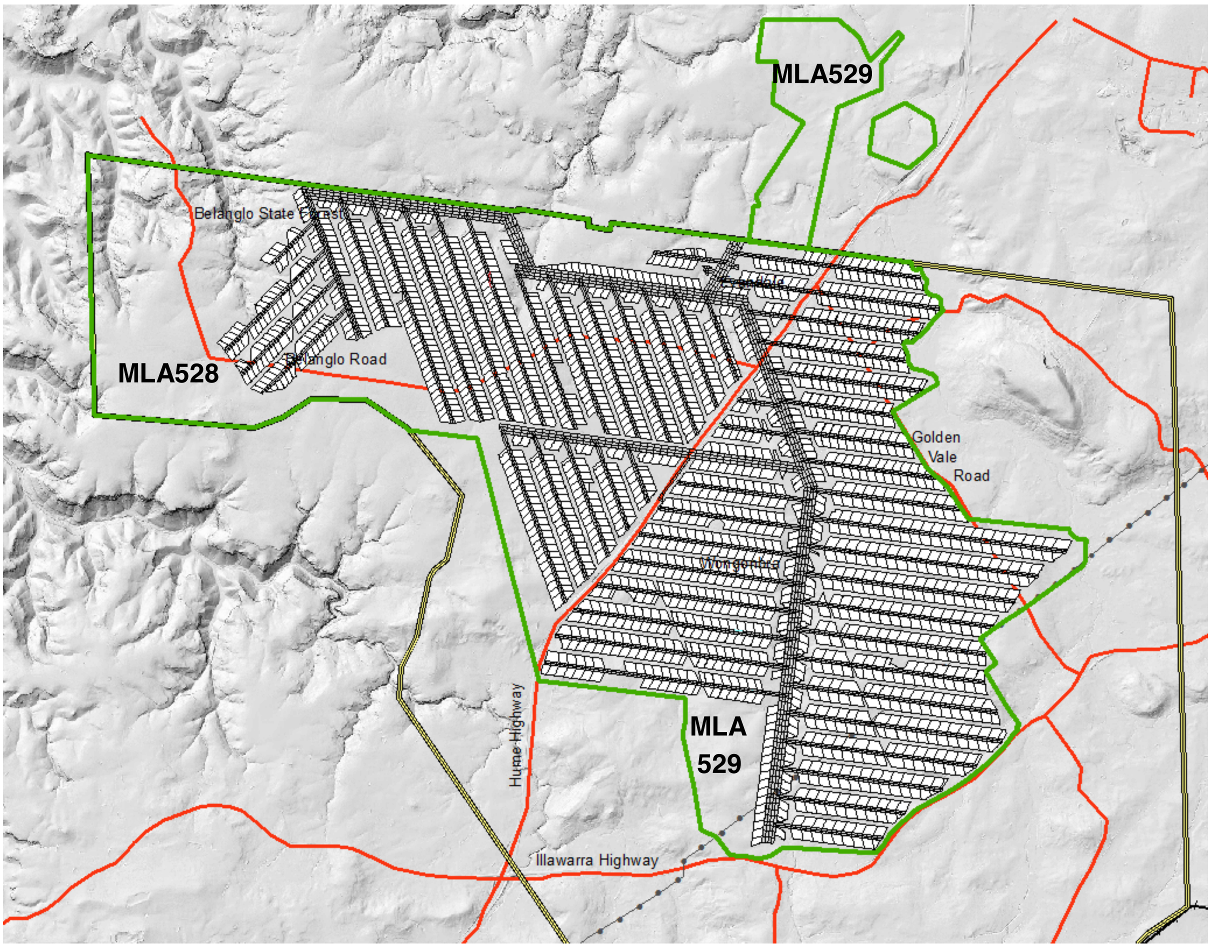

Figure 4: Hume Coal's proposed mine plan, showing the mining lease application areas in green outline. Note MLA527 and MLA528 – underground and MLA529 surface facilities.

CONCLUSION

The Hume Coal Project is on track for public exhibition of its EIS early in 2017. Mine plan design has been influenced by the geological model and the interpreted geological structures as well as other constraints. Coal resources are sufficient to justify an underground operation centred around development and maintaining ground stability through pillar design. This stability will allow protection of the overlying groundwater system and critical surface infrastructure.

A significant portion of the Narrabeen and the Illawarra Coal Measures are not present within the Authorisation 349 area. It is uncertain, if the Narrabeen strata was deposited in the first instance or if the material was eroded by the Hawkesbury Sandstone.

The Wongawilli Seam is of sufficient quality to produce a good coking coal as well as a middlings thermal product. The mine's position is a significant advantage in respect to infrastructure with both major road access and the use of existing rail for coal transport to Port Kembla's coal loader.

Adverse community groups are opposed to the project, but the commitment that Hume Coal has to the consultation process is seeing changing attitudes in the region. A strong community consultation program by the company has seen local support for the development and jobs improve significantly.

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