TASMANIA

BEACONSFIELD INVESTIGATION REPORT

PREPARED FOR THE CORONER

AT THE REQUEST OF THE TASMANIAN GOVERNMENT

Concerning the Incident Resulting in

The Death of Larry Knight

and

The entrapment of Todd Russell and Brant Webb

Which occurred at the Beaconsfield Mine

On 25th April 2006

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28TH August 2007

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"AA" O'Toole, D. & Mawdesley C. 2004. Virgin Stress Measurement Results and Stress Management Options. Coffey Mining Pty Ltd. January 2004

"AB" Hudyma, M., 2004. Mining-induced seismicity in underground, mechanized, hardrock mines – results of a world wide survey. Australian Centre for Geomechanics

"AC" Mawdesley C, 2004. Broad-scale MAP3D Stress Modelling. Coffey Mining Pty Ltd. February 2004

"AD" Turner, M.H., 2004. Beaconsfield Seismicity Review. AMC Consultants P/L. 5th May 2004

"AE" Turner, M.H., 2004. Beaconsfield Site Visit July 2004. AMC Consultants P/L. 6th August 2004

"AF" Turner, M.H., 2004. 840/850 Level December 2004 Seismicity. AMC Consultants P/L. 23rd December 2004

"AG" Mine Seismicity and Rockburst Risk Management, Phase 3 Project Proposal to BMJV by ACG, February 2005

"AH" Turner, M.H., 2005. Beaconsfield Site Visit February 2005. AMC Consultants P/L. 31st March 2004

"AI" Hudyma, M.R., 2005. Beaconsfield Gold Mine Seismicity Summary. Australian Centre for Geomechanics. May 2005.

"AJ" Albrecht, J., 2005. Example analysis of seismic events recorded at the Beaconsfield Mine. AMC Consultants P/L. 10th May 2005

"AK" Turner, M.H., 2005. 925 Fall of Ground, 9 October 2005 (Between 11:22 and 12:30). AMC Consultants P/L. 20th October 2005.

"AL" Mikula P. 2005. Geotechnical Services for Beaconsfield Gold Mine. Mikula Geotechnics P/L. 2nd

"AM" Turner, M.H., 2005. Ground Support Review. Turner Mining and Geotechnical P/L. 14th November

"AN" Mikula, P., 2005. Comments on Site Visit to Beaconsfield Gold Mine. Mikula Geotechnics P/L. 25th November 2005

"AO" Fairfield, P., 2005. Beaconsfield Gold Mine Continuation Study. AMC Consultants P/L. December 2005

"AP" Sharrock, G. & Sandy, M., 2005a. Powerpoint presentations of seismicity calibration points. AMC Consultants P/L. 24th November 2005.

"AQ" Sharrock, G. & Sandy, M., 2005b. Powerpoint presentations of modelling results for cumulative event count and cumulative energy. AMC Consultants P/L. 30th November 2005.

"AR" Sharrock, G., 2005 An Analysis of Seismicity and Damage at Beaconsfield Mine. AMC Consultants P/L. December 2005

"AS" Basson, F., 2005. Beaconsfield Gold Mine Study of Seismic Patterns and an Evaluation of the Proposed Stoping Schedule for 2006. AMC Consultants P/L. 9th March 2006.

"AT" Heal D, 2006. Mine Seismicity and Rockburst Risk Management Project Phase 3. Australian Centre for Geomechanics March 2006

“AU” Turner, M.H., 2006. Underground Geotechnical Review. Turner Mining and Geotechnical P/L. 21st April 2006
‘AW” Kaiser, P Geomechanics of Beaconsfield Mine September 2006
“AX” Coffey Mining – Report into the Geotechnical Causes of 25th April 2006 Rockfall, 25th October 2006.
“AY” Ground Control Management Plan, version “C” dated 18th October 2005.
“AZ” Ground Control Management Plan, version “D” dated 18th October 2005.
“BA” Report from Howarths dated December 2006
“BB” Report from BDO Kendalls, dated June 2007
“BC” Report from Mr Scott Marisett dated 28th August 2007
“BD” Report from Professor Michael Quinlan dated 28th August 2007

SUMMARY OF FINDINGS AND RECOMMENDATIONS

1. At 9.23 pm on 25th April 2006 a mining induced seismic event of a reported magnitude of 2.3M_L (local magnitude scale) caused rockfalls on, inter alia, the 915m Level and 925m Level at the Beaconsfield Gold Mine (BGM).

2 The seismic event was caused by a slip along a shear; the C-HW (hangingwall) Shear

3 The main fall of ground on the 925 Level was attributable to;

(a) The progressive stress/strain driven degradation of the quartz ankerite reef due to HW and FW (footwall) convergence and possibly blasting,
(b) The presence of geological structures in the immediate fall areas – both the Tasmania Shear and bedding parallel shears forming release planes and allowing increased lateral closure,
(c) The proximity of the production brow,
(d) The shaking associated with the incoming seismic waves generated by the 2.3ML event in the immediate hangingwall rocks adjacent to the 925 level, and,
(e) The recommended support system (a mixture of split sets and threadbars) installed on the 925 Level in the area of the fatal FoG was unable to maintain the stability of the excavation, and the failure of the ore body extended to a depth greater than the length of the installed ground support

4 Although rockfalls that occurred in October 2005 and April 2006 occurred in approximate locations the causative seismic events originated in two different structures some distance from each other.

5 The main fall on the 925m Level killed Larry Knight and entrapped Todd Russell and Brant Webb who were working on the brow of a stoping panel.

6 As mining activity had progressed beyond a depth of 800m the pressure on the ore body in some locations commenced to exceed the inherent rock strength. In other areas of the mine, the removal of ore unclamped geological features.

7 This caused an increase in seismic activity throughout the mine and also increased the number of rock falls, especially adjacent to firing times.

8 Some miners had raised concerns about the increase in seismic activity, the removal of the crown pillar at about the 805m Level and the pillarless mining method. It should be noted that no consultant recommended or was likely to recommend that the crown pillar on the 805m Level should not be mined, but this information had not been communicated to the miners.

9 Because of inadequate communication and consultative processes within BGM, Senior management were not aware of many of the concerns raised. This was despite management's attempts and beliefs that they had appropriate systems in place.

10 Despite the good relationship between BGM and Workplace Standards Tasmania (WST) there were many rock falls in 2005-2006 that were not reported to WST. These were not rock falls that were required to be reported by virtue of s47 of the Workplace Health and Safety Act 1995. (The Act)

11 Even if the rock falls had been reported to WST because of the lack of resources then in place, I cannot conclude that any action more effective than those already undertaken by BGM would have flowed therefrom. Furthermore, even if WST had issued a notice pursuant to s38 of the Act, their concerns probably would have been alleviated by the consultants' reports referred to below.

12 On 9th and 26th October 2005, there were substantial falls of ground on the 915 and 925 Levels. The fall on 26th October 2005 followed a seismic event of $2.1M_L$ which was, to that date, the largest ever recorded at BGM These rock falls exceeded the length of ground support then in place. This event originated in the A shear to the west of the Reef Offset Zone.

13 BGM immediately ceased mining operations, notified WST, and called in a series of consultants to advise as to how these areas could be safely mined.

14 None of the consultants consulted mine workers which may have made them more aware of the miners' concerns in relation to increasing levels of rock falls. The consultants were typically on site for 2 day stints but were well aware, as were mine management, of the increase in levels of seismic activity.

15 No formal written risk assessment was undertaken prior to, during or after the consultative process. Such an approach may have highlighted the fact that no account seemed to have been taken of the possibility of the (previously thought to be benign) C-HW Shear becoming seismically active.

16 All the consultants noted that the mine would experience an increase in seismic activity, including significant events, and recommendations were made to;

(a) Alter the mining method in an attempt to mitigate the risk of major seismic events
(b) Enhance the levels of ground support to cope with increase seismic activity
(c) Alter the future mine design to increase pillar thicknesses from 7m to 10m in unworked areas.

17 However, much of the consultants' concerns seemed to be directed to the area west of the Reef Offset Zone which was known to be seismically active, and the recommended ground support installed should have been able to cope with events originating in this area.

18 Most recommendations were immediately adopted by BGM but the pillar thicknesses on the 915 and 925 Levels (which were part of the 940 mining block) were already in place.

19 No consultants suggested that the 915 and 925 Levels should not be mined

20 Despite BGM being under administration, I could find no evidence of inappropriate

financial pressures upon the management of BGM.

21 Because of the location and magnitude of the event, I am unable to conclude that the falls of ground of 25th April 2006 would not have occurred if;

(a) The mine design had allowed for 10m pillars beyond the 880m Level
(b) Ground support had been installed to greater depths and
(c) There had been a better system of communication and consultation at BGM
(d) All rockfalls (rather than only those required to be reported) had been reported to WST.
(e) WST had been resourced to the levels recommended in this report.

22 If BGM had in place a ground support system that was designed to withstand seismic events of a magnitude in excess of those previously recorded, there would have been a less chance of the ground support at the 925mL failing. However, since it is not possible to design a support to prevent all damage from seismicity of magnitudes of the order of M_L< 2.5 and because of the proximity of the falls of ground to the "near centre" of the seismic event, I consider it unlikely that falls of ground could have been prevented.

23 To ensure a safer way forward for mining operations at BGM and generally in Tasmania, I make several recommendations in the body of my report, including;

(a) installation of geotechnically engineered ground support systems, designed to contain events well in excess of magnitudes that have already been recorded or expected by appropriate modelling
(b) that areas of high seismic risk at BGM such as the seismically active Western Stopes be mined remotely.
(c) An enhancement of the resources of WST most of which appear to have already been undertaken,
(d) An adoption in Tasmania of a case for safety regime to ensure independent scrutiny of risk assessment, mine design and mining methods in Tasmanian mines
(f) An improvement in the communication and consultative processes at BGM and the mining industry generally
(g) The Workplace Health and Safety Act 1995 be amended to make all rock falls in mines reportable.

Enquiries of this nature are wholly retrospective and uncover facts in a sterile investigative environment, as opposed to the day to day activities of a mining operation.

I note the comments of Gleeson, CJ at para 58 of *New South Wales v. Fahey* [2007] HCA20 (22 May 2007).

> *In* Vary v. Wyong Shire Council *(223 CLR 422) it was explained why it is wrong to focus exclusively upon the way in which the particular injury of which a plaintiff complains came about. In* Vary *it was said at 461 [124] that;*
>
> *The apparent precision of investigations into what happened to the*

> *particular plaintiffs must not be permitted to obscure the nature of the questions that are presented in connection with the inquiry into breach of duty. In particular, the examination of the causes of an accident that* has *happened cannot be equated with the examination that is to be undertaken when asking whether there was a breach of duty of care which was a cause of the plaintiff's injuries. The inquiry into the causes of an accident is wholly retrospective. It seeks to identify what happened and why. The inquiry into breach, although made after the accident, must attempt to answer what response a reasonable person, confronted with a foreseeable risk of injury, would have made to that risk. And one of the possible answers to that inquiry must be "nothing".*

I am grateful for the full and frank assistance of all those involved in this investigation, and especially the family of Larry Knight, who has shown great forbearance in the aftermath of their tragic loss.

METHOD OF INVESTIGATION

The methods and process of investigation are set out in full in the preamble to Professor Quinlan's report (Annexure "BD") but included the following.

1. Approximately one hundred interviews were conducted between June 2006 and August 2007 (See Schedule at Annexure "B".) Such interviews were recorded and were free-flowing, often involving up to four members of the investigative team and sometimes taking in excess of five hours. To ensure full and frank discussions the investigators undertook not to make the transcripts of the interviews public, but to provide them to the Coroner, who would then decide what information would be released.

2. Service of formal notices of requests for information pursuant to s36 of the Workplace Health and Safety Act 1995 (The Act) (copies annexed hereto and marked "G" to "R"). Pursuant to those notices, Beaconsfield Gold Mine (BGM) produced a plethora of information including an electronic copy of all e-mails, on their computer system (approximately 4,000), financial records, occupational health and safety (OH &S) records and complete mining records. Much of the information is commercially sensitive but will be provided to the Coroner.

3. The investigation was ably assisted by Professor Michael Quinlan and Mr Scott Marisett and both have produced comprehensive reports which are annexed hereto at "BC" and "BD". Professor Quinlan's report describes all relevant events and interview material in great detail and I have not burdened my report by re-ploughing the same ground. Mr Marisett's report speaks for itself, but it should be noted that he was tasked to examine procedures with a view to recommending the best way forward for future mining operations in mines with significant levels of seismicity. Accordingly he has concentrated on operations and procedures that he considers could be improved.

4. The investigation conducted a detailed examination and consideration of numerous consultants' reports, the relevant ones being attached hereto at Annexures "AA" to "AX". Many of the consultants were formally interviewed whilst others were interviewed by telephone. The information and detail contained therein is extensive and complex and both Mr Marisett and I have attempted to summarise relevant aspects of such reports. I am satisfied as to my conclusion regarding the cause of the rockfalls of 25th April and some contributing factors. Unfortunately because of the very late receipt of some information, relevant to geotechnical issues, I have been unable to reach firm conclusions in some areas of apparent conflicts of opinion between the geotechnical experts.

5. I was very grateful for the assistance of Paul Raftery, a very able and experienced senior mining investigator from the New South Wales Department of Primary Industry. Despite the fact that he was only available for the first half of the investigation, Mr Raftery continued to provide guidance throughout what became a very complex and drawn-out process.

6. The investigation was also greatly enhanced in its initial stages by the secondment

of the Officer in Charge of the George Town Division Inspector Paul Reynolds, whose empathy with, and knowledge of, the local community was of great assistance. We were also fortunate to have the advice and assistance of the Coroner's Associate, Senior Constable John Morgan who was also seconded during the initial stages of the investigation.

7. I very much appreciated the willing co-operation of the parties and their representatives. The investigation benefited from the frank exchange of views between many of the experts involved as well as the legal practitioners representing diverging interests.

8. A Glossary of Terms appears from page 81 and it reflects the meanings given to such terms throughout the investigation and in this report.

BACKGROUND.

GEOLOGY AND OREBODY

The Tasmania Reef is a steeply dipping shear hosted quartz-ankerite Sulphide vein hosted in sedimentary country rock. The reef extends some 350 metres along strike and has been drilled to a depth of 1,000metres below surface with an average thickness of 2.6 metres.

Beaconsfield is not Tasmania's deepest mine, with Rosebery descending to about 1700 metres. Mt Isa and Hill 50 in WA have exceeded 1500 metres in depth and Broken Hill reached 2300 metres. The world's deepest mine is Western Deep Levels at Carltonville, south-west of Johannesburg, at around 3,800m and the Kolar Mine in India was close to that depth when it shut a few years ago.

The Tasmania Reef at Beaconsfield Gold Mine has an identified gold endowment approaching two million ounces. It is a Lachlan fold belt mineralisation hosted in rocks equivalent to the Kanmantoo Fold Belt and is one of the largest sedimentary hosted slate belt style mesothermal gold deposits in south eastern Australia. The model for mineralisation is very similar to that proposed for the formation of the late Ordovician-aged Lachlan Fold Belt mineralisation in the goldfields of Victoria, at Stawell (+3 million ounces Au), Ballarat (+1 million ounces Au) and Bendigo (+20 million ounces Au).

The gold yield averages 14 gms per tonne which is well above the 6 gms per tonne which is regarded as being the lower limit for commercial underground mining viability.

Geoscientific data collected and analysed over the period from 1996 - 2001 revised the concepts of geology and the controls of mineralisation in the West Tamar region of central northern Tasmania. Detailed geological mapping and geophysical data including deep seismic profiles, has shown the presence of northwest trending thrust faults which bound the Beaconsfield area.

Figure 1 shows that the pre-Permian geology of the Beaconsfield Region outcrops as a series of north northwest-striking, east dipping imbricate thrust slices. From west to east the slices are the Peaked Hill slice, the Cabbage Tree slice and the Cobblestone Creek slice. Each of these are bounded to the west by thrusts of the same name. The rocks unconformably overlie the Anderson's Creek Ultramafic Complex.

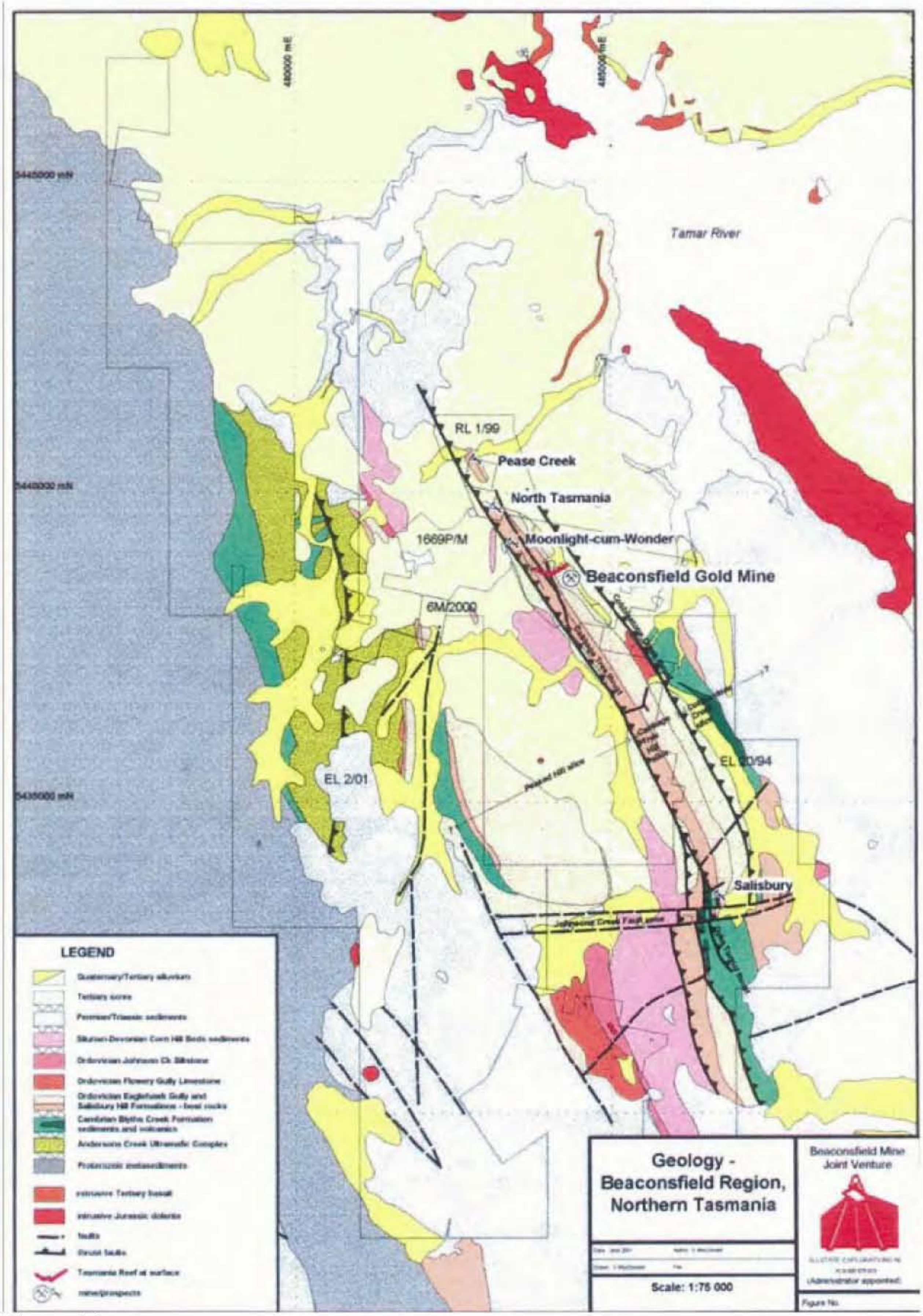
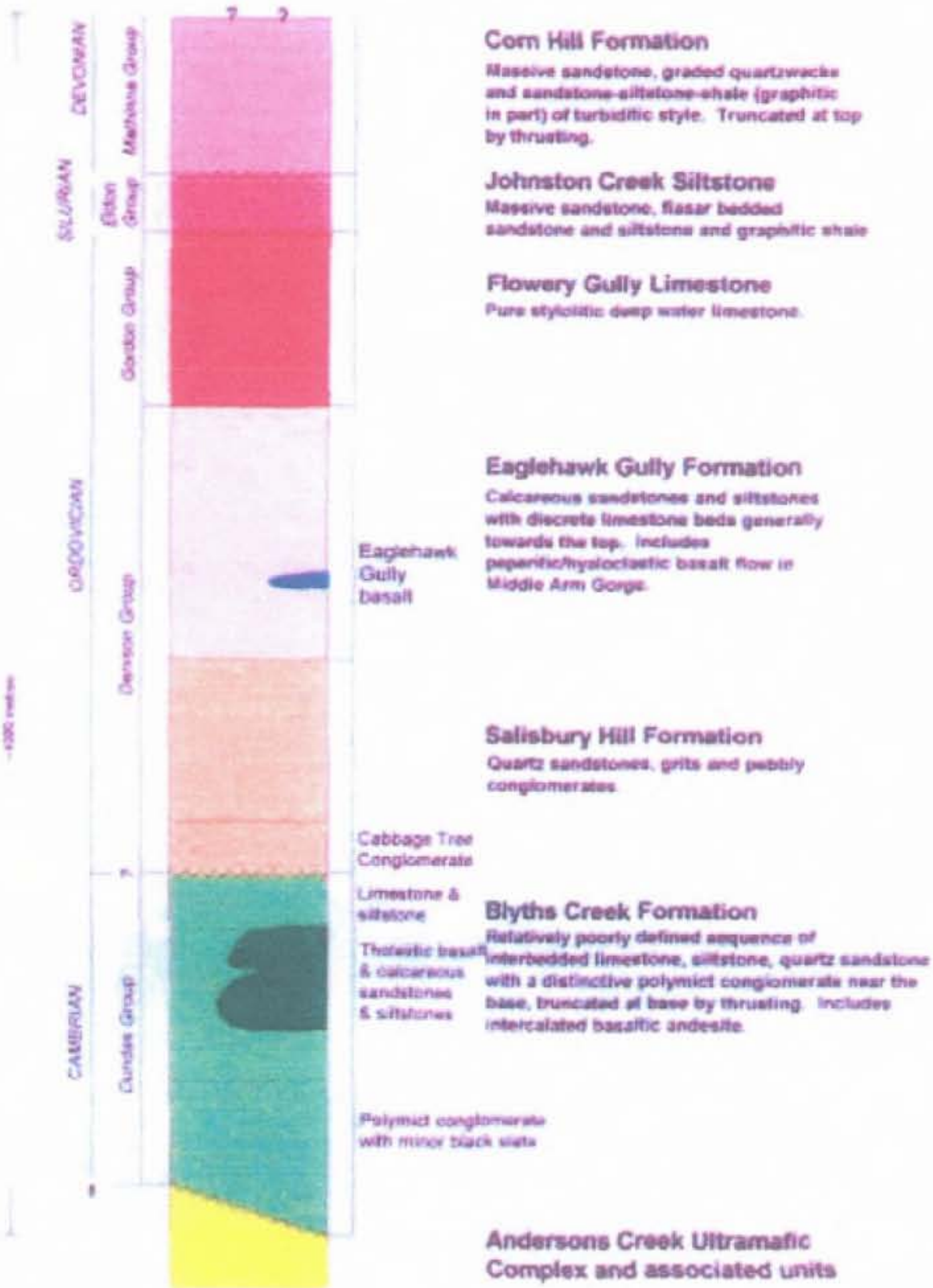
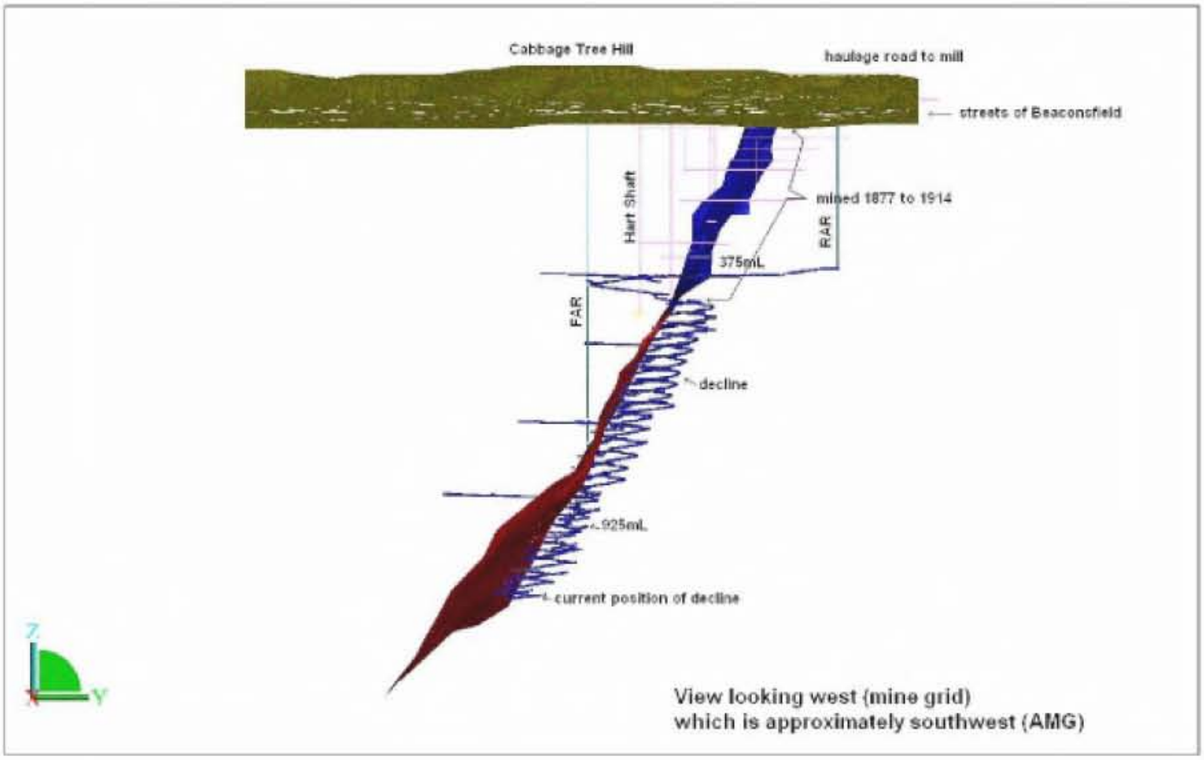

Tamar River
RL 1/99
Pease Creek
North Tasmania
1669P/M
Moonlight-cum-Wonder
Beaconsfield Gold Mine
6M/2000
EL 2/01
Salisbury
LEGEND
Geology -
Beaconsfield Region,
Northern Tasmania
Beaconsfield Mine
Joint Venture
Scale: 1:75 000
Figure 01

Figure 02



The lower to middle Palaeozoic stratigraphy (see Figure 2) crops out in a relatively narrow 6km wide belt stretching around 20km from Pease Creek, 3km north of Beaconsfield to Reids Creek near Biralee. Overall, the structure of the Beaconsfield district is dominated by faulting. Faulting is more common in southern parts of the Beaconsfield district, but is everywhere associated with thrusts. The deposit formed along a Devonian-aged dilational fault within siliciclastic-calcareous rocks correlated with the Dundas, Denison, Gordon, Eldon and Mathinna Groups.

Figure 03 and Figure 04



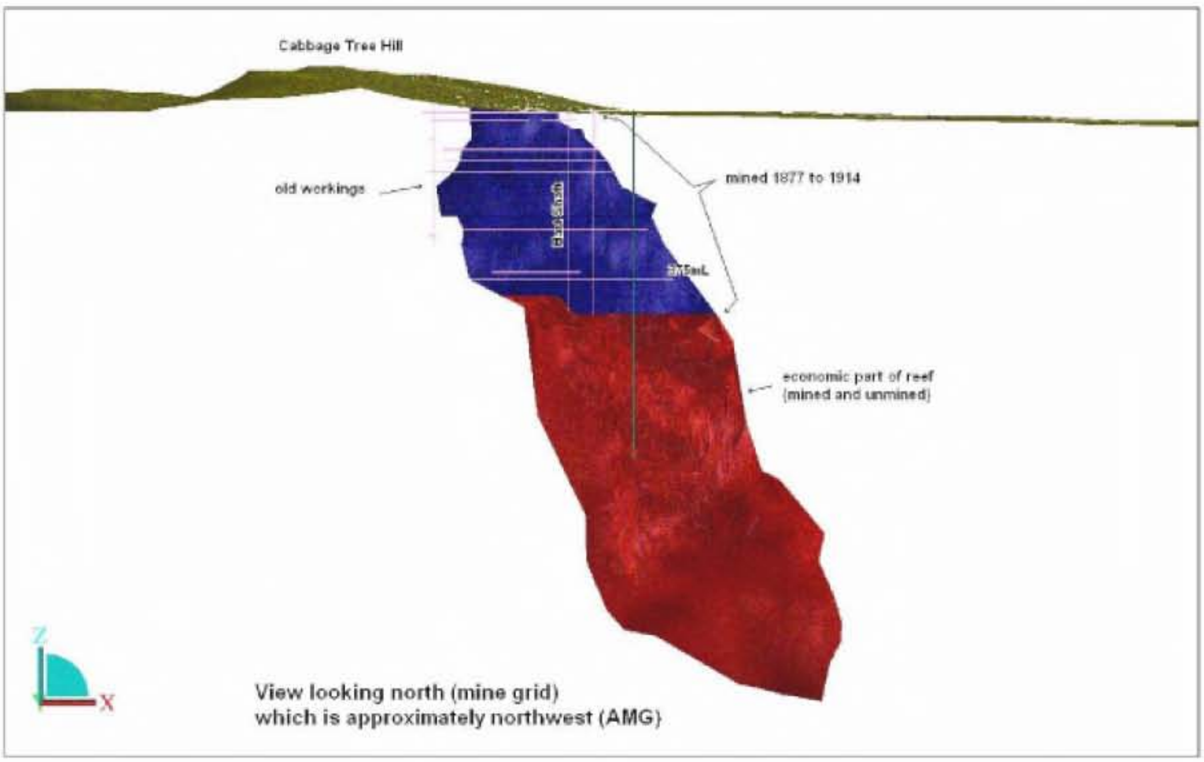


Figure 3 shows the orientation of the ore body with a depth of 1100 metres and an average thickness of 2.6 metres. - The thickness varies from about 0.2 to 8 metres and is approximately 4 – 5 metres on many of the mining levels. Also shown to the right of the ore body is the decline from which access is gained to the ore body. The decline is mined through waste rock and is ground supported by the use of split sets, strap and mesh, with shotcreting and cable bolting in some parts. It is wide enough to accommodate the free movement of heavy mining vehicles.

Figure 4 demonstrates the width of the ore body which is approximately 350 metres along strike.

MINE AREA GEOLOGY

The fault and related mineralisation is hosted mostly by Ordovician-aged siliciclastic and carbonate rocks, but penetrates into the unconformably underlying Cambrian Blyth's Creek Formation and the conformably overlying Flowery Gully Limestone.

Lewis (1998) formalised the stratigraphy (see Figure 5) of the Denison Group correlates at the Beaconsfield Gold Mine and recognised two formations, the Salisbury Hill Formation and the Eaglehawk Gully Formation for the units historically referred to as the Lower and Upper Transition beds respectively.

The reef strikes northeast, discordant to the predominantly northwest-striking stratigraphy. The deposit is thought to have formed when hot gold-bearing fluid ascended from depth via stratigraphically concordant, steeply northeast-dipping Tabberabberan-age thrusts. As the fluids flowed into the void created by the discordant Tasmania shear, the associated pressure drop led to the precipitation of ore bearing fluids. Exposure to host rocks of varying composition affected the chemistry of the fluids leading to variations in mineral deposition.

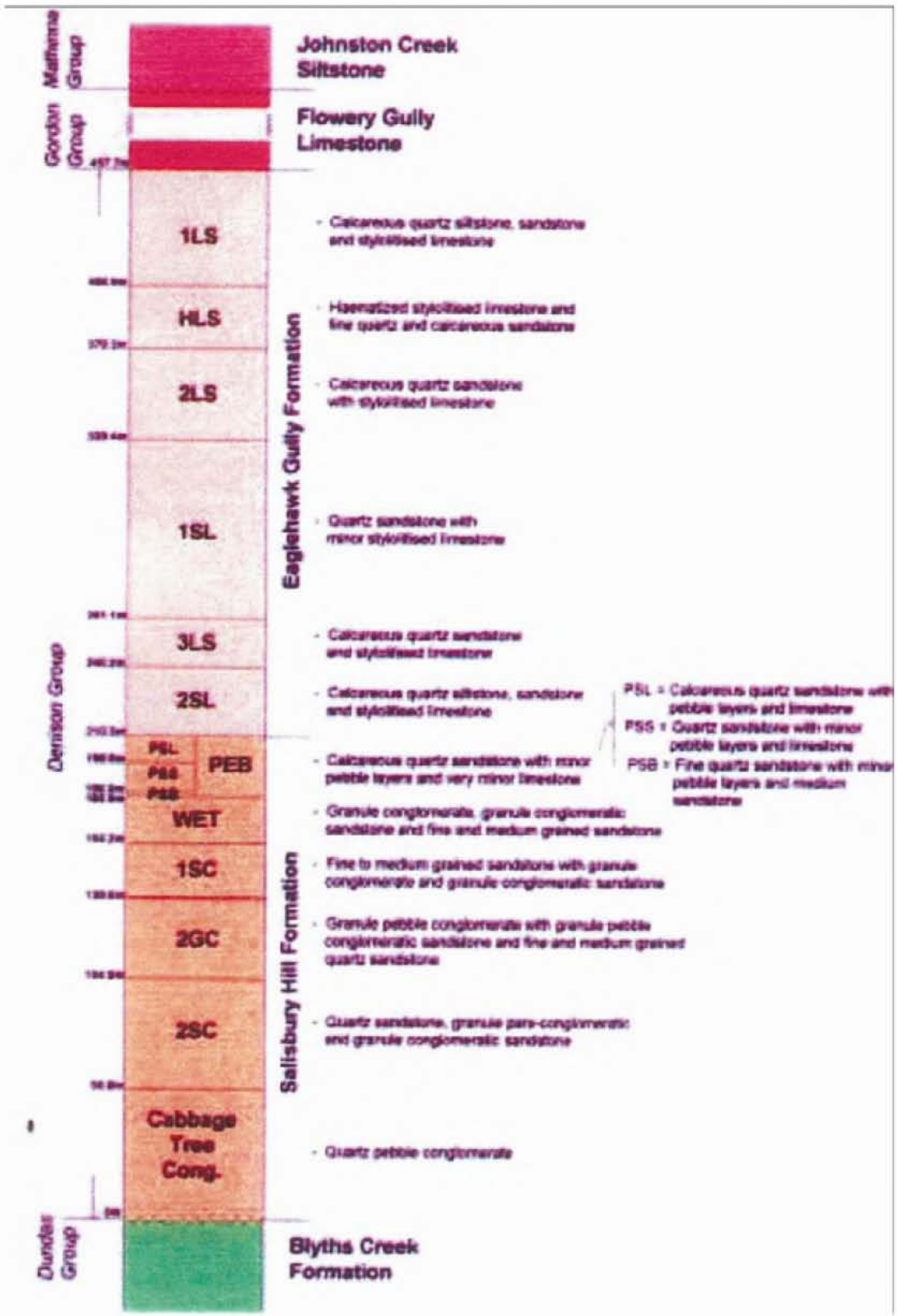
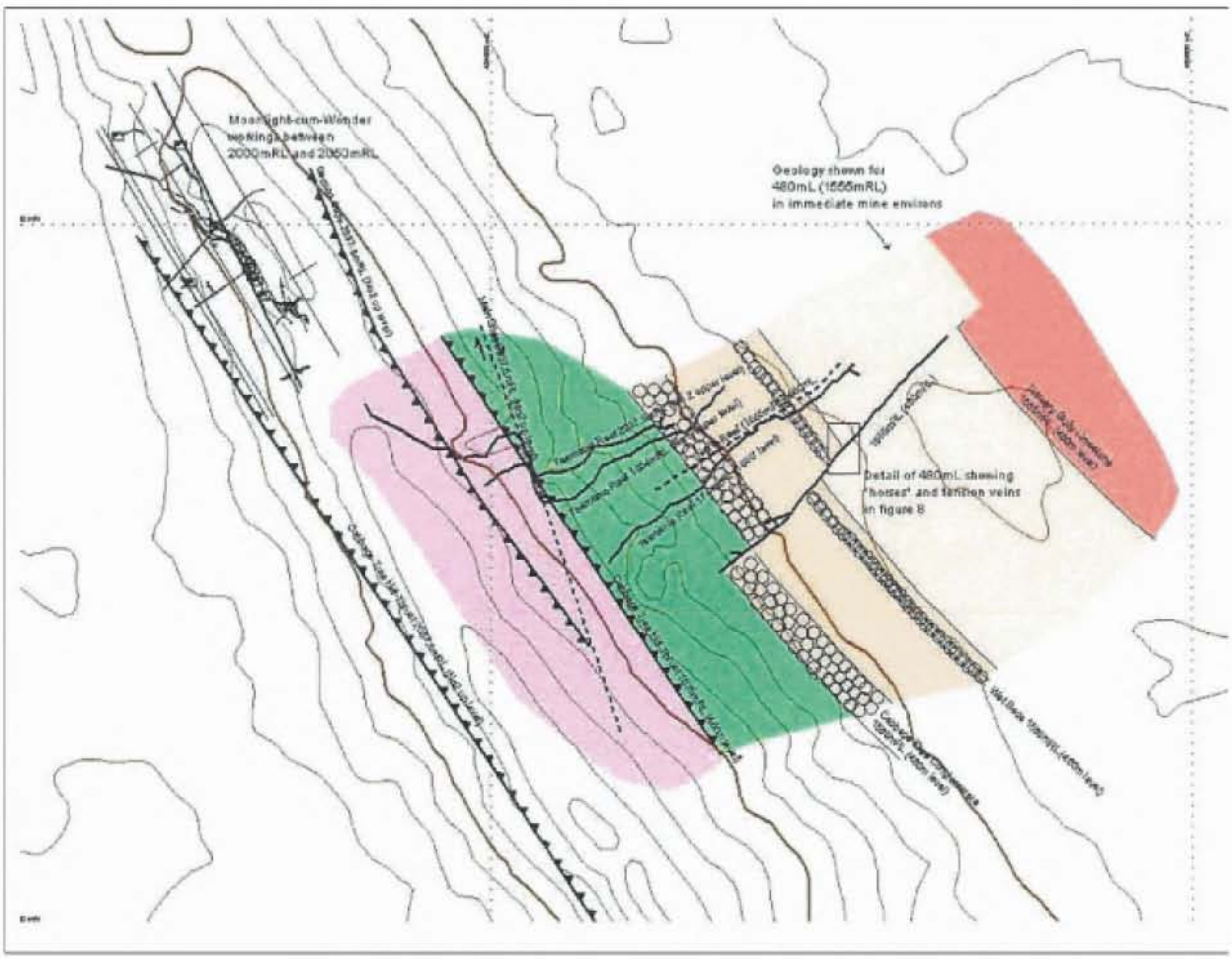


Figure 05: Mine Stratigraphy Beaconsfield

GEOMETRY OF THE TASMANIA REEF

The Tasmania Reef cropped out on Cabbage Tree Hill (120m above sea level) west of Beaconsfield and has been intersected by deep diamond drilling at 1,000m below sea level. It has a strike length of up to 400m and extends further at sub-economic grades. While somewhat irregular, the overall strike direction of the Reef in the upper part of the historical workings is approximatcly 055°" truc north and swings anti-clockwisc at dcpth to around 045°" true north (see Figure 6). The dip of the reef ranges from 050°" to 070°" to the southeast giving a down-dip unconstrained length of at least 1,200m and occurs essentially as a single quartz + carbonate + sulphide vein with minor splays and bifurcations.

Figure 06 – Plan of the Tasmania Reef and Associated Structures



Overall, the reef averages 2.6m in width ranging from a minimum of 0.5m to a maximum of 8m. Zones of above average width generally occur at the intersections of splays and bifurcations. Mining in the late 1990s demonstrated that the reef pinches and swells down plunge and along strike.

The highest gold grades occur in a zone corresponding to the boundary between the Salisbury Hill and Eaglehawk Gully Formations. This central zone is considered to be the principal ore shoot. In the eastern zone, the reef tends to be narrower and lower grade.

The western zone is also narrow but is more brecciated and higher grade than the eastern zone. The western zone also appears to have more gravity recoverable gold and is generally thought to be less refractory. Other zones of elevated grade occur at the intersection of splays and bifurcations. These intersection nodes in the wider central part of the reef appear to have a moderate to steep southwest plunge.

Figure 07 which appears as a fold-out page, diagrammatically represents the geology as seen as at the backs of the 925mL. CTC is the Cabbage Tree Conglomerate moving east to the 2SC, Second Sandstone and Conglomerate, then the 2CG, Second Conglomerate, then the 1SC First Sandstone and Conglomerate, and then the WET, or Wet Beds Conglomerate abutted by the Eaglehawk Gully Formation. To the west of the ore body there is the Tasmania Reef Continuation indicated by a red dotted line and it is to be noted that the ore body departs the Tasmania Reef at this junction. There is a hanging wall extension that follows the line of the Tasmania Reef continuation and it is in this area that the 2.1ML seismic event of 26 October 2005 is thought to have occurred.

There is continual seismic pressure travelling both north and south through the ore body but such forces are more readily transmitted through the stiffer conglomerate zones rather than the more yielding sandstone beds. Until the ore body is mined, those forces readily transfer through the Tasmania Reef fault, but once the ore is removed and replaced with rock fill, the reef has a damming effect on those pressures which then seep away around the mined reef. There is a build up of pressure, and hence increased seismic activity in the conglomerate overlap zone because of the tendency of the pressures to follow the conglomerate and there is also increased seismic pressure and activity where the ore body departs the Tasmania Reef fault. These areas are indicated on the diagram as the Conglomerate Overlap Zone and the Reef Offset Fault Zone.

Also of note is the hanging wall shear structure to the south of the Conglomerate Overlap Zone, which until 25th April 2006 was thought to be seismically benign.

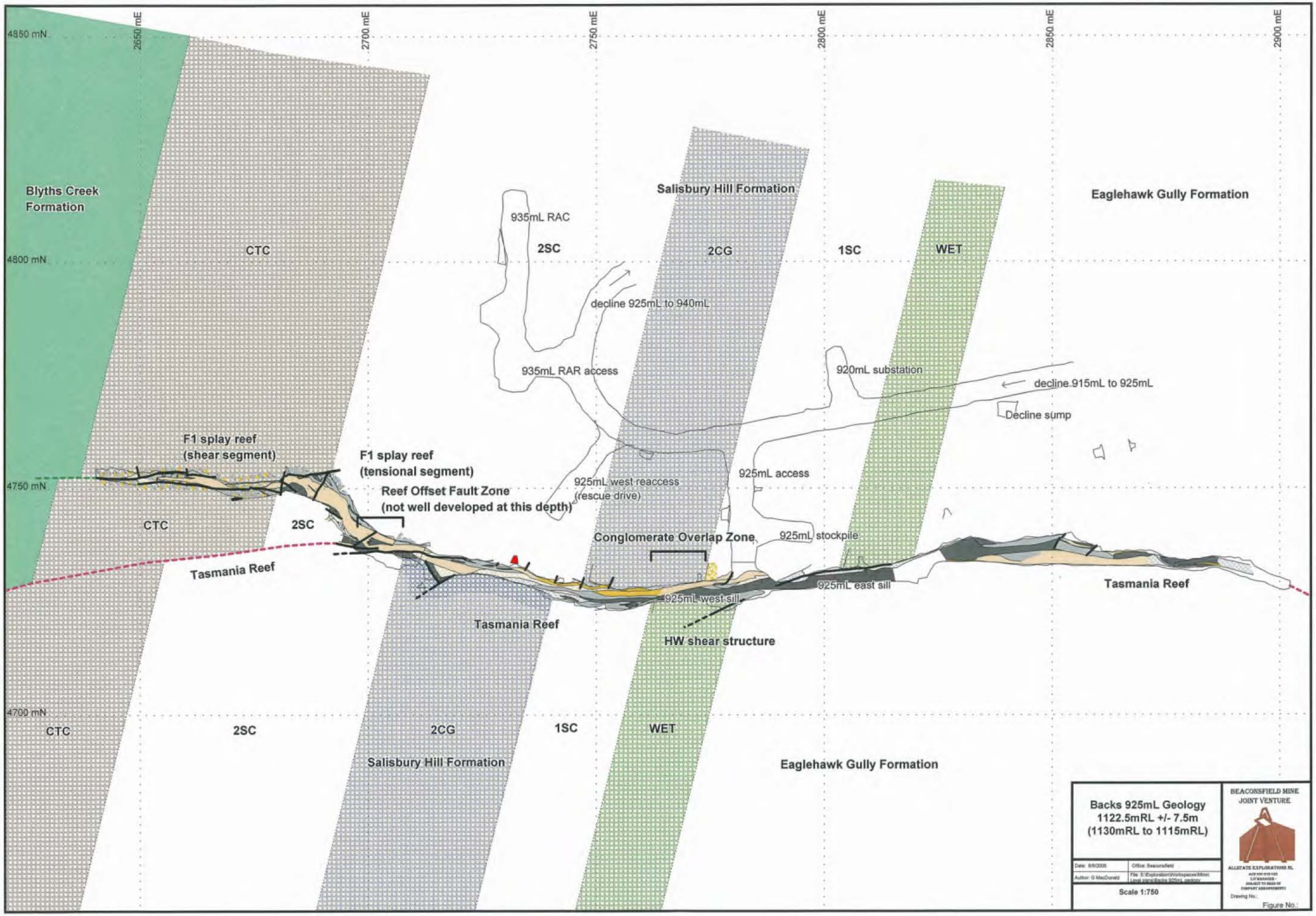
HISTORICAL PERSPECTIVE

Alluvial gold was first discovered in Brandy Creek at the northern end of the present day township of Beaconsfield in 1877. The Tasmania Reef was identified shortly after on the eastern slope of Cabbage Tree Hill, immediately west of Beaconsfield, leading to the development of the Tasmania Gold Mine.

During its operating years from 1877 to 1914, the Beaconsfield Gold Mine was one of the richest gold mining operations in Australia producing some 854,570 ounces (from 1.08 million tonnes @ 24.7g/t recovered) from the Tasmania Reef down to a depth of 454 metres below surface.

At the turn of the 20th Century, the Tasmania Gold Mine was at the forefront of steam driven pumping technology with large Cornish beam pumping engines installed to pump from depths of up to 4.54 metres at rates up to 6 million gallons per day. Gold was extracted using gravity, flotation and cyanidation methods. Towards the later part of the mine's operation, a small roaster was also used.

When the mine closed in 1914, the reef had been worked continuously from surface to a



Location of April 25th rock fall

Figure 7

ALX.016.002.0002_021

vertical depth of 454m below the current Hart Shaft collar. Closure as a consequence of high wage demands from the workforce, limits to the available pumping capacity and poor metallurgical recovery was expedited by labour and materials shortages at the onset of World War 1.

The abandoned mine workings were permitted to flood, which took approximately 23 years. The old shafts used to access the orebody fell into disrepair with only the Hart Shaft remaining reasonably accessible.

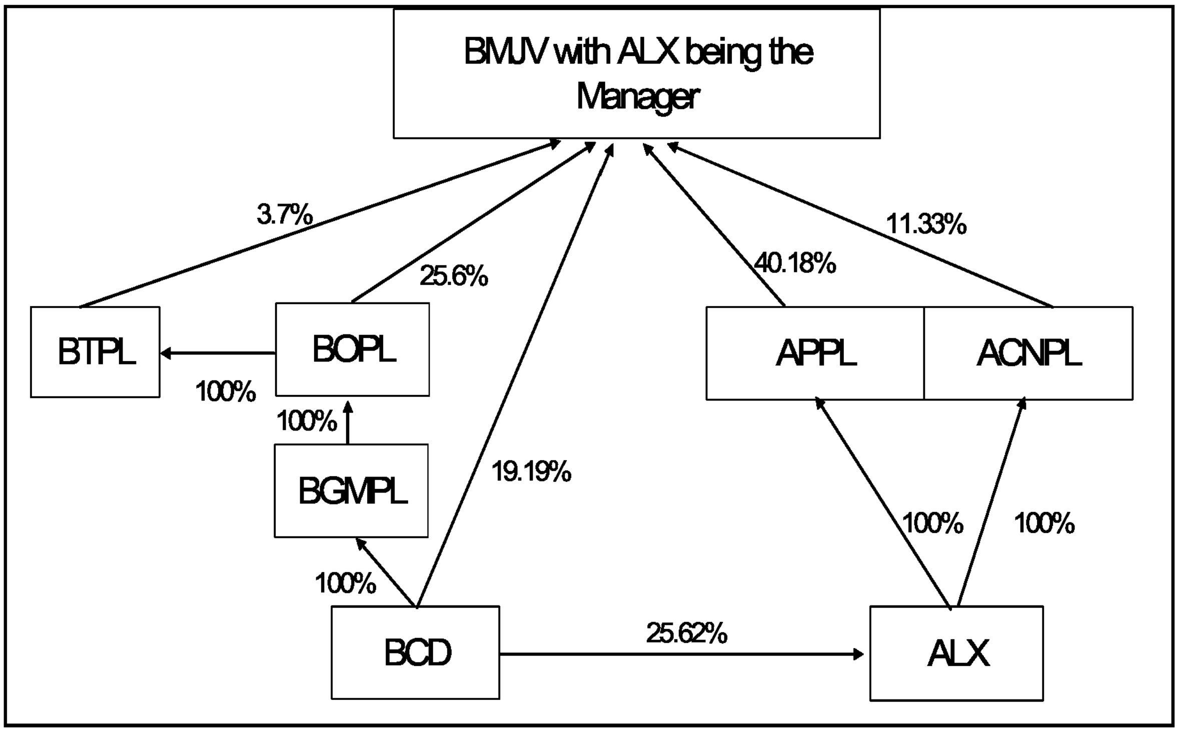
In 1969, the original tenements for the Mine were acquired by ALX. By 4 August 1987, the owners of the Mine were Beaconsfield Gold Mines Ltd (now called Beaconsfield Gold Mines Pty Ltd) (BGML), Allstate Tasmania Pty Ltd (later called Beaconsfield Operations Pty Ltd) (BOPL) which is one of the present joint venturers, Tricentrol Exploration Australia Pty Ltd (later called Beaconsfield Tasmania Pty Ltd) (BTPL) which is another one of the present joint venturers, and Australian Consolidated Minerals Ltd (now called Australian Consolidated Minerals Pty Ltd). On 4 March 1987, a Management Agreement was executed whereby these parties appointed ACM Management Pty Ltd (later called CLZ Investments Pty Ltd and now deregistered) to be the original Manager of the exploration (and, if appropriate, the development and mining) of the Mine.

There being a capital reconstruction of BGML via a scheme of arrangement, on 19 October 1992, an unincorporated joint venture to conduct exploration and commercial mining operations at the Mine was formed. This joint venture was known as the Beaconsfield Joint Venture (this was later changed to the Beaconsfield Mine Joint Venture (BMJV) and was regulated by the Beaconsfield Joint Venture Agreement (JVA) (which was amended in October 1997 and July 2000). At this time, the joint venturers, who owned the Mine, were BOPL, BTPL, ACM Gold Mines Ltd (Posgold) and Allstate Prospecting Pty Ltd (APPL) (which is now a subsidiary of ALX and another one of the present joint venturers). The Manager was then Posgold.

In about April or May 1994, APPL acquired the highest percentage interest in the BMJV and appointed ALX as Manager. Between October 1992 and 1997, through various transactions, Posgold sold its interest in the BMJV and the joint venturers became (and remain):

(a) APPL and ACN 070 164 653 Pty Ltd (**ACN**), both subsidiaries of ALX, who together hold a 51.51% interest in the BMJV; and
(b) Beaconsfield Gold NL (**BCD**) and its two subsidiaries, BOPL and BTPL, (together the **BCD Companies**), who together hold a 48.49% interest in the BMJV.

The present position is shown in the following diagram. (BGML is no longer a joint venturer, but is a subsidiary of BCD.)



By the end of July 1995, the Mine had been successfully dewatered to a depth of 200m below the surface. A large pumping station was constructed on the 180mL and further dewatering of the Mine continued. Between July 1995 and June 1996, the Mine was dewatered to 375 metres below the surface and construction of various mine facilities was completed (including surface electrical infrastructure and a new hoisting system). In May 1996, underground mining operations commenced on the 375mL. Development of the 375mL allowed further exploration diamond drilling to be conducted, this time from underground. This drilling confirmed the high grade nature of the ore body at depth beneath the old workings and allowed for the estimation of an ore reserve and development of detailed mine plans.

In September 1997, the BMJV completed a bankable feasibility study for the Mine. This feasibility study was updated in July 1998. In 1998, the Beaconsfield Mine's Development Proposal and Environmental Management Plan was approved by the West Tamar Council and Tasmanian Government In 1998, the BMJV began work on the decline from the bottom of the Hart Shaft at the 375mL to gain access to the orebody at depth below the workings from the 1877-1914 period of operation. Significant dewatering infrastructure was progressively installed and dewatering remained under control.

Access to the orebody beneath the old workings was achieved with development accesses off the decline for the first time in the modern era in September 1998, with the ore that was mined being stockpiled until the gold treatment plant was constructed.

In July 1998, the BMJV and ALX (as manager of the BMJV) engaged Batepro Australia Pty Ltd and Brown & Root Engineering and Construction Pty Ltd to design, supply, construct and commission a gold treatment plant at the Mine, which included crushing and grinding, gravity, flotation, bacterial oxidation, cyanide leaching and Merrill-Crowe precipitation circuits.

Between July 1998 and September 1999, the gold ore treatment plant was designed, constructed and commissioned at the Mine and the first gold bar was poured on 28

September 1999. However, there were significant delays in commissioning the plant and it was failing to perform to the design parameters. This led to the joint venturers and ALX as manager having significant financial difficulties. On 8 June 2001, the directors of ALX and its subsidiaries, APPL and ACN, appointed Michael Ryan and Antony Woodings of Taylor Woodings as joint and several administrators. On 28 June 2001, the Bank of Western Australia Ltd (BankWest) appointed Garry Trevor of Ferrier Hodgson as receiver and manager to the assets of the BCD Companies.

On 4 October 2001, at the second meeting of creditors of ALX (and its subsidiaries, APPL and ACN), the creditors resolved that they should execute deeds of company arrangement, and pursuant to s 444A(2) of the Corporations Act 2001 (Cth) Mr Ryan and Mr Woodings became joint and several deed administrators. On 17 December 2001, the creditors of ALX (and its subsidiaries, APPL and ACN) resolved that the deeds of company arrangement be varied. On 19 March 2002, the creditors of ALX resolved that ALX's deed of company arrangement be further varied.

On 12 March 2004, following the BCD Companies successfully completing various capital raisings and restructuring their debt facilities, BankWest retired Mr Trevor as receiver and manager. ALX, APPL and ACN remained subject to deeds of company arrangement. At Anzac day last year, each of them still owed money to their pre-June 2001 creditors. Before the events of Anzac Day last year, the deed administrators were trying to explore ways in which ALX, APPL and ACN could be brought out of deed administration. Those efforts were continuing, as at 25 April 2006.

MINING OVERVIEW

The original mining activity on the Tasmania reef was above the 455mL. Access to the current workings is via the historic Hart Shaft to the 375mL. The shaft is concrete lined to 90m where it was recovered through the surface collapse zone and from there to 375mL utilises steel sets and the original two compartment square set timber shaft. Intermediate steel sets have been installed and the shaft has been re-equipped with new steel guides bolted into the rock behind the original timbers of the larger compartment which originally housed the pump rods for the historic beam pump. Ladderways and services, including the rising main, are installed in the smaller compartment. The integrity of the shaft timbers is maintained using water sprays to hold a consistent moisture content.

Re-development of the underground mine began in the early 1980s with a number of deep diamond drill holes confirming that the Tasmania Reef extended with good gold values below the old workings. Re-establishment of access to the mine via the remaining Hart Shaft was immediately met with significant challenges. The rising water table, after closure of the old mine, had caused a severe deterioration to ground conditions around the Hart Shaft, which required a major program of stabilisation and ground support before other work could progress.

The current mine has been developed below the old workings with the reef accessed by a 4.5m x 4.5m internal decline at 1 in 8 slope from the 375mL. The decline is largely located in the Eaglehawk Gully Formation in the footwall of the reef, although it passes into the Salisbury Hill Formation at depth. The deepest stoping level is currently 980mL and the decline has been advanced to just below the 1100mL.

The winder is a 2.7m diameter single drum (manufactured in 1981) with a 700kw DC electric drive. Ore and waste are hauled by truck from operating areas and fed through a 40cm x 40cm grizzley to a loading pocket and then into a weight flask using a plate feeder. Hoist speed is 5.5m/sec for a hoisting capacity of approximately 1,200 tomes per day, 375,000 tonnes a year, using a six tonne skip installed below the single deck 14 man cage. Due to access requirements during day shift, most hoisting is carried out at night. At surface, material hoisted is tipped into a bin and fed by plate feeder onto a conveyor to the separate ore and waste stockpiles, from which the ore is reloaded and trucked the approximately 3km to the mill where it is dumped on the run of mine (ROM) ore pad.

MINE DESIGN

The Tasmania reef averages only 2.7m in width with an average of 3,000 tonnes per vertical metre. This requires a vertical advance of approximately 70m a year to achieve the required 200,000tpa output. For planning purposes the reef is divided into three panels, the western, central and eastern with strike lengths of approximately 65m, 180m and 80m respectively. This division coincides generally with the different stratigraphy intersected by the reef and hence different average width, gold grade and metallurgical characteristics, the orebody below 680mL to be divided into two stoping blocks each with an access crosscut thus reducing the future development requirement by approximately 170m on each level.

Geotechnical ground conditions within the mine are generally good, the reef is within a dextral fault, orthogonal to bedding. Prior to mining the 700mL there was little or no stress but the rock mass is jointed and "blocky" particularly close to the reef. However, once the 800mL was reached the pressure on the rock started to exceed the inherent rock strength and stress and seismic activity increased.

Outside the reef faulting is relatively minor, although some slip movement has occurred along shale beds within the predominantly siliceous elastic sequence with, in places, minor development of pug zones parallel to bedding.

Within the reef, pug and minor graphitic zones result in local weakness in the hangingwall, particularly in the western panel where the reef is more brecciated rather than laminated. Geotechnical mapping was carried out throughout the mine on a regular basis to ensure all development was covered prior to general use. One of the primary aims of the mapping was to determine the condition and orientation of discontinuity surfaces which will control failure of blocks and wedges.

When mining operations originally re-commenced, a “flat back cut and fill” method was used, but by 2003 mining had migrated to the “Half upper stoping” (HUS) method.

From the approximately 680mL there was a transition to the Avoca mining method and by the 850 mL all mining operations were conducted by the Avoca or modified Avoca method.

The HUS method yielded stopes of approximately 17 metres in height but greater heights had caused unacceptable lengths of exposed hangingwall at shallower depths in the mine. Accordingly, when the Avoca method was adopted, the mine opted for 7 metre pillar thicknesses, because they yielded similar hangingwall exposures which had previously been successfully handled.

It should be noted that the thicker the pillar thickness, the more economical the mining, because a greater amount of ore body can be extracted in each mining block. The equipment at the mine also allowed for pillar thicknesses well beyond the adopted seven-metre thickness.

Because of the incline (dip) of the ore body, 7 metre pillars usually allowed for very little vertical overlap of the mined ore body, approximately 5 – 15 per cent, although a ten-metre pillar thickness would have meant virtually no vertical overlap. Seven metre pillars were considered suitable in 2004 when reports were obtained from AMC Consultants (see annexure "AD" p7)

The mine design had originally allowed for 8 metre pillar thicknesses from the 1020 Block but after reports and discussions with Mr M Turner, a decision was made in approximately March 2005 to migrate to ten metre pillar thicknesses, from that level onwards.

Set out below are tables that outline the details of the dates and dimensions of the mining blocks.

At September 2005, the 940 block had already commenced, so it was not possible to alter the pillar thickness. The option to not re-commence mining on the basis of inadequate pillar thickness was available, but none of the consultants made that suggestion even in light of the October rockfalls.

The following tables show the details of the dimensions and dates of the mining blocks.

Table 1

815 Block: total height 27m - single panel modified Avoca method block mined - Commenced March 2003

815 Sill Drive	4m High
Half Upper Lift	5m Thick
Pillar	7m Thick
805 Crown Pillar Drive	4m High
Crown Pillar	7m Thick
Total	27m

870 Block: total height 38m - two panel modified Avoca method stope mined - Commenced May 2003

870 Sill Drive	4m High
Half Upper Lift	5m Thick
870-850 Pillar	7m Thick
850 Intermediate Drive	4m High
850-840 Pillar	7m Thick
840 Crown Pillar Drive	4m High
Crown Pillar	7m Thick
Total	38m

905 Block: total height 38m - two panel modified Avoca method stope mined - Commenced November 2003.

905 Sill Drive	4m High
Half Upper Lift	5m Thick
905-890 Pillar	7m Thick
890 Intermediate Drive	4m High
890-880 Pillar	7m Thick
880 Crown Pillar Drive	4m High
Crown Pillar	7m Thick
Total	38m

940 Block: total height 38m - started as a two panel modified Avoca method stope in September/October 2005 then transitioned to a two panel checkerboard stope in the first half of 2006 - Commenced March 2004.

940 Sill Drive	4m High
Half Upper Lift	5m Thick
940-925 Pillar	7m Thick
925 Intermediate Drive	4m High
925-915 Pillar	7m Thick
915 Crown Pillar Drive	4m High
Crown Pillar	7m Thick
Total	38m

980 Block: total height 38m - two panel modified Avoca method stope mine - Commenced August 2004. Was to be converted to checkerboard post October 2005.

980 Sill Drive	4m High
Half Upper Lift	5m Thick
980-965 Pillar	7m Thick
965 Intermediate Drive	4m High
965-955 Pillar	7m Thick
955 Crown Pillar Drive	4m High
Crown Pillar	7m Thick
Total	38m

1020 Block: total height 47m - two panel modified Avoca method stope mined. Originally designed with a total height of 42m and to incorporate two 8m intermediate pillars and a 9m crown pillar. Mine Management increased the pillar thickness to 10m on geotechnical advice prior to development - Commenced June 2005. Was to be converted to checkerboard post October 2005.

1020 Sill Drive	4m High
Half Upper Lift	5m Thick
1020-1005 Pillar	10m Thick
1005 Intermediate Drive	4m High
1005-990 Pillar	10m Thick
990 Crown Pillar Drive	4m High
Crown Pillar	10m Thick
Total	47m

1080 Block: total height 47m - two panel modified Avoca method stope mined - Commenced September 2005. Was to be converted to checkerboard post October 2005.

1080 Sill Drive	4m High
Half Upper Lift	5m Thick
1080-1040 Pillar	10m Thick
1040 Intermediate Drive	4m High
1040-1030 Pillar	10m Thick
1030 Crown Pillar Drive	4m High
Crown Pillar	10m Thick
Total	47m

ORE DEVELOPMENT

In the upper levels of the mine and when using flat back and fill mining, levels were spaced at 25m vertical intervals with access to the stopes by an access drive located approximately in the centre of the ore body. As mining progresses upward the backs of the access ramp are stripped and floor filled until the access is inclined. After the completion of the 2001 dewatering program, an additional 50 vertical metres of the western panel was dewatered. This allowed stoping in the higher grade panels 580 and 605 West and possibly the 630 West panel as well as allowing access to the next central stoping block ($705M_L$).

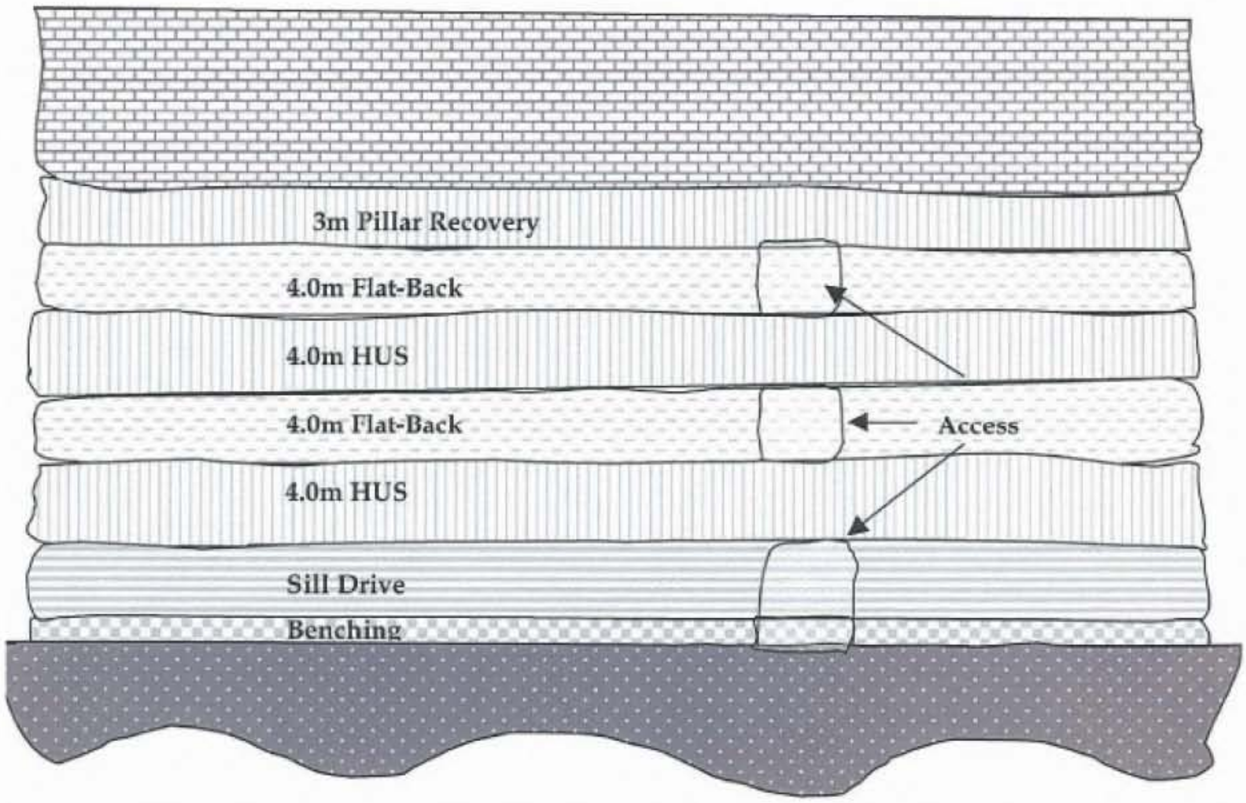
Initial planning was for ore to be mined by mechanised cut and fill with the narrower sections, mined by hand held methods. In an attempt to increase productivity two long hole open stopes were developed with a height of 17m from the back of the sill drive to the floor of the crown pillar drive. During mining these stopes experienced dilution of around 100%, consequently a change to half upper stoping has been used since mid-2000. Hand held cut and fill with modification to suit local conditions continued to be used in the narrow sections of the reef, particularly in the east and west panels, approximately 35% of the reserve was mined by hand held air leg methods, 15% from ore drives, and 50% from HUS, until the development of the modified Avoca method.

As each level is developed, the reef access crosscuts are advanced under geological control. Once the reef has been intersected a sill drive is mined, again under geological control. As mining advances, geologists mark the ore boundaries to guide development and face samples are taken for grade control, lithological and structural mapping is completed for all development. The reef boundaries are marked on the backs and the outline of openings and are picked up by survey. Geology department develops a wire frame model for each stope panel from all available information to guide mine design.

THE HUS METHOD

The layout of the HUS mining (which was used in the upper levels) is shown schematically in Figure 15. Following development of a sill drive along the reef the floor is benched down 2m starting from the access ramp into the stope. The void created by the benching is then filled with cemented rock fill. Once the stope has been filled, detailed geological cross-sections were used by the mining department to produce blasthole ring designs. Ring positions were marked up and a four metre slot rise is established at the extremities of the stope. Up holes of 51mm diameter were drilled using a jumbo based on the ring plans to ensure that potential damage to the hanging-wall from blasting is minimised. Holes were charged with ANFO/Isanol using Nonel detonators and blasted up to several rings at a time depending on ground conditions, stope width and production requirements. Ore was bogged remotely and hauled to a stockpile. After final clean up the stope was tight filled with a combination of waste rock and hydraulic fill. The ramp is then stripped so that the floor of the ramp is at the design level of the stope backs and a 4.0m high flat back lift above the fill is taken over the length of the stope. The cycle is repeated three times until there is a seven metre crown pillar between the backs of the stope and the CW sill pillar on the level above. The crown pillar (3m high) is then removed by HUS, starting from the end of the stope and working back to the access.

Figure 08: Layout of HUS Method



Cross section (not to scale):

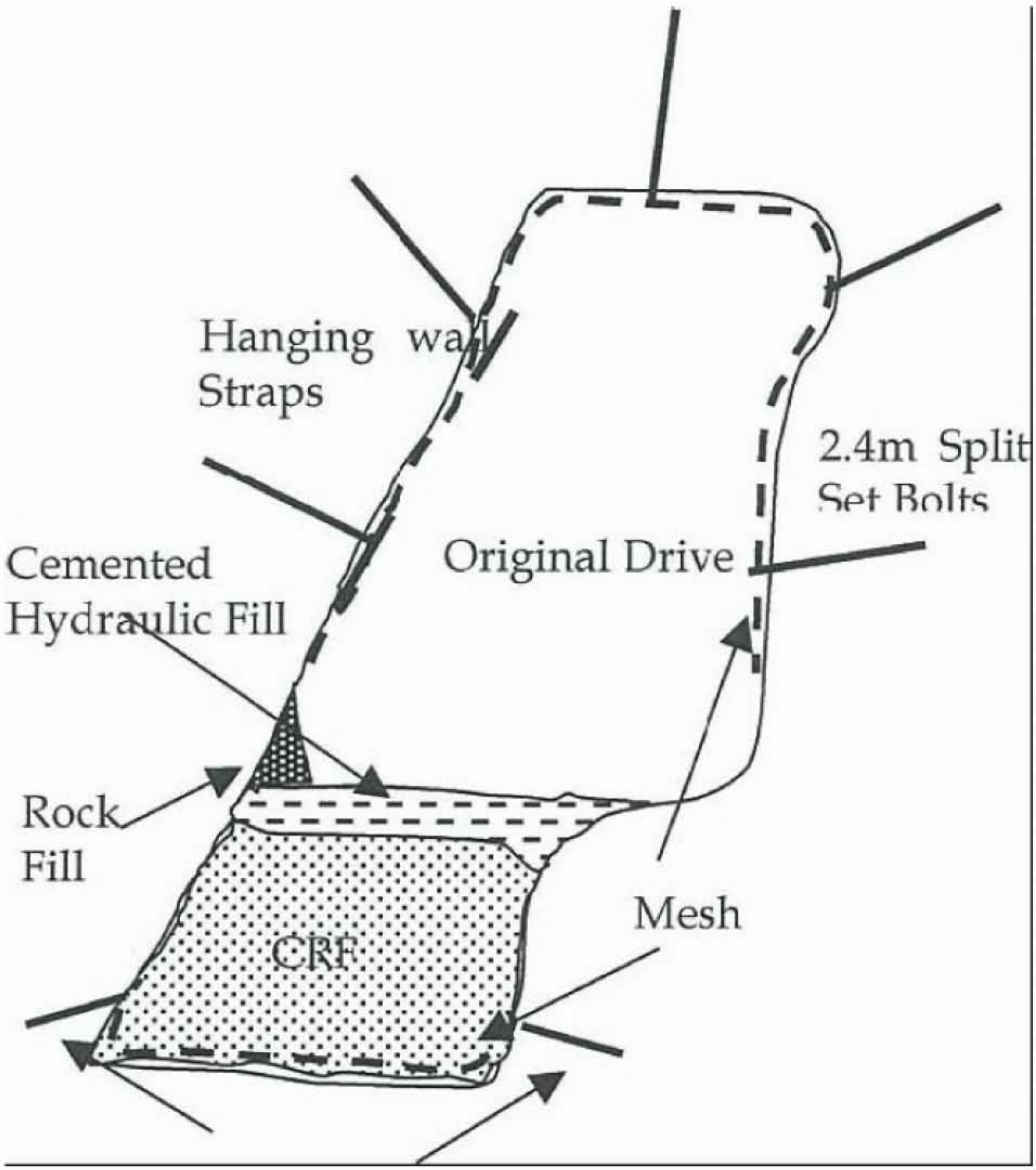


Figure 09

From the level stockpile ore is hauled by truck up the decline and either tipped direct into the ore bin at the shaft loading station or stockpiled on the 375mL for rehandling when required for hoisting.

GROUND SUPPORT

Ground support at the Beaconsfield Gold Mine (BGM) usually utilised mesh which was placed in contact with the rock surface to limit rock movement.

In figure 9 above, the dotted lines around the drive indicate the wire mesh which was held in place by straps which were in turn bolted into the rock face. The diagram refers to 2.4m Split Set Bolts, but different forms of bolts could be used. Usually the greater the length of the bolt, the greater support offered, although a relatively short bolt into solid rock would offer more support than a longer bolt placed into friable or damaged rock. Greater protection could also be afforded by the use of dynamic ground support which would allow a dynamic arch, which could cope with the events of greater seismic magnitude.

There are many types of bolting arrangements that can be used to fix the straps and mesh to provide the ground support to the back of a sill drive or stoping drive. The following types of bolting arrangements can be used.

1. Split sets. Split sets are essentially friction bolts which look like a giant split pin. They usually come in lengths of 900mm 1.8 metres, 2.4 metres and 3 metres. They are readily installed and are more than adequate for areas of low seismicity. They are a static method of ground support, but afford some dynamic support.

2. Cable Bolts. Cable bolts can come in virtually any length and are essentially a length of cable fixed or cemented into the rock with a plate on the outer end which is used to support the straps. In larger spans or broken ground, cable bolts can be installed through the ore body, through to a solid portion of the footwall or hanging wall. They are often cemented for their entire length and this format is mainly a static method of ground support. If necessary, plastic piping can be placed over a part of the cable, and that part not being fixed to the hole bored in the rock, allows for a dynamic effect. Without the piping, (or in some cases a grease covering) cable provide a relatively static load but can be post-tensioned to about five tonnes.

3. Posimix Bolts, Threadbars or Gooey Bars. – those used at the Beaconsfield mine, were 2.4 metres on length, and had a spiral mixing thread on the inner end. A hole was drilled into the rock, and a two part chemical pack is then inserted, followed by the spiral thread of the bolt which is screwed into the chemical pack, mixing the chemical and resulting in a bonding into the hole. As the mixture cures the bolt can withstand loads of up to eighteen tonnes. This is essentially a static method of ground support, but with a 1.8m debonded length as is the case at Beaconsfield, also provides some level of dynamic support.

4. Cone bolts. . The most sophisticated bolt used at the Beaconsfield Mine were cone bolts. They are essentially a dynamic bolt, 2.4 metres in length with a cone at one end, which is thicker than the shank of the bolt. The bolt is placed into a drilled hole, which is then filled with resin before the outer plate is screwed onto the bolt. Depending on the thickness/mixture of the resin, for the bolt to be extracted, the cone has to be pulled through the resin. To install a cone bolt, a

hole is drilled and resin cartridges are placed into the hole, then the cone bolt is placed into the hole, where a paddle-like device on one end of it ruptures and resin cartridges and mixes the two parts. I understand that Beaconsfield Mines was the first in Australia to use the modified cone bolts from Canada.

BACK FILL

BGM backfilled all voids created by mining the ore body except for voids created by the mining of crown pillars.

The four main methods of back fill used at BGM were uncemented rockfill (RF), Cemented Rock Fill (CRF) Hydraulic Fill (HF) and Cemented Hydraulic Fill (CHF)

Cemented rock fill is a blending of waste rock and cement to form a hard and stable platform from which to work and which also acts as the roof of the next lower mining block. RF and CRF are good ways of getting rid of waste rock fill without having to cart it to the surface but is sometimes not as uniform as the HF or CHF.

The HF or CHF is taken from the flotation tailings from the processing plant to which water is added to make into a slurry. CHF is less likely to crush as the pressure increases because it tends to compact rather than cracking along rock bands, or between rocks as can be the case with CRF. Hydraulic fill (HF) or cemented hydraulic fill (CHF) is placed by water and therefore has less chance of gaps than cemented rock fill (CRF).

MODIFIED AVOCA METHOD:

Set out at Annexure "Z" are a series of Power Point slides demonstrating the differences in sequencing of the modified Avoca and checkerboarding mining methods. The modified Avoca method is outlined below.

This is a top down, bottom up mining method where a 4m high sill drive would be driven along the bottom of a mining block by blasting into the ore body from the access drive. These drives would be ground supported along their length. An intermediate sill drive is driven twelve metres above the roof of the original sill drive and a crown sill would be driven 7m above the intermediate sill drive.

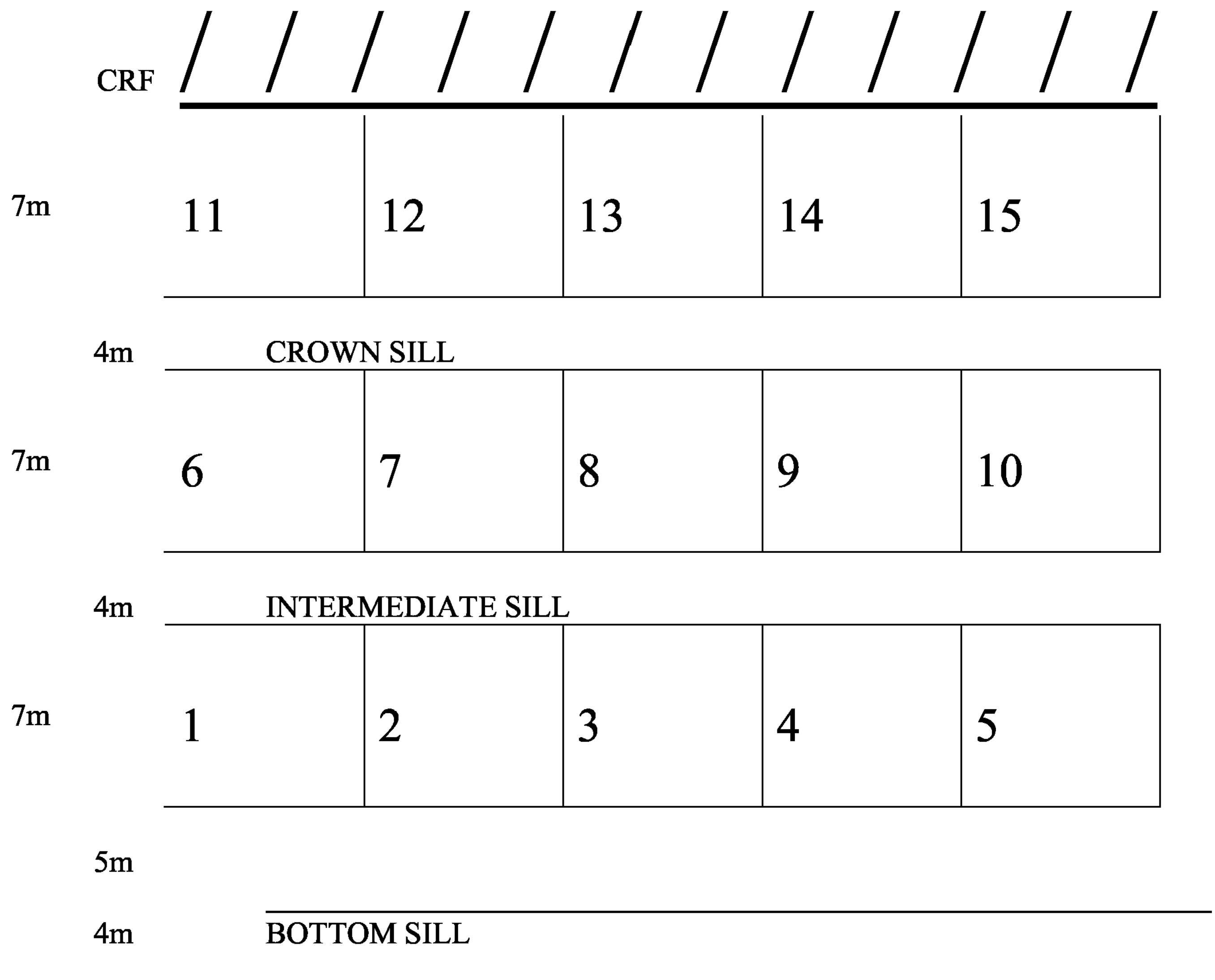


Figure 10

The figure above indicates a typical mining sequence using the Modified Avoca Method. Upon the completion of the sill drives, which could be up to approximately 175m in length, “half uppers” of 5m in height would be blasted above the bottom sill, by placing charges in the backs (roof) of the bottom sill, panel by panel and retreat mining towards the access drive.

As each panel is blasted the ground support is destroyed and therefore the ore deposited on the ground is removed towards the access drive by remote boggers. From there, the ore is taken up the access drive to be treated. Once the 5m level above the bottom sill has been mined, ground support is placed in the backs of that level and cemented rockfill (CRF) is placed along the bottom sill to a height of 5m. This CRF will effectively become the roof of the mining block below, as well as a platform from which to commence blasting the stopes above.

The stopes or panels would then be mined according to the sequence in the diagram above by once again placing charges into the backs below the stope to be mined and blasting. The ore would then be remotely bogged leaving a void of approximately 11m.

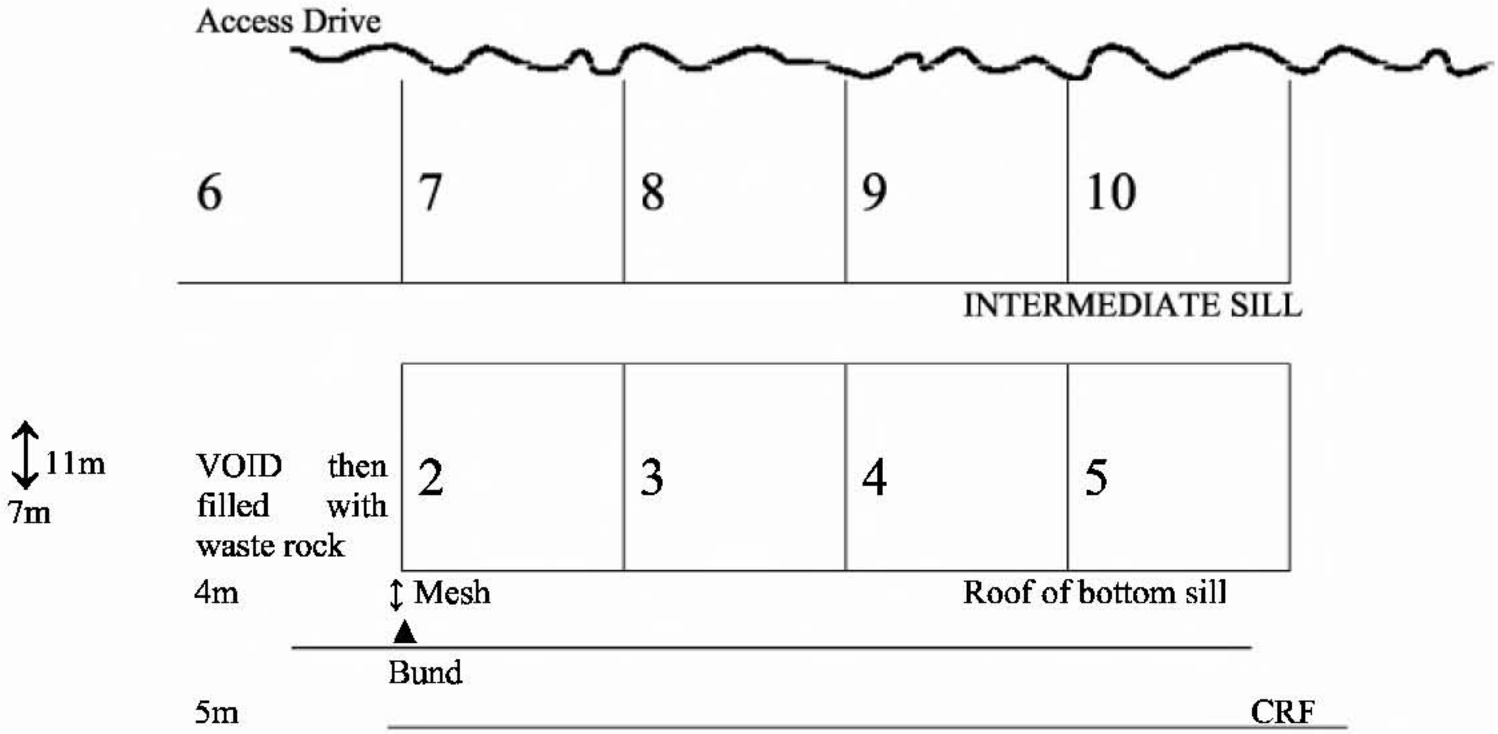


Figure 11

Miners would then move to the edge of the void and place a 'bund" at the limit of the ground support where wire mesh would be set up to prevent waste rock due to be inserted into the void, spilling in to the working area. (It was this type of procedure that was being performed by Messrs Knight, Russell and Webb when the accident of 25th April 2006 occurred.) Once the mesh was in place, waste would then be transported along the intermediate sill and filled level with the base of the intermediate sill to allow later access to panel 6 above.

This method would be used until the first ten panels were mined and the last five panels would be mined in a similar method, except that no waste would be placed into the voids left by the mining activity (panels 11 – 15). This void is known as an open stope and is a no-go area because there is no ground support above it. The checkerboarding method differs in that the mining sequence in Figure 10 would be 1, 6, 11, 2, 7, 12, 3, 8, 13, 4, 9, 14, and 5, 10, 15 with each stoping panel, apart from the crown, being backfilled before the next panel is mined.

THE OCTOBER 2005 ROCKFALLS

By September 2005 the bottom level of the 940mL mining block had been mined and work had commenced on the intermediate stope, being the 925mL. Foldout Figure 12 illustrates the remaining stopes to be mined on the 940mL block. Panel 1 was fired from 23 – 28th September 2005 and panel 2 from 3 – 5th October 2005. On 9th October the eastern edge of Panel 3 was fired after which there was a fall of ground beneath panel 5 on the 925mL. In the usual course of events, the entirety of the 925mL would have been mined before commencing at the western end of the 915mL. The numbering on the diagram illustrates the revised mining method adopted after the events of 26th October, and the dates within

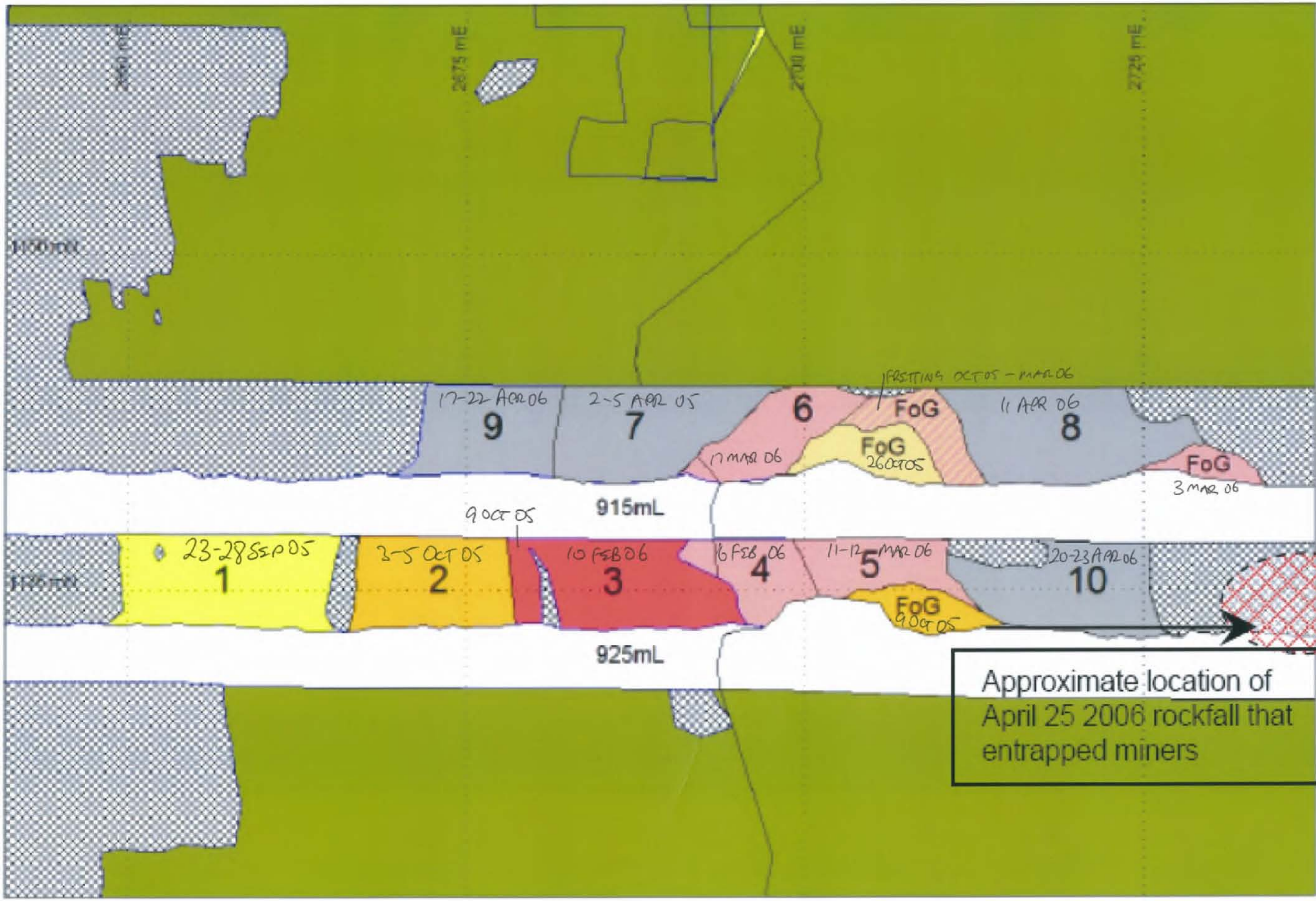

2675 mE
2700 mE
2725 mE
FRETTING OCT 05 - MAR 06
17-22 APR 06
9
2-5 APR 05
7
6
FoG
11 APR 06
8
17 MAR 06
FoG
26 OCT 05
FoG
3 MAR 06
915mL
9 OCT 05
23-28 SEP 05
1
3-5 OCT 05
2
10 FEB 06
3
16 FEB 06
4
11-12 MAR 06
5
FoG
9 OCT 05
20-23 APR 06
10
925mL
Approximate location of April 25 2006 rockfall that entrapped miners

Figure 12

the panels indicate when they were fired.

On 26th October there was a major seismic event of 2.1 M_L which is believed to have originated in the area of the continuation of the Tasmania Reef, to the west of the Tasmania Reef Offset Fault zone. This induced a major fall of ground on the 915mL which is illustrated in yellow on Figure 12. Both the falls of ground on 9th and 26th October involved a failure beyond the level of ground support and naturally caused great concern to the operators of BGM. Workplace Safety Tasmania (WST) were notified after both falls, mining operations ceased, and the Mines' operators sought the advice of at least five consultants, namely

(a) Dr Glenn Sharrock from (AMC) (and now with the University of New South Wales) who was engaged to do a modelling and a back analysis to come up with a conception model of what actually caused the October 26th event, by looking at the seismic and damage record between May 2004 and October 2005.
(b) Mr Frans Basson from AMC Consultants, who was engaged to do forward modelling and assist the instruction of BGM staff to enable them to adopt the model in accordance with future mining sequences
(c) Mr Michael Turner from AMC Consultants, (and then TMG) who was to conduct a review of the ground support. It will be noted from the reports at annexures "AD", "AE", "AF", "AH", "AK" and "AM" attached hereto that Mr Turner provided reports to BGM both before and after the October 2005 event.
(d) Mr Dan Heal was Coordinator of the MS-RAP Project and came to Beaconsfield after BGM became a sponsor of the MS-RAP Project to install the software and introduce the seismic modelling aspects of the package. He inspected the mine and analysed extant seismic data with a view to attempting to predict the levels of seismic activity in various zones of the Mine.
(e) Dr Peter Mikula who was to conduct an overall review of the consultants' reports.

Also occurring was a Continuation Study into the ongoing viability of the Mine below the current reserves. The Study was holistic in nature and considered geology, geomechanics (ground support, pillar thickness, stress modelling), backfill, ventilation, mining method and extraction sequencing and economics. Some thirteen geologists and engineers within AMC contributed to this Study, including M Turner.

Much of the materials provided have been referred to in Mr Marisett's report at Annexure "BC" and annexure, but I will deal with some of the salient points below.

Glenn Sharrock.

As previously noted, he was engaged to develop a conceptual model of what actually caused the 26 October 2005 seismic event by looking at the seismic damage record between May 2004 and October 2005. He concluded that the root cause of the 2.1 M_L event was both the unfavourable geometry of the mine, ie the pillars relative to the hanging wall shear, and also the uncontrollable release of energy.

He noted that the mine could expect further seismic events and that this needed to be carefully considered in BGM ground support design, firing designs and their forward analysis with numerical modelling and extraction sequence. Although not specifically part of his remit, and expressly saying that this was not a recommendation from him. He stated

that the GCMP
"…should address the depth of failure and install cable bolts with the appropriate surface support where required." See Annexure "AP" p3.

The GCMP already contained information as to where, when and how cable bolts should be used in intersections and mining areas exceeding 6m in width, but Dr Sharrock was clearly concerned because the depth of the failure was beyond the level of the ground support.

He considered that the seismic monitoring system that had been installed by BGM was a good and very sensitive system.

Frans Basson

Mr Basson prepared a report dated February 2006 headed "Study of Seismic Patterns and an Evaluation of the Proposed Stoping Schedule for 2006 (Annexure "AS".)

At page 4 of the report, Mr Basson sets out factors that increased the seismic hazard of Beaconsfield.

> *"Factor 1.*
> *Stoping close to the Western Offset Fault Zone – especially stoping directly north of the HW Fault could result in significant events on the HW Fault. The ground around the intersection between the HW and Offset Faults previously resulted in significant fall of ground incidents.*
>
> *Factor 2.*
> *Stoping in the vicinity of the conglomerate overlap zones normally generates a higher then normal intensity of smaller magnitude events. The current overlap is between the Wet and 2CG conglomerate zones, but the overlaps change with depth.*
>
> *Factor 3.*
> *Stoping the last two levels of a stoping block in the conventional way where the stopes are extracted from bottom to top, previously resulted in increased seismic activity and difficult stoping conditions. This is a result of high stress in the remaining pillars and modelling should highlight these areas. The modelling indicates that the checkerboard pattern should greatly alleviate the difficulty traditionally associated with the stoping of the last two levels.*
>
> *Factor 4.*
> *Excessive hanging wall spans needs to be identified by the mine personnel, and support requirements adjusted accordingly.*
>
> *Factor 1 and 2 change as stoping progresses downwards, due to the complex geological environment – changes in the folding axis of the reef horizon, changing conglomerate overlap zones, and mineralised Off-set Fault changes in relation to the reef horizon. When combinations of the above factors are encountered simultaneously, an even higher hazard could be expected during stoping operations.*

Figure 1.1 Current Extraction Sequence

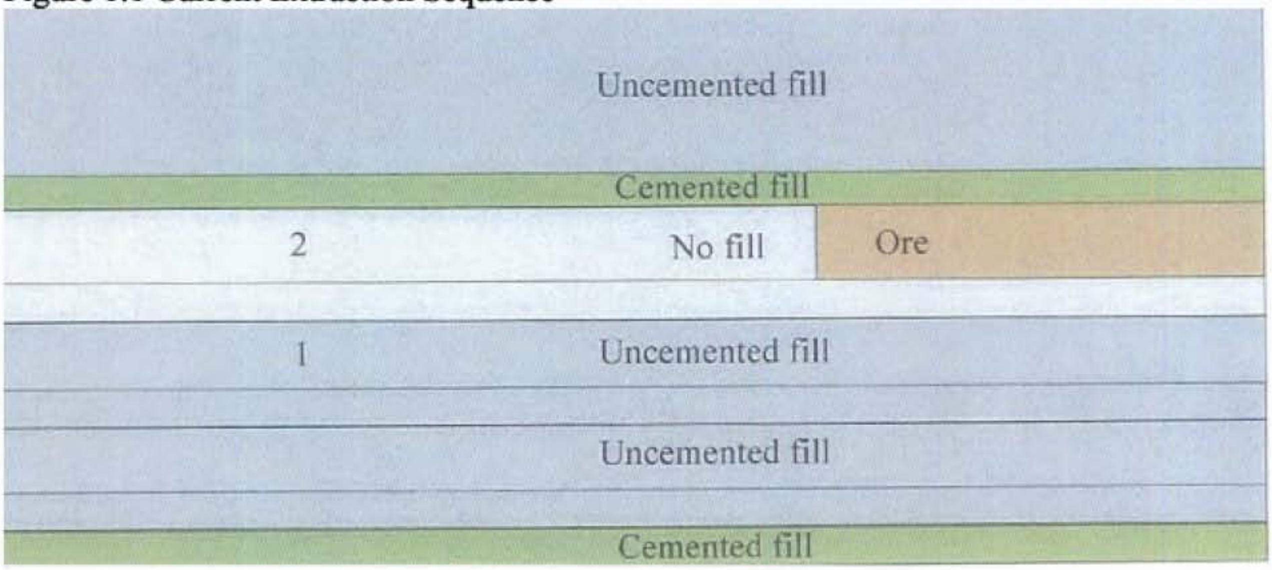
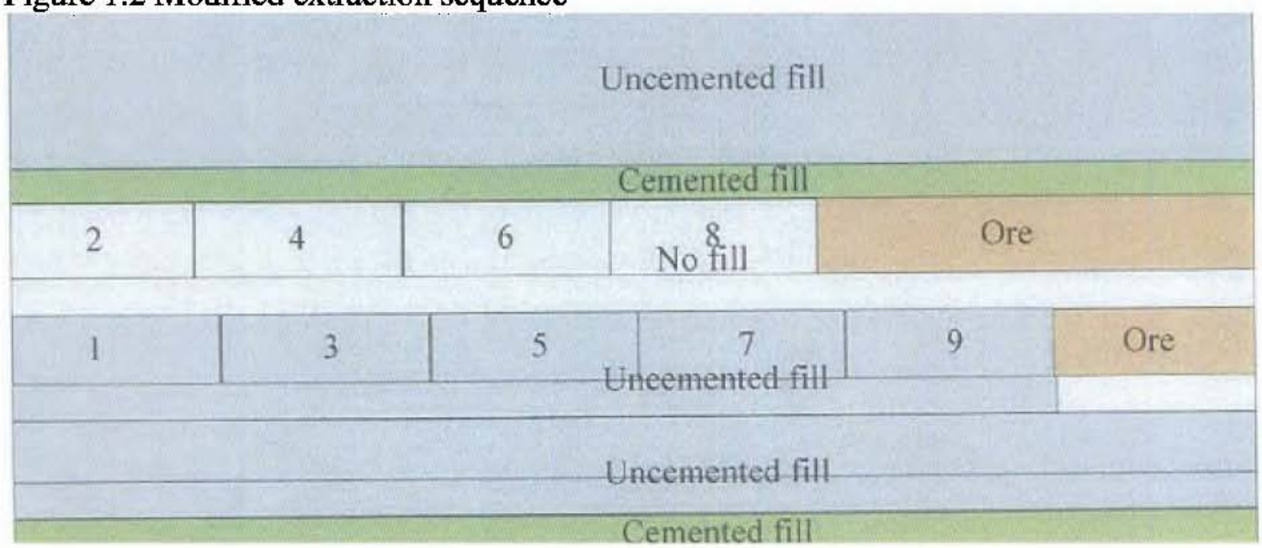


Figure 1.2 Modified extraction sequence



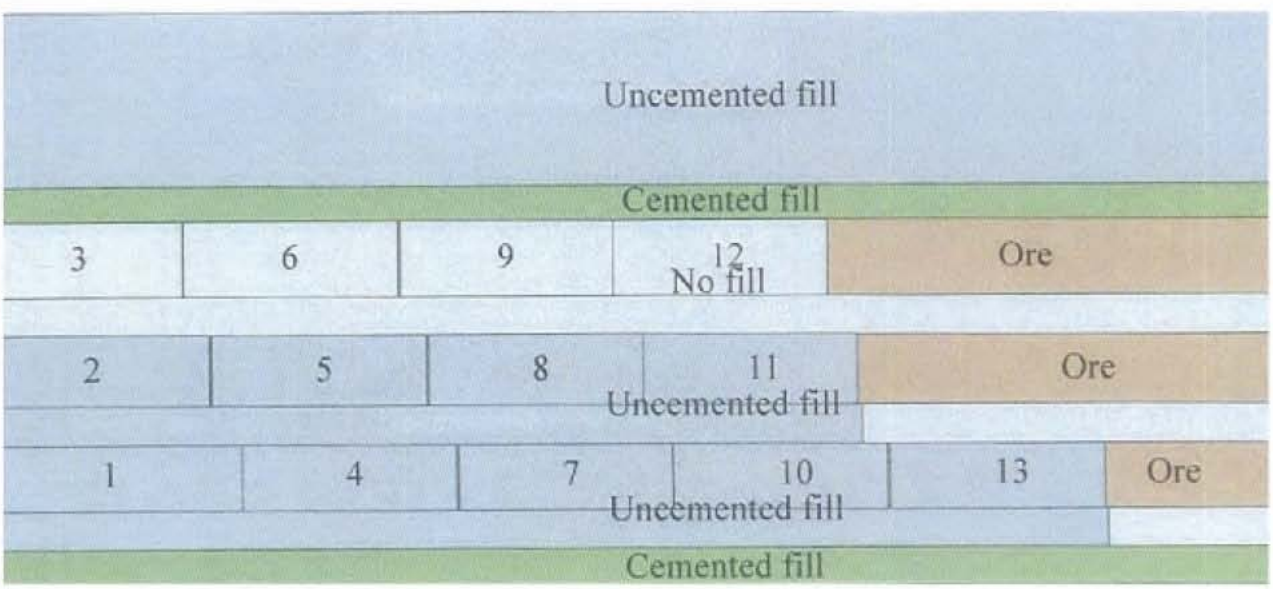


Figure 1.3 Extraction Sequence Modified over 3 Levels.

Factor 1.

Stoping close to the Western Offset Fault Zone is identified as more hazardous for the following reasons (see Figure 1.4)

- *In the seismic data received (2004-06-15 to 2006-01-17), all the ML>=1.0 events plotted west of the offset fault, either on reef or in the hanging wall (red dots in Figure 1.4)*
- *7 Fall of Ground ("FOG") incidents were provided to AMC and 5 of them occurred close to an area where stoping broke away from the main reef on one of the Off-set Faults splays (white dots in Figure 1.4)*

Figure 1.4 All Seismic Events with ML> 1 and FOG incidents recorded at Beaconsfield Mine

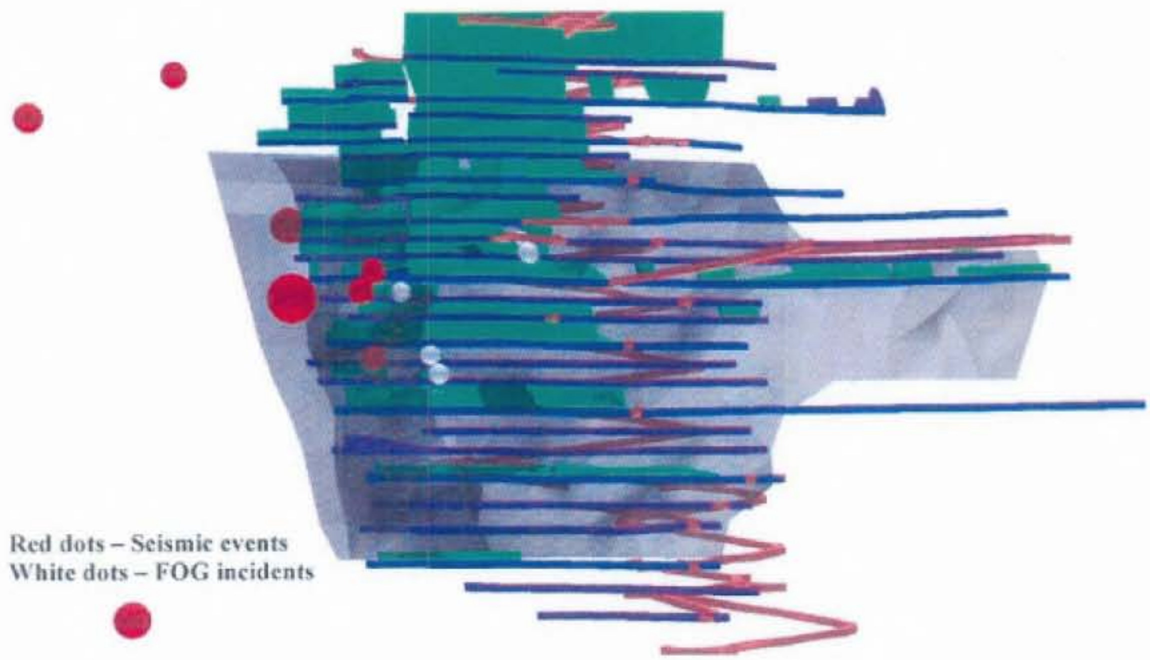


Figure 01.4

And at page 15 of his report under the heading of General Comments for January Mr Basson makes the following comments about the 925 Level.

A combination of Factors 1 and 3. The model predicts pillar failure and stoping is towards the Offset and HW Fault intersection. A hazardous stope with the potential to generate significant seismic events . Stoping towards the offset Fault could result in clamping of the structure with a sudden release as stoping proceeds towards the fault intersection.

On page 16 he makes the following comments about the 915 Level:

A combination of Factors 1 and 3. The model predicts pillar failure but in this case stoping starts at the Offset and HW Fault intersection and will *continue away from the structure.*

A hazardous stope with the potential to generate significant seismic events. Slot cutting is adjacent to a previous fall of ground incident, as well as close to the Offset and HW Fault intersection. The stope should be less hazardous than the 925 level stoping in February for the following reasons:

- *Stoping away from the structure should result in a more gradual release of energy on the structure.*
- *Stoping proceeds away from the hazardous intersection between the HW and Offset faults.*

It is significant that yet again the areas highlighted that had been of most concern were the F1 splay reef, Reef Offset Fault zone and the conglomerate overlap zone particularly the area of the offset and HW fault intersection. Enhanced ground support was placed in all of these areas but unfortunately the rock fall of the 25th April occurred in an area between the areas of concern and where levels of such high seismicity were not expected. Even so, the same levels of enhancement ground support had also been installed in this area.

He made the following comments at p 17:

> *The two stopes on 915 Level and the stope on 925 Level could all mobilize the HW Fault, it is thus recommended that the three stopes are not mined simultaneously, but in different time periods during the month.*

This advice appears to have been followed by the Mine as shown by the firing times in Figure 12.

Michael Turner

Michael Turner from AMC Consultants and then TMG visited the mine six times. On one of those visits from the 8th to 10th November 2005 he conducted a review of underground support, following the seismic event on 26th October 2005. (See Annexure "AM") As previously noted, this event had a local magnitude of 2.1. As noted elsewhere Mr Turner when interviewed, seemed to suggest that he was not asked to design the ongoing ground support for the mine but his report is headed "Ground Support Review" and it was not unreasonable for the mine to treat his report as recommendations for future ground support.

I deal more fully with Mr Turner's recommendations because of his familiarity with the mine and the number of reports he had provided. It should, however, be noted that his reports were some of a multiplicity of reports and factors (including the significant qualifications and experience of the Mines' management) used to determine the methods of mining operations post October 2005.

Mr Turner uses the word "recommended" in this report where he wrote:

Support deficiencies were highlighted and modifications recommended where applicable". "Recommended" appears at several other sections of that report and at other sections Mr Turner states that certain actions "should be undertaken", although his report contain a specific disclaimer about the adoption of recommendations. Following his visit in March of 2006, Mr Turner noted in his April report "...Threadbar and Cone bolts, straps and additional mesh have been installed in the active levels in accordance with the previous recommendations made in November 2005 (Annexure "AV" p1)

It should be noted that Mr Turner's main concern was with the western edge of the stoping close to the F1 and main reef fault intersection, and that this area was not affected by the seismic event on 26th April. At pages 2 and 3 he recommends an extraction sequence for 915 and 925 levels as follows: (Annexure "AM")

The 925 Level suffered a major fall on 9th October 2005 (AMC Report, 20 October 2005) and the 915 Level suffered damage due to the recent large seismic event on 26th October 2005. Both falls were located from Easting 2700 to 2719mE.

The fall material observed in photographs of both the 925 and 915 Level falls appears to be in line with a 'shakedown burst' (Jager AJ and Ryder JA, a Handbook on Rock engineering Practice for Tabular Hard Rock Mines p252) The rock fragments show mainly pre-existing fracture surfaces with no fresh powdery or intense fragmentation (Figure 1). In both falls the support systems were not up to level required to survive large seismic events. The ground was mainly supported with split sets, mesh and hangingwall straps. The current support standards for seismic-prone areas includes straps and Threadbars on mesh overlaps over the backs of the ore drive and this is installed on a campaign basis as required. The photos of the falls (Figures 1 and 3) also indicate that the support damage would fall under the 'shakedown' category, with the mesh and bolts mainly intact and the rockmass unravelling around the bolts. The failure probably initiated at a weak mesh overlap with only split set support.

In both of the falls, faults were also present (Western Offset Faults and the Tasmanian Fault) and the ore drives were wider than normal.

The 925 Level fall occurred after blasting in the 925 stope, but the 915 Level fall occurred at blast time on 26th October 2005, when only a few minor blasts were set off, far away from the 915 Level. The seismic event triggered by this blasting located on 880 Level, to the west of the Western Offset Fault, possibly on an extension of the Main Tasmanian Fault. This is a change from previous event locations, where the events have been located close to the blast.

***Extraction** – extraction of the 925/915 Levels can now be effectively split into 2 sections – West and East of the falls on 2710mE. Movement of personnel and equipment underneath or over the fall areas should not be considered as these areas are unstable.*

The 925 fall has been supported with split sets and straps (no mesh) (Figure 2) but this should not be considered as 'supported ground' and personnel should not be permitted to access the areas. The 915 fall area cannot be readily rehabilitated as *the back of the fall is less than 3m from the cemented fill on 905 Level. Driving of jumbos and boggers on 915 level, over the 925 fall area is also not advisable due to the thin pillar (also around 3m thick).*

The extraction of the remaining reserves to the West of the falls on 915 and 925 Levels will have to be undertaken without traversing the fall areas. The possible extraction sequences for this section were discussed with D Barua and P Hills on 10th November 2005.

A major factor governing the extraction rate for the remaining ore to the west of the falls is that this has to be stoped out prior to the 965 and 955 mining commencing. If the 980, 965 and 955 Levels are to be extracted on a checkerboard sequence, as preferred in order to reduce the stress impact on the 955 Level pillar, the 915 and 925 mining should be fast-tracked using new footwall access drives from the return airway, developed using the twin-boom jumbo. There is an option of developing footwall by-passes from the current 915 and 925 ore drives but this would involve the use of single-boom jumbos, which will be fully utilised installing rehabilitation support in the 805 and 880 West stopes. The remaining intact reserves on 925 will need to be drilled from a footwall drill drive or cross-cut, followed by remote bogging from either the footwall cross-cut or the current ore drive. The void could then be filled from the 915 drive, which will have to be accessed from additional footwall access development (eg from the return airway access). It is highly likely that the 915 drive is damaged due to stress and seismicity and in such a case, final filling of the 925 would have to be undertaken remotely. If the conditions on 915 Level are too poor to rehabilitate safely, production drilling and bogging would have to be undertaken from footwall drill drives or cross-cuts.

Extraction of the reserves to the East of the falls should convert to a checkerboard method, using the fall areas as free-faces for the initial slot blasts.

At page 5 of the report he made the following recommendations in relation to the 915 and 925 areas:

915 West *–The narrow width of the 915, combined with the fact that the 940 stope has already been mined lead to high risk of further seismic related damage. During one of the underground visits for the review (9 November 2005) there was a ML=0.1 event close to the 915 overlap zone, confirming the high stress levels and fact that intact risk or structures are close to movement or failure. The event also occurred at 13:23, well outside blast time, when there was no mining activity in the area. There are signs of high stress and minor seismic damage along the footwall shoulder of the drive for most of the footwall 2CG exposure. Cone bolts are recommended with straps over the backs for the entire level as significant stress damage, deformation and seismicity is expected.*

925 West *– The 925 level to the west of 2700mE has been cut-off from the rest of the drive by major falls of ground in October. At the time of the review there were still fresh falls occurring between 2700mE and the stope brow. Extraction of these remaining reserves might be limited to wrecking of pillars and loading out of fallen ore using remote boggers. The hangingwall overbreak on the 940 stope has also impacted on the 925 and will probably lead to severe dilution during stoping..*

Additional straps and Threadbars are required on the backs from the stope access to the fall prior to stoping recommencing.

At page 7 of the report Mr Turner concludes:

***Closure** –*

The recent seismic event was far larger than previous events at Beaconsfield and has led to this review to assess the suitability of the current support. The possible source mechanisms and stress changes leading to this event and the possibility of further large seismic events are being investigated using Map3D modelling by AMC in Perth. For the purpose of this review it has been assumed that modifications to designs and extraction sequencing will not eliminate such events. The review highlighted a number of areas that require support upgrades to cope with the increase in seismic event magnitude.

The review also highlighted the requirement to change the extraction sequence as soon as possible to a 'checkerboard' pattern. This sequencing should be introduced for the 925 and 915 Levels (East) and the 980, 965 and 955 Levels and for the remaining deeper stopes.

Mr Turner visited the mine on 9th March 2006. He provided an update report subsequent to his report of November 2005. The main parts of this report (Annexure "AV") can be summarised as follows:

***Support** – The quality of the installed support observed during the site visit was higher than observed during previous visits. In particular, the installation of Threadbars, straps and Cone bolts were generally very good.*

The Threadbar and Cone bolt support is being installed in those areas at a high risk of stress and seismic damage, as determined during the review in November 2005. A few areas need this additional support installed prior to stoping re-commencing on the 980 Level, such as the 990, 955 and 960 ore drives.

***Extraction Sequencing** – The extraction sequence is currently in the process of changing over to the 'checkerboard' pattern for the 915 and 925 levels. The 980, 960 and 955 levels will also use this sequence when stoping recommencing. This sequence needs to be maintained to limit the stress levels in the 915 and 955 Levels.*

***Rockmass, Structures and Stress** – There were indications of very high stress in the 915, 925, 955 and 960 Levels, such as rocknoise, slabbing, loading up of bolts and bulking of failed material behind the mesh. The seismic system is being successfully used to apply extended re-entry periods in high stress areas. The seismic system has also picked up a large number of events along the various faults near the F1-Main Reef intersection, and this area will have to be carefully monitored in case of stress transfer to adjacent pillars, such as the 960 and 990 Levels.*

Overall, the stress-related changes in ground conditions are currently being managed successfully. Seismicity is unpredictable however and continuous monitoring of high stress working areas is required to provide a warning of *changes in conditions that could lead to fault-slip, strainbursts and rockbursts.*

He reiterated his recommendations for the use of cone bolts on the 915 and 955 Levels and noted at the time of the visit most of the areas had been supported with Cone bolts to the required standard apart from a small section in the 955 Level.

At page 5 of his report Mr Turner noted the following:

There were several indications of high stresses in the 915,925, 955 and 960 Levels, such as rocknoise, slabbing, loading up of bolts, and bulking of failed material behind the mesh. The performance of the support systems in these areas and changes in underground conditions relative to stoping and seismicity will all have to be continually checked. Extended re-entry periods and additional support rehabilitation could be required.

Recent seismic monitoring indicates that stress concentrations are continuing to move down-dip with stoping, especially on the western edge of stoping, close to the F1 and Main Reef fault intersection. The stress changes and associated seismicity are being closely followed by the geotechnical engineer and this should continue.

There is still a possibility of another large-magnitude seismic event due to movement along one of the western faults, similar to the October 2005 event. The recent Map3D modelling completed by AMC (AMC,2006) indicated significant areas of fault with a high Excess Shear Stress (ESS)

Some salient points arising during Mr Turner's interview were as follows:

He indicted he was asked to provide advice in several areas, including designing and installing seismic systems, reviewing support conditions and rock conditions.

On a scale peaking at very severe, he would rate the rock problems at Beaconsfield Mine as between moderate and severe.

Some Avoca gold mines leave crown pillars, but at Beaconsfield leaving the pillars of the dimensions they had in place would cause more problems, and hence it was beneficial to take out the pillars between the pre-existing drives.

He did not specifically do design work but he might recommend change to the extraction sequence with provision that they have to be modelled before they are implemented. He would have felt able to propose radical changes to mining methods that may have affected mine-able reserves or mining costs. For example, if he felt there was a need for a pillar, they would have to leave the pillar.

After their fall of October 2005 he went to review the support or institute a support review system. There were indications of very high stress in the 915, 925,955 and 960 metre levels and that's where the support was increased.

He thought the mine's approach to the seismic problem was very good. They were contacting consultants and getting advice and implementing advice where they could.

He was not sure of the time period or how long it was before the 915 and 925 levels were developed but they were developed before there was a quantification of a problem. They changed design as soon as they could but you couldn't change something that was developed two years ago.

The pillars were originally seven metres and he thought were increasing them to nine or ten metres.

Mr Turner was further interviewed by telephone on 25th August 2007 and I noted the reason he recommended Cone bolts for the 915 and Threadbars for the 925 was because he understood the 925 level would be mined first. Accordingly, there would be twice the amount of pillar above the 925 whilst it was being mined and he did not think as much dynamic support would be needed there as for the 915 level. The only occasion where this did not occur was when Panel 8 was mined before Panel 10. BGM maintain that this course was commended by Mr Turner when visiting the mine, on 28th March 2006, because of concerns caused by the rockfall of 3rd March. (See Stope Audit Sheet dated 28 March 2006 at Annexure "Y")

Despite the fact there had been a 2.1 magnitude event in October, he understood the revised mining method would result in sharing the stress over more faces, which would allow a more gradual release of energy.

Although the Mine's view is that no amount of ground support would have prevented the rock fall for 25th April, this was in part based upon the proximity of the seismic event to the area being mined. As I understand it, energy readily dissipates as it travels away from a seismic event and hence mining can occur in mines with greater magnitudes of seismicity than were present at Beaconsfield, especially if the events occur at some distance from the mining operations.

The October 26th event seems to have originated in the Tasmania Reef Continuation and areas potentially affected by similar future events had substantial increased ground support installed. Unfortunately it is very difficult to locate, let alone predict the precise origin of seismic events, as was demonstrated by the event of the 26th April 2006, which appears to have originated in the previously benign hanging wall shear structure to the south of the Conglomerate Overlap Zone.

Large seismic events in underground mines have become a relatively common occurrence in Australia. Most of those mines are in Western Australia. BGM had engaged the authors of some of these reports (Mikula, Hudyma) to advise it when seismicity became an issue at the Beaconsfield mine. Personnel from BGM also met and discussed monitoring and managing mining induced seismicity with two other authors (Slade at the Kundana Gold Mine, WA, and Butcher at the Longshaft Nichel Mine, WA)

BGM provided the following table of Magnitudes of Seismic Ranges in Australian Mines
2.0 – 2.5
Beaconsfield Mine
Mount Isa Lead Mine (Dailey, 1993)
Big Bell (Barrett & Player, 2002)
Longshaft (Butcher et al, 2005)
Super Pit (Hudyma et al (2003)'

Strzelecki (Slade & Ascott, 2002)
Junction mine (Singh et al, 2004)

2.5 – 3.0
Darlot (Wondrad & Chen, 2006)
Broken Hill (Rauert & Tully, 1998)

3.0 – 3.5
Bounty (Dailey, 2000)
Mount charlotte (Mikula, 1998)
Leinster Nickel (Datau, 2006)

Mr Turner has not been back to the mine since about a month before the accident, so is not sure exactly where the fall occurred, but he understands from discussion that there were some cone bolt failures on the 915 level. (I think these probably occurred on the western edge of the fall on that level.) He did not recommend cable bolts because of the size of the drive, which he thought was a maximum of four and a half metres, but he believed the mine had some rules about cable bolting larger areas (The Mine had in fact employed cable bolting during earlier mining operations where the thickness of the ore body had exceeded 6 metres, as stipulated and the site's Ground Control Management Plan (GCMP) standards).

He thought part of the problem was that part of the Mine was developed 2 years before they mined it and that later developments would have 10m thick pillars, whereas these ones are only 7m thick.

Despite the limitations of the mine he was quite confident the area was safe to mine. He regarded the Mine as very safe operators and if they had any doubts, would have stopped operations.

An examination of Figure 3 shows the extent of the development of the decline well past the current mining operations. Mr Marisett has noted the problems that can arise during the mine design and development phase if the mine is developed well past current mining levels and the need arises to alter the mine design.

The Mine had resolved to increase the pillar thicknesses in the unmined areas of the mine, despite the fact that this may incur additional costs. Prior to the April 26 event, BGM had resolved to increase the pillar thickness to ten metres from the 1020 block rather than the 1080 block as originally intended. Mining had already commenced in August 2004 on the 980 block, so it was not possible to increase the pillar thicknesses prior to the 1020 block.

As noted in the reports of both Professor Quinlan (Annexure "AD") and Mr Marisett, one of the biggest concerns was the failure of the mine management to conduct a formal risk assessment after the October 2005 event. It is very difficult to now speculate as to whether or not the risk assessment would have highlighted the problems raised in expert reports, but it is unfortunate that a myriad of consultants were engaged "on the run" without somebody first sitting down and doing a formal written risk assessment, which hopefully would have resulted in clear, concise written instructions to each of the consultants setting out their roles and responsibilities. I have dealt further with this aspect later this report.

If such a course had been undertaken, any gaps in the proposed consulting regime may well have been uncovered. For example, both of the following statements are true:

1. The mine – "We followed all the recommendations in relation to the ground support."
(I note this is in the main true, although Dr Sharrock had suggested longer ground support but this was not repeated in Mr Turner's recommendations. Dr Sharrock was engaged to design a backwards-looking model, whereas Mr Turner was engaged to review the ground support. Mr Turner's approach was supported by Dr Mikula whose comments are noted below. Hence, it was probably not unreasonable that the Mine followed Mr Turner's recommendations in relation to ground support, despite the concerns expressed by Dr Sharrock.)

2. Consultants – "We were not retained to design ground support."
Although Mr Turner had been engaged to review the ground support, he had not been asked to design same and if he had been so tasked, he no doubt would have spend considerably more time at the mine and consulted with workers to enable him to design the support from the ground up.

Mr Turner did not recommend the same level of ground support on the 925mL as he recommended for the 915mL. It seems that the majority of the Cone bolting ground support on the 915mL held, even during the 2.3 magnitude event on 25th April, whereas the Threadbars placed on the 925mL which was closer to the consequences of the causative event failed over much of the area.

Peter Mikula

Dr Mikula of Mikula Geotechnics Pty. Ltd. was commissioned to provide an opinion as to the nature of the events of October 2005 and the circumstances leading to them, together with the resulting actions being undertaken. At section 9 of his report (Annexure "N") he notes the following in relation to ground support.

> *"(4) A sudden dynamic load can be many times larger than 20 tonnes and can snap a Threadbar or a cable bolt clean without necking. Splitsets, cone bolts and dynamic cable bolts are more able to survive seismic impulse.. . . .*
>
> *(7) The splitset /Threadbar combination is attractive, as the splitset (if no hole offsetting) survives moderate dynamic loading, but has low dead weight capacity, while the Threadbar carries dead weight well with 0.3m elongation capability. This combination is used at Mt Charlotte (REF7 and Fig 5) and Longshaft. . . . .*
> *(10) Cable bolts suit deeper anchorage and higher tonnage requirements, but can still snap on dynamic load. Note that Mt Charlotte installs 3.5m long Posimix bolts in lieu of cable bolts in places where back height permits (usually available where rehab is needed), and this is logistically better and certainly quicker for them than cable bolting. . . .*

And under Section 10 "Cone bolting 915 Level and 955 Level":-

> *(5) However in the final lifts with narrow sill pillars, seismicity could be too much for cables, so that cone bolts (for example) are needed.*
>
> *(6) Cone bolts or dynamic cable bolts with good surface restraint should have been able to contain the FOG. The premise is that these bolts are*

better able to slow and halt the movement of rock in the very process of failing, so that less broken rockmass is produced.

Daniel Heal

Mr Heal of the Australian Centre for Geomechanics is the coordinator for the Mine Seismicity and Rockburst Risk Management project. Mr Heal visited the site in February 2006 to introduce the project, familiarise himself with Beaconsfield and install and provide training on the MS-RAP software. BGM had implemented the MS-RAP software as a risk management tool and for the interpretation of seismic hazards. This was still in the developmental stages. In his report (Annexure "AU") Mr Heal recommended the ensuring that ground support capable of withstanding strong dynamic loading was installed in areas having an elevated seismic hazard.

Mr Heal relied upon extensive seismic data provided to him by BGM but noted in a telephone conversation with me on 27th August 2007 "predicting seismic activity is not an exact science." He did note that the ground motion required to cause damage to ground support and the rockmass decays rapidly from the hypocentre or source of a seismic event. (The strength of the ground motion is inversely proportional to the square of the distance from the source.) Accordingly, most major seismic events have a dangerous "near field" of less than approximately twenty metres and if the event of 25th April had occurred in the areas of high seismicity previously noted at figure 7, ie to the west of the Reef Offset Fault or the Conglomerate Overlap Zone, then by the time the ground motion reached the area where Messrs Knight, Russell and Webb were working, it would have had a very much reduced impact. I note that they were working approximately thirty metres from the western edge of the Conglomerate Overlap Zone, and in excess of 40 metres from the source of the 2.1 magnitude event of 26th October.

A combination of page 19 and Appendix C of Mr Heal's report, rates the seismic hazard at the 915 level as being moderate to high, which equates to 0.5 – 1 magnitude level. By interrogating the MS-RAP system BGM interpreted Mr Heal's report as predicting a seismic event of a maximum magnitude of 0.9 in the area of the April 25th rockfalls and if this had been the case, the installed ground support should have been more than adequate.

Unfortunately, as previously noted, the source of the event of 25th April 2006 is believed to be in the hangingwall structure, and in an area that had previously been thought to be seismically benign. This highlights that the precise location and strength of seismic events is very difficult to predict, and even though BGM appears to have correctly interpreted Mr Heal's analysis, they did not predict an event occurring in the C-HW Shear that intersected the reef in that area.

The enhanced ground support installed after the 2005 rockfalls, probably would have withstood an event of similar magnitude to that in October if the event had occurred in a similar location because of the distance from the area known to be seismically active that caused the October event. The April 25th event occurred much closer to the area in which Messrs Knight, Russell and Webb were working and as noted later in his report, although enhanced ground support would have reduced the risk of the falls of ground that occurred on the 915 level, it is doubtful as to whether such falls would have been prevented.

AMC Consultants were involved in considering the viability of extending ("continuing") the mining operation below the then current reserves. They were engaged in mid 2005 to conduct this Study, which covered geology, geotechnical (modelling, seismicity, ground support, mining method and extraction sequencing), backfill, ventilation, stope designs and schedules, and financials. The project manager was Peter Fairfield, the Report was peer reviewed and signed off by the managing director of AMC Dr Peter McCarthy, and had input from 13 geological / geotechnical / mining engineers within AMC, including M Turner and G Sharrock. This Study (at Annexure "AO") contains a significant body of work on geotechnical matters (Chapter 4) including taking into account the October 2005 seismic events, proposed stope designs and extraction sequences, pillar thickness, and stress analysis from Map3D modelling, and ground support but related to a different location in the mine. Although dealing with a different area of the mine the report did not recommend the blanket installation of cone bolts or cable bolts even for the F21 Zone, over 200m deeper than the 940 Block.

At pages 12 and 13 of his report Mr Marisett expressed concern about the contents of an e-mail from Mr Fairfield in September of 2005 and postulates that part of the problem of the mine design may have been restrictions imposed by equipment. Mr Fairfield was not formally interviewed but in a telephone conversation with the writer indicated that whatever concerns he expressed in the e-mail would have been overtaken by the study and he could not recall any equipment or machinery-related restrictions. He was of the view that BGM was very well organised, was a lot better than most mines and that Matthew Gill was a very thoughtful and diligent manager. There were several consultants involved in the team and they were content with the way forward, as recommended in their report.

For many years the Mine has relied extensively on the advice of consultants, but it also had in Matthew Gill and Peter Hills two extremely competent people, both very experienced in geotechnical matters. It was obvious that all decisions would have required, and had, significant input from Messrs Gill and Hills, as well as other management staff including the underground manager Pat Ball. I do not understand BGM to be suggesting that anyone other than their management was responsible for decisions made in relation to mining activity.

OPERATIONS POST OCTOBER 2005

As a result of the recommendations of Messrs Basson, Turner and the AMC Continuation Study Team, which were reviewed by Dr Mikula and the stress modelling by Mr Heal, BGM resolved to alter the mining method from Modified Avoca to Checkerboarding (As noted above, see annexure "Z" to demonstrate the different sequencings). Because the 940mL block had already commenced using the Modified Avoca Method, it was decided to finish mining that block by a modified two-panel checkerboard method. The sequencing was altered in accordance with the numbering on Figure 12. It should be noted that the fall of ground on 26th October had increased in size by fretting between that date and March of 2006 and that there was a further smaller fall of ground to the east of panel 8 on 3rd March 2006. This fretting and further fall of ground all occurred prior to the reinstallation and strengthening of ground support, as recommended by Mr Turner on the 915mL and 925mL.

Set out below is the sequence of firing of the panels on the 915 and 925 levels, both before and after the events of October 2005.

Production blasting dates from the 915W/925W area are tabulated with reference to fig12

Panel (as per fig. 12)	Firing Dates	Reef Segment (as per fig. 7)	Comments
1	23, 25, 26, 28 Sep. 2005	F1 Splay Reef (shear segment)	Fired as upholes from 925mL. Mucked by remote from the east on 925mL.
2	3,4,5 Oct. 2005	F1 Splay Reef (shear segment)	Fired as upholes from 925mL. Mucked by remote from the east on 925mL.
3	9 Oct, 2005, 10 Feb. 2006	F1 Splay Reef (tensional segment)	Initially fired as upholes from 925mL. Interrupted by FoG accompanying firing on 9 Oct. 2005. Remainder fired as downholes from 915mL accessed from the west by a ramp mined for the purpose after 26 Oct. 2005. Mucked by remote from the east via the original access on 925mL after threadbar bolting.
4	16 Feb, 2006	Tasmania Reef (Offset Fault Zone)	Fired as downholes from 915mL accessed from the west by a ramp mined for the purpose after 26 Oct 2005. Mucked by remote from the east via the original access on 925mL after threadbar bolting.
5	11, 12 Mar. 2006	Tasmania Reef (Offset Fault Zone)	Fired as downholes from 915mL accessed from the west by a ramp mined for the purpose after 26 Oct. 2005. Mucked by remote from the east via the original access on 925mL after threadbar bolting.

6	17 Mar. 2006	Tasmania Reef (Offset Fault Zone)	Fired as upholes from 915mL accessed and remote mucked from the west by a ramp mined for the purpose after 26 Oct. 2005.
7	2,3,4,5 Apr. 2006	F1 Splay Reef (tensional segment)	Fired as upholes from 915mL accessed and remote mucked from the west by a ramp mined for the purpose after 26 Oct. 2005.
8	11 Apr. 2006	Tasmania Reef	Fired as upholes in one blast (as recommended by Turner with i-Kon detonators from 915mL accessed and remote mucked from the east via the original access after cone bolting.
9	17,19,20,22 Apr. 2006	F1 Splay Reef (shear segment)	Fired as upholes from 915mL accessed and remote mucked from the west by a ramp mined for the purpose after 26 Oct 2005.
10	20,22,23 Apr. 2006	Tasmania Reef	Fired as upholes from 925mL accessed and remote mucked from the east via the original access after threadbar bolting.

On 25th April 2006, Messrs Knight, Russell and Webb were allocated the task of placing netting at the brow of the remains of the eastern edge of panel 10 to allow the placing of rock fill from the 915 west sill on to the 925 west sill. Figure 13 shows a long section of the operation immediately prior to the rock fall. Messrs Russell and Webb were in a basket at the front of the telehandler which was being operated by Larry Knight. Immediately prior to the rock fall, Mr Knight had lowered the cage onto the rock bund and had left the telehandler to collect some mesh. An overhead plan of the same position is shown at Figure 14. At 9.23 pm there was a seismic event of approximately 2.3 magnitude level, which caused rock falls on both the 925 and 915 levels. Figure 15 is a long section of the mine showing the position of those rock falls and Figure 16 and Figure 17 show overhead plans of the position of the rock falls. Also shown on Figures 16 and 17 is the position of the raise bore tunnel which was drilled to allow the rescue of Messrs Russell and Webb.

It would appear that Mr Knight was trapped under the fall of ground immediately behind

Figure 13

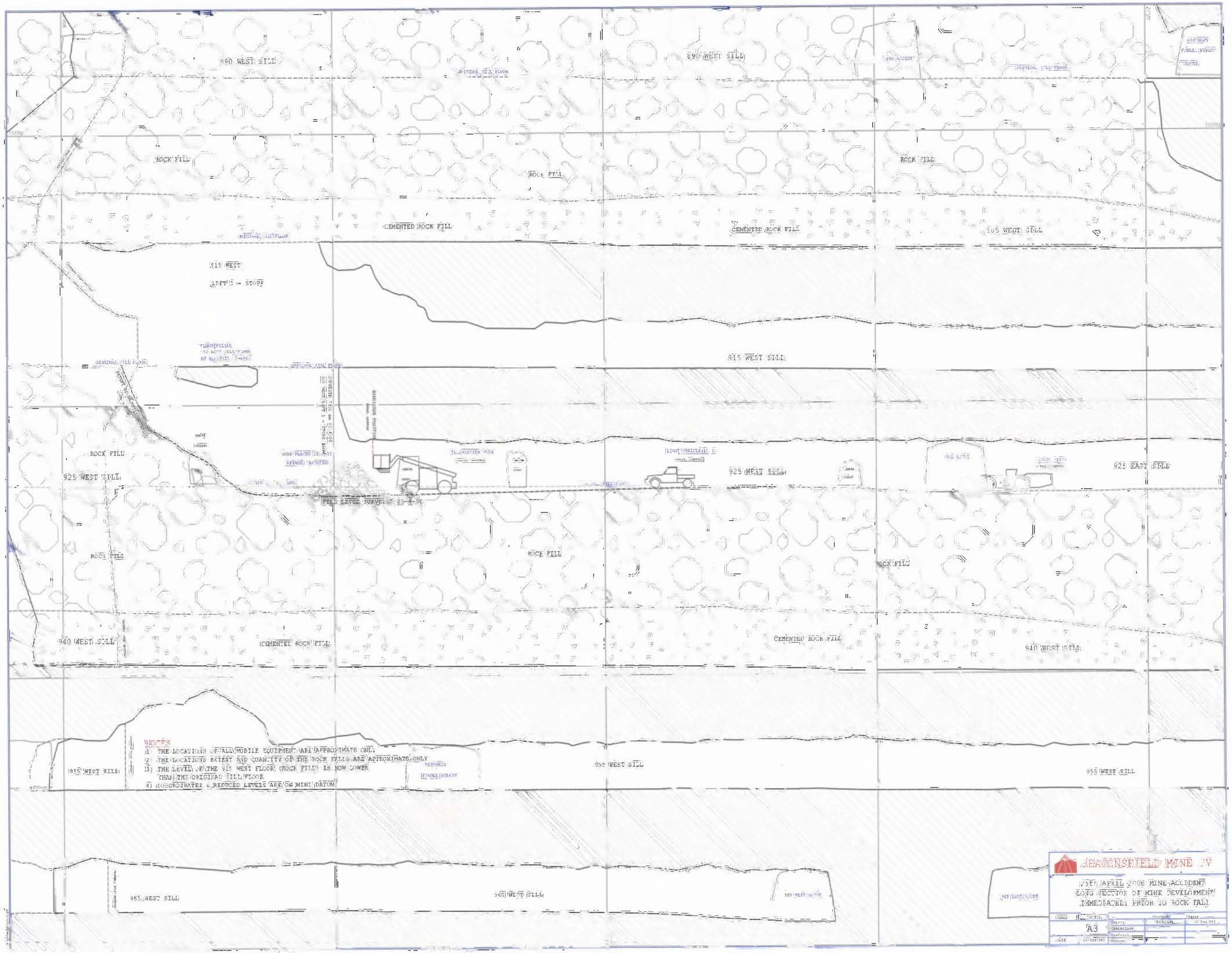


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Figure 14

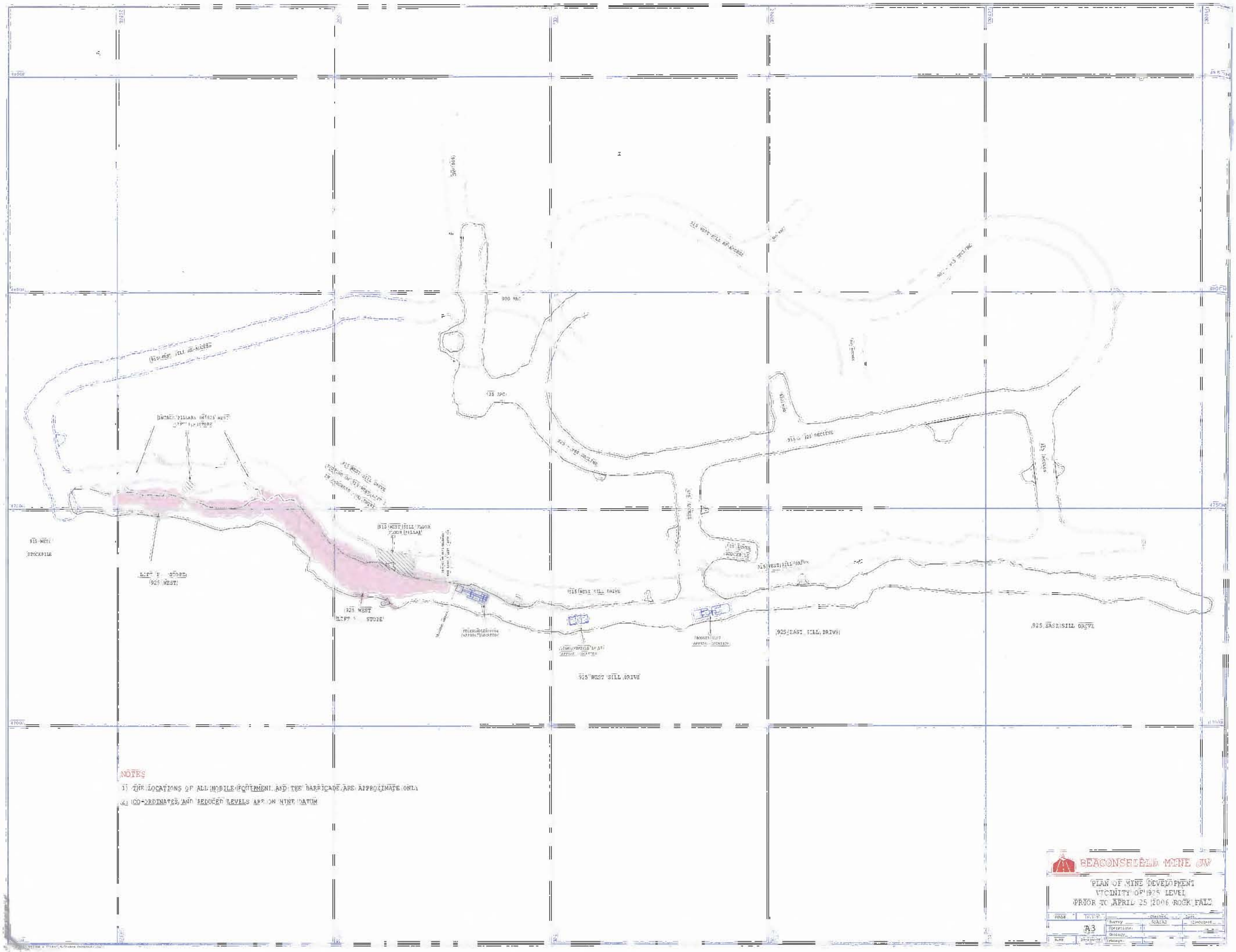

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Figure 15

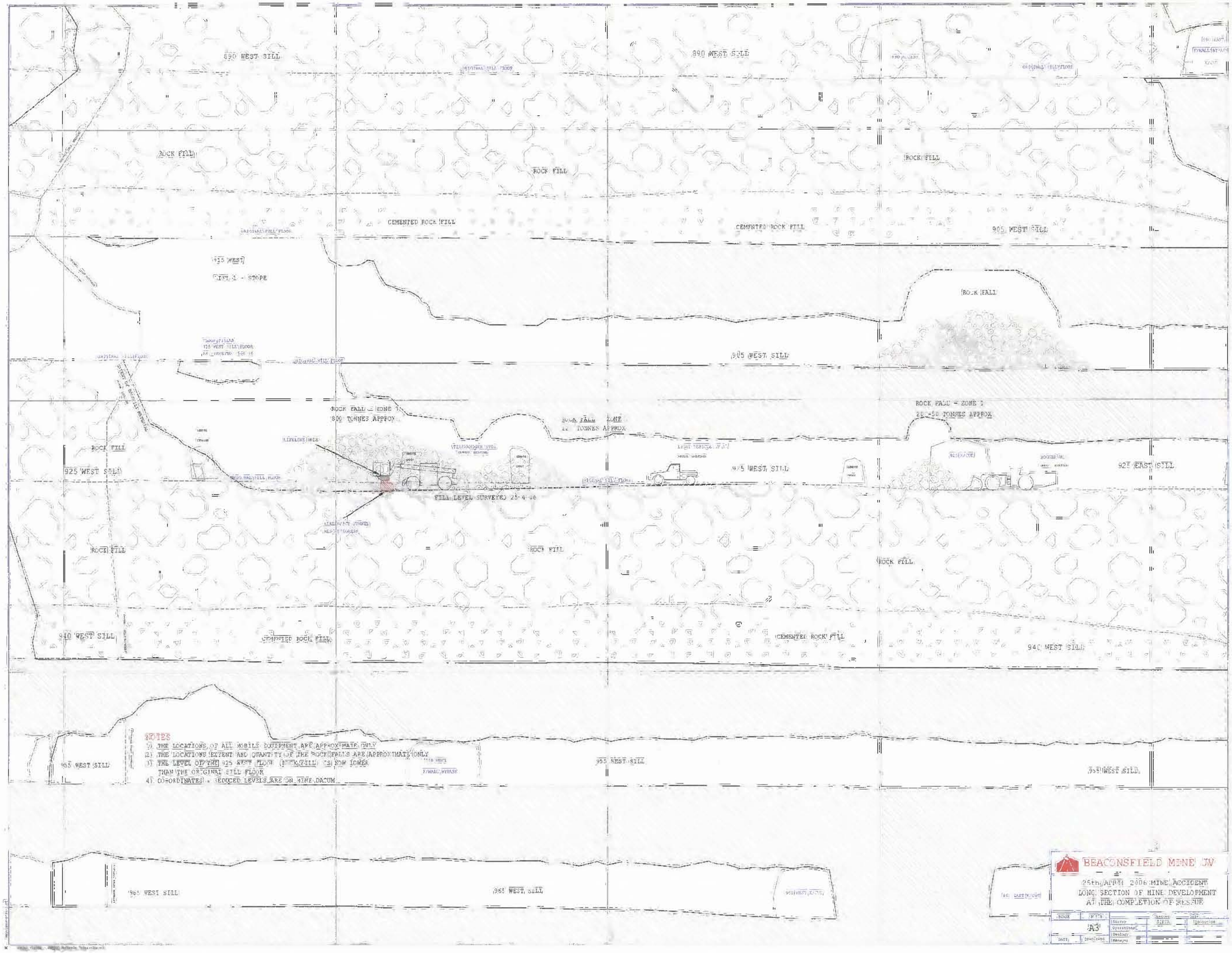

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Figure 16

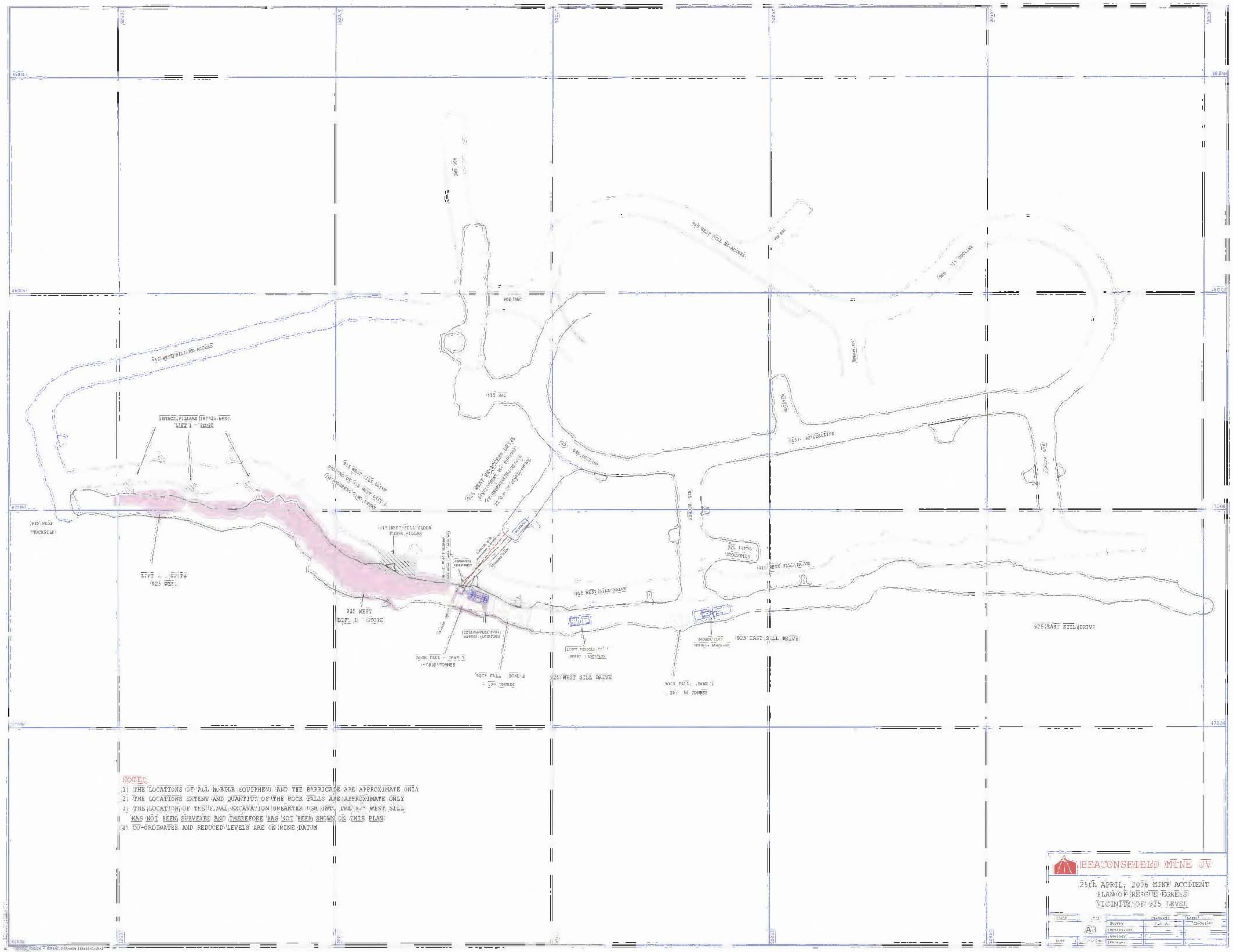
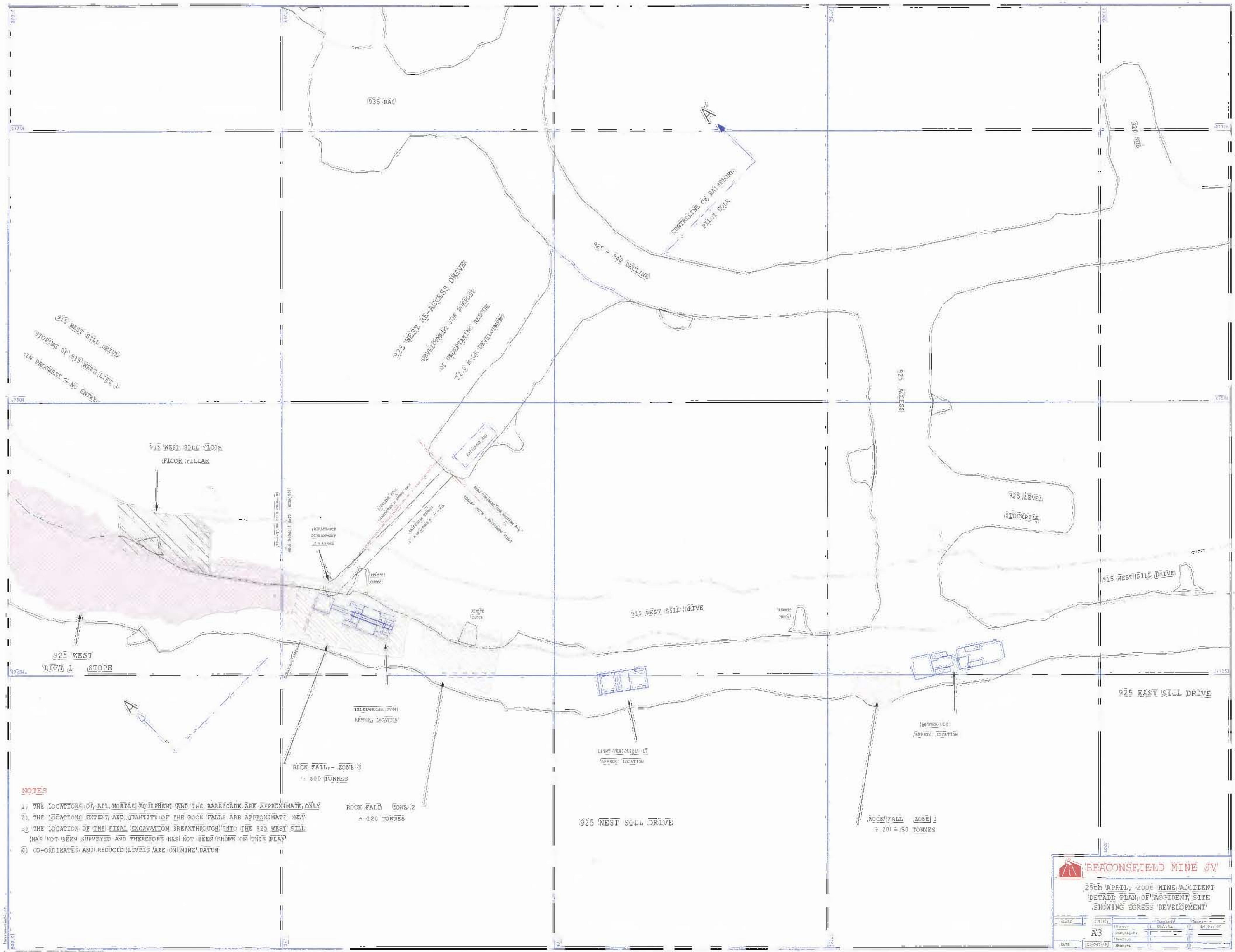

925 WEST SILL DRIVE
925 EAST SILL DRIVE
915 WEST SILL DRIVE
925 EAST SILL DRIVE
NOTES
(1) THE LOCATIONS OF ALL MOBILE EQUIPMENT AND THE BARRICADE ARE APPROXIMATE ONLY
(2) THE LOCATIONS EXTENT AND QUANTITY OF THE ROCK FALLS ARE APPROXIMATE ONLY
(3) THE LOCATION OF THE FINAL EXCAVATION BREAKTHROUGH INTO THE 925 WEST SILL HAS NOT BEEN SURVEYED AND THEREFORE HAS NOT BEEN SHOWN ON THIS PLAN
(4) CO-ORDINATES AND REDUCED LEVELS ARE ON MINE DATUM
BEACONSFIELD MINE JV
25th APRIL, 2006 MINE ACCIDENT
PLAN OF RESCUE EGRESS
VICINITY OF 925 LEVEL
A3

Figure 17



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the telehandler, and *inter alia* the affidavit and letter from the Director of Forensic Pathology Dr C. Lawrence, annexed hereto at Annexures "E" and "F" lead me to conclude that Mr Knight was killed instantly. Dr Lawrence notes that Mr Knight had suffered considerable injuries but there was an absence of the bruising that he would expect to find had Mr Knight survived for any appreciable time after the fall.

I also base this conclusion on evidence obtained from interviewing four supervisors and miners who, in complete breach of mine safety procedures and regulations, but with considerable bravery, entered the unsupported ground in an attempt to locate any survivors. They viewed the areas between the rock falls and called out on several occasions without receiving an answer. None of them saw Mr Knight and three were quite sure that if he had been lying injured anywhere along that drive, that they would have seen him.

CAUSES OF THE EVENT OF 25TH APRIL

BGM obtained reports relating to the event of 25th April from Dr William Bawden and Coffey Engineering, who also engaged the services of Professor Peter Kaiser Chair of Rock Mechanics and Ground Control, Mirarco Mining Innovation, Sudbury, Ontario, and those reports are annexed hereto as Annexures "AW" and "AX". The investigation was assisted by a Canadian-trained, Western Australian-based Mr Scott Marisett from GeoMech Services Pty. Ltd, whose report is annexed hereto at "BC.

The reports are complex in nature and speak for themselves, but simply put, the rockfalls occurred as the result of an unexpected seismic event of a magnitude of 2.3M_L that occurred to the south of the Conglomerate Overlap Zone in the hangingwall. This event was caused by a slip along the C-HW shear shown on Figure 18. As previously noted, this shear had been thought to be seismically benign. Unfortunately, Messrs Knight, Russell and Webb were working within the near field of this event and the ground support was unable to withstand the consequential ground motion.

A definition of shearing appears in the Glossary but could be explained in terms of two rock masses being held together by pressure operating from either side. When pressure is released from either side, these masses can slip, shear or slide, releasing stored energy. As discussed above, there were forces operating from the north and south of the Tasmania Reef but when ore body was removed, such pressures would not be so readily transferred through the Reef. This, in effect allows an unclamping of the shear structures resulting in a seismic event.

A simple illustration is afforded by one holding two hands pressed hard together and trying to slide one hand against the other. If the pressure is sufficient, the hands will not move, but once there is a release of pressure, or unclamping, a sliding motion is possible.

The event was apparently initiated in the hypocentre in the approximate area marked in green on Figure 18, but the energy release was along the C-HW shear and as Professor Kaiser notes, that an event magnitude of 2.3M_L and involved the displacement of approximately twenty thousand square metres of rock. This could suggest movement along the complete length of the C-HW shear as it related to the 940 mining block.

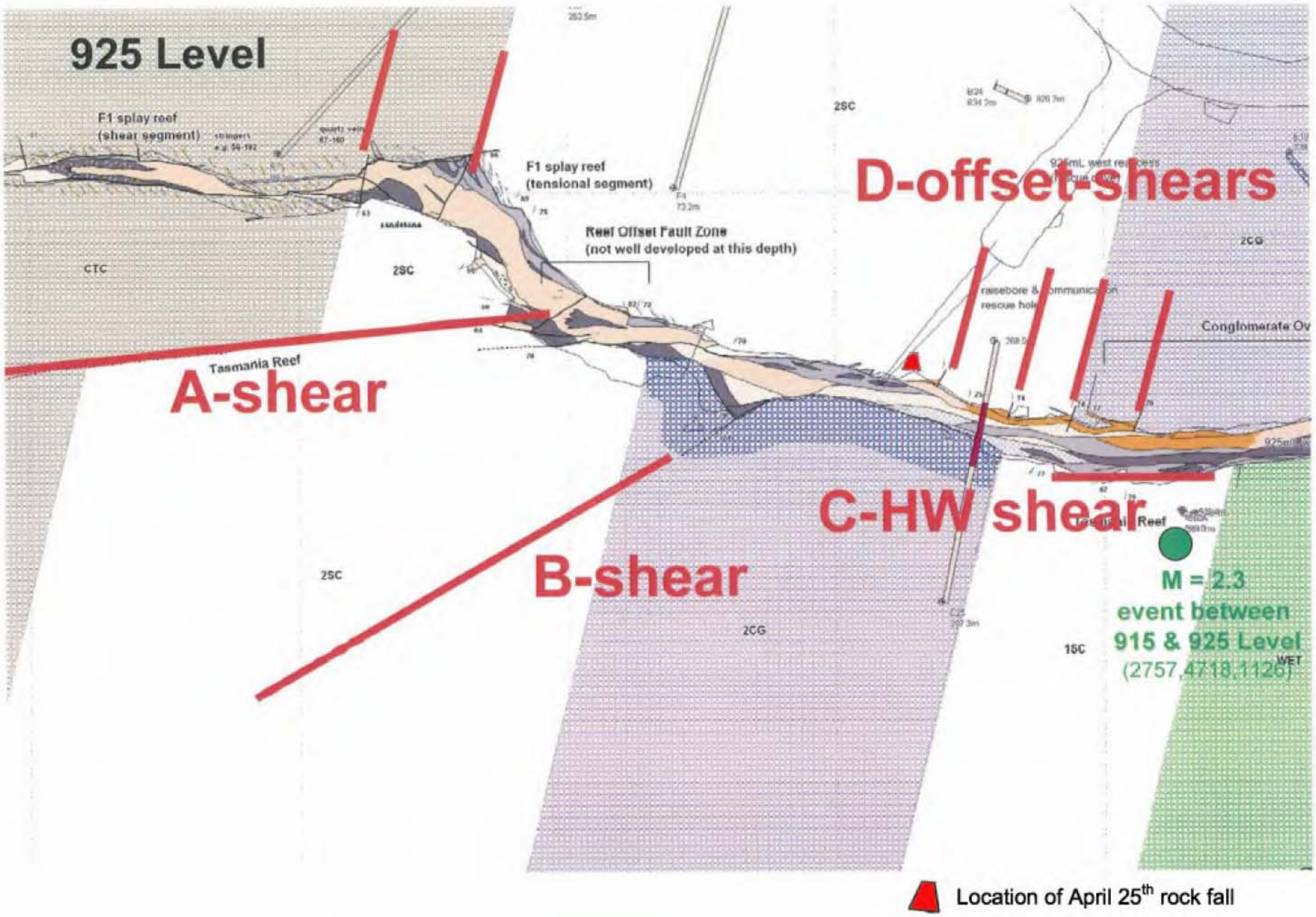

925 Level
F1 splay reef
(shear segment)
F1 splay reef
(tensional segment)
Reef Offset Fault Zone
(not well developed at this depth)
CTC
2SC
2CG
1SC
Tasmania Reef
A-shear
B-shear
C-HW shear
D-offset-shears
Conglomerate Ov
M = 2.3
event between
915 & 925 Level
(2757,4718,1126)
Location of April 25th rock fall

Figure 18

I set out below relevant portions of Professor Kaiser's report;
At page 1

Two friable rock types of the reef (Quartz and Ankerite) are extremely sensitive to straining and rapidly loose their intrinsic strength when deformed past their peak strength. As a consequence, reef sections with wide inclusions of friable rock units and areas that are highly strained (HW-FW-closure) are most prone to deep rock mass degradation and related ravelling. Consequently, these sections are prone to seismic shakedown. This sensitivity has lead to the recent series of FoGs.

The seismic behaviour of the mine is dominated by a series of shears: "Tasmania" Shear (called A-shear) and a splay (called B-Shear) at the west end of the reef; a reef parallel shear in the HW near 2780mE±40 that joins the reef near the 925 Level (called C-shear); and FW-offset shears (called D-Shears) that can be traced back into the FW as far as the decline. The first of two events with magnitudes exceeding M=2 was associated with the A-shear; the second, most recent event with M>2 is interpreted to be related to the C-shear. They are activated when they get unclamped. Events in the FW seem to be related to the D-shears as they are activated by shear stresses when the mining front advances.

The HW-FW convergence experienced by the remnant sill pillars is affected by the reef geometry (width and distance from abutments), the mining sequence, and the D-FW-offset shears. The latter may cause localised gradients and concentrations of FW convergence and thus lead to localised overstraining of the reef.

Due to the friable nature of the reef rocks, the depth of failure propagates rapidly when the friable reef rocks are excessively strained to depths exceeding 1 to 2m. the installed support in the ore development drives consisting predominately of 2.4m splitset bolts at 1.5m spacing with mesh and straps, recent additions of resin point-anchored rebar in some areas, and modified conebolts (in selected sections), is not adequate to hold the broken rock in place. The bolts are too short or support system components are not compatible leading to sequential overloading when the bolts are highly strained. Hence, it is concluded that longer, yielding bolts such as 6m debonded cable bolts or SuperSwellex bolts will be required to ensure stability of ore development drifts in reefs containing the friable rock types.

While declamping of the A- (and B-) shears due to mining at the west end lead to two distinct seismic clusters in the HW and the magnitude 2.1 -event of Oct'05, mining between 940 and 955 (to about 2820mE) declamped the C-HW shear near 2780mE±40 which in turn lead to the 2.3- event of Apr'06 (near the 925 Level). Further seismicity of similar intensity must be expected in these areas and mining sequences must be adopted to manage the energy release in the A-, B- and C-shears. Seismically induced shakedown hazards must be anticipated within at least ±50m from a magnitude 2.3-event.

At page 13:

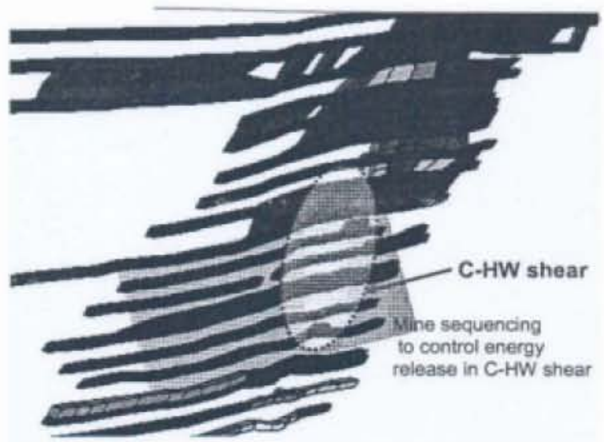
About 10 events with magnitudes M>1 where recorded since Apr'05 and two events exceeding M = 2 were recorded in Oct'05 (M = 2.1) and Apr'06 (M = 2.3; see

Figure 1 and Figure 6). The former event was associated with A-shear and the later was associated with the conglomerate overlap but is reinterpreted here as being associated with the C-HW shear (Figure 1; Figure4).

The suggestion that the conglomerate overlap was the primary cause for the Apr'06 event was questioned for several reasons. First, the stiffness difference between fine-grained host rock and the conglomerate is not very high (at best double). Stiff beds attract stress when deformed; either when affected by mining or when strained due to tectonic deformations. The former situation, most likely lead to the strainbursting observed in the decline at the 1080 Level. In the latter case, the sills should be systematically stressed near the overlap but stress related failure of the haunches was only observed at 955 Level. Also, no consistent evidence could be found that the conglomerates are higher stressed. Nevertheless, it is noted that micro-seismic clustering in these overlap areas suggests that the rock mass is highly stressed in these zones. Finally, to trigger a magnitude M = 2.3 event, a substantial portion of a sill would have had to fail to release the necessary energy (in the order of 200MJ) for such an event. For stiff, strong rock as encountered here, about 100m³ of rock would have to fail simultaneously. This volume corresponds to a 50m section in a 7m high sill of 3m width; clearly such a wide spread destruction of the sill was not observed anywhere (note: the outlines of the failures suggest that only the edges of the sill or the brows were involved in the failure).

It would therefore seem more likely that the event was caused by slip along a shear; the C-HW-shear. The location of the event is shown in plan and section in Figure 4. The Apr'06 event is roughly located where the C-HW shear reaches the reef near the 925 Level. As can be seen from the plan view, this location corresponds to the area where the C-shear passes through the stiffer conglomerates, suggesting that the effect of the conglomerate is to clamp this structure at this location. Considering the dip of the reef in this zone relative to the anticipated stress field (•ι at 0 or possibly -20°/160°), the C-shear is loaded up-dip at an angle of between 25 and 35°, i.e. close to its potential capacity. Since the major principal stress is also inclined relative to the reef, the potential for both strike and/or dip slip exists.

At page 14 of his report, Professor Kaiser notes:



The level of seismicity experienced by and foreseen for the mine is relatively low by international standards of seismically active mines. Hence, there is no reason to suggest that the mine cannot be re-opened based on the level of seismicity experienced. However, as the sills below the 940 Level are being mined, there is a high potential for activation of the C-HW-shear and extraction must be sequenced to control energy release (see margin figure). Support and mining sequence designs must be validated by systematic monitoring and tied to a management and response procedure (i.e., re-entry policy) that is responsive to the hazards posed by a seismically active mine. Appropriates standards, monitoring and training programs at all levels should be implemented.

According to Table 1, when compared to the properties listed above for the recommended support system, the proposed system has a load capacity that is sufficient for minor to major damage severity, a deformation capacity that is sufficient for minor to moderate damage severity, and an energy capacity that is sufficient for minor to moderate damage severity. According to common practice, this is considered to be adequate for seismicity with magnitudes below M_L= 2.5. It must however be understood that there is always a finite risk that this support is not adequate and localised failures must therefore be anticipated. Even if the support capacity was enhanced to the maximum practical support limit (Table 1) there would still be a possibility for support failure (even though with a lower probability for failure.)

Since it is not possible to design a support to prevent all damage from seismicity with magnitudes of the order of M_L <2.5, it is necessary to clearly understand what the limits of the support system are and when and where its capacity may not be adequate. As illustrated by Kaiser et al (1996; Chapter 3) the analytical methodologies are not applicable and dynamic effects become excessive at 10m from an event if M_L > 1.5 and at 20 to 30 m for an event of M_L > 2.5. Consequently, it must be assumed that the recommended support system will cease *to perform well in an ore development drive that is located within 25m from the maximum anticipated (design) event (M_L =2.5).*

As can be seen on Figure 12, the telehandler was well within the near zone of the C-HW shear, and hence I am of the view that it was unlikely that any ground support could have fully withstood the consequences of such a release of energy. I am informed that before formally presenting his report, Professor Kaiser during a conference with Mine management and other consultants, was of a similar opinion.

The Coffey report reached similar conclusions, and I set out some relevant parts of that report at pi .

The BGM geological environment is structurally complex. This study has revealed that the Tasmania Reef departs into the footwall from its host structure, the Tasmania Shear between the 915L and 980L. Mining on both the 915 and 980 and intervening levels resulted in the structure being unclamped. It was also found that a series of bedding parallel shears partially transect the footwall and reef which in turn focuses localised increases in lateral drive closure and resultant rock mass damage.

Both the rate and event magnitude of mining induced seismicity has increased over the past year. There are two distinct sources of seismicity; large shear events on the Tasmania Shear and smaller shear and tensile events that occur in the reef itself and adjacent footwall and hangingwall rocks. The reef events are a product of brittle rockmass failure while the footwall events are interpreted to be associated with some slippage on bedding parallel shears and tensile events in the conglomerate units. A hazard – magnitude analysis performed on all data prior to the 25th April event indicated that the Beaconsfield environment had the potential to generate events with local magnitudes in excess of 2.0ML, however, it was not possible to predict either the time or location of large events.

The reef rockmass is brittle. It is strongly microfractured and variably consists of quartz and a softer mineral assemblage dominated by ankerite. As this material is subjected to strain by the convergence of the hangingwall and footwall, it rapidly degrades into a cohesionless mass of finely fragmented material.

The 2.3ML seismic event is interpreted to have been generated by slip on an unmined section of the Tasmania Shear in the hangingwall of the workings. This structure diverges from the economically mineralised section of the Tasmania Reef at approximately 915L and rejoins some 80m down dip at the 980L. Mining on the 925L has effectively unclamped the structure which was then able to slip.

The main 925L and associated rockfalls were due to seismic shaking caused by the 2.3ML event. This sudden increase in energy was sufficient to exceed the capacity of the installed ground support at the rockfall locations.

And at p26

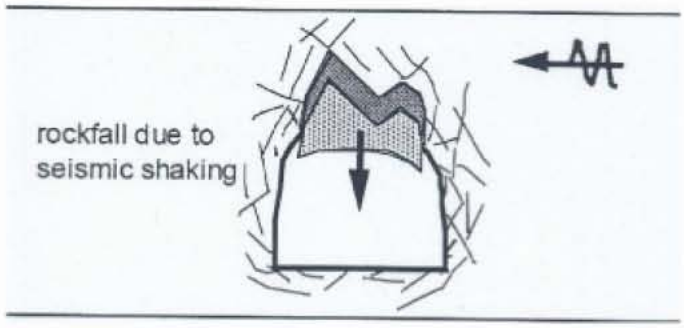


Figure 19 *Schematic diagram showing the interpreted mechanism (Kaiser et al 1996)*

A summary of contributing factors appears at page 26 of the Coffey report

SUMMARY OF INTERPRETED FACTORS THAT CONTRIBUTED TO THE 25TH OF APRIL 2006 FAILURE

From the review of events at BGM prior to the 25th April, it is currently inferred that the main fall of ground on the 925 Level was attributable to:

1. *The progressive stress/strain driven degradation of the quartz ankerite reef due to HW and FW convergence and possibly blasting,*
2. *The presence of geological structures in the immediate fall areas – both the Tasmania Shear and bedding parallel shears forming release planes and allowing increased lateral closure,*
3. *The proximity of the production brow'*
4. *The shaking associated with the incoming seismic waves generated by the 2.3ML event in the immediate hangingwall rocks adjacent to the 925 level, and,*
5. *The recommended support system installed on the 925 Level in the area of the fatal FoG was unable to maintain the stability of the excavation.*

Mr Marisett's findings are in the main consistent with both those of the Coffey Consultants and Professor Kaiser.

I have had the benefit of comprehensive and detailed reports from Dr Quinlan and Mr Marisett, which are set out in full and annexured hereto. I do not intend to overburden this report with large extracts therefrom, but I note below some areas in which I consider further comment may be helpful.

Before so doing, I note that Mr Marisett's report provides valuable insight into the way forward not only at BGM but in all mines with significant levels of seismic activity. It should be noted that the report is designed to highlight perceived inadequacies in some of the procedures in place at BGM rather than an examination of all of the mine's procedures.

It is also relevant to note that Mr Marisett is Canadian trained and brought to bear a different perspective on questions of mine design and methods of ground support. I am aware from my general reading during this investigation that the use in the backs of friction bolts, including split sets, whilst a common practice in Australia was not so in Canada.

In view of the conclusions in the Coffey report that the event of 25th April was not predictable by time or location, I find it difficult to envisage how the mine design could adequately cater for such an event if conventional mining methods are to be used and hence my recommendation to utilise remote bogging in areas of high or unpredictable seismic risk.

I am concerned that the extensive post-accident modelling by BGM and their consultants still does not predict an event of this size and hence feel the only recommendation I can make is for the seismic western stopes of BGM to be remotely mined. I cannot identify any direct causal connection between the concerns raised by Mr Marisett and the events of April 25th, although thicker pillars and more extensive ground support would have reduced the risk of the resulting rockfalls. It seems unlikely that such measures would overcome such a "near field" event.

ROCKFALLS

A contentious issue that has arisen too late in the investigation to now be adequately dealt with is a question of the state of knowledge of all consultants as to the frequency of rockfalls being experienced at the mine. This issue is discussed in both Professor Quinlan and Mr Marisett's reports but I have not had the opportunity to properly investigate the concerns raised, although I note that the Mine management and their consultants were all aware that the mine was becoming more seismically active.

As noted elsewhere, BGM complied with all their WST reporting requirements in relation to rockfalls, but it is not clear as to how many were "reported" to their consultants. BGM maintains that the crucial relevant factor is not the frequency of rockfalls but the fact that between October 2005 and 25th April 2006 there had not been a rockfall as a result of a failure of ground in which had been placed the recommended enhanced ground support

As intuitive as it may seem I am unable to conclude as confidently as Professor Quinlan and Mr Marisett as to the relativity of such levels of rock falls as an indicator of an increasing chance of a major seismic event.

However, it would have been appropriate (and should be in the future) for BGM to provide their consultants (and in the future, WST) details of all rockfalls to allow them access to all information that may be relevant to them when advising as to future mining operations. This course would also ensure that all relevant information was incorporated into any risk assessment process.

ROCK MASS PROPERTIES

There was considerable difference of opinion between Mr Marisett and the Mine in relation to the number of samples taken to determine rock mass properties. The Mine has indicated that they took at least ten samples per rock type and that was considered more than enough, especially as some text books recommended at least five samples per rock type.

However, as pointed out by Mr Marisett, the area to be mined consisted of highly bedded anisotropic rock which would necessitate the examining of the orientation of the rock before determining how many different samples would have to be taken. This was strongly bedded sedimentary rock, and a group of five samples taken from rock running in one direction would not give useful readings for rock that was bedded in another direction. The Mine took at least ten samples of each major rock type, in different orientations. Testing procedures state that tests should be orthogonal and if there is a more than a + or - 10% variation in test results, further testing is required.

At the end of the day I am not sure how much difference additional procedures would have made as the tests in situ taken by the mine and subsequent modelling and testing have shown that the figures obtained by the Mine were fairly accurate and I do not find any causal connection between BGM's testing regime and the events of 25th April.

COMMUNICATION AND CONSULTATION

Professor Quinlan had identified several problems with the management and communication system at BGM and has referred to a significant body of evidence to support his findings, with which I concur.

There is a well-known cultural divide throughout mining operations in Australia, (and probably in most places in the world), whereby there is a perceived "us" and "them" relationship between managers and workers. Unfortunately this perception is widespread and it is up to management to ensure that this culture is not allowed to be perpetuated.

For example, Matthew Gill impressed as being extremely competent, articulate and sympathetic towards his workers. However, many workers considered him to be aloof and commented that they did not see him visit underground very often, to speak to workers either on the job or in the crib rooms.

Workers will always respect managers who actually come down and "get their hands dirty". I am not suggesting that managers should do the work of a miner but regular underground visits and walk-arounds will help to break down both cultural and communication barriers. Mr Gill agreed with this philosophy and stated that he regularly made underground visits which is at odds with the perceptions of many of his workers.

I note that Professor Hopkins has stated the following:

> *"Leaders who wish to attend systematically to safety, and be seen to be doing so, need to develop some regular safety practices. One critical practice is regular site "walkarounds" to talk informally with front line staff about safety issues they may be facing. The report on the Ladbroke Grove train crash in the United Kingdom stressed the importance of this practice; "Companies within the rail industry should be expected to demonstrate that they have, and implement, a system to ensure that senior management spend an adequate time devoted to safety issues, with front line workers.....Best practice suggests that at least one hour per week*

should be formally scheduled in the diaries of senior executives for this task. Middle ranking managers should have one hour per day devoted to it, and first line managers spend at least thirty per cent of their time in the field. (Cullen, 2001;64-65)."

(Footnote – Hopkins, A (2005) Safety, Culture and Risk – The Organisational Causes of Disaster CCH Australia Sydney, p10.

These cultural and communication problems were not as a result of any deliberate action on the part of management, who quite genuinely believed no such problems existed.

Mr Wakefield, the miners' AWU representative, was adamant that none of the miner's concerns in relation to increased seismicity and rock falls had been raised with him and that if they had in fact been so raised he would have brought them to the attention of the Mine managers immediately. He indicated that if he had been allowed more direct access to the workers on site, that these concerns would have been raised with him, and the vexed issue of union safety representatives is addressed in Professor Quinlan's report, and my comments thereon. I also note that no miner indicated to us that they had raised any concerns with their unions.

It also behoves unions to develop their own communication systems and feedback loops with their members to ensure that in future such issues are relayed to union representatives who would be far more articulate in communicating such concerns to management.

RISK ASSESSMENT

The concept of hazard identification and risk assessments is an accepted part of occupational health and safety systems. Occupational health and safety legislation requires employers to ensure that hazards associated with the use of plant and equipment and the systems of work in the workplace are identified and that a risk assessment takes place which takes into account the interaction between plant and equipment, systems of work, the physical layout of the workplace, and the skill and experience of the personnel. Where risks are identified, the employer has a duty to control that risk either by eliminating it or otherwise reducing it as far as reasonably practicable

There are a number of different pro-forma hazard identification/risk assessment sheets which have been produced by various safety bodies which are typically used to demonstrate compliance with this process. Typically they require the person completing the Hazard ID/Risk Assessment to fill in boxes listing the hazard, listing the measures to control the risk, and some measures to assign a numerical risk rating. It is fair to say, that the routine completion of hazard identification and risk assessment forms, such as those referred to above, have debased the currency of hazard identification and risk assessment, especially when low probability, high consequence catastrophic risks are considered. The forms are often done mechanistically and do not reflect the key concepts which underlie hazard identification and risk assessment. They are often done in a routine way to demonstrate "paper compliance" with the statutory obligation.

The use of these pro-formas is not mandated by legislation or regulations. The Australian Standard on risk management – AS4360 - does not prescribe any one process and acknowledges that qualitative, semi-quantitative or quantitative approaches could be adopted. The use of pro-formas in the assessment of the hazard of rockfalls at BGM, especially after the 26 October rockfalls would have been inappropriate and would have run the risk of over-simplifying a technically complex matter. This risk assessment required detailed and highly expert engineering assessments of the exact nature of the hazard then presented, and similarly expert assessments to assess whether the risks posed by these hazards could be remedied by any and, if so, what was required as control measures

Hazard identification and risk assessment is required not only when new plant or new systems of work are introduced to a workplace, but they are also required where new or additional information about hazards becomes available. The 26 October 2005 rock fall at BGM clearly constituted new information about risks at the Mine which required a hazard identification and risk assessment. The Mine's immediate reaction to that event was to cease the mining and to announce in a memo to its employees dated 3 November 2005: "Our current mining method and instruction sequence is now under total review. We will complete the reviews mentioned to ensure that it is safe for our employees to continue."

The 26 October rock fall took the mine management by surprise because of its size (M_L 2.1), the quantity of rock that fell, and most importantly, that it occurred 14 days after the last production blasting in the area. Unlike previous rockfalls where the mechanisms of failure were understood, the mine management were concerned that they did not understand the causes of this incident and that it was necessary to cease mining those areas so that detailed investigations could be carried out. The Mine's Chief Geologist, Mr Hills, phoned Mr Sears of WST to brief him about the issue and invite him to visit the mine. When Mr Sears advised that he was unable to do so, Mr Hills travelled to Hobart on 28 October 2005 to brief him about the 26 October rock fall and the reasons why, unlike previous rockfalls at the mine, this rock fall was of particular concern. The mine provided Mr Sears with a further briefing on the rock fall issues raised by the 26 October rock fall during his visit to the mine on 2 November 2005, and in the written *Seismic Risk Management Update Report* in March 2006 and a follow-up PowerPoint Presentation in April 2006, which reviewed the response to the 26 October rockfalls and also dealt with the significant seismic rockfalls which had occurred at the mine. In light of these briefings, Mr Sears' response and the resources then available to WST, as noted above, it is difficult to speculate as to what Mr Sears would or might have done, had he been provided with information about other rockfalls. Despite none of these rockfalls occurring in areas in which were installed post-October 2005 enhanced rock support, Mr Sears has indicated that he would have had heightened concerns had he been aware of the number of rockfalls which had occurred despite the fact that many of them were not required to be reported by virtue of s47 of the Act. I have already noted that BGM appears to have complied with the requirements of s47 of the Act in relation to rockfalls.

The issues raised by the 26 October 2005 rock fall relating to seismicity and rock falls were then the subject of intense study over the ensuing six months, but it is not clear as to whether the experts were provided with data in relation to all the rockfalls set out in the table at para 736 of Professor Quinlan's report. The Mine engaged a series of expert consultants to deal with specific aspects of the problem. The principal consultant was Mr

Turner, formerly of AMC and subsequently in his own consulting practice. Mr Turner had been engaged with the issue of seismicity management at the BGM since 2004. Mr Turner provided one of many reports to the Mine in November 2005, (Annexure "AM") and conducted audits of the existing ground support schemes in November, and then again in March 2006 to ensure that the upgraded ground support regimes that he had recommended had been implemented. (Annexure "AV") There was a December Report on the issue from the AMC Continuation Study team. (Annexure "AO") There was an additional brief to Dr Sharrock and Mr Basson of AMC to analyse the seismic data held by the Mine historically and to develop a retrospective model and a model for use in future situations. Dr Sharrock of AMC had been involved in work at the Mine since May 2004, and was the peer reviewer at AMC of the work being done by Mr Turner in 2004. Dr Sharrock provided two PowerPoint presentations to the Mine in November, 2005, a draft Report in December and his final Report in January 2006. (Annexure "AR") Mr Basson provided reports in February 2006 and March 2006. (Annexures "AS" and "AT") It is significant that the investigation has been unable to locate any written brief to any of these consultants.

The Mine sought a further opinion on mine methods and ground support the AMC from Dr Mikula an expert in seismicity management from Western Australia as a counter-point to the work being done by Mr Turner and the AMC consultants. In addition, the Mine, through its sponsorship of the MS-RAP Project engaged ACG, a specialist body at the University of Western Australia which was at the forefront of research on mining seismicity and engaged in the development of MS-RAP software which allowed a more discriminating analysis of seismicity, by breaking up the mine's areas into seismic "domains", allowing more specific analysis of the seismic characteristics of those areas. BGM became a sponsor of the MS-RAP project which was a world wide project, in line with Dr Mikula's suggestion. BGM was also participating in mine re-entry research being done by Professor Stephen McKinnon, Chair of Mine Design, Department of Mining and Engineering, Queens University, Kingston, Ontario, Canada. BGM's sponsorship and participation in such research evidences its commitment to keeping abreast of the latest safety developments in its field. Professor McKinnon noted that BGM's GCMP was the best he had seen to date. (See Annexure "X")

The information provided by BGM shows that each of these consultants was provided with relevant documentation (with the possible exception of a complete list of rockfalls) and information, and that they had access to the work being done by each of them. Further, there were meetings between the consultants and the senior BGM technical staff and that their reports were circulated to those technical staff. I am satisfied that the recommendations of the consultants were implemented.

It has been submitted that BGM responded appropriately to the 26 October 2005 rock fall, a serious and unexpected fall of ground, well removed in time from the most recent blasting. The Mine had been monitoring the increase in seismicity at the Mine since early 2004 and monitoring falls of ground associated with that seismicity, in particular in response to the previous work of Mr Turner, and the work of the AMC Continuation Study. Prior to the 26 October 2005 rockfalls, there had been reconsideration of issues such as pillar thickness and the type of ground support being used, and various upgrades of ground support and pillar thickness in response to that seismicity. However, I remain concerned that none of the BGM's good intentions or efforts were underpinned by a formal and rigorous risk assessment.

The Mine provided a response to Item 26 of the Section 36 Notice of 8 June 2006 section 2.7 detailing mine management's response to the October rockfall from a risk management perspective, and which was summarised in the "Seismic Risk Management Update Memo" dated March 2006. In fairness to the Mine, I set out below the section 2.7 extract, which the Mine submits, provides evidence of appropriate risk assessment processes.

Further Steps and Actions Taken Following the Seismic Event in Late October 2005

Following the seismic event in late October 2005, mine management took immediate action to suspend all stoping activities, pending completion of a full review of the situation and an independent geotechnical audit. Mine management took action because the unanticipated seismicity and rockfalls indicated to them that there was a safety concern, and that the risk associated with seismicity had taken on a new or different dimension that needed to be addressed.

In terms of the risk management that was then applied, mine management's view was that a comprehensive review was required in order to properly understand what appeared to be an unanticipated outcome. Mine management considered that a comprehensive review would enable them to analyse and evaluate the risk associated with seismicity to determine whether (and what, if any) additional controls could be implemented to properly manage the risk, in light of the seismic event that had occurred.

To deal with the situation, mine management conducted the following risk management process:

(a) Identification of risk

To identify the risk associated with seismicity after the seismic event of late October 2005, mine management determined that the following audits, reviews and inspections should be undertaken:

(i) Geotechnical Audits
Audits were carried out by site personnel (Adrian Penney) with Turner Mining and Geotechnical Pty Ltd (Mike Turner) in November 2005 and March 2006.

(ii) Geotechnical Reviews and Inspections

Geotechnical reviews and inspections were carried out by site personnel (Peter Hills and Adrian Penney) with AMC Consultants (Glenn Sharrock) and Mikula Geotechnics Pty Ltd (Peter Mikula) in November 2005, AMC Consultants (Frans Basson) in January 2006 and ACG (Daniel Heal) in February 2006.

Mine management commissioned Dr Sharrock of AMC Consultants to back analyse stress and seismicity data to assist mine management to understand the events that had taken place. This included developing site specific rock failure criteria for ore pillars at the Beaconsfield Gold Mine. Mine management subsequently engaged Mr Frans Basson of AMC Consultants to undertake forward analysis of the planned *mining extraction sequence based on the site specific failure criteria developed by Dr Sharrock*

Dr Mikula of Mikula Geotechnics Pty Ltd was commissioned by mine management to provide an independent separate opinion as to the nature of the events of October 2005, the circumstances that led to them and the actions being undertaken as a result.

(b) *Analysis of the risk*

To analyse the risk associated with seismicity following the seismic event in late October 2005, the following discussions were held, and modelling undertaken, at the direction of mine management:

(i) *Discussions*
Discussions were held with the specialist external consultants referred to above following the audits, reviews and inspections carried out at the Beaconsfield Gold Mine. The external consultants also produced reports summarising their findings.

(ii) *Modelling*
Mine management determined that modelling should be undertaken by AMC Consultants in November 2005 (Glenn Sharrock), December 2005 (Peter Fairfield) and February 2006 (Frans Basson) and by ACG (Daniel Heal) in March 2006.

(iii) *Stress measurements*
Mine management determined that further 3D stress measurements should be undertaken by Coffey Mining (Robert Walton) at the 1080mL in December 2005/January 2006.

(c) *Evaluation of the Risk*

To assist mine management to evaluate the risk associated with seismicity following the seismic event of late October 2005, AMC Consultants and ACG were requested by mine management to undertake various modelling work. This was done by AMC Consultants (Glenn Sharrock and Frans Basson) in December 2005 and February 2006 and ACG (Daniel Heal) in March 2006.

(d) *Changes Implemented to Control the Risk*

Mine management considered the situation carefully, including the reports, analysis and evaluation that had been undertaken in relation to the risk associated with seismicity following the late October 2005 seismic event. They formed the view that if certain additional controls were implemented, the risk associated with seismicity could continue to be appropriately managed, notwithstanding escalation in seismicity at the Beaconsfield Gold Mine.

The changes that mine management considered necessary and which they decided to implement, as the key tools to manage the risk associated with seismicity *following the seismic event of late October 2005 are summarised below:*

(i) ***Enhancement of Ground Support***
Mine management made the decision to upgrade ground support to the latest recommended standard throughout the mine (these standards were incorporated into version D of the GCMP) and to undertake a documented audit of all accessible sill drives. The audit was undertaken by Turner Mining and Geotechnical Pty Ltd (Mike Turner) in conjunction with site personnel (Peter Hills and Adrian Penney) (November 2005).

Mine management implemented a formal audit system to ensure that all headings were supported to the latest standard (as contained in version D of the GCMP). Mine management made it mandatory to retrospectively support all previously developed sill drives which remained in use to the latest standard, rather than only adopting those new standards for new sill drives. Mine management also implemented a ground support checklist outlining work to be completed, and this was issued with the design plans for that work. The work was then required to be signed off as having been completed on the November 2005 audit form before production commenced. A further external audit to ensure that this process was being implemented was undertaken in March 2006 by Turner Mining and Geotechnical Pty Ltd (Mike Turner) in conjunction with site personnel (Adrian Penney).

Enhancements in ground support included the wider use of threadbar bolts, straps and mesh.

(ii) ***Installation of Dynamic Support***
Mine management made the decision, at the recommendation of the specialist external consultants, to install cone bolts for dynamic support in areas which had been identified by the specialist external consultants as requiring enhanced dynamic support above that which threadbar bolts could provide. Specifically, this was in 915mL and 955mL.

(iii) ***Mining away from the Offset Fault***
Mine management took steps to ensure that mining occurred away from the Offset Fault to reduce the risk of mining induced rock stress as several specialist external consultants recommended.

(iv) ***Mining Sequence***
Mine management decided to accelerate the introduction of "checkerboarding", immediately following the resumption of stoping.

As set out in the AMC Continuation Study, it had been understood for some time that a change in the mining sequence would be appropriate as the Beaconsfield Gold Mine went deeper and the associated rock stresses increased. The decision was taken by mine management following the seismic event of late October 2005, to accelerate the introduction of the "checkerboarding" mining sequence as early as possible. For the 940 stoping block (which includes the 915W and 925W), this involved transitioning to "checkerboarding" in that stoping block to the maximum *extent reasonably practicable in light of the existing development.*

On the basis of advice from specialist external consultants and on their own analysis, mine management believed that a change in the mining sequence would reduce the amplification of rock stress. Checkerboard mining is discussed in greater detail in section 7.

(v) Alternative access

Mine management decided that the site of the rockfalls caused by the late October 2005 seismic event would not be rehabilitated and designated the site as a non-entry area for site personnel. Mine management decided that an alternative access into the western-most extremity of the 915mL was to be mined and the remaining ore extracted using a combination of down-holes and up-holes from 915mL.

(e) Monitor and Review the Risk

To monitor and review the risk of seismicity at the Beaconsfield Gold Mine following the seismic event of late October 2005, mine management decided that a specific audit should be undertaken. This audit was undertaken by site personnel (Adrian Penney) and Turner Mining and Geotechnical Pty Ltd (Mike Turner) in March 2006 and a report of the outcome was prepared by Turner Mining and Geotechnical Pty Ltd and provided to mine management.

A report reviewing the seismic hazard was received in April 2006 ("Analysis of Seismic Data and Seismic Hazard Assessment" by D Heal, ACG) as part of Phase 3 of the MS-RAP Project of which BMJV was a sponsor. The report provided an interpretation of seismic data, and an assessment of an area's seismic hazard. It rated the 915-925 CG Overlap Zone (the area of the ANZAC Day event) seismic hazard rating as moderate, and it did not predict the Anzac Day event in the cluster group 915-925 CG Overlap Zone.

Mine management appointed an additional senior mining engineer to assist in the increased mine planning and sequencing aspects as a result of the increased work load associated with monitoring and reviewing the risk associated with seismicity at the Beaconsfield Gold Mine.

(f) Communication and Consultation in Relation to the Risk

The seismic event in late October 2005 was an indication to mine management that there had been an escalation in the risk associated with seismicity at the mine. As a part of the risk management process being applied by mine management, they decided that it was important to communicate and consult with site personnel and the community in relation to the risk associated with seismicity, the seismic event of late October 2005 and the additional controls that were to be put in place before full production activity would recommence.

In terms of other communication and consultation in relation to the above issues, mine management decided that the following steps should be implemented:

(i) ***Ongoing communication with WST and other government bodies***
This was done by Peter Hills through briefings to WST which were given on 28 October 2005, 2 November 2005, March 2006 and the provision of further updates by way of written material. Briefings were given on 28 October to officers of DPIWE, and in February 2006 to DPIWE, WTC, the Tasmanian Minerals Council, the Department for Economic Development and the Legislative Council.

(ii) ***Community Consultation***
This led to the holding of a community forum on 2 March 2006; and

(iii) ***Communications with Site Personnel***
Mine management explained and discussed the changes to mining methods with site personnel and also explained and discussed the additional controls being put in place to manage the risk associated with seismicity. This occurred during informal discussions, at shift supervisor meetings, planning/scheduling meetings and toolbox meetings between October 2005 and April 2006, at information sessions held in October and November 2005 and April 2006, and in response to any specific questions raised by members of the underground workforce. This included discussion of the sequencing plans, copies of which were displayed on notice boards underground and on the surface. The steps required to transition to checkerboarding were also discussed at these meetings. Participants were invited to ask questions, raise any safety issues or concerns and reminded that they should leave any area they thought it was unsafe and report this to a shift supervisor.

In addition, mine management arranged for site personnel to be trained on the installation of modified cone bolts. This training was conducted by Strata Control Systems, the bolt supplier in Australia and Mansour Mining, the modified cone bolt manufacturer from Canada.

Mine management also continued its practice of giving one on one training to individual members of site personnel as requested or required, covering how the ore was being mined, what stresses were acting on the orebody, the measured seismicity, the ground support being used, what to look for when entering a heading, how to determine if the ground support installed looks standard and how to report a rockfall.

As described above, mine management undertook a comprehensive review of the situation following the seismic event of late October 2005, which included the identification, analysis and evaluation of risk. Based on specialist external advice and their own consideration of the situation, they decided that although there had been an unanticipated escalation in seismicity at the mine, the risk could be appropriately managed with the additional controls that they had put in place. Therefore, they decided it was appropriate for mining operations to recommence, in a staged fashion, but continued to monitor the situation after this occurred. Finally, mine management took steps to ensure they regularly communicated and consulted with site personnel, the Joint Venture Committee, WST and the community regarding seismicity and the risks associated with it.

An overview of the steps taken by mine management to manage the risk associated with seismicity at the Beaconsfield Gold Mine following the seismic event of late October 2005 is documented in a memorandum entitled "Seismic Risk Management Update", dated March 2006.

The steps outlined above may well amount to a series of commendable actions, some of which would form part of risk assessment practices, but do not in my view amount to an appropriate risk assessment.

The striking feature of the 26 October 2005 rock fall was that it occurred at a time when there had been no blasting for a period of 14 days. It was clearly appropriate for the Mine to stop the mining and reassess all its management of seismicity. The M_L 2.1 event was very significant, a "mini earthquake" as quoted in Mr Gills' Memo to the BGM employees on 1 November 2005. However, seismic events are common in mines including many Australian mines. At least ten currently operating Australian underground hard rock mines have had seismic events of greater than M_L 2.0, and five have had events ranging from 2.5 up to 3.5. Most of those mines are in Western Australia. BGM had engaged the authors of some of these reports (Mikula, Hudyma) to advise it when seismicity became an issue at the Beaconsfield mine. Personnel from BGM also met and discussed monitoring and managing mining induced seismicity with two other authors (Slade at the Kundana Gold Mine (WA) and Butcher (at the Longshaft Nickel Mine (WA)).

The critical question to be addressed was not whether seismic events will occur, but whether a mine can plan for and manage large seismic events. Appropriately, BGM engaged consultants expert in the field of seismicity to provide it with advice about the situation at BGM. Unfortunately, no one seems to have included the possibility that the C-HW shear was seismically active in their calculations or considerations, and this is typical of the sort of consideration that could be highlighted by an appropriate risk assessment process.

Another consideration that may have been thrown up by a formal risk assessment was the predictability or otherwise of the rockfalls set out at paragraph 736 of Professor Quinlan's report. If some were not explainable by known seismic risks it may have highlighted the presence of other possible seismic risks.

BGM appears to have had in place appropriate systems to counter an event such as that of 25th October 2005 but had not considered such an event occurring in the location of the Anzac Day event. During the investigation process there were several comments made to the effect that the proximity of the rockfalls of 26th October 2005 and 26th April 2006 indicate that the latter falls were clearly foreseeable. As intuitive as this approach may seem, it fails to appreciate that the critical aspect is the location of the event and its consequences which led to a rockfall and not the location of the rockfall itself. The event of 26th October was well to the west of the area being worked and the ground motion would have substantially dissipated by the time it reached the areas of the rockfalls. I consider that the ground support in place as at 26th April would have been unlikely to fail if there had been a repeat of the event (both in location and size) of 26th October. The fatal difference was the unexpected location of the April 26th event.

The status quo encountered by the consultants briefed to advise on the October rockfalls at BGM was that mining had ceased until it could be recommenced safely. Although the

Investigation has not found any document specifically asking the question, "Can mining be recommenced safely?", I cannot conclude of anyone concerned - consultants and management alike – that they would have made or accepted recommendations, or that BGM would have recommenced the mining if any of them thought that it was unsafe to do so. It would seem obvious that if, on inspection, any of the parties involved in the decision making thought that there was not a safe way to do the mining at BGM that they would have said so. None of them did, but then, none were asked the seminal question that would have put this issue beyond doubt– "Is it safe to continue mining these areas?"

If the answer to this question had been equivocal, BGM had demonstrated its preparedness to cease mining when conditions became unsafe as demonstrated by their immediate cessation of mining in October 2005 and the permanent closure in early 2005 of a portion of the 955W sill drive when it was being mined, due to bad ground. The ore in this section was abandoned and a bypass was tunnelled at a very significant cost.

The fact that large seismic events are managed safely in other mines, including Australian mines, means that the option of continuing the mining was available, subject to the specific conditions at BGM. I found no evidence that any of the main decision makers, consultants or management alike, believed that it was not safe to continue the mining. However, I recommend that for future planning all shear structures present in the mine be treated as having the potential to become seismically active.

The investigation received many submissions, most of which have been dealt with by Professor Quinlan and Mr Marisett or in the general body of this report.

I note that we received submissions from residents concerning about damage and cracking to their homes caused by seismic activity, but these are not matters within the scope of this report.

I was also asked to comment as to whether emergency procedures, including procedures for escape and rescue caused or contributed to the event. There was no evidence to suggest anything other than such procedures were more than adequate and all personnel involved should be commended for their ingenuity, bravery and assistance which led to the successful rescue of Messrs Russell and Webb. I consider the successful events after the rockfalls of 25th April to be outside the scope of this report, but note that the adequacy of the procedures in place is addressed by Professor Quinlan at paras 26, 31, 51, 81, 162-4, 576-8, 553 and 559 – 60 of his report.

CONCERNS EXPRESSED BY THE KNIGHT FAMILY

I received a separate written submission from Mr Shane Knight, the brother of Larry Knight, and also some information from Larry Knight's wife, Jaquie.

Although many of the matters are addressed in the investigation's reports, I will comment further on some of the concerns raised by the family.

There is some dispute or confusion about the location of a fall of ground observed by Shane Knight in the decline, which I was unable to resolve. I consider it to be a matter of little import in relation to the nature of the other events discussed in this report and do not think it necessary to resolve this issue.

Jaquie Knight was upset about incorrect information supplied as to the condition and location of her husband's body. Shane Knight expressed similar concerns. It appears that there were several pieces of incorrect information passed on to the family. It may well have been that those communicating the news were attempting to soften the blow, but it is important in events of this nature that accurate information be quickly relayed to the families of miners involved in such tragedies. I could find no evidence of deliberate mis-information by the mine or its employees, and Jaquie Knight has been complimentary of the mines' actions towards her after the rescue operation.

Shane Knight expressed concerns about the rescue methodology and inquired about the possibility of the mine using heat seeking equipment prior to allowing a remotely controlled 15 tonne bogger into the area of the rockfall. This concern was well justified, but the mine was not able to use this technology because of the relatively higher ambient temperature (approximately 30 degrees at the 925 level.)

The family were concerned that Larry Knight may have been killed by the later recovery operations rather than in the initial rock fall. This matter has already been discussed above and I am satisfied that he would have been killed instantly by the rockfall.

Shane Knight expressed concern about the condition of the backs, and that the Mine was not using low impact explosives. Paul Raftery accompanied Mr Knight on his inspection of the mine and noted that there was some unevenness in the backs caused by the friable nature of the rock. He ascertained that the mine was in fact using low impact explosives, and I have since checked this and it has been confirmed by the mine.

Shane Knight also raised questions about the morale of the work force and the communication system within the mine. Jacquie Knight also indicated that Larry had complained that it was difficult to get messages through to the Mine management, and as noted in this report and the report of Professor Quinlan, these concerns were justified.

Shane Knight also expressed concerns about the fact that he'd been told there were four rockfalls on the 915 and 925 levels. This information is correct, and the position of those rockfalls is set out at Figure 12. These rockfalls had been disclosed to WST.

Shane Knight also expressed concerns about the operation of a bonus system, and Professor Quinlan has adequately dealt with the problems associated with this system. I have made recommendations in relation to same

Mr Knight queried the mining method being used at the time of the rockfall, but as previously noted, this is a complex issue and has been dealt with at length earlier in this report. However, he also expressed concern (as did many of the miners) about the removal of crown pillars. I should note at this stage that these are horizontal rather than vertical pillars and many miners felt that if such pillars had been left in place below 800mL that there would have been less seismic activity in the mine. Mine management and consultants considered that this was a potentially more dangerous course as a pillar failure could lead to a catastrophic domino effect and it was far safer to allow a gradual settling of the mined areas. When interviewed, Mr Turner was of the opinion that pillar-less mining was the appropriate method for BGM. However, these reasons do not seem to have been adequately communicated to BGM's workforce.

FINANCIAL CONSIDERATIONS

There was some concern expressed during the investigation (including by Shane Knight), that the pressures of Receivership may have impacted upon the safe running of BGM.

I could find no evidence to suggest any inappropriate financial pressures upon the management and investigation obtained the services of a forensic accountant Mr R.L. Byrne now of BDO Kendalls, to review the mine's OH & S expenditure. His reports appear at Annexures "BA": and "BB" and I have set out below a summary of findings.

1. For the period 1 July 2001 to April 2006 the expenditure of OH&S was $3,296,104 against a budget of $3,665,832. The majority of the expenditure was on OH&S staff and general administration. There were shortfalls of expenditure against budget in the areas of Training, Monitoring/Audits, and Emergency services:

   (a) **Training.**

   We reviewed training on OH&S and across all departments. Whilst there was a shortfall of expenditure against that planned, expenditure on training has been consistently incurred across all periods.

   (b) **Monitoring/Audits.**

   For the calendar years ended December 2002 and December 2003 there appears to be limited or no expenditure on monitoring and audits. In the six months to December 2004 some considerable expenditure was made on monitoring/audits and this was continued during 2005. Limited expenditure is shown for the period October 2005 to April 2006 (when mining operations had been suspended).

   (c) **Emergency Services.**

   In every six month period expect one there has been a shortfall of expenditure over that approved by the mine budget.

2. **Capital Expenditure.**

   We were satisfied that whilst the actual expenditure was well below that planned, that the differences relate to over budgeting, or to projects that were deferred to later periods that were again included in the budgeted figures. We do not believe that there was a significant underspend on capital expenditure on OH&S against that included in the six monthly mine plans.

3. **Accident Reports.** The safety statistics provided by the joint Venture are accurate and there had been a trend downward in the number of accidents particularly since August 2002.

THE ROLE OF WORKPLACE STANDARDS TASMANIA

This investigation was asked to examine the role of the Government regulator (WST) and in particular the adequacy of processes and procedures established to ensure that the obligations imposed by the Workplace Health and Safety Act 1995 (WHSA) were adhered to.

WST is an organisation that has jurisdiction for safety at all workplaces in Tasmania. In the context of this investigation it is logical to restrict an examination of the role of WST to how that function was being addressed with respect to safety in mines.

Examining the role of WST has consequently been restricted to its responsibility for health and safety in mining, and in so doing it is acknowledged that some of the issues raised may apply more broadly to WST, however this is a matter for WST and government to address. The examination of WST by this investigation consisted of:

1. Discussions with Departmental officers, principally Chief inspector F Sears and his assistant M Smith;
2. An examination of a range of departmental files; and
3. Seeking and receiving submissions from WST in response to a range of questions provided. Documents submitted by WST were

(a) *Submission to - G Melick S C Beaconsfield Investigation 1 November 2006* (That document was incomplete and identified a further submission would be submitted)

(b) *Submission to Beaconsfield Investigation - response to Question 9 and discussions concerning the office of the Chief Inspector of Mines* (this document had two attachments listed below)

(c) OCIM Workers Compensation Claims Since 1 July 2005 (Attachment 7A)

(d) Mining Fatalities 1967-2006 (Attachment 7B)

The role of WST has also been discussed at length by Professor Quinlan in his report with associated recommendations provided. While it is not practical to fully canvass here the issues raised by Professor Quinlan it behoves WST to examine them in detail.

At the time of the Beaconsfield disaster it seems without question that the government resources applied to inspecting, monitoring and enforcing safety in mines and mineral processing sites was inadequate. The situation was described by Professor Quinlan as:

> *"In sum, available evidence indicates that WST is not adequately resourced to carry out its tasks in relation of mining safety. Inspectors acted diligently but were not in a position to give management's response to seismicity the close attention warranted, especially after the seismic events in October 2005. While it will always be open to conjecture whether a more adequate level of resourcing would have helped to prevent the incident of 25 April 2006 – and this conjecture in no way*

diminishes the responsibilities of other parties – it seems clear that several underground inspections, including areas of the rock falls, and even cursory discussions with workers would have resulted in more scrutiny of management's response, to the benefit of all concerned. There are also good grounds for believing that a better resourced inspectorate, vigorously but equitably enforcing the legislation, would make a substantial contribution to improving OHS standards in the Tasmanian mining industry"

The under-resourcing with respect to mines seems to have had its genesis in a misplaced ideology that a move to performance based legislation in 1995 would somehow create a ground shift in the approach to safety by the mining industry such that the government resources needed for inspection and compliance could be drastically reduced from about 10 persons to 3.

Professor Quinlan notes that most jurisdictions have retained a separate mining inspectorate, while taking a cautious approach to introduction of performance based legislation, such that separate acts (some subsidiary) or regulations have been retained for mining in recognition of the special hazards of mining together with the specialised knowledge needed for mining inspectors.

A review of the policies, procedures and business plan attached to the initial WST submission indicate the WST Inspectorate Branch had a not unreasonable approach to its stated purpose

The Branch's purpose is to add value to the Tasmanian community by ensuring high standards of service delivery reflected in better occupational standards and community safety. Our aim is no deaths, serious injury, disease, or damage to property and fair working conditions that meet or exceed minimum requirements.

A review of the business plan also shows the Inspectorate Branch responsibilities are broad and that while the Project Objectives for the Mines Inspectorate are worthwhile with the planned outputs being modest the planned resources were unavailable and so the outputs were not delivered.

At the time of drafting this report the Office of the Chief Inspector of Mines (OCIM) had only the Chief Inspector and the two generalists recruited after Beaconsfield, the Senior Inspector left in late 2006 to take up another position. Since that time WST has grappled with budgetary, classification and procedural issues, has advertised for personnel but has failed to employ anyone.

In this sense little has changed post Beaconsfield and while the investigation is aware of a litany of issues it has to be noted that from a whole of Government perspective there had been a failure to deliver a sensible response to the issues plaguing the OCIM prior to Beaconsfield.

This investigation has formed the view that Tasmania should have a properly resourced inspectorate that can have a proactive impact on safe mining in Tasmania as opined by Quinlan above. The issue remains as to what is the appropriate resourcing for the OCIM. This investigation supports the recommendations of Professor Quinlan that

1. WST add one mining qualified person to the existing establishment of five

making a total of six of whom three would be mining qualified

2. WST urgently address the pay scale issue so mining qualified persons can in fact be recruited
3. The vacant positions in the OCIM be filled urgently
4. Geotechnical expertise be sourced from other inspectorates or consultants on an as needs basis.
5. Budget resources and support staff are provided to allow efficient operation of the OCIM

It is noted that this recommendation exceeds the five suggested by WST by the addition one mining qualified person. It is noted that the suggestion of five by WST carries considerable qualifiers as to its workability and appears to overlook the fact that the Chief Inspector carries a managerial role in addition to an inspectorial one. For these reasons the recommendations of Professor Quinlan are considered more prudent.

People will ask the imponderable question *"would the application of more WST resources have prevented Beaconsfield?"* It is of course impossible to say and to do so would inevitably involve some conjecture. The Beaconsfield event was quite complicated and impacted on by a broad range of factors over time, only one of which was WST resourcing.

What can be said is that had there been a more proactive approach by WST this would have led to them having more involvement with the mine, having more information and consequently the mine likely being challenged as to the adequacy of its response to the emergence of seismicity and to the import of the series of rockfalls occurring prior to the incident. However, in view of the many reports obtained by the mine following the October rockfalls it would seem unlikely that WST would have required further action on the part of the mine.

THE ROLE OF GOVERNMENT IN ACHIEVING OHS COMPLIANCE IN TASMANIAN MINES

One of the key roles of government is to identify or respond to matters of concern that improperly or unfairly affect its constituents and to introduce laws to regulate such matters or activities, in this case the issue is "Mine Safety".

The WHSA legislation covers mining and makes it clear that the employer is legally responsibility for health and safety and is required (in part) to "…ensure so far as is reasonably practicable that the employee is, while at work, safe from injury and risks to health…"

The Act also places obligations on employers, designers, manufacturers, importers, suppliers, installers as well as self employed persons to not adversely affected the health and safety of any person as a result of the work carried on at a workplace.

Having made legal provisions for the safety of employees the government also has a moral and a political responsibility to apply sufficient enforcement resources to achieve a level of compliance with the WHSA that is acceptable to government and its constituents.

The challenge for any government in enforcement activities is that it has a responsibility to apply sufficient resources to each of the many areas of government and has to do so within the constraints of the overall resources available. A failure to apply sufficient resources in a particular sector to meet community expectations usually leads to the drawing of negative conclusions eg "the current level of death and injury from road accidents is unacceptable"

The legislation and resources applied to mine safety are discussed below.

RESOURCES APPLIED TO MINING BY WST AT AND PRIOR TO THE INCIDENT

At the time of the Beaconsfield incident on 25th April 2006 there were two inspectors of mines for the State of Tasmania, one of these also carried the role of the Chief Inspector.

The below timeline was provided by WST

Timeline:

1994	1996	2000
Coverage: Mines, quarries Resource: Chief Inspector of Mines 5inspectors of mines 4 mining specialists Chief Inspector of Explosives and 8 inspectors of explosives (shared).	Coverage: Mines, quarries and energy Resource: Chief Inspector of Mines 1 mining Engineer 1 inspector equivalent (generalist)	Coverage: Mines, quarries and energy Resource: Chief Inspector of Mines 1 mining Engineer I inspector equivalent (generalist)

2002	2003	2005
Coverage: Mines, quarries and energy Resource: Chief Inspector of Mines 1 mining engineer 1 inspector equivalent (generalist)	Coverage: Mines, quarries and energy Resource: Chief Inspector of Mines 1 inspector equivalent (generalist) for a period from 1 Jan 03 until Dec 7 03	Coverage: Mines, quarries and energy Resource: Chief Inspector of Mines 1 Senior mining Inspector (generalist) 1 inspector equivalent (generalist) Additional funding: Provision for 3 additional mines inspectors to replace 1 inspector equivalent.

2006	October 2006	July 2007
Coverage: Mines, quarries and mineral processing Resource: Chief Inspector of Mines 1 Senior mining inspector (generalist) 2 new mining inspectors (generalist) One position unfilled	Coverage: Mines, quarries and mineral processing Resource: Chief Inspector of Mines 1 Senior mining inspector (generalist) 2 new mining inspectors (generalist) One position unfilled	Coverage: Mines, quarries and mineral processing Resource: Chief Inspector of Mines 2 new mining inspectors (generalist) Two positions unfilled

WST explained the change in resources as:

> *"The timeline shows significant resource shift downward from 1994 to 1996 and thereafter remains somewhat constant apart from periods of recruitment. Introduction of the Workplace Health and Safety Act 1995 legislation was primary reason for resource reduction from initial establishment. During this period there was a shift downward in specialist activity from within Workplace Standards Tasmania generally including mines activity. There was increased expectation on employers to identify, assess, control and monitor hazards to meet duty of care requirement in all industries including mines."*

Concurrent with the introduction of the WHSA and the reduction of resources to inspect mines was the removal of the Mines Inspectorate from Mineral Resources Tasmania to Workplace Standards Tasmania as described below:

> *"The Authority was established in 27 Mar 1996 to concentrate the regulation and supervision of working conditions in one agency. It was formed by amalgamating the Industry Safety and Mines Division (excluding Mineral Resources Tasmania) of Tasmania Development and Resources with those parts of the Department of Industrial Relations, Vocational Education and Training that dealt with Long Service Leave and inspections under the Industrial Relations Act 1984.*
>
> *The Authority was under direct ministerial control until 18 September 1998 when it was placed under the administrative control of the newly created Department of Infrastructure, Energy and Resources. On that date the Workers Rehabilitation and Compensation Tribunal was transferred to the Department of Justice and Industrial Relations. The Agency underwent a name change on 21 March 2000 to Workplace Standards Tasmania.*
>
> *Workplace Standards Tasmania was amalgamated with the Department of Justice on 5 April 2006."*

The above timeline shows that prior to the introduction of the WHSA the Chief Inspector of Mines had mining inspection resources of 10 persons (not including support staff) to cover mines and minerals processing, while the Chief Inspector of Explosives had resources of 9 persons and is believed to have covered explosives and dangerous goods throughout the state.

Some of the resources of the explosives group would have been used for mining and some of the mines inspection resources would have covered mineral processing such as smelters. No attempt was made to fully clarify and delineate the resources applied just to mining. It is considered sufficient for current (comparative) purposes to assume that the resources allocated to mining can be approximated by those at the disposal of the Chief Inspector of Mines.

The time line indicates that the Chief Inspector of Mines' resources fell from 10 persons to 3 by 1996. The three consisted of two dedicated inspectors (both mining qualified) and an *inspector equivalent*, the third person was made up of part use of a generalist inspector in Launceston and one in Burnie. The coverage of minerals processing (eg smelters) had ceased and coverage of the energy sector commenced.

The above manning levels continued until retirement of a mining engineer in 2002 left two persons for the inspection of mines - only one of whom was qualified in mining. In late 2003 another generalist inspector (M Smith) was recruited which returned the number of inspectors to three.

In the 2001/03 years there had been three fatalities, investigation and legal matters associated with those, especially the Renison fatalities, would occupy much of the Chief Inspector's time (being the only person qualified to assess below ground matters) up to and beyond the Beaconsfield event of 2006.

The Office of the Chief Inspector of Mines (OCIM) was established in July 2005 with the intention of having five mining inspectors, at the same time the energy sector was dropped and inspection of mineral processing resumed. The envisaged recruiting of an additional three mining inspectors did not occur but the relinquishment of the two persons supplying the one inspector equivalent did occur. At the time of the Beaconsfield incident there were only two inspectors since the recruitment of additional inspectors had not occurred due to difficulties in being able to attract qualified applicants.

One of the key reasons WST was unable to attract mining engineers to the role of inspectors was the salary structure on offer. Most other jurisdictions recognise that they cannot pay general public service salaries for mining engineers and have in place special arrangements to meet the need to recruit mining personnel to inspect mines, this is illustrated by the below salary comparisons provided by WST:

"A comparison of conditions for a qualified mining engineer inspector is shown below.

Year 2003

Tasmania	*Queensland*	*New South Wales*
$72K + 9% Super	*$90K + 12% Super + vehicle*	*~$130K + 9% super*

Year 2006

Tasmania	*Queensland*	*New South Wales*	*W Aust*
$78K + 9%	*~$105K + 12% + vehicle*	*$142-145K + 9%*	*~$115 –135K + 9%"*

Discussions with the two inspectors following Beaconsfield indicated they felt under-resourced, that they had difficulty even being reactive to accidents and incidents occurring, this being attributed to;

1. Two Inspectors covering the whole of Tasmania from Hobart
2. Difficulty in getting access to vehicles
3. Insufficient inspectors
4. Administrative duties and lack of funds

These concerns led Inspector Smith in March 2006 to write a memorandum to the Chief Inspector outlining the many issues facing the OCIM and to express serious concern at paragraph three that there were incidents occurring that were "..classic lead indicators of further impending events…..".

The reflections of Inspector Smith are not seen as a prediction of the Beaconsfield event per se, they were however a clear concern that the resources required to carry out the understood duties of the OCIM were quite lacking and that it was difficult if not possible to have a proactive impact on the industry.

THE CHANGES APPLIED TO REGULATION OF SAFETY AND IN PARTICULAR MINING BY GOVERNMENT

Prior to 1995 Tasmania had separate legislation for regulation of safety in Mines. When the WHSA came into effect it replaced the mining specific legislation by rescinding the Mines Inspection Act. The Mines Inspection (General) Regulations were rescinded in 1998 when WHSA Regulations were introduced.

The WHSA was performance-based legislation requiring operators to identify and assess risks and take appropriate safety measures to combat the risks to health and safety. Since introduction of the WHSA regulations Tasmania has had no mining specific provisions (there are codes for exploration and quarrying under the Mineral Resource Development Act that give brief OHS guidance), it was intended to introduce a Mining Code of Practice in the 05/06 year but this did not proceed due to resourcing and workload issues.

Professor Quinlan made observations concerning the process of introduction of post-Robens OHS legislation, noting that in other jurisdictions there tended to be a process to

> *"...assess existing subsidiary regulations before these were removed, rationalized or incorporated into new regulations or codes or practice."*

He noted that he could find no evidence of a similar approach in Tasmania.

PROGRAMS, POLICES AND STRATEGIES OF WST

WST commented in its submission on the programs and strategies it has proposed to undertake since 2001. These include recognition in 2005 that an OCIM was appropriate, audits of major mines conducted in 2002, the investigation and guidance on working time arrangements, OHS improvements for targeted companies, development of a Mining Industry Code Of Practice and implementation of the National mine safety framework. Not all these programs were delivered due to resource issues.

WST also provided a number of policies and its 2005-06 Business Plan with it's submission. The business plan showed the Inspectorate had worthwhile Project Objectives for the Mines Inspectorate with the planned outputs being modest. Again a lack of resources and investigation work meant the planned outputs could not be delivered.

While the policies and programs of WST could have been examined in much more detail, this was not done as it appears, that while WST was capable of having the programs and processes to address mine safety the real issue for WST was having the resources to implement them.

CHANGES IN WST SINCE THE INCIDENT

The timeline indicates that at November 2006 one of the five mining inspector positions were vacant, the two positions that had been filled were WST generalist inspectors who internally transferred to the OCIM . There were ongoing attempts to recruit a mining qualified person which were complicated by not being able to offer a competitive salary.

At the time of writing this report there were three mining inspectors, numbers had reduced from four when the senior generalist inspector had resigned his position in January 2007. Recruitment efforts in 2007 have not led to appointment of any additional staff, some insight into this situation may be gained from second submission which states

> *"A Budget Submission in early 2005 was successful, allowing for the establishment of the Office of the Chief Inspector of Mines (OCIM) commencing in July 2005. This allowed for three Professional Officer (PO) Level 3 and two PO Level 4 engineers. The Submission was based upon the PO3 inspectors having a high visibility on mine sites, while the PO4 inspectors were to provide technical expertise, and address issues with company executives at the highest level, including at interstate company head offices. Due to budget limitations, the PO3 positions were reduced to PO2 and lower level in an effort to attract a mining engineer at a higher salary (SES1). To date, one PO2 has been appointed, and another at a lower level, both from within WST. A SES Level 2 mining engineer has been advertised (see No.17 below), and a PO3 to replace the one appointed in 2003."*

Since the introduction of the WHSA formal audits had been conducted in 2002. Since Beaconsfield auditing has recommenced

> *"Since September 2006 comprehensive audits have been completed in six mines which were completed by July 2007, plus an additional major mining contractor working across several sites.*

THE COMPARATIVE RESOURCES APPLIED TO SAFETY IN MINING

Each state and territory will look at its own circumstances and needs and apply resources and programs in an attempt to meet its objectives in health and safety. One comparative measure that can be looked at is the number of inspectors versus employees or man hours.

Professor Quinlan has identified the Tasmanian OCIM as having a critical mass problem and provided comparative data by State for inspectors allocated to mining:

> *"Third, related to the last point there is also a critical mass problem. In other states with larger mine inspectorates (for example in 2005 the Queensland Mines Inspectorate had an establishment of 39, NSW had over 50, Western Australia 38, Victoria 10, South Australia 4 and the Northern Territory 7) there are opportunities for task division or specialization and the strategic focusing of available resources."*

From its perspective WST identified Mines/Quarries/Energy as having the second best servicing level in Tasmania at 2.5 millions of man-hours per inspector at December 2002 and went on to give the comparison of:

> *"In 1994 for mines , quarries and processing resource levels were approximately 1 inspector per 460,000 man hours worked in the mining industry. In 2004 the resource level was 1 inspector per 2,500,000 man hours worked in the mine, quarries and energy sectors. In 2005-6 the resource level is 1 inspector per 786,328 man hours worked in the mining industry"*

The Minerals Council of Australia produces a document titled "Safety Performance Report of the Australian Minerals Industry", the most recent version being for 2004-2005.

Using Professor Quinlan's inspector numbers and MCA 2004-05 numbers for employees and hours the following table was constructed

Comparison of Inspector resources by state for 2004-2005 year					
State	Inspectors	Mining employees*	Hrs (Millions)*	Empl/ Insp	Hrs/ Insp
WA	38	41,104	82.130	1082	2.16
QLD	39	27,380	60.796	702	1.56
NSW	50	15,320	31.506	306	0.63
VIC	10	6,215	7.565	622	0.76
SA	4	2,953	4.454	738	1.11
TAS	3	1,110	2.765	370	0.92
NT	7	2462	6.013	352	0.86

* indicates numbers related to mining and exploration only ie mineral processing (smelting and refining) has been excluded from the figures

The table shows quite a variation in resources applied and industry size. These figures of themselves would not be seen as a cause for concern in Tasmania, however an examination of the number of inspectors versus the geographical spread and workload on inspectors may have.

Another means of attempting to assess the effectiveness of Tasmania's mining inspectorate is to look at comparative statistics (while acknowledging that statistics can only tell one part of the story). For this purpose the Minerals Council of Australia produces a document titled "Safety Performance Report of the Australian Minerals Industry", the most recent version being for 2004-2005.

This report shows the following comparison of fatality rate by state

Table 3 Fatal injury frequency rates by State 1995–96 to 2004–05

	1995–96	1996–97	1997–98	1998–99	1999–2000	2000–01	2001–02	2002–03	2003–04	2004–05	10-year Average
WA	0.05	0.09	0.14	0.03	0.07	0.06	0.03	0.06	0.04	0.02	0.06
QLD	0.02	0.24	0.02	0.04	0.04	0.04	0.04	0.05	0.02	0.06	0.06
NSW	0.05	0.25	0.11	0.11	0.31	0.13	0.06	0.03	0.12	0.03	0.12
VIC	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.10	0.00	0.00	0.02
TAS	0.00	0.12	0.00	0.11	0.00	0.36	0.00	0.33	0.00	0.00	0.09
SA	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.34	0.23	0.08
NT	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.02
ALL	0.03	0.15	0.09	0.05	0.09	0.08	0.03	0.06	0.05	0.04	0.07

Fatalities provide a low sampling number and so may be not be statistically reliable, it can be seen Tasmania has the second highest 10-year average. NSW which had Gretley and North Parkes disasters had the highest average.

Looking at Injury rates the MCA found:

Table 5: Lost Time Injury Frequency Rate by sector 1995–96 to 2004–05

Mining method	STATE	1995–1996	1996–1997	1997–1998	1998–1999	1999–2000	2000–2001	2001–2002	2002–2003	2003–2004	2004–2005
Total mining	WA	14	10	8	7	8	6	5	5	4	4
	QLD	22	21	16	12	12	10	8	6	6	4
	NSW	45	43	44	33	30	29	23	21	17	14
	VIC	12	15	13	11	9	9	6	8	5	5
	SA	7	10	6	4	4	7	9	5	5	6
	TAS	25	19	18	18	24	28	16	17	13	9
	NT	9	8	7	7	9	9	8	7	8	4
Average		23	20	17	12	13	12	9	8	7	6

These figures show NSW is the worst performing state with Tasmania being second worst. This information together with considerations as to workload and geographical spread along with an intuitive assessment by management of the situation should have been a cause for concern and corrective action.

It does seem the situation was recognised to the extent that the OCIM was supposed to be enlarged. That this did not occur pre-Beaconsfield should be cause to examine why the WST could not address and overcome the barriers to implementing its own reforms. If the reasons lie outside of WST then whole of Government issues may be at play and should be addressed.

One problem identified by the investigation was the difficulty in obtaining suitably qualified geotechnical experts who are not already consulted to the Beaconsfield Gold Mine. However, it is not recommended that WST employ a geotechnical expert for the following reasons:

(a) This is a field of continuing evolving expertise and experience and a "resident expert" would have trouble in remaining as current as someone consulting throughout Australia and other countries.

(b) Different mines present with different problems and it would be preferable to be able to obtain an expert with specialised experience relating to the issues involved and

(c) With the current mining boom throughout Australia there would be considerable difficulties in obtaining a suitably qualified person, especially at a salary range that would normally be expected to be available in Tasmania.

O H & S RECOMMENDATIONS

I refer to the comprehensive recommendations made by Professor Quinlan from paragraph 869 of his report.

Apart from those set out at paragraph 26 below, I adopt Professor Quinlan's recommendations.

The matters in paragraph 868 (Union appointed inspectors) raise several questions which need to be considered before deciding whether or not such a recommendation should be adopted.

In my view, a "mining inspector" should be qualified in O H & S matters, have significant mining industry experience and be able to form an independent view. Such people should not be trained by Workplace Standards Tasmania, but accredited by a third party institution such as a TAFE.

In view of the mining boom currently under way in Australia, and the wages that can be earnt by such qualified people, inspectors may have to be paid at a rate disproportionate to other inspectors appointed under the Act.

If a union member were to be appointed an inspector it would have to be determined who would arrange and pay for their training and on-going salary.

In Western Australia legislation provides for employee inspectors who do not belong to a third party, such as a union. This in part has been driven by the relatively low rate of union membership in Western Australia and also by concerns that union members could cause industrial disruption.

Nothing we have observed during this investigation would suggest that such disruption would be caused by the Unions and/or personalities involved in the relevant unions in Tasmania, who throughout the investigation impressed as being diligent and genuinely concerned for their members' welfare.

I refer to my comments on the role of WST and note that the initial effect of Professor Quinlan's recommendation could also be achieved by a greater number of mining inspectors in WST. With that in mind, I set out below the recommendations of Professor Quinlan, noting the caveats placed upon paragraph 868 - which appears as paragraph 25 below.

RECOMMENDATIONS AS TO OH & S PRACTICES

1. That BMJV maintain an on-site OHS Committee at the Beaconsfield mine covering both underground and above ground operations (and representing both employee and contract workers) and implement other measures to enhance genuine two-way communication over OHS matters, including feedback loops in relation to the mine safety management plan.

2. That mineworkers be provided by mine management with information on trends in rock noise/seismic activity and rock falls on a regular basis and be kept informed and have a chance to express views in relation to deliberations on changing mining methods (including changes to pillar thickness, extraction sequences and the like).

3. That Beaconsfield and other mines give attention to using leading or process performance indicators in addition to lag indicator such as lost time and medical injuries as part of their OHS management systems. Valuable indicators include detailed analysis of trends in mining related seismicity, rock noise reports, 'near misses', and analysis of all rockfall incidents on a periodic basis.

4. That the Beaconsfield mine and other mines should take explicit account of changes to work processes including mining methods as an integral part of their mine safety management plan, including documenting the risk assessment and consultation process undertaken in conjunction with this change.

5. That mineworkers not be obliged to read and sign off on SWPs and similar documentation during crib breaks.

6. That the Beaconsfield mine and the Tasmanian mining industry examine the adequacy of ground awareness training and, in conjunction with WST and any new tripartite advisory body (see 17 below) examine whether key principles be incorporated into a code of practice for the mining industry.

7. That the Beaconsfield mine and other Tasmanian mines keep a record of all uncontrolled or unplanned falls of ground (time, location, relationship to firing activities, relevant ground control measures and estimated risk exposure). The resulting database should be examined at regular intervals to determine trends if any.

8. That the Beaconsfield mine give consideration to developing 'red flag' protocols in relation to seismic activity, rockfalls and other major hazard risks at the mine and that re-entry procedures be reassessed.

9. That BMJV review the nature and application of the bonus system at the Beaconsfield mine with a view to eliminating any adverse effects on safe work practices.

10. That mining companies with more than 50 employees or contractors engaged on-site be required to establish clear monitoring mechanisms in relation to their mine safety management plan or OHS management system. Further, the mine safety plan or OHS management system be subject to an independent third party audit every three years and that a copy of this audit sent to WST.

11. That the Tasmanian government provide for the appointment of at least one additional WST inspector with general mining responsibilities, over and above the existing WST staffing establishment, to cover the mining, processing and quarrying industries

12. That the salary level of mining qualified inspectors be reviewed.

13. That a formal system of training for mining inspectors be implemented.

14. That WST undertake an urgent review to develop a suitable body of regulations to govern OHS in the Tasmanian mining industry (as well as supporting guidance material) to address such critical areas such as ventilation, risk assessment and the management of rockfalls (and drawing on best practice in other Australian jurisdictions).

15. The Tasmanian *Workplace Health and Safety Act* should be amended to require that mines engaging 100 or more workers (employees and regular contractors) be required to adopt a safety case regime.

16. Consistent with the last recommendation, consideration should also be given to establishing a specialist mining and high hazard unit within WST.

17. That the Tasmanian Government/WST establish a tripartite mining industry advisory council along lines similar to bodies in Queensland, Western Australia and New South Wales.

18. That s10 of the Act re appointment of responsible officer for the workplace be amended so that only one responsible officer may be appointed in a workplace, namely the person with overarching responsibility/managerial control of that workplace. Any deviation from this requirement to be only permitted on application to the Director of WST.

19. That s47 of the Act be amended to increase the requirements to notify WST of dangerous or potentially dangerous incidents

20. That the provisions relating to the establishment of OHS committees be strengthened and that the establishment of such committees be made mandatory in Tasmanian Mines.

21. That consideration be given to measures that would encourage the election and presence of ESRs at all Tasmanian mines.

22. That consideration be given to moving requirements for hazard identification, risk assessment and control from Regulations to the general duty provisions of the Workplace Health and Safety Act

23. That the consultation provisions within the Workplace Health and Safety Act be strengthened.

24. That guidance material be produced to better acquaint both users of consultants and consultants themselves of their responsibilities, as well as trying to ensure the best outcome in terms of OHS.

25. That consideration be given to introducing the scheme of union-appointed safety representatives in the Tasmanian mining industry, with such representatives being given the power to visit mines and hold discussions with workers, even where

complaints have not been lodged. To avoid abuse of this power it is recommended that such visits be limited to a maximum of one visit every six months to any mine where no complaint has been lodged by worker/s at that mine during this period.

26. That the WHSA and WST inspection protocols be amended so as to ensure that inspectors make contact with employee safety representatives or a member/s of the health and safety committee if they are present on site during their visits and that they seek to identify, clarify the status of and review the operations of health and safety committees on a regular basis

27. That consideration be given to taking measures to prohibit the practice of imposing bonus penalties in relation to authorized or sickness related absence from work.

28. That WST review the application and safety implications, if any, of the use of production bonus schemes in Tasmanian mines, drawing on independent research currently being undertaken in NSW.

I should also note at this stage, that whilst it is highly desirable that an arrangement be reached for another Australian Mining Inspectorate so that expertise can be drawn upon when required, that such a course would be almost impossible in the current mining environment. We were very fortunate in this investigation to have the services of Paul Raftery, who as noted before is a Senior Mines Inspector from New South Wales but unfortunately Mr Raftery had to leave the investigation in November of 2006 to undertake investigative work in his own jurisdiction. Mr Raftery noted at the outset of this investigation that it was the type of investigation that would normally require some twelve months. (We optimistically thought we could do it in less, but have been proven wrong). The chances of getting an inspector of the calibre of Mr Raftery, for even three to four months in the future, is highly problematical.

I also note that the provisions of s55 of the Act are unrealistic in that they require a prosecution being commenced within 12 months of an investigator becoming aware of a possible breach of the Act. I am not suggesting that any prosecutions should flow from this incident, but in complex matters such as this it is often impossible to provide a complete report to the Director of Public Prosecutions within a twelve month period. Discussions with mining investigators have indicated that matters of this nature can often take up to two years, and accordingly I recommend that s55 be amended to allow prosecutions to be taken within two years of an investigator becoming aware of a possible breach of the Act.

RECOMMENDATIONS AS TO MINING PRACTICES

I note that these recommendations are applicable not only to BGM but also to all mining activities involving seismic risks.

1. That mine operators adopt a rigorous design approach to overcome damage associated with the sudden release of energy from the build-up of mining induced stresses and that the resulting design be reviewed by way of a case for safety regime.
2. That mine operators install appropriate equipment to enable seismic monitoring,

geological mapping and interpretation and the analysis of the behaviour of supported ground within the mine and that appropriate records be kept of all such information.

3. That resulting designs and their assumptions are continuously modelled, tested and updated.
4. That mines install geotechnically engineered ground support systems, designed to contain events well in excess of magnitudes that have already been recorded or expected by appropriate modelling, and that such support designs consider:

   (a) the intended life of the excavation
   (b) the mining induced stress changes and potential cycles of loading and unloading
   (c) blasts vibrations during development mining and from surrounding stopes
   (d) potential impact of voids and void management
   (e) tolerance for stability problems and rehabilitation
   (f) potential for rockbursts

5. That areas of high or unpredictable seismic risk be mined remotely.
6. That mines adopt an effective seismic monitoring plan which would contain trigger mechanisms to ensure actions or procedures occur if certain criteria were met.
7 That all shear structures present in mines be treated as having the potential to become seismically active.
8 That BGM and the mining industry in Australia generally undertake a study as to whether it remains appropriate to use friction based ground support in the backs of seismically active deep vein mining operations.

GLOSSARY OF TERMS

The following brief explanations of some geology, geotechnical and mining terms are not intended to be a dictionary of definitions or detailed technical explanations 2CG Conglomerate, the middle conglomerate unit within the Salisbury Hill formation, being approximately 35m.

A

Abutment	The areas of unmined rock at the edges of a stoping block that carry may large regional loads. Generally a zone of support for ground arching.
Accountability	Responsibility assigned to a person or group for some obligation or the performance of an activity, for which the person (or group) accountable is answerable for its implementation.
Active workings	Any place in a mine where miners are normally required to work or travel and which are ventilated and inspected regularly
Advance	Mining in the same direction, or order of sequence; first mining as distinguished from retreat. Or a noun describing the distance a tunnel has advanced during a period of time. For example, the advance in the tunnel last month was 100 metres.
Air leg	A hand operated air powered percussion drill used for driving or stoping that is mounted on a telescopic leg which has an extension of about 2.5m. The leg and machine are hinged so that the drill need not be in the same direction as the leg.
Ankerite	A mineral; Manganese iron carbonate.
Anomaly	Any departure from the norm which may indicate the presence of mineralization in the underlying bedrock. In geophysics and geochemistry, an area where the property being measured is significantly higher or lower than the larger, surrounding area
Arching	The transfer of rock stress or load from an active mining area, e.g. stope back, to a more stable area or abutment; this may result in the release of rock blocks. Fracture processes around a mine opening, leading to stabilization by an arching effect.
As-built process	A process for identifying, and carrying out, updates of design documentation and data (including, but not limited to, specifications, calculations, drawings, sketches, operating and maintenance manuals, etc) to reflect the final as-installed and operating configuration.
Assessment	Assessment. A systematic and documented review of the effectiveness of implementation of HSEC processes, programs and procedures, based on general process criteria and the professional judgment of experienced assessors.
At-risk behaviour	Conduct (whether witnessed or not) that unnecessarily increases the likelihood of injury.
At-risk situation	A physical situation in the workplace that may lead to an incident or injury if not correct
Audit	A systematic, independent and documented process for obtaining audit evidence and evaluating it objectively to determine the extent to which the management systems audit criteria set by the organisation are fulfilled.
Auriferous	Containing gold
AVOCA stoping	A method of stoping whereby individual stope panels are backfilled towards the retreating face. At the Beaconsfield Gold Mine, modified AVOCA stoping is employed whereby backfilling and stoping occur from the same access side of the stoping block. The backfill is placed until the entire stope is filled and the next block of ore is choke-fired against the compacted backfill causing it to stand near-vertical when stoping continues.

B

Back	The ceiling or roof of an underground opening
Backfill	Waste material used to fill the void created by mining an orebody
Barricade	A term used to describe a rope, chain or tape stretched across a roadway/travelway from side to side to prevent access by persons or vehicles. It can also refer to an obstacle constructed to retain or obstruct the movement of materials such as air, backfill or water.
Barricading	Enclosing part of a mine to prevent inflow of noxious gasses from a mine fire or an explosion.
Barren	Rock or vein material containing no minerals or value
Base metal	Any non-precious metal (e.g.: copper, lead, zinc, nickel, etc.).
Barrier	Something that bars or keeps out. Barrier pillars are solid blocks of coal left between two mines or sections of a mine to prevent accidents due to inrushes of water, gas, or from explosions or a mine fire.
Base	Bottom or support for any structure
Bearing plate	A plate used to distribute the load on the head of a rock bolt.
Bed	A stratum or layer of sedimentary deposit
Bedded	Bedding. The arrangement of sedimentary rocks in layers. Parallel beds, surfaces, or

	planes of weakness in the rock formed by placement of sediments during deposition.
Bedding planes	Parallel beds or planes of weakness in the rock formed when there was a change in the deposition of minerals under water.
Bedding plane slip	The relative movement or slip of continuous bedding planes or foliation planes in response to large areas of stope wall moving into a void, filled or unfilled. May be observed in areas where extensive stoping has been carried out in a well bedded rock mass.
Bedrock	Solid rock forming the Earth's crust, frequently covered by soil or water
Berm	A pile or mound of material capable of restraining or obstructing a vehicle.
Bit	The hardened and strengthened device at the end of a drill rod that transmits the energy of breakage to the rock. The size of the bit determines the size of the hole. A bit may be either detachable from or integral with its supporting drill rod. A bit is frequently made of an ultra-hard material such as industrial diamonds or tungsten carbide
Blasthole	A hole drilled for purposes of blasting rather than for exploration or geological information.
Blasting	Detonating explosives to break and loosen rock for excavation.
Blasting circuit	Electric circuits used to fire electric detonators or to ignite an igniters cord by means of an electric starter.
Blyths Creek Formation	A rock formation at BGM composed of a sequence of siltstones, limestone's and conglomerates stratigraphically below the Salisbury Hill Formation.
Borehole	Common term for a drilled hole in rock.
Boring	Drilling holes into hard rock or driving a tunnel with a tunnel boring machine.
Bolt torgue	The turning force in foot-pounds applied to a roof bolt to achieve an installed tension.
Boom	A telescoping, hydraulically powered steel arm on which drifters, manbaskets and hydraulic hammers are mounted.
Bottom	Floor or underlying surface of an underground excavation
Brace	Area on surface around the mouth of the Hart shaft
Breakthrough	A passage or borehole that intersects an existing opening
Breast	The faces of an overhand cut and fill stope where the drill holes are driven horizontally
Breccia	A type of rock whose components are angular in shape, as distinguished from a conglomerate, whose components are water- worn into a rounded shape.
Brittle	Easily fractured or broken
Broken reserves	The amount of ore in a mine which has been broken by blasting but which has not yet been transported to the surface.
Brow	The threshold (edge) of an open stope
Bulkhead	Partition erected to seal off certain portions of the mines.
Bulk mining	Bulk mining. Any large-scale, mechanized method of mining involving many thousands of tonnes of ore being brought to surface per day by a relatively few number of miners
Bump	Rock noise and ground vibration associated with a seismic event.
C	
Cabbage Tree Conglomerate (CTC)	The lower conglomerate unit within the Salisbury Hill Formation, being approximately 55m thick.
Cabbage Tree Thrust	Thrust. Major regional thrust fault at the base of the mine sequence at Beaconsfield.
Cable bolts	Cable bolts. One or more steel reinforcing strands placed in a hole drilled in rock, with cement or other grout pumped into the hole over the full length of the cable. A steel face plate, in contact with the excavation perimeter, is usually attached to the cable by a barrel and wedge anchor. The cable(s) may be tensioned or untensioned. The steel rope strand may be plain strand or modified to improve the load transfer between the grout and the steel strand.
Cage	The conveyance used to transport men and equipment in a shaft
Calcareous	Like limestone or calcium carbonate, or composed of the same
Canop	A protective covering of a cab on mobile equipment, certified to provide protection to the operator in the event of a roll-over or falling objects.
Carbonaceous	Refers to rocks containing carbon
Change	A deviation, permanent, temporary, or incremental, from a currently established baseline, or anything that is or may be substituted for something else. This includes changes to personnel, processes, systems, plant and equipment, technology, documents, risks, legislation, commitments, obligations, other requirements, and external environmental, physical and social factors affecting or affected by the organisation.
Change management	The systematic process for dealing with change to manage HSEC risk.

Channel sample	A method of sampling a rock exposure whereby a regular series of small chips of rock is broken off along a line across the face.
Classic rock	A sedimentary rock composed principally of fragments derived from pre-existing rocks and transported mechanically to their place of deposition.
Clay	A fine-grained material composed of hydrous aluminium silicates.
Closure	1. The amount by which the cross-sectional dimension of an excavation is reduced by the combined effect of convergence and additional in-elastic movements such as bedding separation, dilation, bulking etc. 2. The process and activities related to the cessation of the operating life of an operation following a decision to close the operation which ends following decommissioning, rehabilitation and, if required, remediation.
Coarse gold	General term applied to larger pieces or nuggets
Cobblestone Creek Thrust	Major regional thrust fault at the top of the mine sequence at Beaconsfield.
Cohesion	Shear resistance at zero normal stress.
Collar	The beginning point of a shaft or drill hole.
Competency	A combination of attributes such as experience, knowledge, skills, abilities and attitudes providing adequate assurance of successful performance or task.
Compliance register	An up-to-date documented record of the regulatory and other requirements applicable to an operation.
Compressive stress	A stress or pressure that tends to push or clamp objects together. The state of stress found in the rock mass before mining occurs. Tends to hold the rock mass together.
Conglomerate	A sedimentary rock consisting of rounded, water-worn pebbles or boulders cemented into a solid mass.
Controlled blasting	The act of minimising rock damage during blasting. It requires the accurate placement and initiation of minimal explosive charges in the perimeter holes to achieve efficient rock breakage with least damage to the remaining rock around an excavation.
Consequence	Outcome or impact of an event
Contract	The place or surface where two different kinds of rock meet
Contractor	An individual, company or other legal entity that carries out work or performs services pursuant to a contract for service. This includes sub-contractors.
Controlled documents	Controlled documents. Controlled documents are those that are pertinent to the HSEC management system, effective planning, operation and control of risks, and in existence to ensure continual improvement. These documents, can be internal or external, and must be current, uniquely identifiable, revised (with changes and revision status recorded) and can only be changed through a formalised change process, assuring that only the current versions are available to users. Document control includes the prompt removal of obsolete documents to avoid their unintended use.
Core	The long cylindrical piece of rock, about 2cm or more in diameter, recovered by diamond drilling.
Corrective Action	An action implemented to eliminate the cause of a non-conformity or incident in order to prevent recurrence. The corrective action is commensurate with the severity of the non-conformity or incident.
Country rock	A loose term to describe the general mass of rock adjacent to an orebody, as distinguished from the vein or ore deposit itself. Also known as the host rock.
Crib	A meal eaten during the shift
Crib room	The excavation underground designated for eating
Crisis	An actual or potential threat to long-term ability to do business due to the impact on safety of employees and contractors or the public, the environment, operability and assets, image and reputation, or liability.
Critical activity	An activity or activities where conduct outside expected performance has the potential to result in a Major Accident Event.
Critical equipment	A piece of equipment or a structure whose failure, or not performing to design specification, has the potential to result in a Major Accident Event.
Critical equipment register	A concise summary of all critical equipment that includes its design function (including operating limits), a unique identification, required performance standards (e.g. minimum reliability) and maintenance requirements.
Critical procedure	A procedure (or step in a procedure), divergence from which has the potential to result in a Major Accident Event.
Critical system	A system (hardware or software, including human behaviour) whose operation outside expected performance has the potential to result in a Major Accident Event.
Crosscut or x-cut	A passageway driven between the decline and the orebody generally perpendicular to the latter for access.
Cross section	A map showing features such as mine workings or geological structures on a vertical plane perpendicular to the strike of the orebody.

Crown Pillar Traditionally a crown pillar is the term used to describe the regional pillar left to isolate ground surface influence from the near-surface underground workings at the time of mining. The term has been extended to refer to regional horizontal barrier pillars left between previous overlying mine workings and current workings.

Culture The whole complex of distinctive spiritual, material, intellectual and emotional features that characterise a society or social group.

Cut and fit A method of stoping in which ore is removed in slices, or lifts, following which the excavation is filled with rock or other waste material known as backfill, before the subsequent slice is mined. The backfill supports the walls of the stope.

D

Decline A sloping underground opening, usually driven at a grade of about 15% to 20%, for machine access from level to level; also called a ramp.

Deposit Mineral deposit or ore deposit is used to designate a natural occurrence of a useful mineral, or an ore, in sufficient extent and degree of concentration to invite exploitation.

Design data Design data. Any information used during, or as a record of, the development of a facility that defines the resource, process, product, equipment, operation, layout or control of the facility. This may include, but not be limited to: basis of design, process flow diagrams, models, plans, single line diagrams, construction drawings, operations and control philosophies, layout drawings, design calculations, site data, design standards, specifications, design data sheets, materials, cause and effect diagrams, manufacturers' data, manufacturers' operating and maintenance manuals, emergency shutdown sequences and critical equipment registers.

De-stressed zone A zone of rock around the perimeter of an excavation where the rock stress field has exceeded the strength of the rock mass at some time during its mining history. The rock mass is in a post-peak loading condition and it may be capable of carrying significant loads with low levels of lateral confinement being provided by reinforcement.

Development Underground work carried out for the purpose of opening up a mineral deposit. Includes shaft sinking, crosscutting, declining and raising.

Development mining Work undertaken to open up the ore deposit as distinguished from the work of actual ore extraction.

Dextral (offset) Offset on a fault or shear in a right-lateral sense (i.e. the opposite side of the fault from the observer has moved to the right).

Diamond drill A rotary type of rock drill in which the cutting is done by abrasion rather than percussion. The cutting bit is set with diamonds and is attached to the end of long hollow rods through which water is pumped to the cutting face. The drill cuts a core of rock that is recovered in long cylindrical sections, generally 76mm or more in diameter.

Dilution The contamination of ore with barren wall rock or low-grade rock during stoping operations.

Dip The angle at which a vein, structure, rock bed or other planar feature is inclined from the horizontal as measured at right angles to the strike.

Discontinuity Any significant mechanical break, defect or fracture of negligible tensile strength in a rock.

Disseminated ore Ore carrying small particles of valuable minerals, spread more or less uniformly through the gangue (waste) matter: distinct from massive ore wherein the valuable minerals occur in almost solid form with very little waste material included

Documents Structured recorded information, published or unpublished, in physical or electronic form, managed as discreet units in the mine management system. Most records are documents; but not all documents are records. A document becomes a record when it is part of a business transaction, is kept as evidence of that transaction and is managed within a record keeping system.

Dowel An un-tensioned rock bolt, anchored by full column or point anchor grouting, generally with a face plate in contact with the rock surface.

Drawpoint The position at the bottom of a stope through which broken ore is extracted from the stope.

Drill A machine utilizing rotation, percussion (hammering) or a combination of both to make holes.

Drill hole Also known as borehole.

Drill log A record of drilling results compiled from an examination of the drill core, and also containing all relevant survey and assay information pertaining to a given diamond drill hole

Drilling The use of a drill to create holes for exploration or for loading with explosives.

Drive A generic term which describes all travel ways in underground mines including adits,

	drifts, drawpoint access, cross measure drivages, ramps, gate roads, main headings, cut throughs, cross cuts, etc. It does not include shafts, stopes, goafs, or longwall faces.
Due diligence	A systematic, comprehensive and verifiable approach to the issue management, which is based on an assessment of the likely risks, potential legal liabilities and costs arising from the issues, and is reasonably designed and operated to control and reduce those risks and prevent those liabilities from being incurred.
E	
Eaglehawk Gully Formation (EGF)	The upper formation of the host rocks at Beaconsfield comprising variably calcareous fine grained sandstone, and siltstone with interbedded limestone over a total thickness of approximately 275m.
Earthquake	The local shaking, trembling or undulation of the ground surface and the radiated seismic energy caused most commonly by sudden fault slip, volcanic activity or other sudden stress changes in the Earth.
Elastic	Capable of sustaining stress without permanent deformation. Tending to return to its original shape or state when the applied stress is removed.
Elastic limit	See yield point.
Elimination	The highest control in the hierarchy of hazard controls and means the hazard is eliminated (no longer exists). In the case of ground control, very seldom is the hazard of falling ground eliminated. Removing the operator from the hazard is not elimination of the hazard, it is considered separation.
Emergency	An abnormal occurrence that can pose a threat to the safety or health of employees, customers, or local communities, or which can cause damage to assets or the environment.
En echelon	A geological term used to describe the geometric structure of minerals found in a roughly parallel but staggered fashion.
Epicentre	The point on the earth's surface directly above the focus of a seismic event. Usually only used by the news media,
Event	Occurrence of a particular set of circumstances.
Exploration	Prospecting, sampling, mapping, diamond drilling and other work involved in searching for ore.
Explosive	Any rapidly combustive or expanding substance. The energy released during this rapid combustion or expansion can be used to break rock.
Extraction	The process of mining and removal of ore from a mine
F	
F1 Footwall Splay	A series of en echelon tension gashes which splay off the Tasmania Reef at its western end and connect the latter with the F4 Footwall Reef.
F4 Footwall Reef	A parallel reef of similar character to the Tasmania Reef.
Face	The end of a drive, crosscut, decline or stope in which work is progressing.
Factor of safety (FoS)	The ratio of the ultimate breaking strength of the material to the force exerted against it. E.g. If a rockbolt will break under a load of 12 tonnes, and it is carrying a load of 4 tonnes, its factor of safety is 12 divided by 4 which equals 3.
Fall of ground (FoG)	An unplanned displacement of rock which has fallen in any part of a mine with the potential to affect safety and/or production.
Fault	A naturally occurring plane or zone of weakness in the rock along which there has been movement. The amount of movement can vary widely.
Fault zone	A fault which, instead of being a single clean fracture, may be a zone hundreds or thousands of feet wide. The fault zone consists of numerous interlacing small faults or a confused zone of gouge, breccia, or mylonite.
Fill	Any material that is put back in place to substitute the extracted ore and provide ground support.
Firing	The term fire in the hole denotes blasting in progress. This term refers to the setting off of explosives.
Flowery Gully Formation (FGF)	Limestone unit stratigraphically above the Eaglehawk Gully Formation.
Foliation	Alignment of minerals into parallel layers; can be planes of weakness in rocks.
Footwall	The rock below the ore body
FOPS	Falling Objects Protection Structures
Focus	The initial rupture point within a seismic source at which strain energy is first converted to elastic energy.
Fold	Any bending or wrinkling of rock strata.
Footwall	The wall or rock on the underside of a vein or ore structure. The rock below the orebody.

Formation	Any assemblage of rocks which have some character in common, whether of origin, age, or composition.
Fracture	A break in the rock, the opening of which affords the opportunity for entry of mineral-bearing solutions. A "cross fracture" is a minor break extending at more-or-less right angles to the direction of the principal fractures.
Friable	Easy to break, or crumbling naturally
Friction bolt or Friction rock stabilisers.	Steel reinforcing elements, typically a "C" shaped shell that is forced into holes drilled in the rock. Frictional forces between the side of the hole and the element to generate forces to limit rock movement. The anchorage capacity of the device depends on the anchorage length above any plane of weakness and the frictional interference between the bore hole wall and the outer surface of the shell. Anchorage capacity is dependent on the hole diameter and the effective anchorage length in solid ground.
G	
Gangue	The worthless minerals in an ore deposit
Geologist	One who studies the constitution, structure, and history of the earth's crust.
Geology	The scientific study of the Earth, the rock of which it is composed and the time related changes which it has undergone or is undergoing.
Geological structure	A general term that describes the arrangement of rock formations. Also refers to the folds, joints, faults, foliation, schistosity, bedding planes and other defects in rock.
Geomechanics	The study of the mechanical properties of rocks, which includes stress conditions around mine openings and the ability of rocks and underground structures to withstand these stresses.
Geophone	A moving coil sensor converting ground velocity (vibration) into a calibrated electric signal.
Geotechnical engineering	The application of engineering geology, hydrogeology, soil mechanics, rock mechanics and mine seismology to the practical solution of ground response to mine design challenges.
Gold	A heavy, soft, yellow, ductile, malleable, metallic element.
Grab sample	A sample taken at random to be assayed to determine if valuable elements are contained in the rock. A grab sample is not intended to be representative of the deposit and usually the best-looking material is selected for the grab sample
Graphite	A soft platy mineral composed of carbon
Graphitic	Containing carbon or graphite.
Ground control	The ability to calculate and influence the expected behaviour of rock in a mining environment, having due regard for the safety of the workforce and the required serviceability and design life of the openings.
Ground control plan	The mine site management approach that defines the strategic details, key geotechnical information and systems a mine will manage the ground control related issues. It is synonymous with Code of Practice, Strata Management Plan, Roof Control Plan and Ground Control Management Plan.
Ground support	The use of timber, mesh, screen, etc that are placed in contact with the rock surface to limit rock movement. The rock mass has to deform onto the support before any stabilising forces can be generated.
Gutenberg-Richter Analysis	Power law based analysis of seismic data used as a tool to assess the likelihood of seismic events occurring.
H	
Hangingwall	The rock above or overlying the orebody
Haulage	The transport of ore and waste material throughout the mine operation by truck, shaft or other mechanised method.
Hazard	A source of potential harm, injury or detriment. A set of circumstances which may cause harmful consequences. The likelihood of its doing so is the risk associated with it.
Headframe	The structure surmounting the Hart Shaft which supports the sheave wheel, and facilitates hoisting.
Heading	Any active decline, cross-cut or drive.
Hierarchy of control	A series of controls, which should be applied in the following order (a number of these options may be considered and applied individually, or in combination): Eliminate - the complete elimination of the hazard Substitute - replacing the material or process with a less hazardous one Re-engineer - redesigning the equipment or work processes Separate - isolating the hazard by guarding or enclosing it Administrative - providing controls such as training, procedures, etc Personal Protective Equipment- using properly fitted PPE where other controls are not practicable.

Hoisting	The vertical transport of men, materials, ore and waste in the Hart Shaft.
Host rock	See country rock
Hydraulic fill	Backfill created using sized tailings and delivered underground in the form of slurry.
Hypocentre	The idealized point source of a seismic event, defined in 3D space.
I	
Imminent risk	An event or scenario that may occur at any moment that could lead to a significant incident.
Indicated mineral resource	That part of a mineral resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a reasonable level of confidence.
Incident	Any occurrence that has resulted in, or has the potential to result in (i.e. a near miss), adverse consequences to people, the environment, property, reputation or a combination of these. Significant deviations from standard operating procedures are also classed as an 'incident'. Ongoing conditions that have the potential to result in adverse consequences are considered to be incidents.
Induced seismicity	The seismicity caused by the mining
Induced stress	The rock stress that is due to the presence of an excavation. The induced stress depends on the level of the in-situ stress and the shape of the excavation.
Inferred mineral resource	That part of a mineral resource for which tonnage, grade and mineral content can be estimated with a low level of confidence.
Instability	Condition resulting from failure of the intact rock material or geological structure in the rock mass.
In situ	In the natural or original position
In-situ stress	The original stress state or conditions that exists within the rock mass before the onset of mining. The politically correct term for Virgin Stress.
Interbedded	Occurring between distinct rock layers of strata.
J	
Joint	A divisional planar defect or surface that divides a rock and along which there has been no visible movement parallel to the plane or surface.
Jumbo	A percussion drilling machine used to drill blast holes.
K	
Keystone	A block of rock which by virtue of its shape, orientation and location in respect of an excavation, prevents other blocks of rock from falling.
Kinematical analysis	Considers the ability or freedom of objects to move without reference to the forces involved. Sometimes also referred to as a block or wedge analysis.
L	
Lagging	Following or subsequent as opposed to 'leading'.
Lamination	Fine layering of rock due to closely spaced bedding.
Layout	The design or pattern of the main roadways and workings.
Leading or best practice	The fulfilment of a requirement of the protocol in a way which most thoroughly addresses the risk of fatality.
Lens	Generally used to describe a body of ore that is thick in the middle and tapers towards the ends.
Level	A horizontal tunnel or drive in an underground mine.
Lift	The amount of ore obtained from one mining cycle.
Likelihood	A description of probability or frequency, in relation to the chance that something will occur.
Limestone	A bedded, sedimentary deposit consisting chiefly of calcium carbonate.
Lithology	The character of a rock described in terms of its structure, colour, mineral composition, grain size, and arrangement of its component parts, namely all those visible features that in the aggregate impart individuality of the rock
Loose	Rock that should be removed by scaling to make the workplace safe.
Load	To place explosives in a drill hole. Also, to transfer broken material into a haulage device.
Loader	Machine for transferring excavated ore or waste rock.
Loading pocket	Transfer point at the Hart Shaft where ore or waste is loaded into the skip for hoisting to the surface.
Local magnitude (ML)	Measure of the strength of a seismic event based on energy release, source size, and forces acting at the source relevant to that particular mine.
Lode	A mineral deposit in solid rock.
Logging	The process of recording observations either on paper or on computer disk.
Longitudinal	A map showing features such as mine designs, infrastructure or geological structures as

section or Long section	a vertical slice parallel to the vertical and long axis through the orebody or mining infrastructure.
M	
Macroscopic	Visible to the unaided eye.
Magazine	An excavation where explosive materials are kept or stored.
Maintainability review	The process undertaken during the design or development of an excavation that reduces the required maintenance effort and time, logistic costs and support facilities to ensure that the excavation satisfy the requirements for its intended use within predetermined requirements over the life of excavation. This is conducted concurrently as the design progresses and is supplemented by facilitated formal review.
Major Accident Event	Any incident with the potential to lead to any of the following: A fatality; Serious environmental effects, including impairment of ecosystem function; Ongoing significant social issues; or Significant adverse attention from national media or non-government organisations (NGO), or loss of licence to operate.
Management system	Management processes and documentation that collectively provide a systematic framework for ensuring that tasks are performed correctly, consistently and effectively to achieve a specified outcome and to drive continual improvement. A systems approach to management requires: an assessment of what needs to be done; planning to achieve the objective; implementation of the plan; and review of performance in meeting the set objectives. A management system also considers employees and contractors, and resource and documentation requirements
Manager	Any employee or contractor who has other persons reporting to him or her, or who has the authority to allocate resources.
Map3D	Numerical analysis software for simulating the rock mass response for a conceptual or 'as built' mine layout for an anticipated geological setting.
Mapping	Measuring and recording the geological details of an excavation on a plan or section.
Marginal deposit	An orebody of minimal profitability
Measured mineral resources	That part of a mineral resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a high level of confidence
Mesh	Welded screen supplied in 3.6 x 2.4m sheets for surface support of excavations.
Metamorphis	The process by which the form or structure of rocks is changed by heat and pressure.
Micro-seismic event	A very small seismic event which is normally detectable only by means of sensitive instruments and which is unlikely to cause damage, but whose effects may extend into the audible range of 'rock noise' underground.
Mine seismology	Seismology associated with the mining industry
Mineral	An inorganic compound occurring naturally in the earth's crust, with a distinctive set of physical properties, and a definite chemical composition.
Mineral resource	An in-situ mineral occurrence quantified on the basis of geological data and an assumed cut-off grade only. More correctly referred to as an Identified Mineral Resource. Strict professional and technical criteria exist for the determination of mineral resources.
Mining engineer	A person qualified by education, training and experience in mining engineering. A trained engineer with knowledge of the science, economics and techniques of mineral location, extraction, concentration and sale, and the administrative and financial problems of practical importance in connection with the profitable conduct of mining.
Mining induced seismicity	Seismicity generated or created by the act or process of mining. The occurrence of seismic events in relative close proximity to mining operations and is commonly associated with volumes of highly stress rock, sudden movements on faults, or intact failure of the rock mass.
Mining lease	A portion of the land claimed for the valuable minerals occurring in it for the purpose of obtaining mineral rights under mining laws.
Misfire	The complete or partial failure of a blasting charge to explode as planned.
Modified cone bolt	A rock bolt installed with a weak epoxy resin or cemenitous designed to yield under load.
Muck	Ore or rock that has been broken by blasting
Mullock	Waste rock

Multi-tiered response plan	A plan in which additional levels of support or monitoring may be added according to triggers or enabling measurements defined under that plan.
N	
Native gold	Metallic gold in its free state
Near miss	A near miss is any occurrence or a situation which potentially could have caused adverse consequences to people, the environment, property, or reputation, or a combination of these but which did not.
Non-conformity	A non-fulfilment of a requirement of policies, standards, procedures, systems, or regulation(s).
Non-metallic	Containing little or no metal.
Nugget	Larger than normal piece of gold.
O	
Offset Fault Zone	That zone where the F1 Footwall Splay separates from the Tasmania Reef.
Omori analysis	Analysis of seismic data to determine re-entry times after a major seismic event or blast, based on time-dependent decay in aftershock activity.
Open ground	Rock which has not had any support installed.
Operability review	The process undertaken during the design and development of an excavation that reduces the required operational skills levels and logistic costs whilst increasing reliability, profitability and availability of the excavation over the life of the plant. This is conducted concurrently as the design progresses and is supplemented by facilitated formal review.
Ore	A mixture of ore minerals and gangue from which at least one of the metals can be extracted at a profit. Part of an ore reserve. See ore reserve.
Ore reserves	The calculated tonnage and grade of mineralization which can be extracted profitably. Ore reserves are classified according to the level of confidence that can be placed in the data. The plural may also used to refer to known ore zones identified as being suitable for mining at some time in the future. Strict professional and technical criteria exist for the determination of ore reserves.
Orebody	A natural concentration of valuable material that can be extracted and sold at a profit.
Origin time	The initiation time of a seismic event.
Overbreak	The excess rock broken outside the design perimeter of an underground excavation. Overbreak increases the amount of rock to be moved and may reduce mining efficiency. It may also increase the amount of barring down and ground support required.
Overlap zone	Overlap zone. The zone along the strike of the Tasmania Reef where dextral offset on the Tasmania Reef Shear juxtaposes (places opposite) the Wet Beds Conglomerate in the hangingwall with the 2CG Conglomerate in the footwall.
Oxidation	A chemical reaction caused by exposure to oxygen resulting in a change in the chemical composition of a mineral.
Oxide	Any chemical combination with oxygen.
Oxidize	To combine with oxygen.
P	
P-wave	Primary or compression component of a seismic energy wave.
Panel	A mining block in a stope that comprises one operating unit.
Percussion drill	A drill that delivers its energy through a pounding or hammering action
Permit	As it pertains to mining, a document issued by a regulatory agency that gives approval for mining operations to take place.
Personnel	People engaged in work for, and on behalf of BGM, including employees, people on temporary contracts and contractors.
Pillar	A volume of ore left as support between hangingwall and footwall rock. Temporary pillars are sometime recovered in the later stages of mining and permanent pillars left in place for the life of the mine. Pillars are also left to support the shaft, walls or roof in a mine. See crown and sill pillars
Plan or plan section	A map showing features such as mine workings or geological structures on a horizontal plane.
Plane of weakness	A naturally occurring crack or break in the rock mass along which movement can occur.
Plastic	Capable of deformation at constant stress once the yield point is exceeded. The ability of a material to undergo permanent deformation without returning to its original shape or failing.
Practicable	The extent to which actions are technically feasible, in view of cost, current knowledge and known best practices.
Preventive	An action implemented to prevent the occurrence of a non-conformity or incident. The

action	preventive action is commensurate with the severity of the potential non-conformity or incident.
Procedure	A specified way to carry out an activity or a process. Procedures can be documented or not. Procedure documents address specific areas (e.g. excavation performance reporting, risk management, incident investigation, etc) where it is important that activities are carried out consistently the mine site
Poisson's ratio	The ratio of axial compression to circumferential dilation of a body under load.
Primer (booster)	A package or cartridge of high explosive which is designed specifically to transmit detonation to other explosives and which does not contain a detonator.
Principal stresses	Orthogonal vector components of maximum, minimum and mutually orthogonal intermediate stress magnitude which are not necessarily vertical and horizontal or aligned to any particular Cartesian reference system.
Probable ore reserve	A probable ore reserve is the economically minable part of an indicated, and in some circumstances, a measured mineral resource.
Proved ore reserve	A proved ore reserve is the economically minable part of a measured mineral resource.
Pyrite	A hard, heavy, shiny, yellow mineral, $FeS2$ or iron disulfide, generally in cubic crystals. Also called iron pyrites or fool's gold.
Q	
Qualified	A term describing a person who has been trained and received the applicable degree or certificate to carry out a given task.
Quartz	Common rock-forming mineral consisting of silicon and oxygen. The major host mineral at Beaconsfield.
Quartzite	A metamorphic rock formed by the transformation of a sandstone rock by heat and pressure. Strictly speaking, all the host rocks at Beaconsfield, other than the limestone within the Eaglehawk Gully Formation is quartzite.
R	
Raise	A vertical or inclined underground working that has been excavated from the bottom upward.
Ravelling	The gradual failure of the rock mass by rock blocks falling/sliding from the opening perimeter under the action of gravity, blast vibrations or deterioration of rock strength. A gradual failure process that may go un-noticed. The term unravelling is also used to mean the same thing.
Reaming	Enlarging the diameter of a hole.
Records	Recorded information, in any form, created or received and maintained by an organisation or person in the transaction of business and kept as evidence of such activity. An electronic record occurs where the above is represented in a form suitable for retrieval, processing and communication by a computer. Records are distinguished from other documentary forms such as information by their intrinsic relationship to the business activity they represent. This relationship is essential to defining a record and is only possible when the links between content, structure and context exist. Records can include but are not limited to monitoring results, evidence of training, audit/self assessment/inspection findings and design reports
Recovery	The percentage of ore mined from the original deposit.
Reef	The reef is the seam of quartz ankerite rock occupying the shear zones which encompass the orebody. The Tasmania Reef is the dominant reef structure at Beaconsfield.
Reinforcement	The use of tensioned rock bolts and cable bolts, placed inside the rock, to apply large stabilising forces to the rock surface or across a joint tending to open. The aim of reinforcement is to develop the inherent strength of the rock and make it self-supporting. Reinforcement is primarily applied internally to the rock mass.
Release of load	Excavation of rock during mining removes or releases the load that the rock was carrying. This allows the rock remaining to expand slightly due to the elastic properties of the rock.
Remedial support	Ground support installed in addition to the primary or original support to improve or regain stability not afforded by the primary support (i.e. to prevent impending or eventual failure).
Remotes	For the purpose of the report, "remotes" means equipment that operates under unsecured or open ground while the operator is under secured ground separated from the equipment. "Tele-remote" means equipment is equipped with video cameras so the operator can be located at a substantial distance from any potential hazards.
Resin bolting	A method of permanent rock support in which steel rods are grouted with chemical resin.
Resource	A concentration of mineral material in such form and amount that economic extraction

of a commodity from the concentration is currently or potentially feasible.

Resources Resources may include human resources and specialised skills, organisational infrastructure, plant, equipment, technology and financial resources.

Resuing A method of stoping in narrow-vein deposits whereby the wall rock on one side of the vein is blasted first and then the ore.

Risk Exposure to the consequences of a hazardous uncertainty. It has two dimensions: the likelihood that a hazard will cause an undesired result and the consequences if the hazard is eventuates.

Risk assessment The systematic evaluation of the degree of risk posed by an activity or operation where identified hazards are ranked and/or compare based on likelihood of occurrence and exposure. An acceptable consequence is the product when appropriate control measures are but in place to eliminate or manage the risk.

Risk management Appropriate control measures used to eliminate or manage the risk using re-design, barriers, systems, training and procedures.

Rock Any natural combination of minerals; part of the Earth's crust.

Rock bolt A tensioned bar or hollow cylinder, usually steel, that is inserted into a drill hole in the rock and anchored by an expansion shell anchor at one end and a steel face plate and a nut at the other end. The steel face plate is in contact with the rock surface.

Rockbolting The act of supporting openings in rock with steel bolts anchored in holes drilled especially for this purpose.

Rockburst The instantaneous failure of rock causing a sudden violent expulsion of rock material at the surface of an excavation. Can be a serious hazard to people and equipment. Sometimes used to describe a seismic disturbance to a surface or underground mine where damage results to the mine structure or equipment.

Rockfall (or Fall of Ground) An uncontrolled fall (detachment or ejection) of ground of any size that causes (or potentially causes) injury or damage.

Rock Mass The sum total of the rock as it exists in place, taking into account the intact rock material, groundwater, as well as joints, faults and other natural planes of weakness that can divide the rock into interlocking blocks of varying sizes and shapes.

Rock mass strength Refers to the overall physical and mechanical properties of a large volume of rock which is controlled by the intact rock material properties, groundwater and any joints or other planes of weakness present. One of the least well understood aspects of geotechnical engineering.

Rock mechanics The scientific study of the mechanical behaviour of rock and rock masses under the influence of force fields.

Rock noise Audible sounds emitted by the rock during failure, may be described as cracking, popping, tearing and banging.

Rock reinforcement The use of rockbolts, cable bolts or ground anchors installed into the rock to apply stabilising forces and adding to the tensile strength of the rock mass to make the rock self supporting.

ROPS/FOPS A framework, safety canopy or similar which protects the operator when equipment overturns or when rock or other material falls on it.

Round Planned pattern of drill holes fired in sequence in tunnelling, shaft sinking, or stoping. First the cut holes are fired, followed by the relief, lifter, and rib holes; back holes are generally last.

Run-of-mine (ROM) A loose term to describe raw ore material as it exists in the mine; average grade, size, or quality.

S

Salisbury Hill Formation (SHF) The lower formation of the host rocks at Beaconsfield comprising silicified sandstone, with interbedded conglomerate beds including the Cabbage Tree, 2CG and Wet Beds Conglomerates over a total thickness of approximately 185m.

Sample A small portion of rock or a mineral deposit, taken so that the metal content can be determined by assaying or so that rock properties can be obtained.

Sandstone A sedimentary rock consisting of quartz sand united by some cementing material, such as iron oxide or calcium carbonate.

Scaling (or Barring Down) The act of making the ground safe by removing loose immediate rock using a scaling bar, scaling machine, high pressure water or other equipment purpose built for locating and removing loose rock from the walls, face and backs of the workplace. Loose or potentially unstable rock is forced off the rock surface.

Secondary support Support which is installed in addition to the primary support as part of the support plan to prepare the opening for further stresses expected as part of the mining cycle.

Secure ground Ground that is supported in accordance with the ground control plan, or unsupported ground, which has been assessed as not requiring support in accordance with the ground control plan. The ground control plan may also stipulate secure ground when it

	has been adequately temporarily supported for the purpose of installing permanent support. However, the temporary support must assessed by a competent person to be adequate or designed to an accepted standard.
Sedimentary rocks	Particles eroded from other rocks and deposited under water. Examples are lime stone, shale and sandstone.
Seismic array	The arrangement or pattern of seismic sensors installed throughout region for the purpose of capturing waveforms generated by seismic events.
Seismic event	A transient dynamic energy wave caused by the sudden failure of rock releasing stored strain energy. Effectively, a seismic event is the energy released from a rock slipping or rock breaking. Seismic events are a response of a rock mass to the stress changes caused by the creation of mining excavations. Most underground mines have seismic events that can be heard and felt. Not all seismic events cause damage to the mine excavations, therefore all seismic events are not necessarily rockbursts.
Seismicity	The spatial and temporal distribution of seismic events.
Seismic hazard	The likelihood of occurrence of seismic events of certain hazardous magnitude.
Seismic location	The point assigned as the central location in the rock mass at which some combination of stress, geological structure and mining influences cause the rock mass to deform or fail, resulting in seismic events.
Seismic magnitude	A relative measure of the strength of a seismic event based on measurements of maximum displacement at a given frequency.
Seismic source mechanism	The mode of deformation or failure of a rock mass that causes the seismic stress wave to be created. Typical seismic source mechanisms include: slip on existing geological structures; creation of new fractures in a rock mass due to high stress or crushing; and tensile failure of intact rock or a rock mass.
Seismology	The scientific study of seismic events through the analysis of seismic waveforms transmitted through rock and soil materials.
Self-assessed	An internal review of systems, procedures, information, practices or facilities carried out by an operation to confirm compliance with regulated or other requirements, to ensure that operating procedures are being followed or to provide assurance that corporate standards are being implemented and are effective.
Shaft	A vertical or steeply inclined excavation for the purpose of opening and servicing a mine. It is usually equipped with a hoist at the top, which lowers and raises a conveyance for handling personnel and materials.
Shaft mine	An underground mine in which the main entry or access is by means of a steeply inclined or vertical shaft.
Shale	A rock formed by consolidated clay, mud or silt, having a laminated structure and being composed of minerals essentially unaltered since deposition.
Shear or shearing	A mode of failure or process where two objects or pieces of rock tend to slide past each other. The deformation of rocks by lateral movement along innumerable parallel planes, generally resulting from pressure and producing such metamorphic structures as cleavage and schistosity; a mode of failure where two objects or pieces of rock slide past each other.
Shear zone	A zone in which shearing has occurred on a large scale.
Shear stress	A stress that tends to cause an object to slide
Sheave wheel	A large grooved wheel in the top of a headframe over which the hoisting rope passes.
Shift	The block of hours or the part of any day worked by a given individual.
Shrinkage stoping	A stoping method which uses part of the broken ore as a working platform and as support for the walls of the stope.
Shotcrete	Pneumatically applied liner composed of cement, water, sand and fine aggregate mix that is sprayed at high velocity on the rock surface. Once cured it tends to inhibit blocks ravelling from the surface of an excavation. Frequently, shotcrete is reinforced with mesh, steel fibres or polyethylene fibres. Fibre reinforced shotcrete is referred to as Fibrecrete.
Significant risk	A risk that causes or has the potential to cause impact or harm that could result in a significant incident.
Sill pillar	A long thin pillar left as one stope is mined out toward an upper stope. The pillar thickness must be sufficient to maintain a safe base of operation above and below to withstand the retort after the fragmented mass is formed as a result of production blasting.
Simultaneous operations	Any instance where work activity at a particular location has the potential to impact on, or be impacted by, other activities at the location at the same time, including existing operations at the location.
Site management	The person or persons with overall control for the management and direction of an operation, activity, project or venture.

Skip	A self-dumping bucket used in a shaft for hoisting ore or rock.
Slabbing	Unstable slabs of rock formed by close spaced foliation or bedding planes in the backs or walls. Can also be caused by high stress levels that produce flat slabs parallel to the walls or backs.
Smooth blasting	The use of closely spaced parallel perimeter holes charged with low strength explosives, fired after the main round. Can be used to reduce blast damage to the rock mass and improve rock stability.
Spalling	Stress induced failure of the rock mass that results in small, thin, curved, sharp edged pieces of rock ejected or falling from the surface of an excavation. Generally accompanied by rock noise, usually associated with highly deviatoric rock stress (a larger ratio between the major and minor principal stresses and hence the rock mass is more likely to fail in shear).
Span	The horizontal distance between the walls of a decline, crosscut or drive.
Specific gravity	The ratio of the weight of a substance compared with the weight of an equal volume of pure water at 4 degrees Celsius.
Sounding	The act of tapping a solid bar against the roof to determine if the immediate roof has voids behind it or is solid.
Standard	The basis for the development and application of management systems at all levels of a mining operation.
Strain	The change in length per unit length of a body resulting from an applied force. Within the elastic limit strain is proportional to stress.
Strength	The largest stress that an object can carry without breaking. Common usage is the stress at failure.
Stress	May be thought of as the internal resistance of an object to an applied load. When an external load is applied to an object, a force inside the object resists the external load. The terms stress and pressure refer to the same thing. Stress is calculated by dividing the force acting by the original area over which it acts. Stress has both magnitude and orientation.
Stress field	A descriptive term to indicate the pattern of the rock stress (magnitude and orientation) in a particular area.
Stress shadow	An area of low stress level due to the flow of stress around a nearby excavation (e.g. a large stope). May result in joints opening up causing rockfalls.
Strike	The bearing of a horizontal line in a plane or a joint.
Stockpile	Broken ore stored pending treatment or shipment.
Stope	An excavation in a mine from which ore is being or has been extracted.
Stope lift	A horizontal slice of ore mined from the back of a stope. Generally applied to cut and fill stoping, and shrinkage mining methods.
Strain	The change in linear length per unit length of a body resulting from an applied force.
Strain burst	Sudden rock failure at the lower end of the spectrum of violent events. A strain burst typical results in a rockburst and fog of ground.
Strap	A moulded steel strap used for ground support.
Stratigraphy	Strictly, the description of bedded rock sequences; used loosely, the sequence of bedded rocks in a particular area.
Stress	Stress is a nebulous concept to describe the force acting on a given point in the rock mass. It is a combination of gravitational and tectonic forces influenced by the impact of mining. It is comprised of 6 Cartesian components of normal and shear stress.
Strike	The direction, or bearing, from true north of a vein or rock formation measured on a horizontal surface.
Stringer	A narrow vein or irregular filament of mineral traversing a rock mass.
Structure	The general form and type of rock formation.
Sublevel	A level or working horizon in a mine between main working levels.
Sump	An underground excavation where water accumulates before being pumped to surface. Or, the bottom of a shaft, or any other place in a mine, that is used as a collecting point for drainage water.
Support	The use of steel or timber sets, concrete lining, steel liners, etc that are placed in contact with the rock surface to limit rock movement. The rock mass has to move on to the support before large stabilizing forces are generated. Support is applied externally to the rock mass.
Supported Ground	Ground that has been supported in accordance with the ground control plan.
S-wave	Secondary or shear wave detected by a geophone resulting from a seismic event.
Syncline	A fold in rock in which the strata dip inward from both sides toward the axis. The opposite of anticline.
System	A set of arrangements, responsibilities and authorities aimed at ensuring the achievement of defined outcomes.

T

Tailings	Material rejected from a mill after most of the recoverable valuable minerals have been extracted. Normally consists of ground up rock in the sand to silt size range. May be sized for use as backfill.
Talking	The noise associated with small failures of rock occurring beyond the excavation surface and not causing any fall of material.
Target	Detailed performance requirements, quantified whenever practicable, that arise from objectives and are set in order to achieve the objectives.
Tasmania Reef	The gold-bearing quartz ankerite vein which occupies the Tasmania Shear and constitutes the orebody at the Beaconsfield Gold Mine.
Tasmanian Shear	A dextral shear fault which hosts the Tasmania Reef.
Tectonic forces	Forces acting in the Earth's crust over very large areas to produce high horizontal stresses which cause can earthquakes. Tectonic forces are associated with the rock deforming processes in the Earth's crust.
Telehandler	A service vehicle with an extendible boom and lifting tynes.
Temporary Support	Support installed temporarily for the purpose of protecting the operator while permanent support installed or while emergency or recovery operations are carried out after a roof fall or equipment breakdown. Properly specified temporary support creates temporarily secure ground for the purpose of this protocol. "Temporary Support" in hard rock is support installed in short term excavations.
Tenor	The relative value or mineral content of ore.
Tensile stress	A stress that tends to cause a material to stretch. Can cause joints to open and may release blocks causing rockfalls and is basically acts in the opposite direction of compressive stress.
Temporary Roof Support	Temporary roof support is installed to provide support and protection until the permanent support is installed and then is removed.
Ticker	Software designed for the rapid visualization of seismic data.
Timber	A collective term for underground wooden supports.
Timber set	A timber frame to support the sides of the Hart Shaft.
Toll-gate	A review system or procedure that must be satisfied before proceeding to the next stage of a project or process.
Tonnes-per-vertical-metre	Term used to describe the amount of ore in a deposit - ore length is multiplied by the width and divided by the appropriate rock factor to give the amount of ore for each vertical metre of depth.
Topography	The physical features of the surface in an area.
Triaxial sensor	Three equally orthogonal uniaxial sensors combined in one instrument.
Triggers	Specific signs or indications of ground deterioration or geological degradation which a mine site has determined to and specified as requiring additional levels of monitoring or support or a modified sequence of mining.

U

Underlying cause	The indirect cause of the incident that, if rectified, will prevent the recurrence of not just incidents with those exact circumstances, but others with similar causes. (Underlying cause is sometimes referred to as root cause.)
Unconfined Compressive Strength (UCS)	A material strength test that is determined as the maximum uniaxial force which a material will withstand without the influence of any lateral confining forces on the test sample.
Uniaxial sensor	A single axial component seismic detection instrument installed.
Unsecured ground	Ground that has not been supported to the standard stated in the ground control plan (unless assessed as not requiring support in accordance with the ground support plan), or ground that has been assessed as unsecured due to support deterioration or ground movement.
Unsupported ground	Rock that has not been supported in accordance with the ground support standard.

V

Vein	A mineralized zone having a more or less regular development in length, width and depth which clearly separates it from neighbouring rock.
Ventilation	The provision of a directed flow of fresh and return air along all underground roadways, travelling roads, workings and service parts.
Virgin stress	A politically incorrect term for in situ or natural stress levels in the ground resulting at any point from the weight of the overburden and tectonic forces.
Visible gold	Native gold which is discernable in a hand specimen by the unaided eye.
Void	A general term for pore space or other openings in rock which may be natural or the

	result of mining.
W	
Wall	The sides of a mine working; rock on either side of an orebody.
Wall rocks	Rock units on either side of an orebody. The hangingwall and footwall rocks of an orebody.
Water table	The underground level at which the ground is saturated with water. The level at which water will stand in an excavation.
Wedge	A block of rock defined by a set of existing discontinuities on three or more sides that can fall or slide out under the action of gravity, unless supported.
Wet Beds Conglomerate	The upper conglomerate unit within the Salisbury Hill Formation, being approximately 20m thick.
Width	The thickness of a lode measured at right angles to the dip.
Winder	At the Beaconsfield Gold Mine, the hoisting system employed for raising and lowering the conveyance in the Hart Shaft.
Winze	Secondary or tertiary vertical or near-vertical opening sunk from a point inside a mine for the purpose of connecting with a lower level.
Workings	The entire system of openings in a mine for the purpose of exploitation.
X	
Y	
Yielding	The process of gradual energy release with a non-violent yet destructive outcome.
Yield point	The maximum stress that a material can sustain without permanent deformation or rupture. The limit of proportionality between stress and strain. Also known as the elastic limit or failure point.
Young's modulus	Elastic modulus or stiffness of a material.
Z	