CENTRAL COLLIERY

312 GERMAN CREEK LOWER CH4 "FLOOR BLOWER" REVIEW

Darren Pisters
Chief Geologist
September 2004

Summary

The 312-floor inrush incident, which occurred on The 27th August 2004, was examined in conjunction with a compilation of previous gas inrush incident data. These incidents were cross-examined with geological mapping data, borehole profile sections and gas production data. The study found that a relationship between where a floor blower crack will appear on the longwall face once a cyclic loading event takes place with geological structure may be present. This relationship appears to have a correlation, however as floor heave with cyclic loading is a dynamic event the relationship ship may not always be valid. None the less, the relationship suggests that geological structure may assist in providing conduits to the workings in conduction with cyclic loading and if an area is benign of structure the probability of conduits forming in the goaf under normal loading conditions may be reduced.

Borehole profiles in the area where the incident occurred showed that borehole 312/12/LW was high in the interburden sequence after a floor touch. The correlation between this hole being high in the sequence and good geological conditions reducing the ability for gas to migrate to this hole is likely to have enabled gas to accumulate. After a significant weighting event, the floor cracked releasing this accumulation into the workings.

Comparison of all other holes in 312 with gas production data from these wells has not been after to optimise design. This is due to gas production data not adequately monitoring gas flow with relation to wall position. Gas flows tend only to be recorded once a flow is established, and null flows are as equally important to monitor especially when the wall has retreated over a significant portion of the hole. This can indicate that gas accumulation is taking place. The current design of maintaining holes approximately 2m above the German Creek Lower seam and 30m from the Tailgate is still considered best practice, however greater emphasis on monitoring gas flows with respect to longwall position and borehole profiles is recommended.

Boreholes which have been identified as being as being either high in the interburden sequence or beneath the German Creek Lower Seam have been marked on the hazard plan as a potential area where the probability of a floor gas inrush may be increased.

Geological models and inseam log data interpretation are required to be updated on a regular basis to ensure hole design can be optimised.

Introduction

Since mining 308 LW there have been 15 incidents of methane inrush on the longwall face. These incidents often occur with the onset of "cyclic weighting" where associated floor heave cracks have allowed a conduit to the German Creek Lower Seam 6.5m below the German Creek Seam. Since Longwall Panel 310, directional boreholes have been drilled in the interburden between the German Creek and German Creek Lower seams to bleed off the peak methane accumulations before cyclic loading events open conduits to the workings. Since the introduction of interburden drilling three gas events have been recorded at Central Colliery, the latest being on the 27th August 2004. On this latest event, CH_4 TARP levels where exceeded and Central Colliery was evacuated until methane levels fell below the TARP level.

This report reviews the current event and compiles historic data on previous events to further understand and refine the process to minimise any potential future reoccurrences.

Floor Gas Inrush event 27th August 2004 312 Panel

At approximately 10 PM Friday 27 August 2004 an inrush of methane from the floor along the longwall face affected the longwall return sufficiently to cause an evacuation of the mine as per Longwall Floor Gas PHMP TARP. Peak readings of 13.4% methane at over 5500 litres per second were recorded. A Total of 43,471 m3 CH4 was recorded from the mines gas monitoring systems. The wall was not in production and the event closely followed a weighting event on the face where numerous supports were recorded to be on yield. Several floor cracks emitting methane were recorded along the face at chock numbers 24, and 68 with a major crack at chock number 80. Figures 1,2 and 3 illustrate the event.

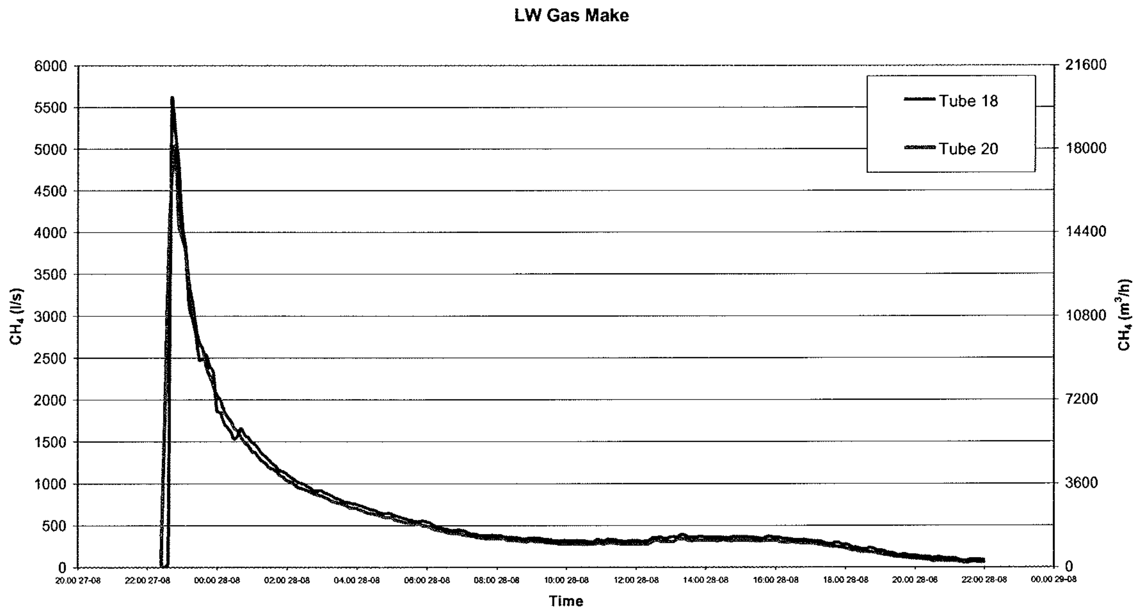


Figure 1: LW gas make 312LW 27/8/04

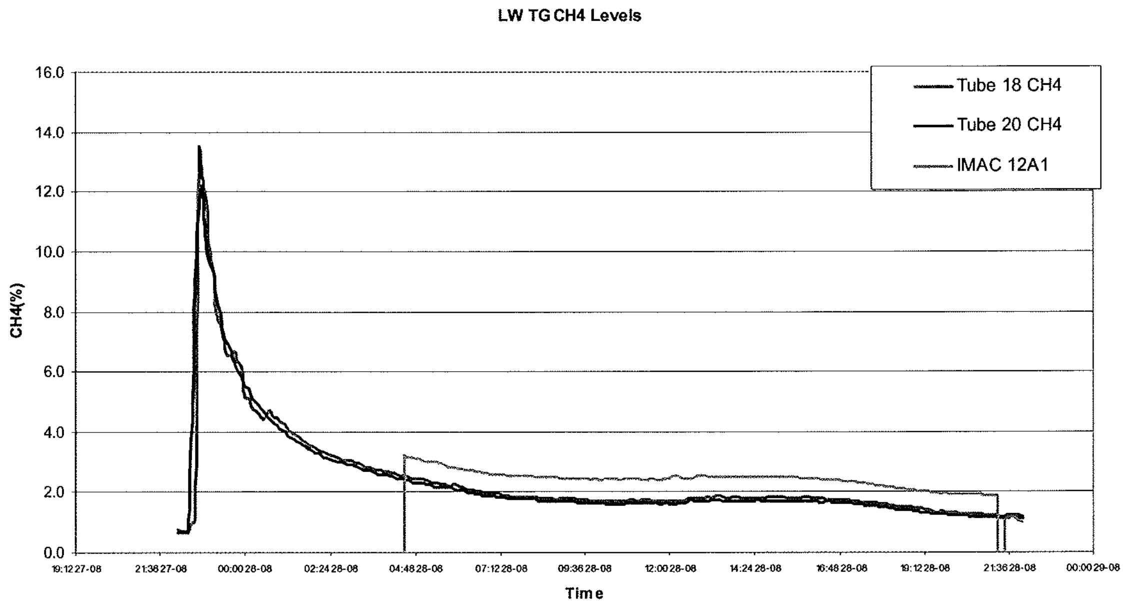


Figure 2: LW TG tube bundle CH4 Levels – 312 27/8/04

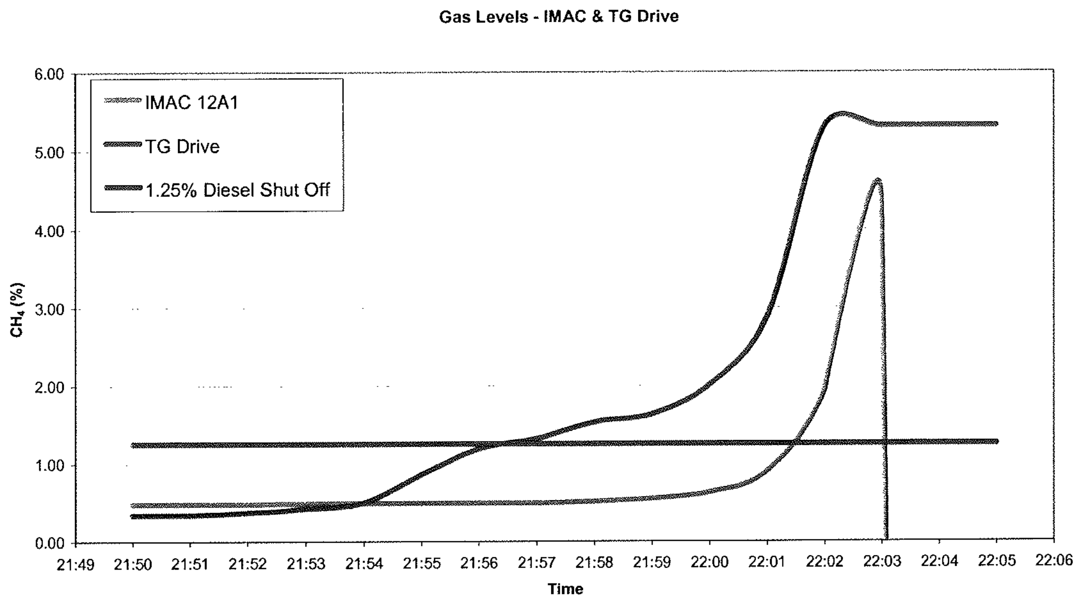


Figure 3: IMAC and TG drive CH4 Levels – 312 27/8/04

Floor Gas Inrush History

To date, 15 similar incidents have been recorded at Central Colliery. The following tables and location plan summarise the history of floor gas inrushes at Central Colliery.

308 L/W Major Gas Delays

Date	Chainage (m)	Shift	Delay	Comments
12/11/1999	1937.28	D/S	320	High CH4 at 100m sensor
		A/S	160	High CH4 at 100m sensor - 7 trips (large falls in goaf)
		nN/S	30	High CH4 at 100m sensor - 6 trips
20/12/1999	1707.91	D/S		
		A/S	315	Gassed out - CH4 issued from goaf floor at #30 chock
			30	High CH4 at T/G drive max 3.3% - 5 trips
		N/S		
5/01/2000	1649.27	D/S	210	High gas in T/G and 100m sensor (trailer move - 3rd goaf pump turned off)
		A/S		
		N/S		
21/01/2000	1506.67	D/S	120	Gassed out - CH4 6% at 100m sensor and 4% at T/G drive 1% between front legs of #100 chock area
		A/S	420	High gas at T/G and 100m sensor
		N/S		
26/02/2000	1246.08	D/S	80	High gas at T/G drive - blowers at#45-85 chock area
		A/S	55	High gas at T/G drive - 12 trips
26/03/2000	971.93	D/S	30	High CH4 at 100m sensor - 5 trips
		A/S	285	Gassed out - high gas level in T/G and 2.2% at 100m sensor
		N/S	23	High gas at 100m sensor - 3 trips

Table 1: 308 Longwall Gas Delays

309 L/W Major Gas Delays

Date	Chainage (m	Shift	Delay	Comments
27/09/2000	2298.77	D/S	125	High CH4 in T/G >2.5% (goaf fall occurred in T/G area)
		A/S	145	Gassed out - 3.5% in T/G 2 trips
			120	High increase in gas 306 raise bore trip at 2%
			60	High CH4 post raise bore trip
		N/S		
31/10/2000	2100.71	D/S	50	High CH4 at 100m sensor - 4 Trips
		A/S	20	High CH4 at tube 24 >2.5%
			10	High gas at 100m sensor - 3 trips
			195	T/G blowers at #154 chock area at 4%
		N/S	15	High Ggas at 100m sensor
8/12/2000	1848.47	D/S	175	High gas at 100m sensor at 2.5% (trailer move blamed)
		A/S	45	Gassed out
			10	High CH4 in tube 24
		N/S	10	high gas at 100m sensor - 4 trips
21/12/2000	1746.34	D/S		
		A/S	95	High gas at T/G drive - 4 trips
		N/S	240	High gas at T/G sensor - maximum of 6%
				Major blow behing #117 chock with smaller blows occurring at #90 chock
				small blowers issuing from under pan line at #50-59 chock area
9/01/2001	1642.13	D/S	275	High gas on the face
		A/S	15	High gas at T/G drive
		N/S	415	Gassed out all shift with the higest concentration being at #115-125 chock
				gas blows under th pan line were audiable.
				CH4 peaked at 19.37% on tube 20
				Gas make 40,586m3
18/01/2001	1564.65	D/S	35	High CH4 at 100m sensor - 3 trips
			90	T/G gassed out > 2% CH4
		A/S	140	High CH4 at 100m sensor - 6 trips
			55	High gas at tube 24 - 3 trips
		N/S	20	High CH4 at 100m sensor - 7 trips

Table 2: 309 LW Gas Delays

310 L/W Major Gas Delays

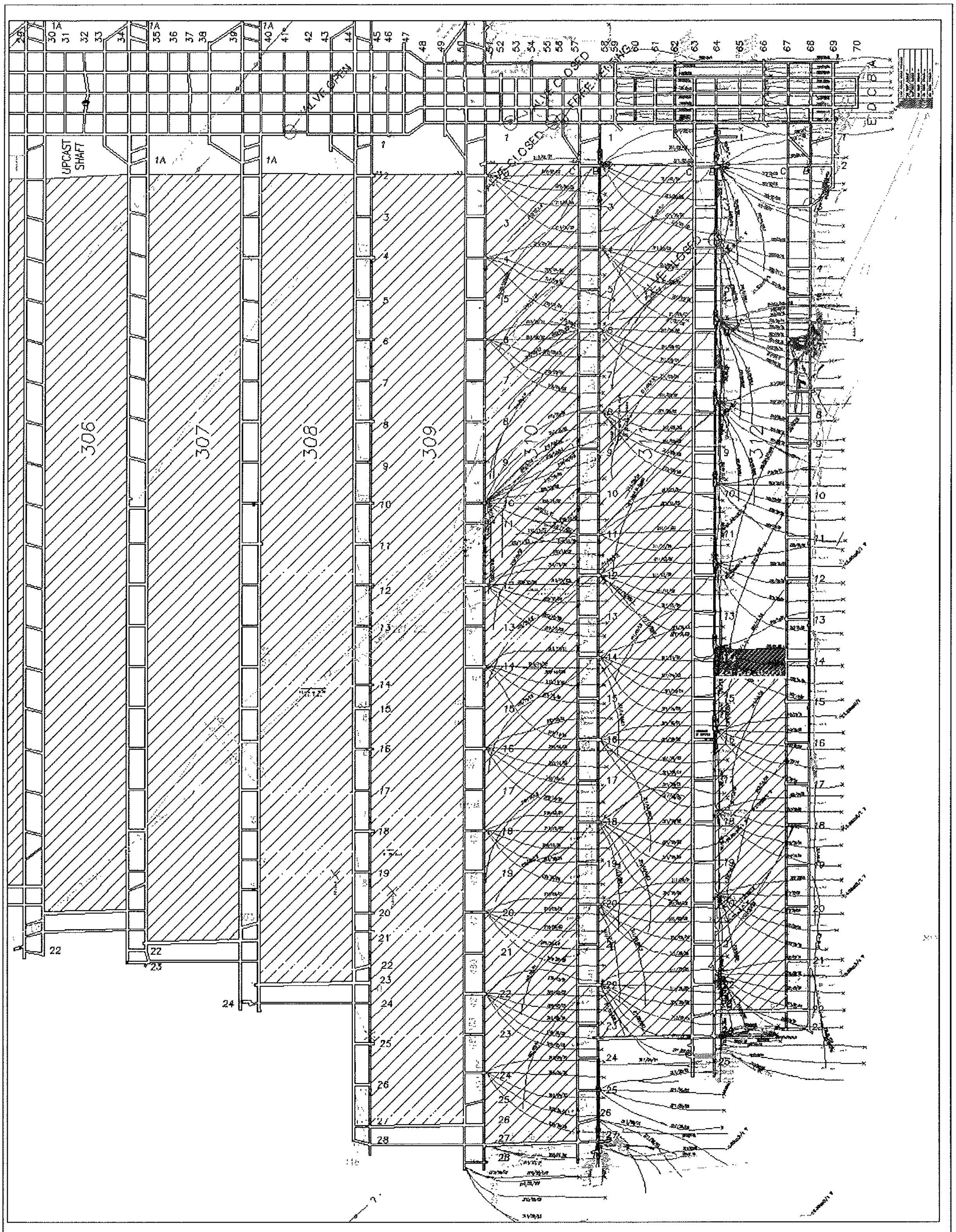
Date	Chainage (m	Shift	Delay	Comments
11/03/2002	1883.5	?	?	CH4 peaked at 9.25% on tube 23 Gas make 32,359m3
10/06/2002	1156.5	?	?	CH4 peaked at 11.48% on tube 23 Gas make 22,999m3

Table 3 :310 LW Gas Delays

312 L/W Major Gas Delays

Date	Chainage (m	Shift	Delay	Comments
28/08/2004	1251	N/S	?	Gas Blower at #80 chock CH4 peaked at 13.4% on tube 18 Gas make 43,341m3 TARP level exceeded - pit evacuated

Table 4: 312 LW Gas Delays



SCALE	N.T.S.	ANGLO COAL (CAPCOAL MANAGEMENT) Pty Ltd CENTRAL COLLIERY
DATE	8/9/04	
DRAWN	A.B.	
CHECKED	CHECKED	German Creek Lower Gas Inrush Location Plan
APPROVED	APPROVED	
ACAD FILE No.: F:		

CAPCOAL

Figure 4: GCL Gas Inrush Location Plan

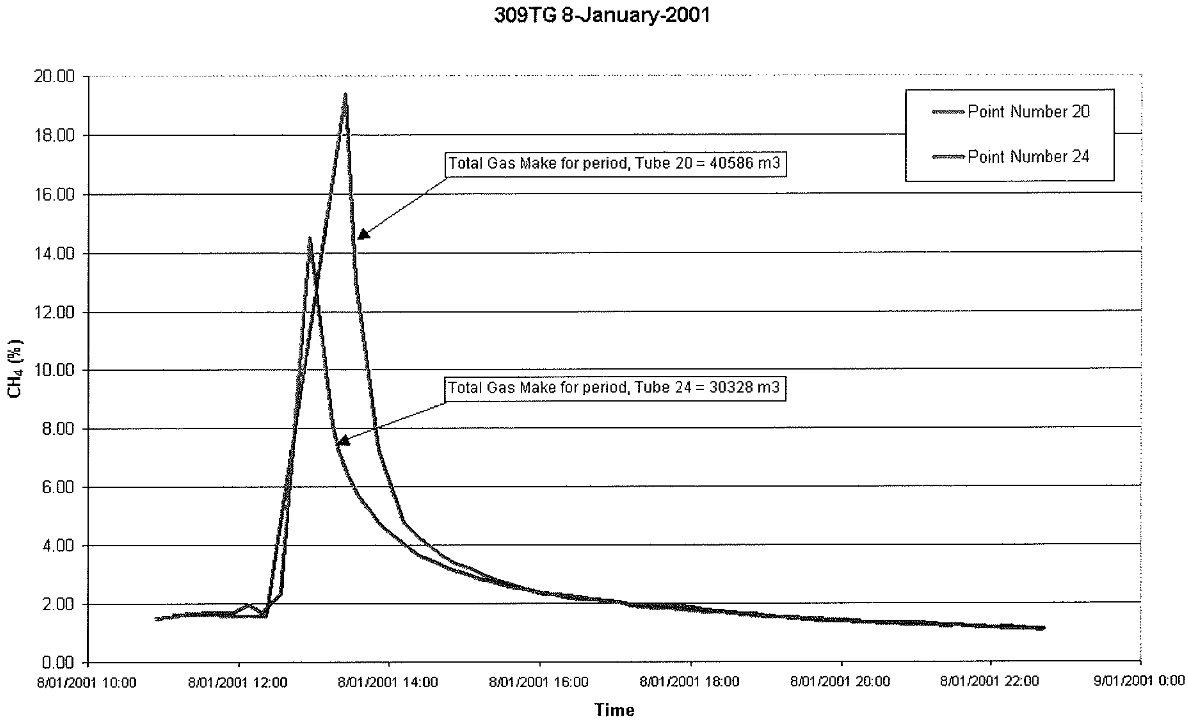


Figure 5: 309 TG Gas Make – 8/1/01

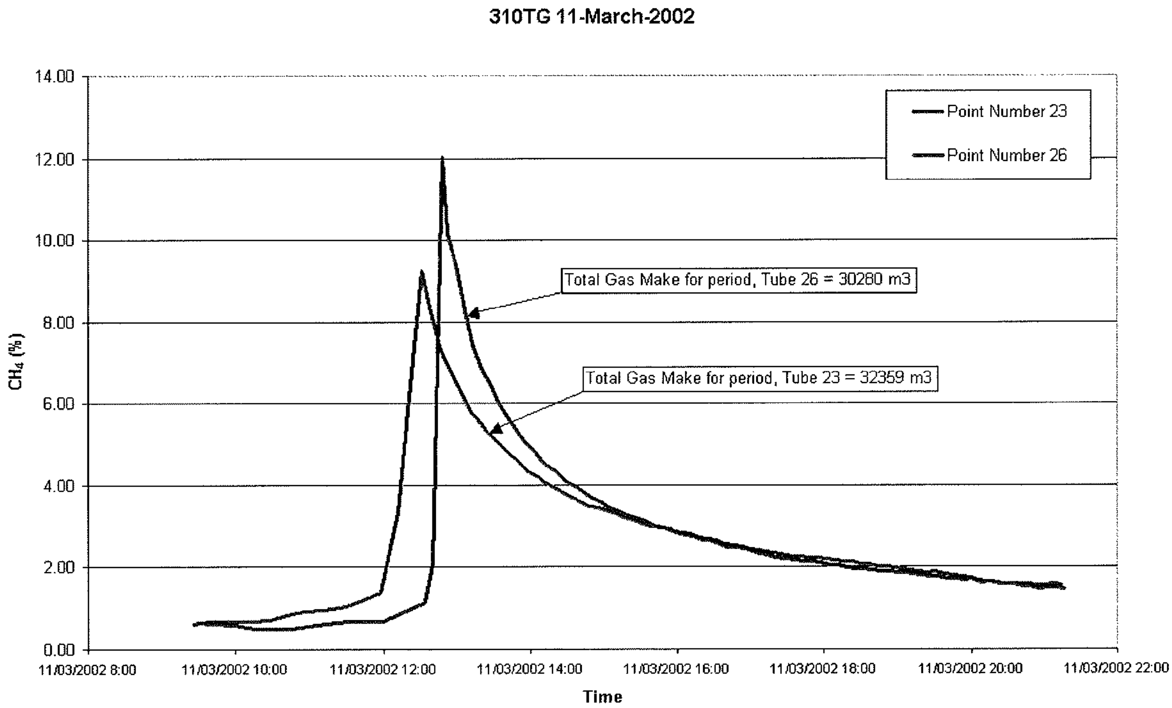


Figure 6: 310 TG Gas Make – 11/3/02

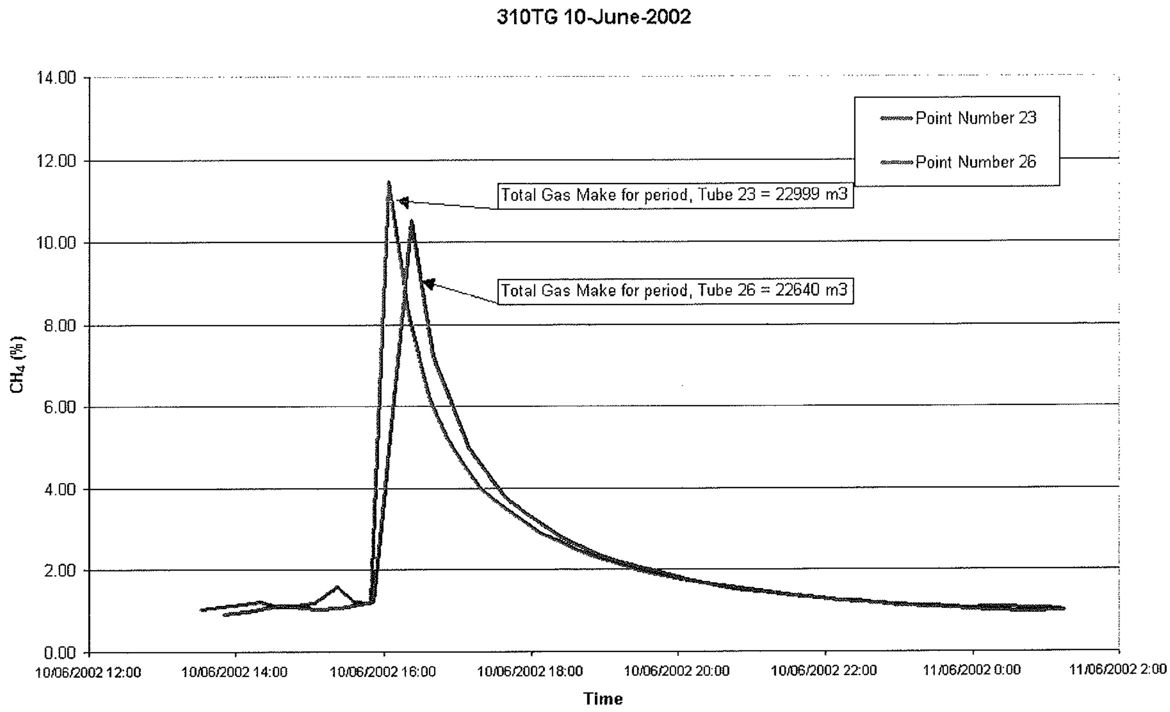


Figure 7: 310 TG Gas Make 10/6/04

The gas incident at 310 LW on the 11th March 2002 can be seen from Figure 4 to be largely related to a floor hole not being drilled at this location. The second incident on the 6th June 2002 was related to the floor hole being turned off at the collar. Therefore the incident on 27th August 2004 at 312 can be considered the first "true" failure of the floor drainage system and therefore requires to be evaluated in detail. The next series of sections further evaluates this failure.

Geological and Geotechnical Setting

The German Creek Seam over the 300's block is on average 2.4m thick ranging from 2.5m thick at the inbye end of 312 and down to 2.3m at the outbye end. The German Creek Seam has a rider seam known as the German Creek Upper which splits away to the north around the middle of the 300's block. The German Creek Seam has an insitu gas content ranging between 10 and 15 m3/t which is drained by inseam directional boreholes to levels beneath 7.5m3/t. Typically, post drainage methane levels range between 3 and 5 m3/t on average, however this can depend on factors such as drainage time, hole performance and geological structure.

The German Creek Lower seam is on average 0.4m thick with an insitu gas content of approximately 10m3/t. The interburden ranges between 6 and 6.7m thick with an average of 6.5m through the 312 block. The interburden has been characterised into 4 geotechnical floor units based on the sonic response from surface boreholes. These floor units are characterised as

Floor Unit 1 - Laminated siltstone and carbonaceous mudstone, weak to moderate in strength (UCS 20 –50 MPa)

Floor Unit 2 - Medium grained sandstone, strong the very strong (UCS 60 –70 MPa) with occasional weak bedding planes. (not present at CC but grades in at GT and SC)

Floor Unit 3 - Laminated fine grained sandstone and siltstone, moderate – strong rock with numerous weak bedding planes.

Floor Unit 4 - Medium grained sandstone, strong to very strong rock (UCS 80 –90 MPa) with occasional weak bedding planes.

These units can be seen on the following borehole profile and core photographs of borehole DD0537 located mid block of 18 c/t 312LW panel.

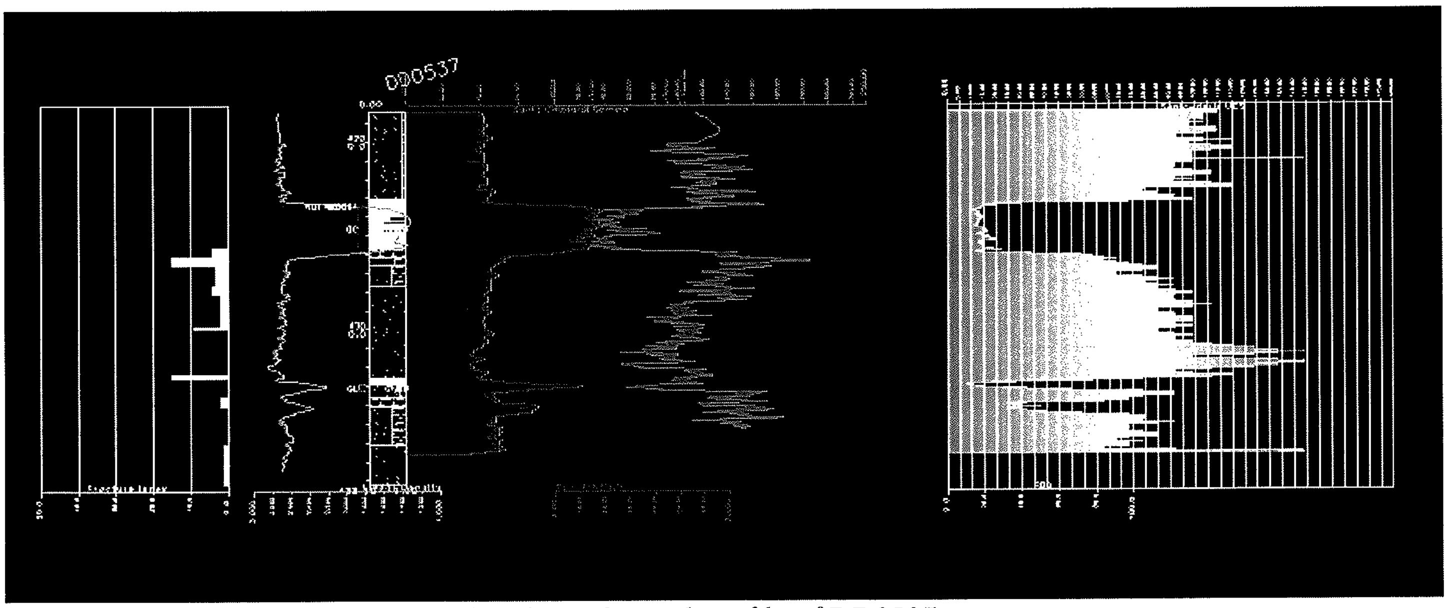


Figure 8 – Lithological and geophysical profile of DD0537

German Creek Seam   Floor Unit 3   Floor Unit 1   Floor unit 4

German Creek Lower seam (sampled)

Plates 1 and 2 – Core Photographs DD0537

Insitu stress measurements have been conducted by various techniques at Central including hydrofracture, laser spin microscopy / paleomag, and insitu overcore. These various techniques have measured the principle horizontal stress to be in a north north east / south south west direction with the more reliable overcore technique measuring on average a vertical to horizontal stress ratio of 1.4. Horizontal stress magnitudes range between 10 and 15 MPa. Hence during longwall extraction a stress notch is concentrated on the TG side of the 300's panels and on the MG side of the 200's panels.

During longwall extraction, floor heave is not considered problematic at Central Colliery, however minor floor heave and cracking has been known to occur along the tailgate and in the mid face area. It is in these regions where gas from the German Creek Lower flows into the longwall workings.

Gas In Rush Mechanism and Drainage Design Criteria

A single crack intersecting the German Creek Lower seam would not produce significant gas to cause methane trips unless an accumulation of methane has been created into a "reservoir". It is believed that during longwall extraction, bed separation in the goaf due to floor heave enables gas from the German Creek Lower Seam to desorb into the voids between the various bedding partings, particularly between the roof of the GCL seam and floor unit 4. Once a cyclic loading event occurs, floor unit 4 is able to crack enabling methane up to the lower strength units 1, 3 and ultimately the mine workings. Without cyclic loading, floor heave typically would occur in the goaf and methane would be captured by the goaf drainage system with minimal impact or delay on the operation.

In order to manage this issue, directional holes initially where targeted at draining the GCL seam, however the seam proved to be too thin to confidently keep directional holes within the seam horizon. Therefore boreholes were drilled in the interburden flanking the TG by 30m and within 2m of the GCL seam roof. This design was based on the criteria that the borehole would bleed off peak methane accumulations as floor unit 4 begins to crack under floor heave conditions. As this mechanism does not actively drain the gas from the GCL seam and hence remove the hazard, it is dependant on floor cracks intersecting the borehole to bleed of methane. Therefore based on this, there will always be a probability that floor cracking may not intersect the borehole.

To date since the implementation of floor drilling, over 30 floor holes have been drilled with 3 significant gas events. If 2 of these events can be discarded as not true failures, then the failure rate is 1 in 30 or 3%.

Relationship of Geological Structure to Floor Blower Locations

Floor heave is a response to abutment load as a Longwall extracts and hence any floor cracking is a mechanical response to this process. Geological structure (i.e. joint swarms) may not necessary play a role with floor heave but may influence areas where gas conduits can open up to the GCL seam when cyclic loading events occur. To evaluate this the location of historic gas events were plotted against underground mapping.

The location of the events in 309 between the 8th Dec 2000 and 9th Jan 2000 can be seen on figure 9 to be in the vicinity of high density jointing at 19 C/T and 20 C/T.

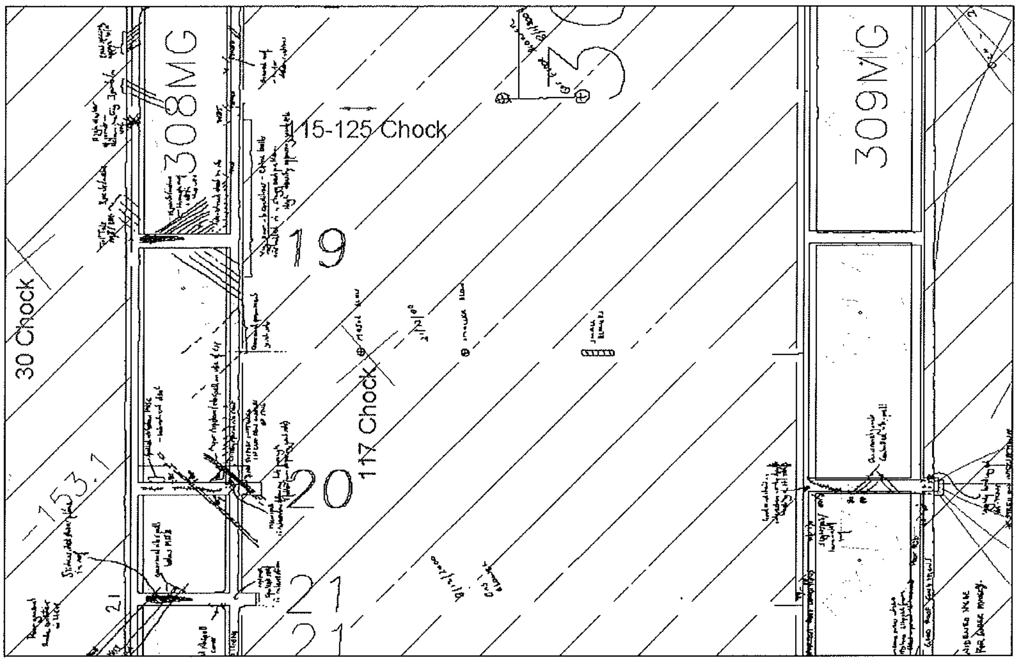


Figure 9 – 309 Gas Inrush Locations and Geological Structure

The event in 310 on 11 March 2002 occurred in an area where a floor hole was not present in the TG area. Therefore this event can largely be related to this fact. However, the location of the main gas blower as seen on figure 10 (cross on mapping on wrong chainage) correlates with a high density cleat/joint zone between 21/22 C/T on the TG and 20 C/T on the maingate.

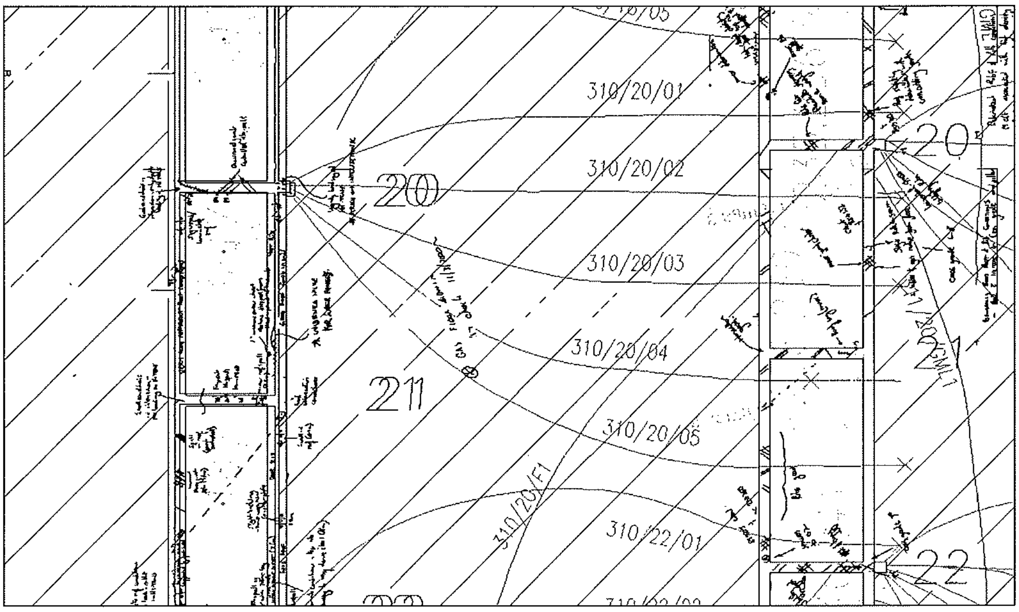


Figure 10 – 310 Gas Inrush Locations and Geological Structure.

The event in 310 LW on 10 June 2002 was in a location where a floor hole had been turned off at the collar. This event can therefore not be regarded as a failure of the system. Gas make was reported to be in the mid face region which is the most likely location for cracking to occur. Figure 11 shows also that the mid face region is an area of intersecting joint sets from both the maingate and the tailgate. In this case however, it is not clear whether structure plays any role with the location of the floor blower.

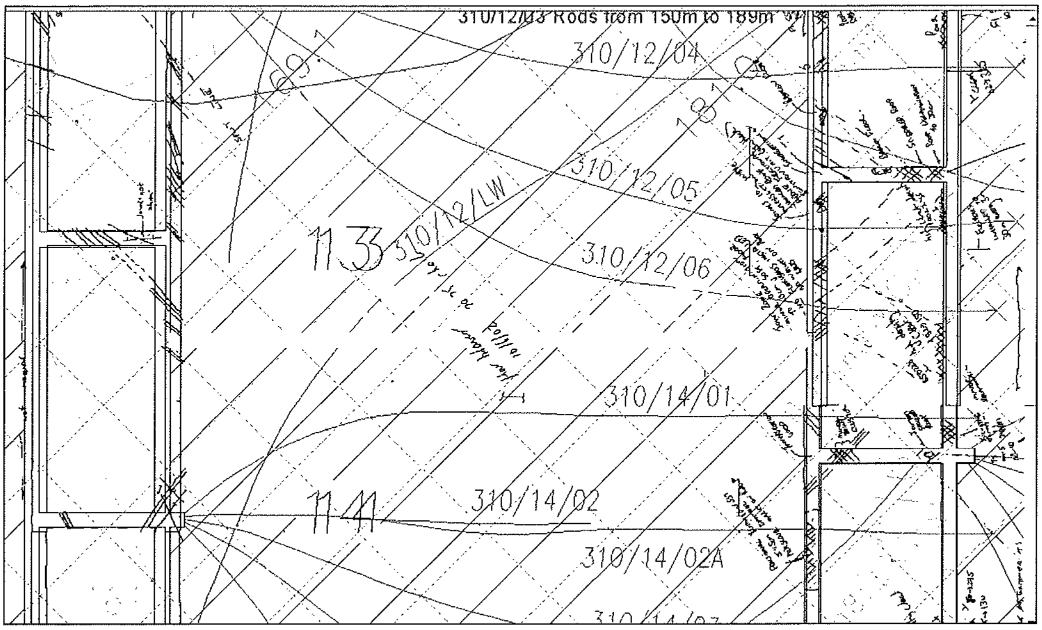


Figure 11: 310 Gas Inrush and Geological Structure

The event in 312 LW on the 27th August 2004 occurred in a location where conditions on the maingate where recorded as good with very few joint sets. Conditions on the tailgate were similar with minor joint sets around 15 cut through. This is interesting, as benign conditions may have reduced the ability for cracking beneath in the goaf under normal weighting conditions and allowed for an accumulation of methane to occur without release to the interburden hole or to the goaf.

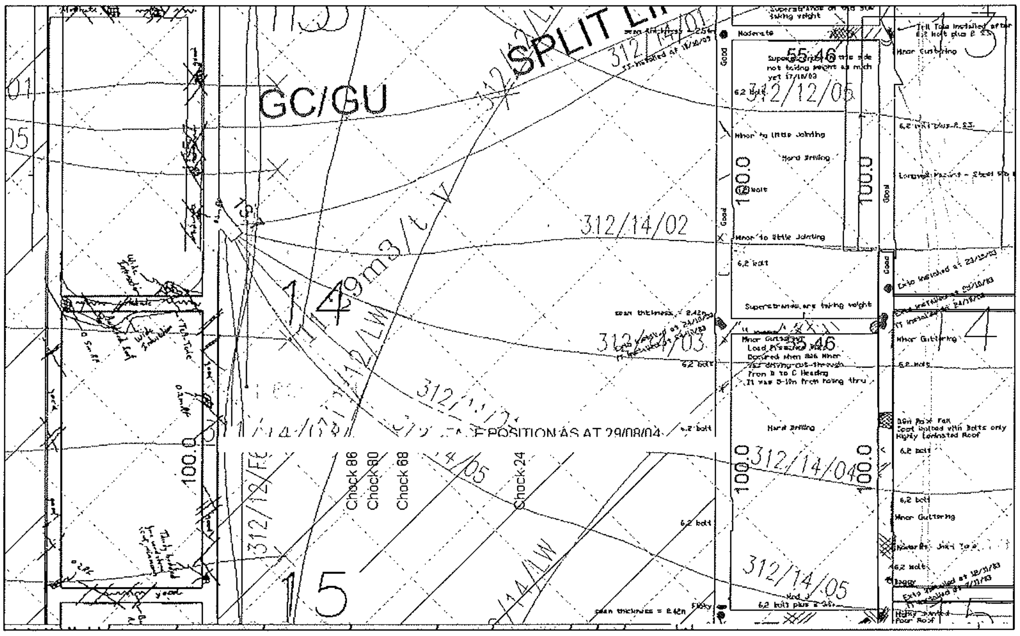


Figure 12: 312 Gas Inrush and Geological Structure

Therefore in summary, the location of previous floor blowers may be correlated with geological structure once a cyclic loading event is initialised. If structures are not present the location of the blowers will tend to be biased to the tailgate side of mid face region. In the case of the 312 event, benign conditions may have not enabled connection with the interburden borehole or allowed cracking to develop in the goaf under "normal condition" to allow gas release.

Interburden Borehole Profiles

The location of interburden boreholes also potentially plays a role in the effectiveness of hole performance. The geotechnical model assumes that gas accumulates beneath floor unit 4 and the German Creek Lower seam. Once unit 4 fractures the weaker units 1 and 3 are likely to have little resistance to the flow of gas. Therefore it is important the keep the hole profile close to the German Creek Lower seam (less 2m) so as unit 4 progressively breaks under abutment load the methane is bled off before the entire unit breaks.

To evaluate this, all the interburden holes have been loaded into Minex and cross section profiles have been generated. Roof and floor information for the GCL from the interburden holes has been collected and structure grids have been reproduced with this data. Figure 13 is a profile of hole 312/12/LW, which is at the 312-inrush location.

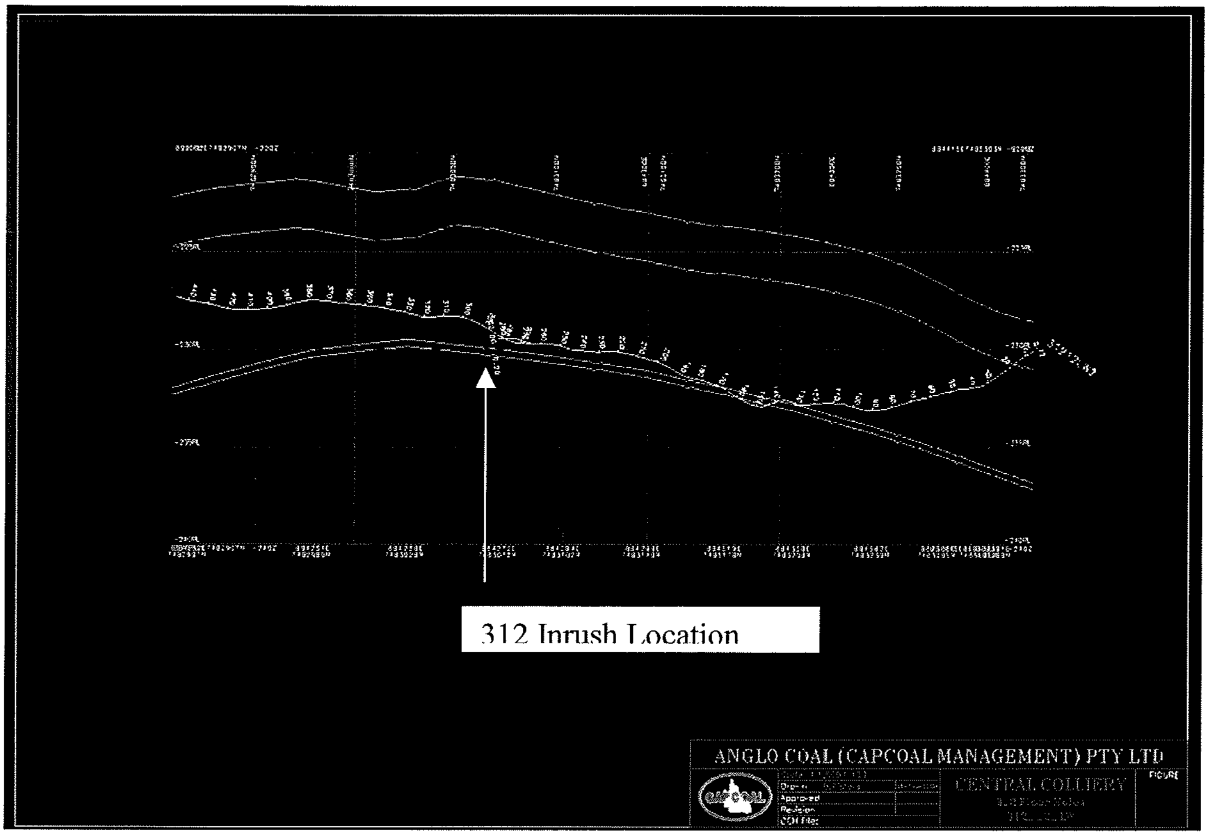


Figure 13: 312/12/LW Borehole Profile

In the above figure it can be seen that at the point where the inrush occurred, a floor touch had been made and the hole was branched. From this point, the hole was kept high but the German Creek Lower seam also begins to roll away as the cross grade steepens. The end result is that the interburden between the hole and the German Creek Lower increases to a point where the hole may not effective. In conjunction the lack of defects in the strata, gas potentially has not been able to bleed off with this hole. When the weighting event occurred, the strata cracked releasing gas into the workings. This is the most likely cause of the 312 event.

The question that now arises is what distance ideally should the holes be drilled above the German Creek Lower Seam. The following figures are borehole profiles of the remaining holes in the 312 block to assess hole performance against hole production rates.

The after reviewing the graphs it is difficult to find a correlation between hole location and gas production. For example, hole 312/18/LW had low production and most of the hole was predominately in the top half of the interburden and hole 312/16/LW which was below the GCL (where you would expect no production) had high production. (gas may be entering at the hole / GCL interface). Hole 312/14/LW which has a similar profile to 312/12/10 which failed has average gas production. It is believed that the gas production data is not measured routinely enough to make a recommendation the ideal location for hole position. Also no gas production is an important measurement with metres extracted over the hole. It is therefore recommended that hole design remains targeted within 2 metres of the German Creek Lower Roof and any hole which is either drilled below the GCL seam or higher in the interburden sequence by flagged on the hazard plan as a potential hazard. Flow measurement data should be collected more routinely in conjunction with hole profile and longwall position to determine if a design optimisation can be achieved.

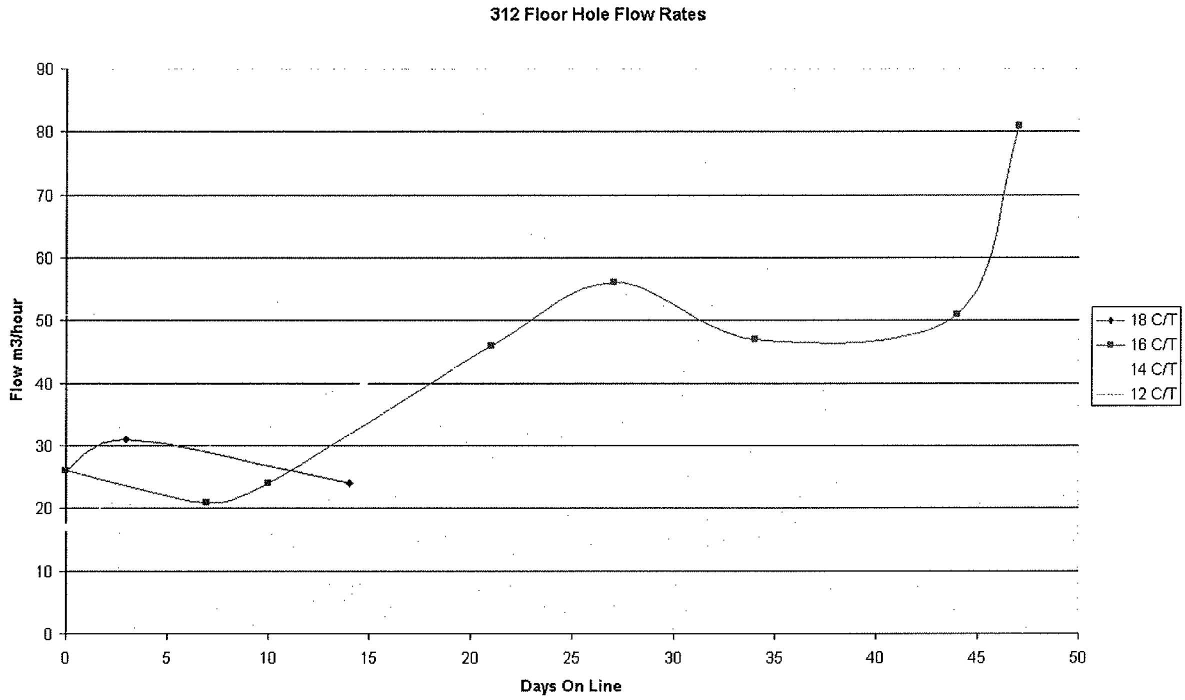


Figure 14: 312 Floor Hole Production Rates

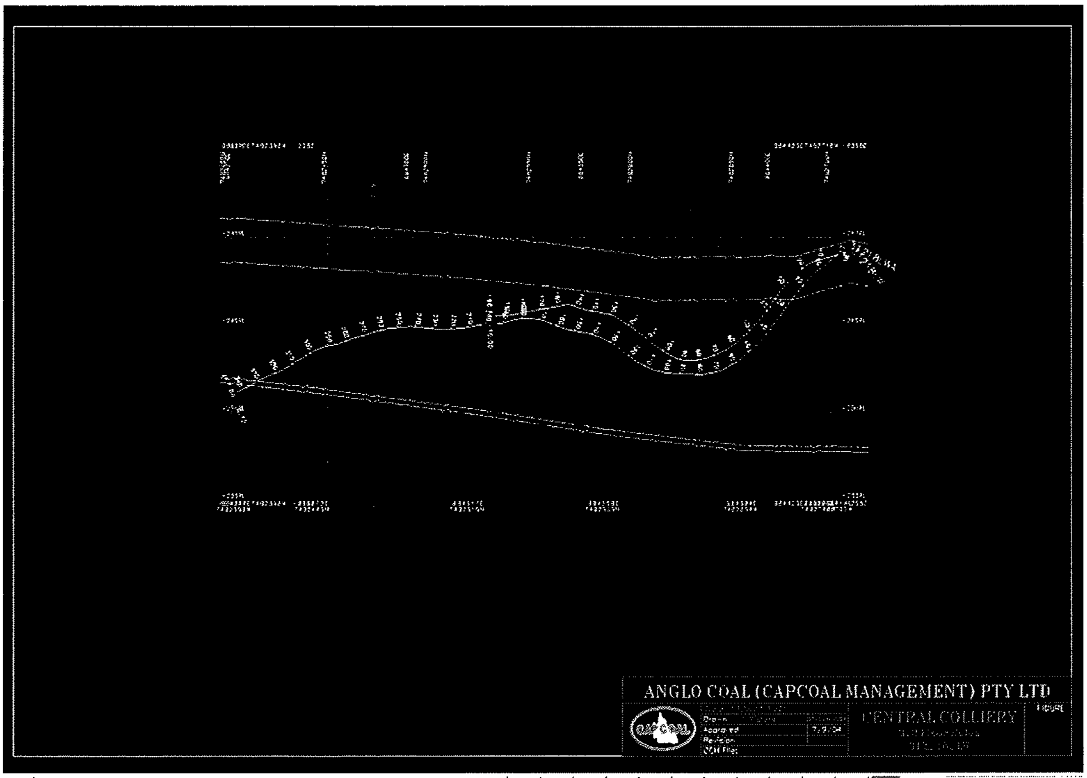


Figure 15: Borehole 312/18/LW

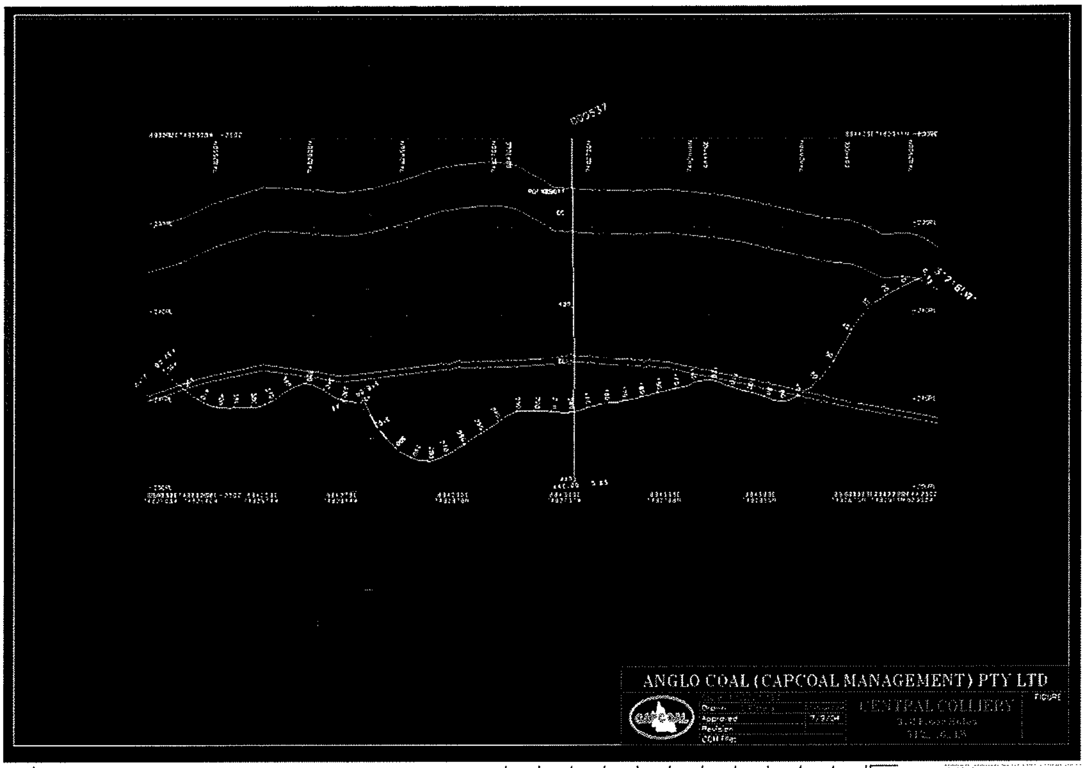


Figure 16: Borehole 312/16/LW

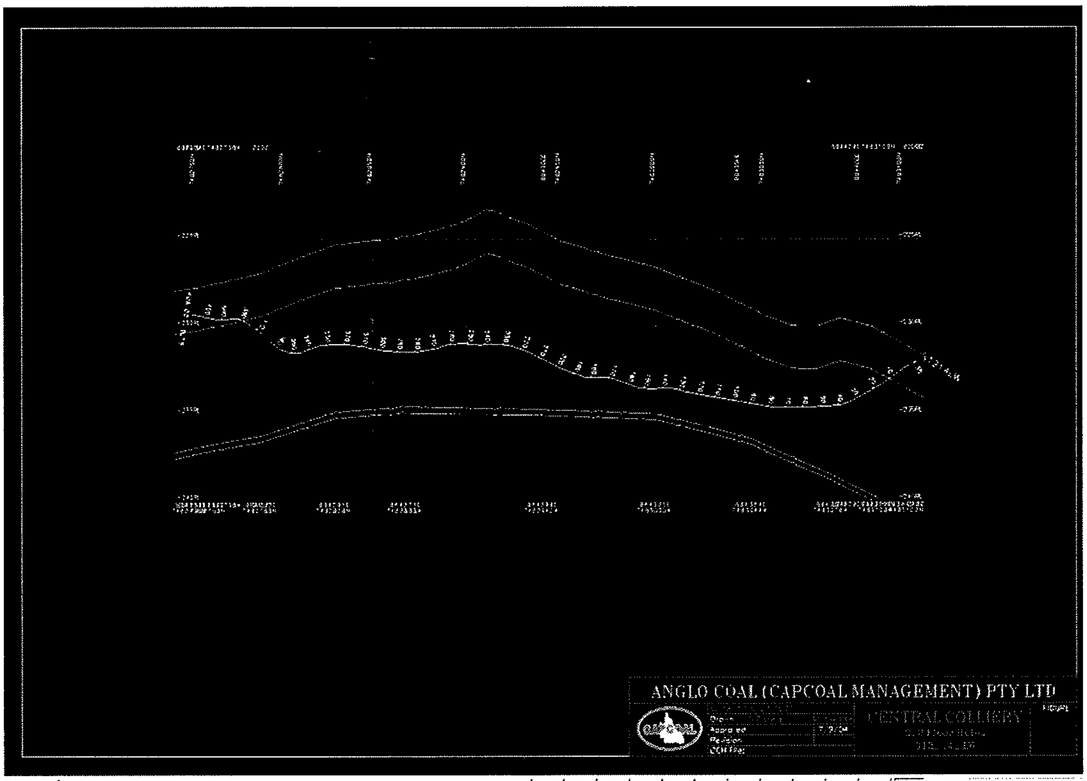


Figure 17: Borehole 312/14/LW

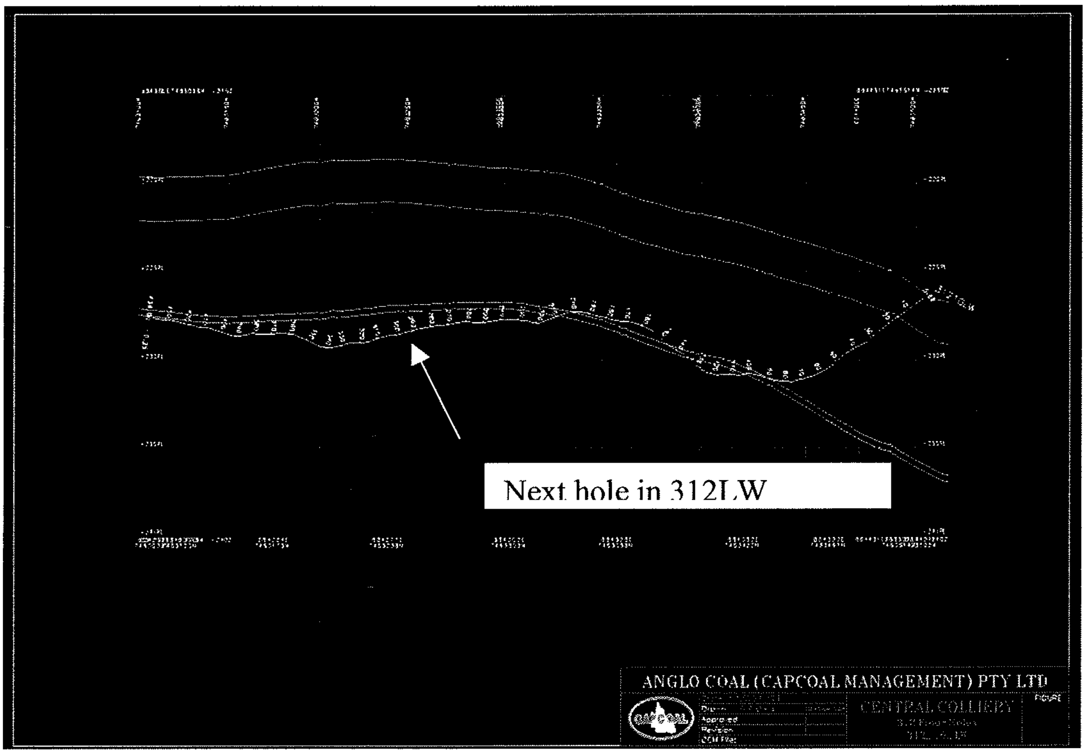


Figure 18: Borehole 312/10/LW

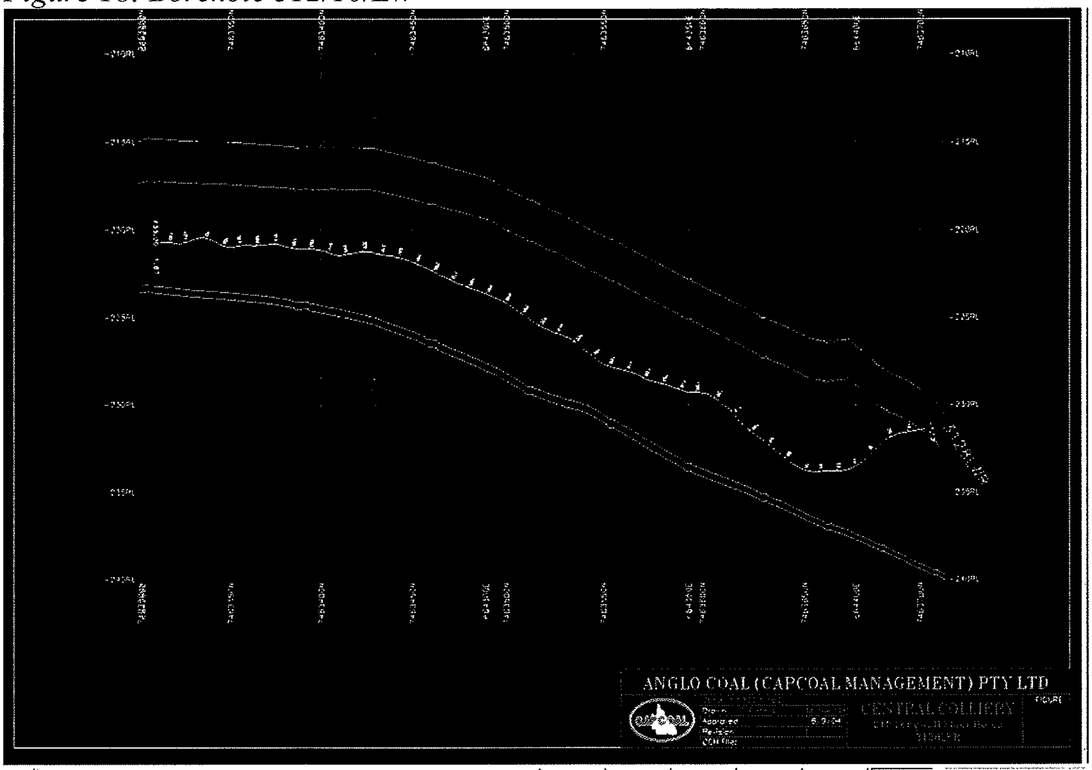


Figure 19: Borehole 312/8/LW

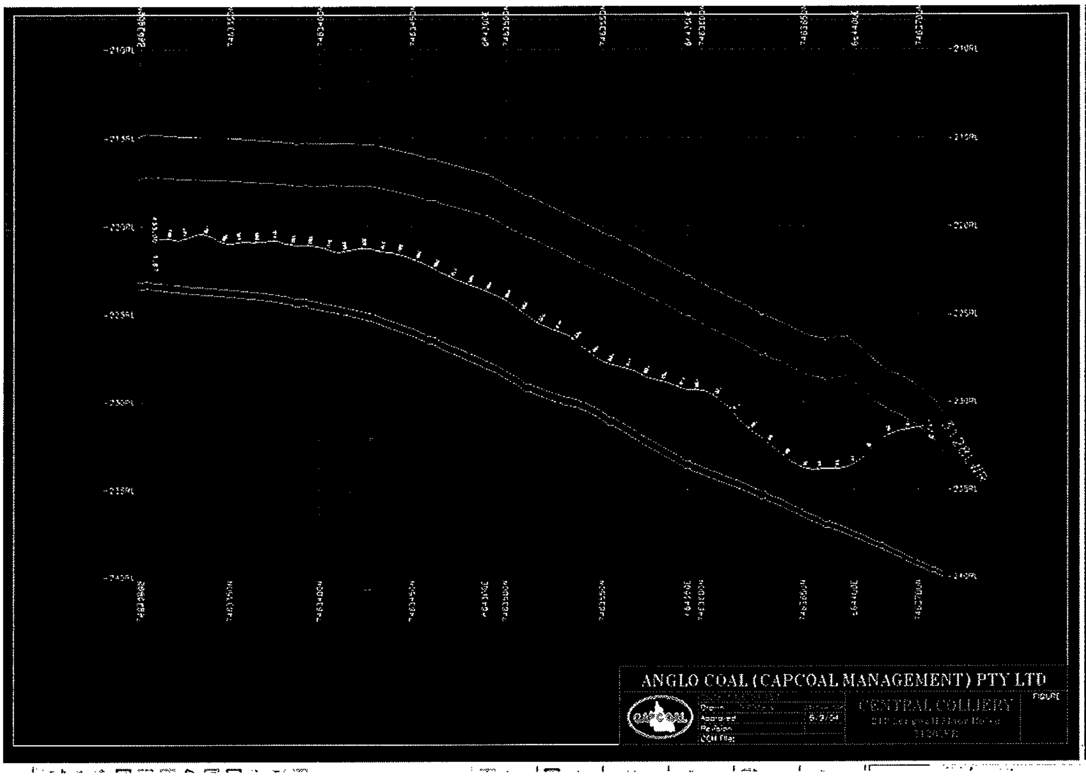


Figure 20: Borehole 312/8/GML1

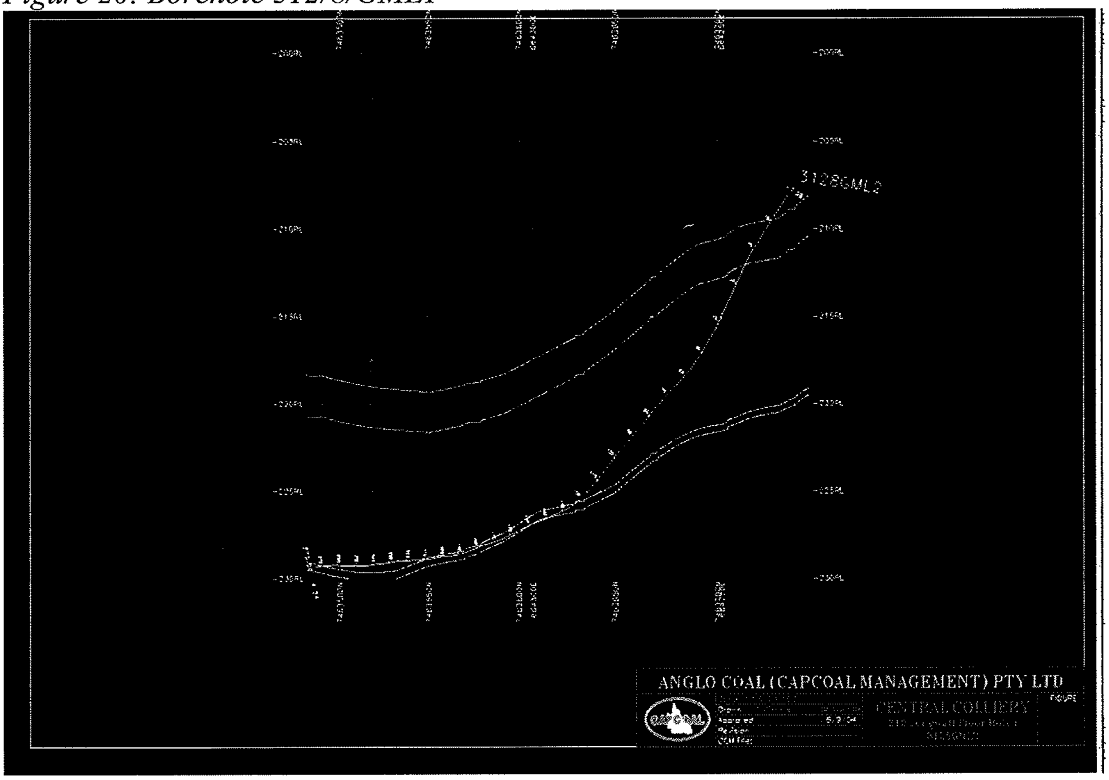


Figure 21: Borehole 312/8/GML2

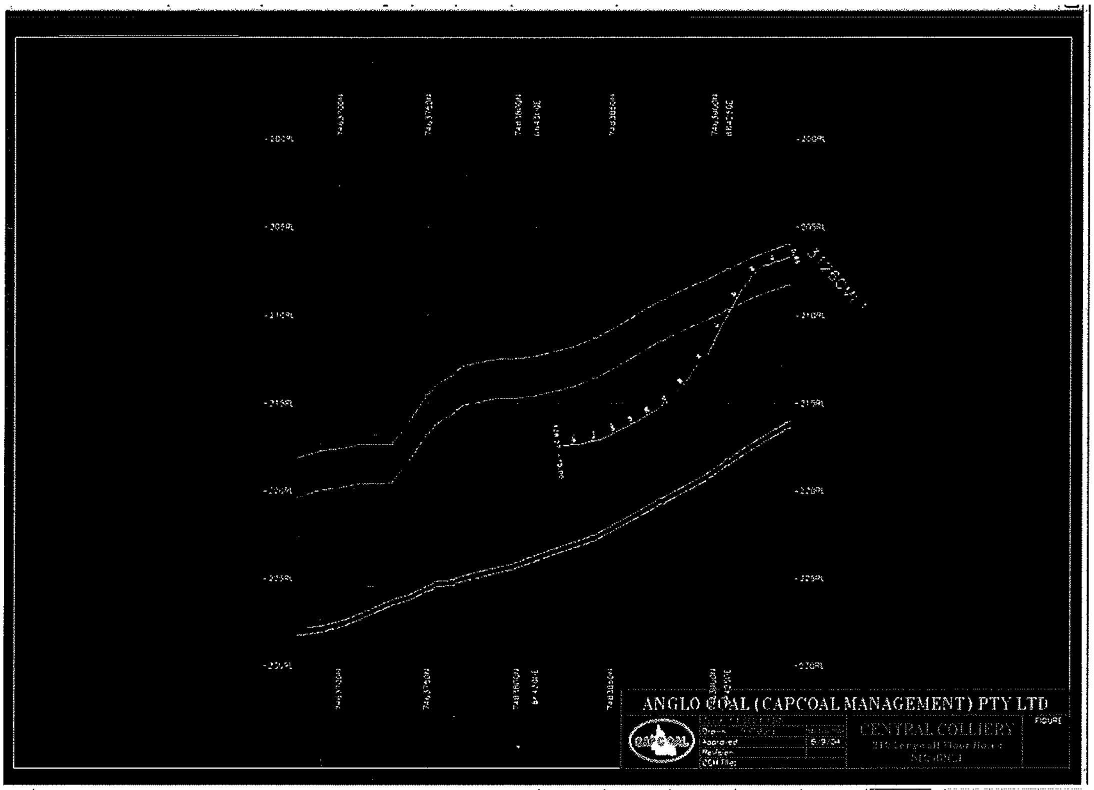


Figure 22: Borehole 312/6/GML1

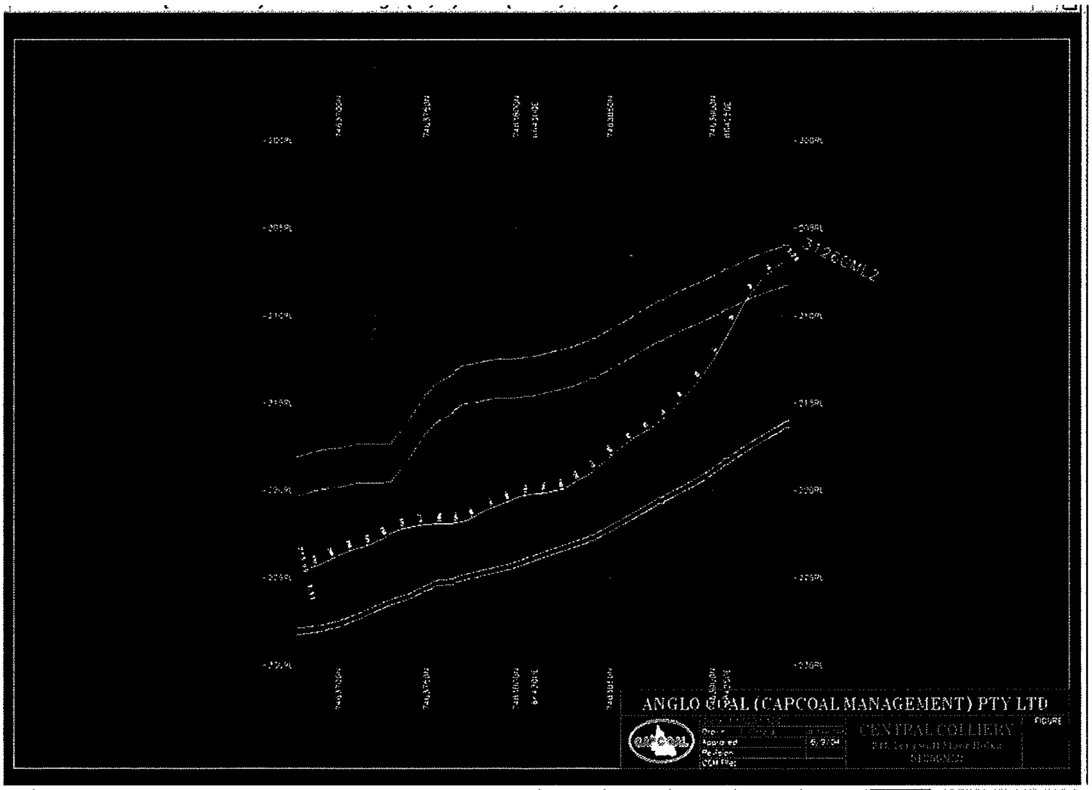


Figure 23: Borehole 312/6/GML2

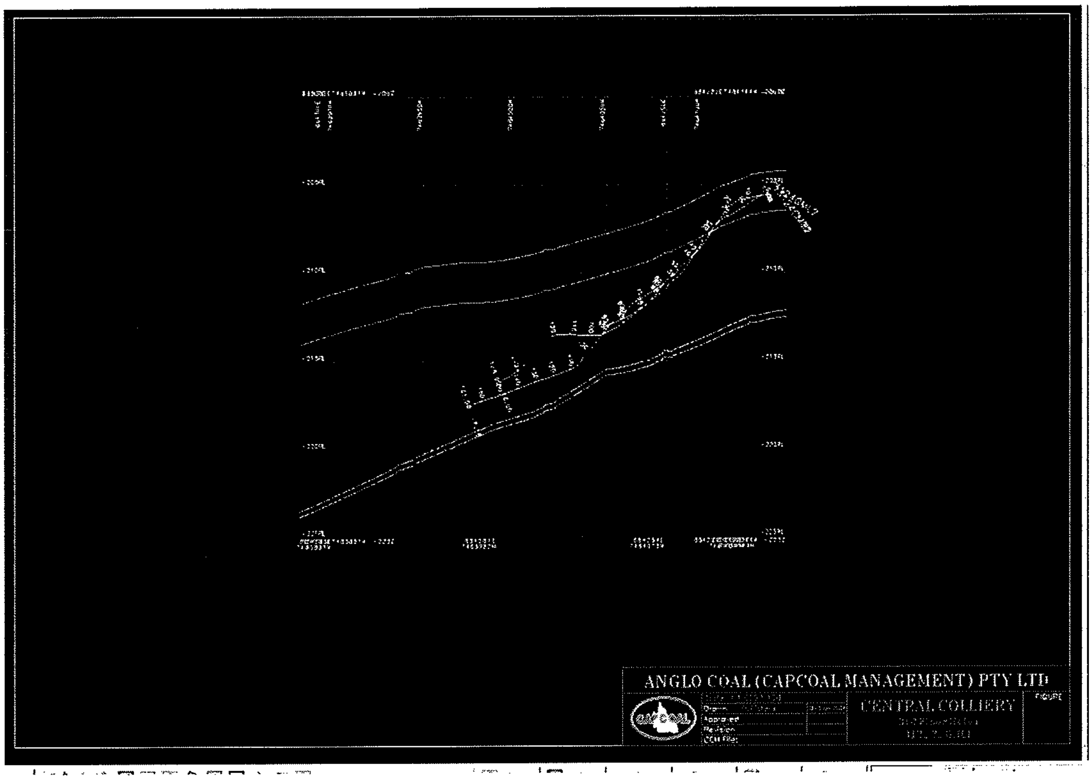


Figure 24: Borehole 312/4/GML1

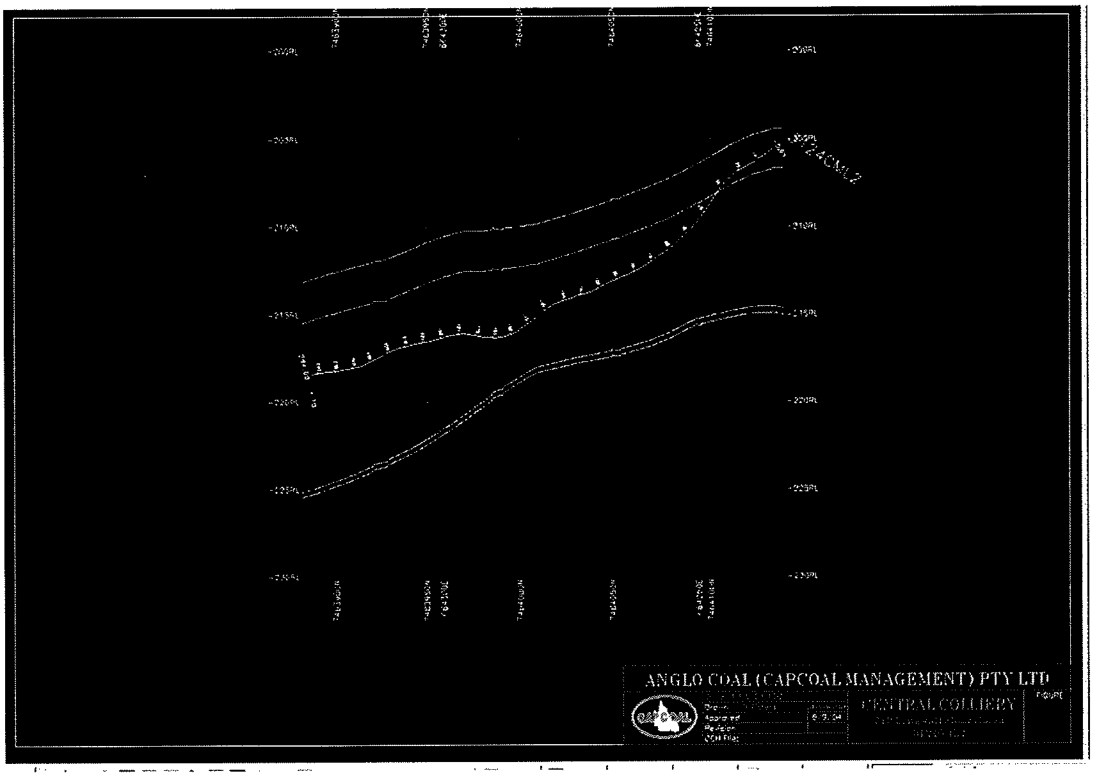


Figure 25: Borehole 312/4/GML2

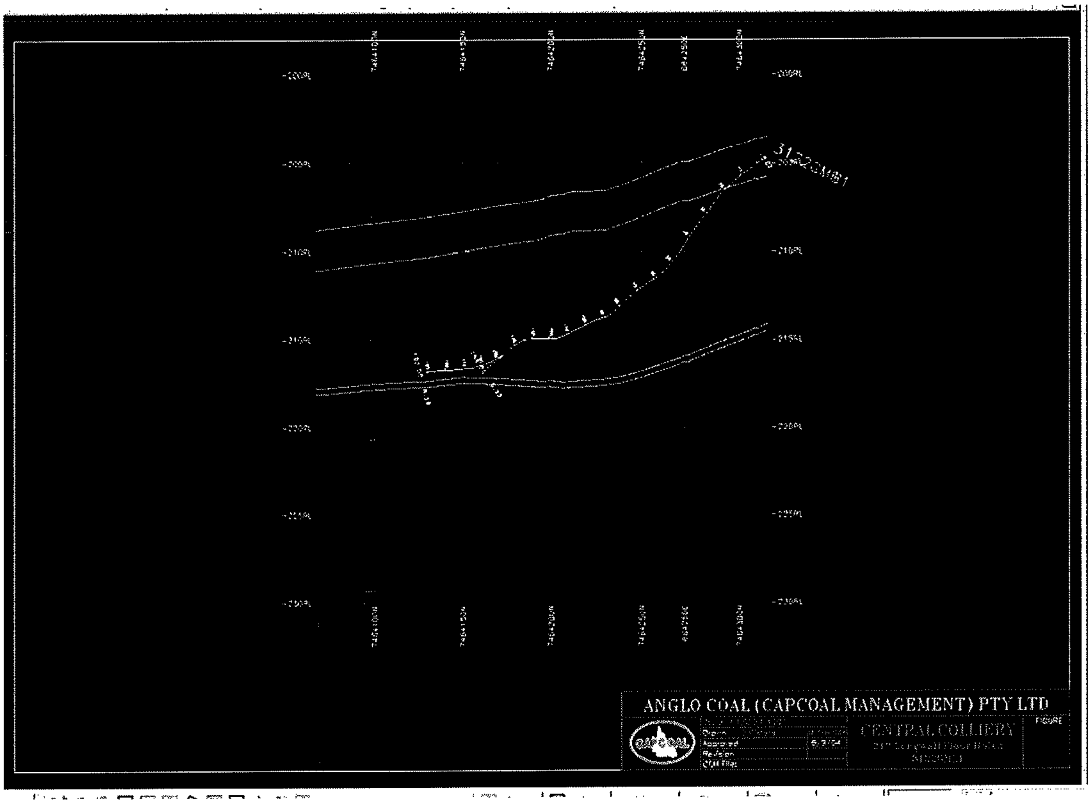


Figure 26: Borehole 312/2/GML1

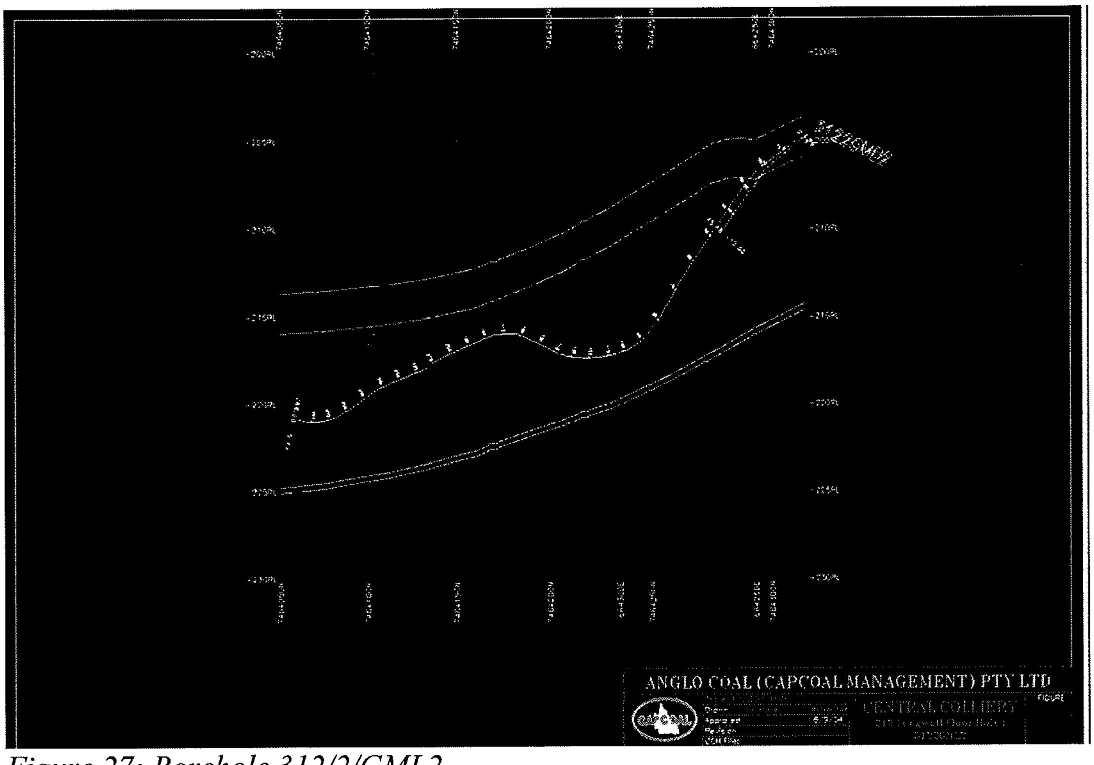


Figure 27: Borehole 312/2/GML2

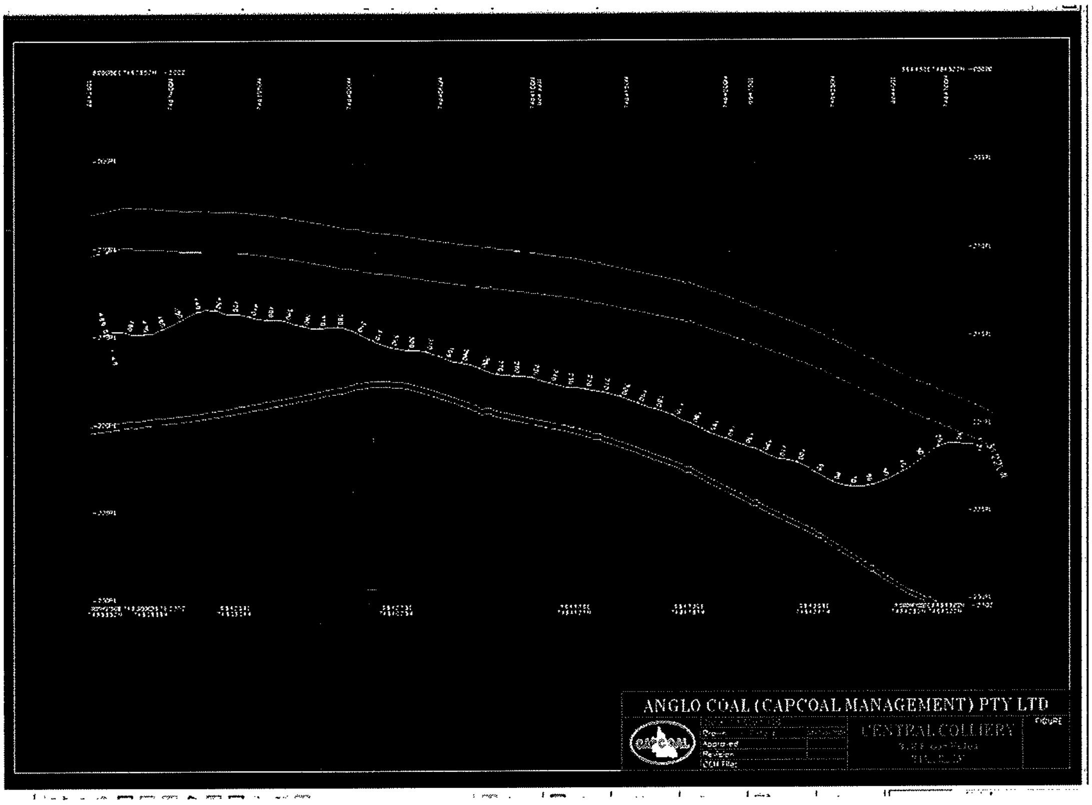


Figure 28: Borehole 312/2/LW