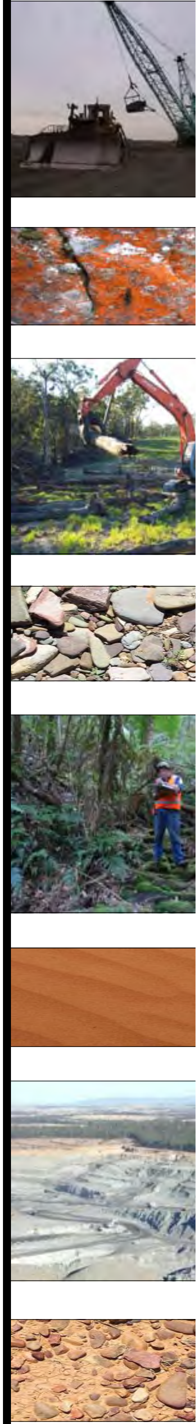

Geotechnical Assessment
(GHA 2011)

APPENDIX I

G E Holt & Associates Pty Ltd
Geotechnical Engineers

15 February 2011

Mr Tony Heinrich
Project Manager
Rocglen Coal Mine
P.O. Box 600
Gunnedah N.S.W. 2380

Dear Mr Heinrich

Re: Short and Long Term Stability of the Eastern Highwall

This report is a revision of our 1 December 2010 report. It incorporates the latest proposed mine plan and clarifies some technical points raised by the Department of Planning.

The purpose of this geotechnical report is to assess the proposed final highwall stability for the Eastern Highwall, or end wall, of the Rocglen Open Cut. Whitehaven Coal Limited has prepared a conceptual mine plan to extract the coal resource contained within ML1620. The mine plan proposes relocation of Wean Road, which currently crosses the coal resource. It is proposed to move the road to beyond the eastern limit of the proposed extension to the existing open cut operation.

This report discusses the issues involved in ensuring a safe and stable highwall design then analyses the likely stability of the final highwall, and provides recommendations to ensure the permanent integrity of Wean Road. The site geology is a significant issue in assessing likely highwall stability and so is briefly reviewed so that the stability assessment can be seen to be anchored to available knowledge.

Geology

The site geology is described elsewhere but there are features that are extremely relevant to final wall stability. Generally the mine is developed on top of an anticline with the western limb steeper than the eastern. The eastern limb is interrupted by the Belmont Fault, which is a significant thrust fault. It tips the eastern dipping coal sequence up vertically, and cuts off the coal seams. It has a deeply weathered fault breccia zone associated with it. In addition there is a thick sequence of poorly consolidated alluvials (clays and sands) overlying the Permian coal measures. Exploration in 1994 delineated the Belmont Fault. Part of the Geological Hazards Plan prepared by MBS in 1994 is shown in Figure 1.

The alluvials, deeply weathered rock and the Belmont Fault zone will have a major influence on final wall stability. This is evident from ground behaviour around the fault in the current operations.

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In October 2009 the eastern highwall intersected the Belmont Fault. It rises steeply from the east, forcing the east dipping strata into a vertical position. The thrust zone is relatively wide, and has resulted in deeper weathering of the strata and significant strength reduction in the weathered rock affected by the thrust.

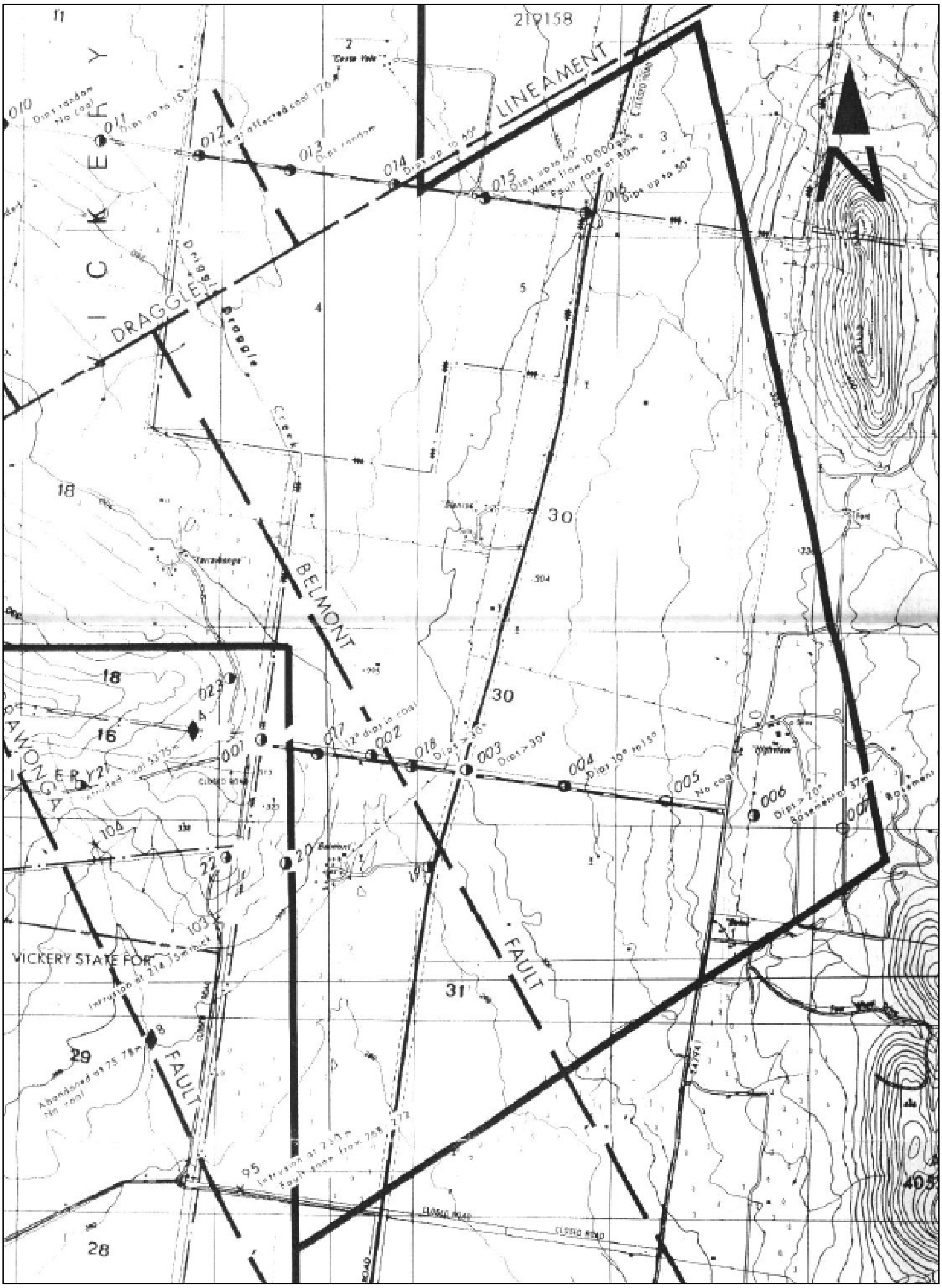

Figure 1: Part of 1994 Geological Hazards plan showing Belmont Fault between Boreholes EVK002 and EVK018

The location of the Fault has since been delineated more accurately by additionally drilling. Its position and extent of the additional drill holes is shown in Figure 2. The drilling has shown that the strike of the thrust is not a straight line from the northwest to south east as indicated in 1994. Rather it meanders along an irregular path in this same direction, and may have offshoots. This is to be expected with a thrust-faulted area so close to the major Hunter-Mooki thrust system just a few kilometres east of the mine.

It effectively cuts off the thick Belmont Seam so the pit limit has been set close to the fault structure.

Stability of Highwall

In order to maximise extraction of the coal contained in the Belmont Seam it will be necessary to push the highwall further to the east from where the Belmont Fault cuts off the coal, to develop a stable highwall. Quite clearly a large fault structure has crushed rock and deep weathering associated with it, and this is potentially de-stabilising for any highwall.

Wean Road currently runs through the proposed extension to the open cut, and as a consequence it is proposed to re-orient it around the pit. Figure 3 shows the road positioned 50m beyond the proposed pit limit. As indicated in Figure 2, the latest drilling suggests that the Belmont Fault will intersect the proposed eastern highwall at a very acute angle. This geometry is the worst possible to ensure highwall stability, and cutback or flattening of the wall would be required to stabilise the highwall. Limitations of land ownership and the re-location limits for Wean Road mean that a theoretical push back of Wean Road further to the east to accommodate a flattened highwall is not possible. Economic factors in excavating considerable quantities of fault affected overburden also affect such a consideration.

The most stable orientation for a fault intersecting a highwall is when the fault is close to right angles to the wall, or at least intersects it at a very high angle. This reduces the area of instability to a little more than the width of the fault zone, and consequently it is a much simpler mining exercise to maintain stability. One possible way of doing this is shown in Figure 3.

This possible highwall configuration assumes the Belmont Fault continues south easterly as a wide, weathered zone of crushed rock and clayey material under alluvials. The eastern highwall is turned westward so that it intersects the fault zone at close to right angles. This then allows the turned highwall to be cut back until stability is achieved in the crushed rock and alluvium, without impacting on Wean Road. There would be a notch developed in the highwall. Once the turned highwall encounters sound rock, as it continues to the west, it can be turned again to develop parallel to the Belmont Fault until it reaches the planned pit limit, as indicated in Figure 3. The width of unmined rock required to hold the Belmont Fault stable can be determined when the final layout of the highwall is being determined.

This sort of approach ensures that within 150m of Wean Road the Belmont Fault is buttressed by solid rock to the west, is stabilised within the pit crest and therefore cannot affect Wean Road.

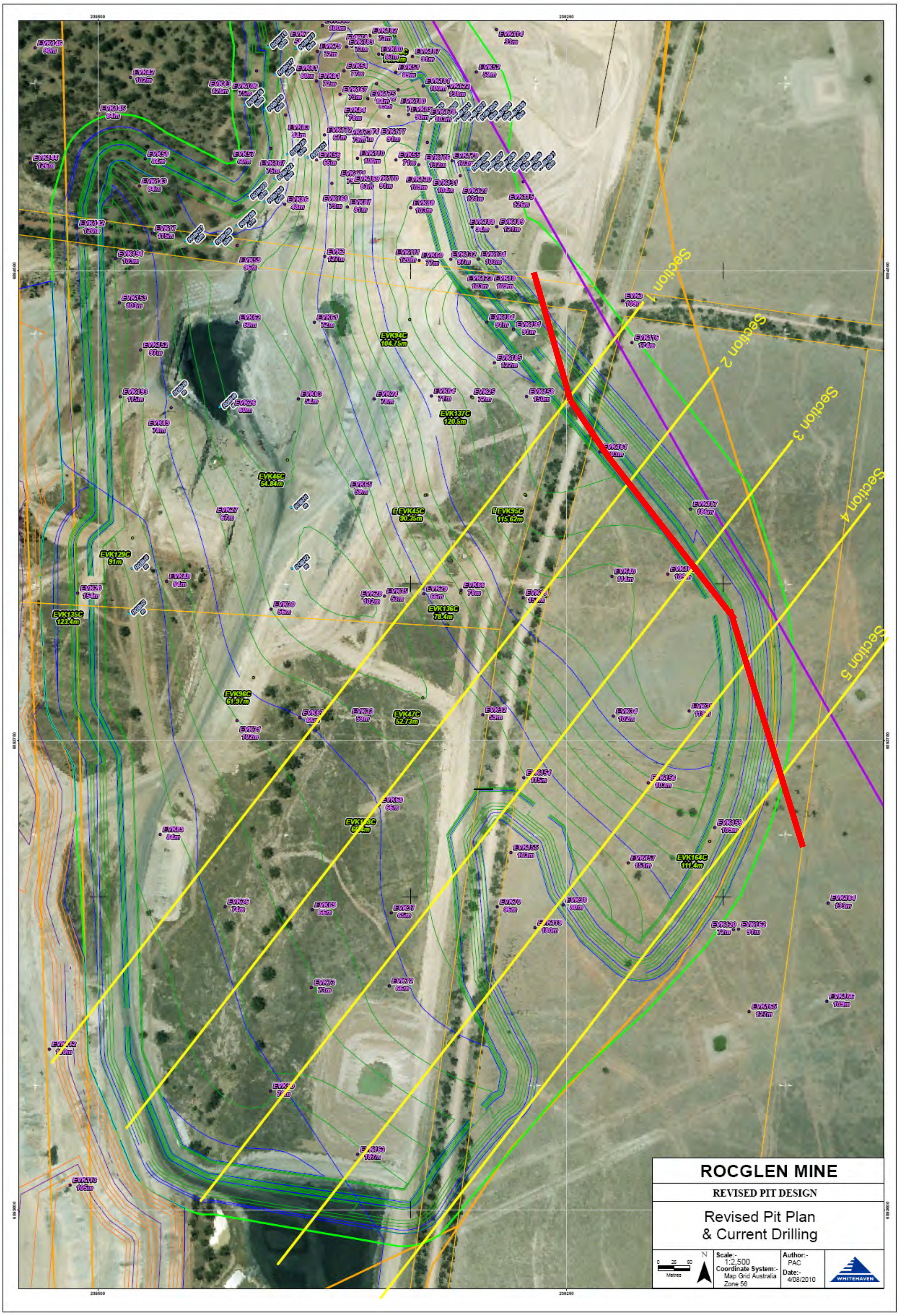

Figure 2: Original proposed shell of pit extension showing recent drillhole locations & location of the Belmont Fault in October 2010. Pit outline has been modified since preparation of this drillhole plan.

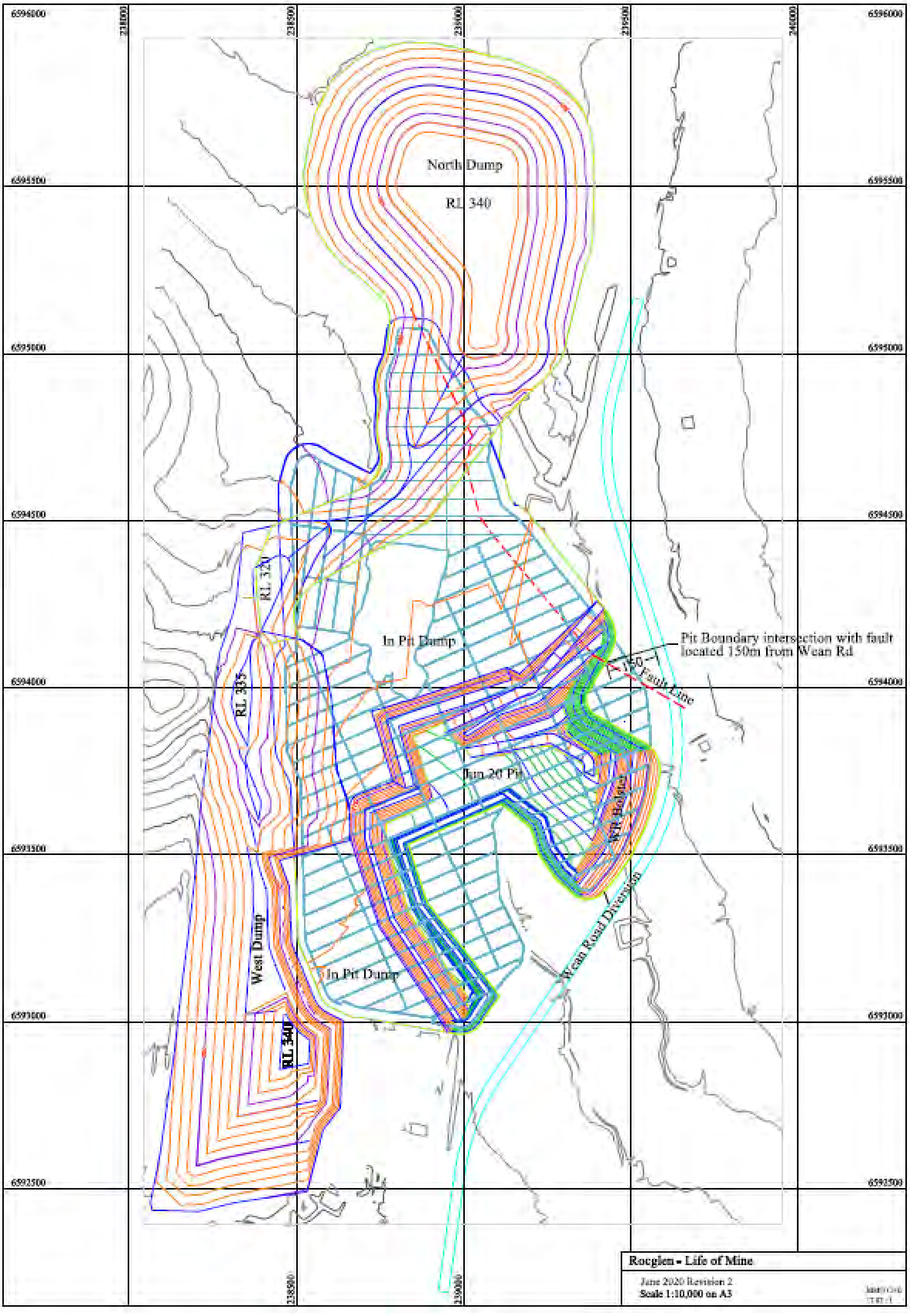

Figure 3: Set back of pit crest 50m from relocated Wean Road, plus suggested re-alignment of highwall to ensure fault zone is stable. Containment of the fault can be done in this manner regardless of its position with respect to Wean Road.

Alterations to a mine plan are not uncommon in any mining operation affected by geological structure so the mine operations plan needs to have sufficient flexibility to enable changes. This can be achieved by including trigger points for action in the mine operations plan. Trigger points could take the form of actions required by the time the highwall is at certain distances from Wean Road, for example. The exact location of the Belmont Fault, the nature of the fault, location of the Belmont Seam with regard to the fault, the stability of the highwall are just some of the issues that will become more accurately known with the advance of mining operations.

Additional Factors Affecting Highwall Stability

Strata dipping into a highwall significantly improve stability by providing resistance to slip of strata out of a highwall. It is virtually impossible for rock strata to slide uphill on bedding planes, against gravity. The strata sequence dips to the east on the western side of the Belmont Fault, and east of the fault strata also dip towards the east. Intersection of the fault zone in the current open cut indicate the fault swings the east dipping strata to vertical at the fault. Then the strata are brecciated in the fault zone and deeply weathered.

Weathering depths up to 72m have been encountered close to the Belmont Fault. Some weathering depths for boreholes in the southeast corner of the proposed pit are provided in Figure 4. Any highwall constructed in such material would require significant flattening to develop a stable wall.

A highwall design to control slip of weak material in the upper part of a highwall was developed in 2010 as a consequence of encountering the Belmont Fault. This is shown marked in blue in Figure 5.

Application of the design proved that it is possible to buttress the thrust zone and maintain a stable face. Using this as a guide a method of operation was developed to advance the pit in a safe manner. The method of operation is integrated with the slope design to provide a plan for a safe and stable operation.

There are two parts to the revised highwall design. The upper part of the wall in weathered and fault-affected strata is of relatively low strength, and here the highwall is flattened with face slopes of 45^0 with a 15m wide bench approximately half way down the face to assist stability. If overall thickness of the weathered zone exceeds 50m then it becomes necessary to incorporate an additional catch bench. This manner of flattening a face requires considerable space.

The fresh strata below the weathering limit is strong and competent over much of the pit and it is possible to form the lower part of the highwall at the floor of the Belmont Seam in one curved downward sloping face.

But if floor strata prove to be too friable for a single sloping face in fresh rock then there is room to provide a 5m catch bench in the highwall.

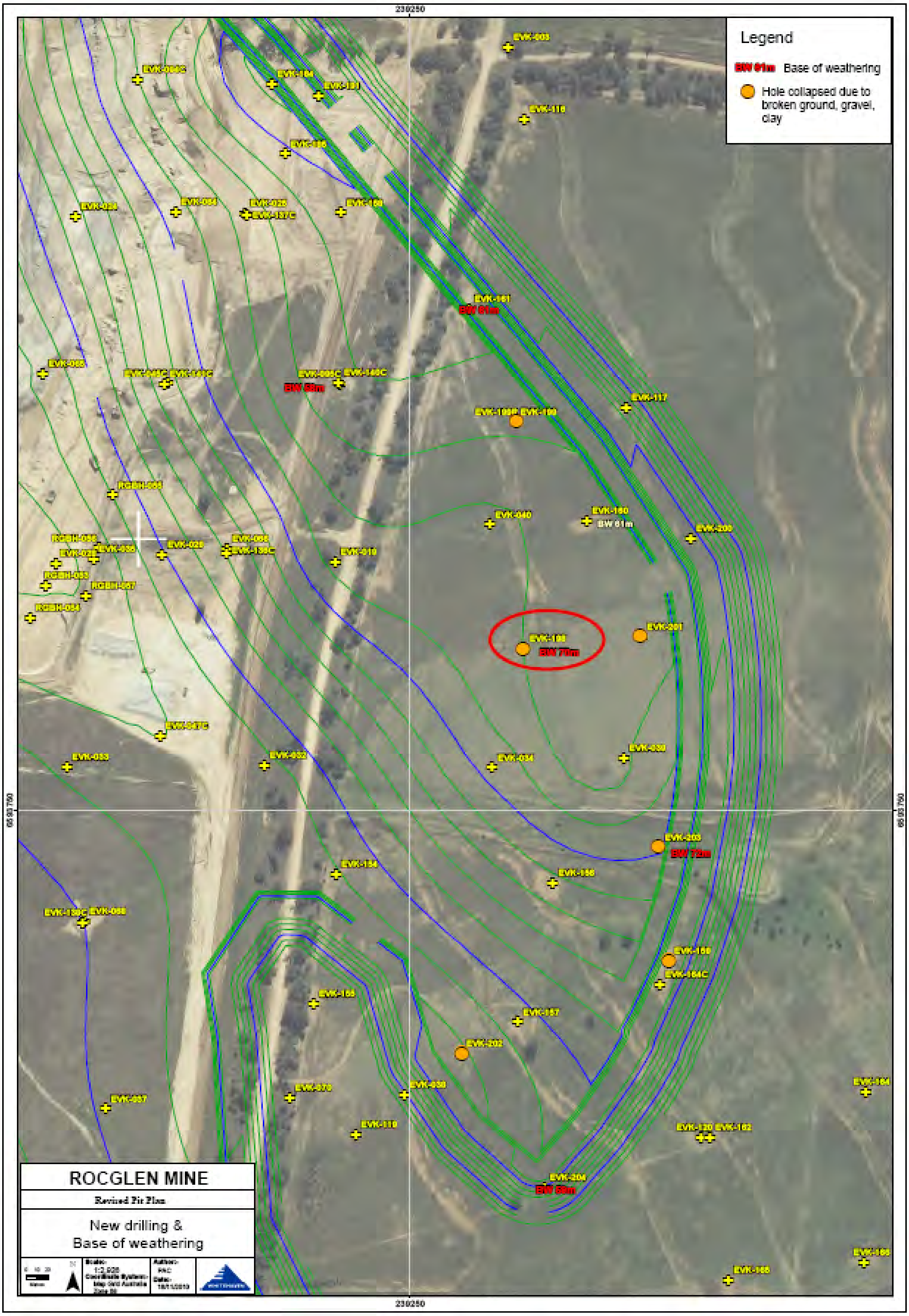

Figure 4: Proposed Rocglen Open Cut showing depth of weathering in some boreholes.
(Enlarge figure to read detail. Note this is old pit shell)

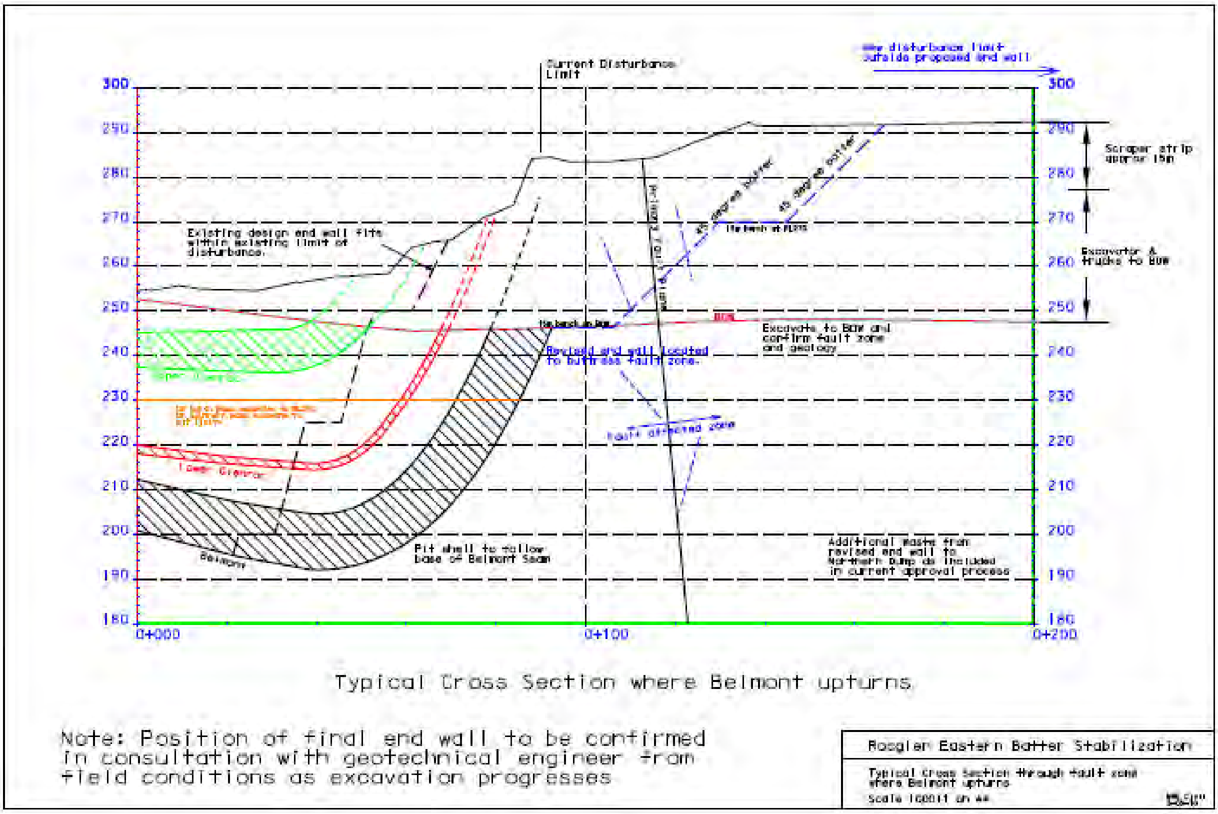

Figure 5: Highwall profile where Belmont Seam is uncovered and turned up nearly vertical
(Enlarge diagram to improve readability)

At some stage in developing the eastern highwall to the southeast the Belmont Fault will approach a distance of 150m from Wean road. The highwall would then be turn westward to contain the fault zone within undisturbed rock, as discussed on page 3. The probable design of the turned face would be as shown in Figure 5 as the black dashed line labelled “Existing Design”. This design would incorporate a flattened area across the fault zone.

Impacts of Mining Methods on Highwall Stability

The geological advice at this stage is that the thrust fault extends the full limit of the pit on its eastern side. A key element in development of a safe and stable highwall is accurate location of the thrust zone.

The approximate position is now known, but its accurate location is necessary to be able to develop the crest of the highwall in its correct location to protect Wean Road. This will be achieved by the method of mining the deposit.

It is intended to advance mining from the north to south to a depth limit of approximately RL230 and use this development to approach the upturned Belmont Seam to the east by widening out the pit as conditions allow. The Belmont Fault has already been intersected and the highwall design has already been partly implemented. The lack of approved pit space prevents further implementation of the final highwall design.

The eastern highwall will actually become, not a just highwall, but also an end wall to the actual highwall that will be advancing to the southeast. The proposed method of working near the Belmont Fault will be a haul back operation. Overburden is taken from the advancing highwall and hauled back to the most recently excavated strip immediately behind and adjacent to the end wall containing the Belmont Fault. This limits the amount of end wall open at any time to about three strip widths at any time. Limited exposure means that any stability issues that might develop are contained within a narrow working zone.

As discussed above, the fault zone is currently 100’s of metres from the proposed Wean Road realignment. As the pit advances to the southeast, the fault zone will be tracked accurately, and it will be some years before the pit crest approaches within 150m of the re-aligned Wean Road. This provides time to monitor and amend highwall design should any other stability issues arise, without affecting land beyond the proposed pit shell. The nature of the Belmont Fault may also change and this might require change to the highwall design. Flexibility is needed in the mine plans (and approval process) to accommodate changes in geological conditions. Current knowledge is not complete.

The mining process will be subject to regular stability review to ensure safe working, and this sort of regular monitoring is commonly written into stability management plans.

Stability Analysis

Having developed a stable highwall design, coupled with a method of operation to maintain stability, the design was checked by slip circle analyses. This is appropriate since the upper part of the eastern highwall will be in poorly consolidated material, and the lower part in fresh rock has been observed to be free of geological discontinuities that might cause slip out of the face. The major geological discontinuity of course is the Belmont Fault.

The Factor of Safety of the proposed wall profile has been checked using the Galena Program, which is a Method of Slices program incorporating a Spencer-Wright analysis to allow for non-circular failure surfaces. Figure 6 shows the model develops a minimum Factor of Safety of 1.1 for the weathered strata section of the proposed wall profile using cohesion of 50kPa and Friction Angle of 19^0 for the alluvial material and weathered rock mass. The wall profile used in the model is as shown in Figure 5.

Factor of Safety increases to 1.6 when the potential failure surfaces are developed to the pit bottom. This model result is shown in Figure 7. This demonstrates the effectiveness of competent rock in the lower part of the face in maintaining face stability. The limiting Factor of Safety however is 1.1 for the upper weathered/faulted part of the face. This is considered satisfactory for the “short term”.

“Short term” stability in mining terms is considered to be a year or two, long enough to advance the face and backfill behind. This is considered appropriate because the model assumes an infinitely long face and in reality only a limited length of face will be developed at a time.

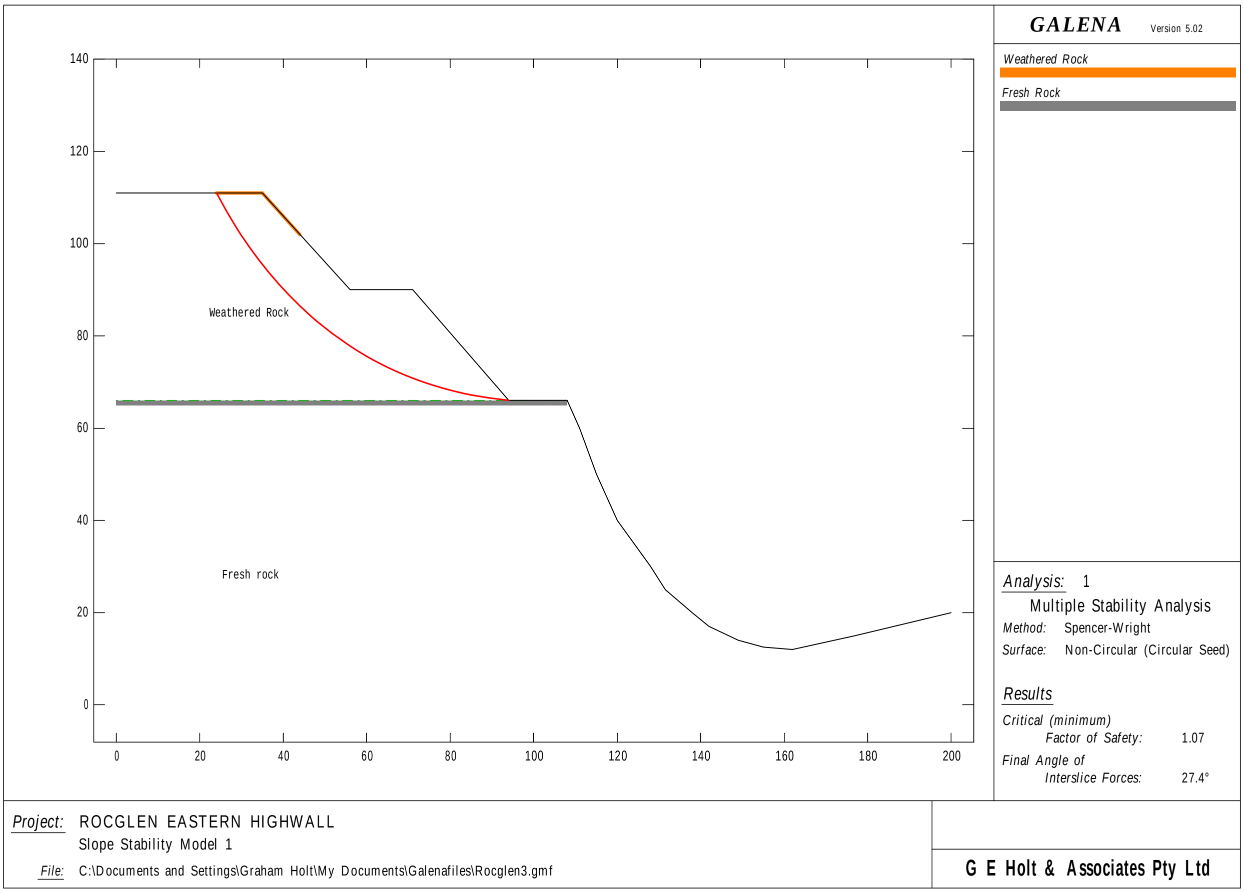

Figure 6: Factor of Safety model for limiting stability case.

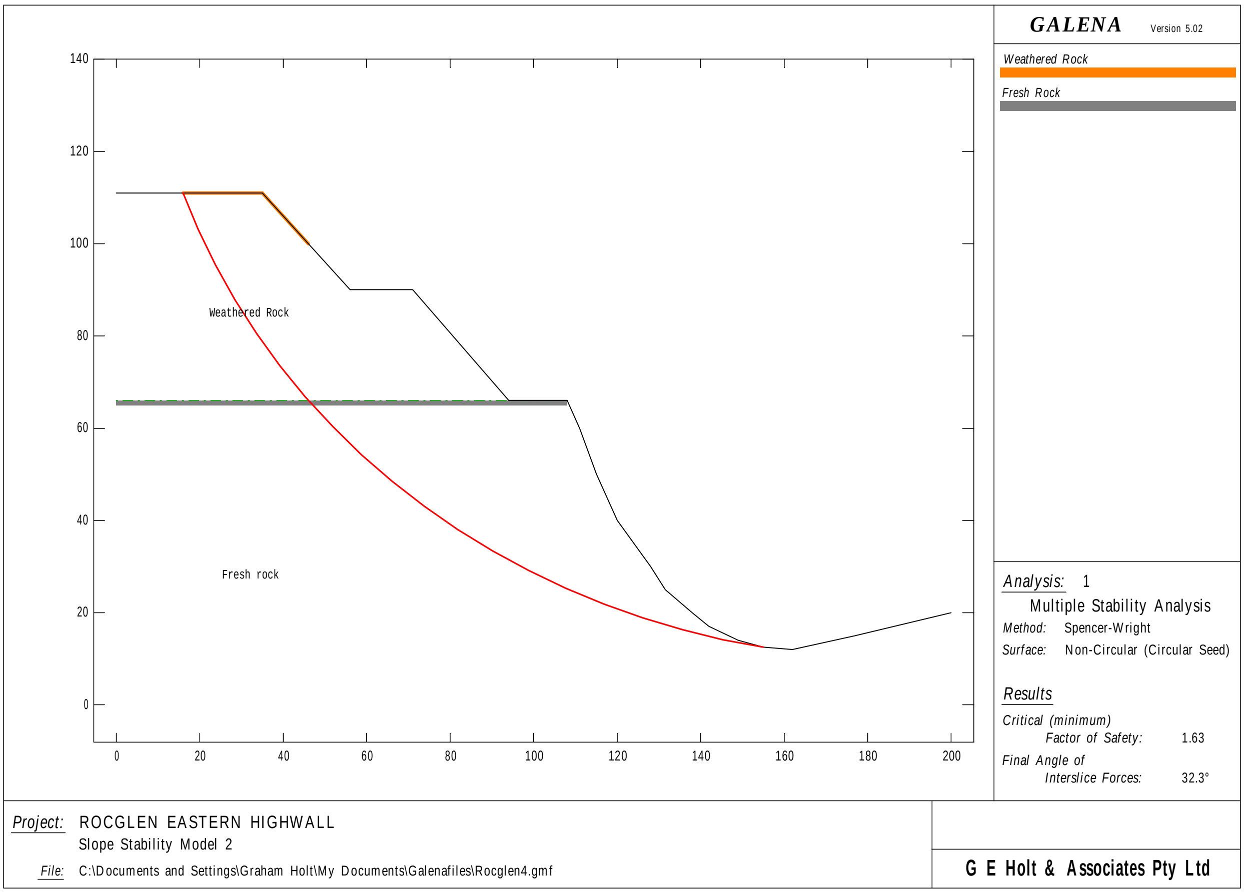

Figure 7: Factor of Safety model for entire face.

The buttress effect of hauled-back spoil against the face behind a working strip, and non-excavated strata ahead of any mining strip will materially assist face stability. The rehabilitation proposals to cover the final wall in the vicinity of Wean Road also ensure that the weaker, upper materials are fully buttressed for the long term.

Also a limiting geological case has been modelled by assuming all weathered material has no dip in the modelling. Strata actually dip into the face in the open cut and this increases the stability of the weathered rock. It can be seen from the model profiles that 100m of surface is required to develop a stable face in 45m of weathered material.

Discussion

The stability analyses apply where the Belmont Fault can be mined through, brecciated and weathered material associated with the fault zone can be removed to access the Belmont Coal, and a stable face developed east of the fault zone. This applies to much of the eastern side of the proposed mine extension. As the pit develops to the southeast the highwall that is cut back on the east side of the Belmont fault zone gradually approaches Wean Road. The flattened upper part of the highwall in weathered material occupies approximately 100m of surface. The distance from the highwall crest to Wean Road, indicated on the proposed pit outline (Figure 3), is 50m.

This theoretically places the eastern margin of the fault zone 150m from Wean Road. The actual point at which this happens will become clearer as the pit is developed and the nature of the fault structure is accurately known.

It is recommended that when the top of a stable highwall reaches 50m from Wean Road (when the fault is 150m from the road) the highwall be turned westward to cut across the fault zone at about right angles. This will result in ”burying” the fault zone inside a large block of unmined ground and preventing it from causing any instability close to Wean Road. Once there is a suitable block of unmined ground to prevent movement of fault affected strata, the highwall can turn again so that pit development can continue southeast to its final limits.

The turn in the highwall allows it to be cut back in the fault zone until stability is achieved. This notch in the highwall will be approximately as wide as the fault zone and cut back so that a barrier of undisturbed ground of width at least 150m is left at the ground surface between the top of the cut back and Wean Road.

If there is no faulting in the highwall then mine development can continue to the crest limit, which is proposed to be 50m from Wean Road. This final part of the highwall will not be as high since the deepest coal in the Belmont Seam will be left in the unmined block of ground holding the Belmont Fault. This part of the highwall is planned to be partially covered backfilled as the area is rehabilitated to become bushland as per the final void planning, described by others. It means that no part of the highwall against Wean Road is abandoned in its final mined form. This approach to mining the deposit allows for variation in the location of the Belmont Fault structure as the pit develops to the south east. It allows also for the possibility of offshoots of the fault structure.

The open pit limits can be adjusted to ensure there is solid unmined ground to prevent the fault structures collapsing the ground in a manner that could affect Wean Road. Adjustment in the manner suggested in this report allows some flexibility if the fault structure changes location from that suspected at present.

In summary the stability recommendations are:

- When the Belmont Fault (or Fault Zone) is more than 150m from Wean Road, operations should mine through the Belmont Fault. The uppermost alluvial material and weathered rock on the eastern side of the fault should have individual face angles no steeper than 45^0.

- Adoption of benching at a maximum of 25m intervals in alluvial, weathered rock and brecciated rock.

- In fresh strata face angles should designed at 75^0 to pit bottom. If in following the upturned Belmont Seam down to pit bottom the floor rock is strong and competent, then the face can be developed on the dip slope without the need for benches in rock beneath the Belmont Seam.

- Turn the eastern end wall at right angles to the west when the eastern limit of the Belmont Fault zone reaches 150m from Wean Road.

- Notch the turned highwall in the fault zone to achieve a stable face. This notch should not approach Wean Road any closer than 150m without geotechnical advice.

- Leave a block of unmined ground to contain the Belmont Fault zone to prevent it causing collapse back towards Wean road. The size of this block of unmined ground will need to be determined by geotechnical investigation by the time a change in highwall direction is required.

- Resume mining southeast towards the currently planned pit limit if the highwall is free of faulting. Such mining to cease when the pit crest reaches 50m from Wean Road. If additional faulting is detected in this advancing face then the relevance of such structure on highwall stability would require investigation before continuation of highwall development.

- Allow that geological conditions can change with further investigations, requiring ongoing amendment to mine plans.

Yours Faithfully

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