

## Technical Review Board

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10 September 2015

Our Ref: TRB.L59

Mr J Mitas  
General Manager Operations  
Earth Resources Regulation  
Department of Economic Development, Jobs, Transport and  
Resources  
Level 9  
121 Exhibition Street  
Melbourne  
Victoria 3000

Dear John

### **TRB Advice Re: Latrobe Planning Scheme Amendment C87**

This letter report addresses the request to the TRB by the Department of Economic Development Jobs Transport and Resources (DEDJTR) to review the proposed Latrobe Planning Scheme Amendment C87. Comment was sought specifically on the change to clause 21.07 to increase the width of the Environmental Significance Overlay Schedule 1 to 2000 m east and south of the Traralgon township from the boundary of the Loy Yang mine open cut until a more specifically defined risk mitigation strategy is defined.

The two documents considered in this report are:

1. Report PSM2690-001R prepared for Ashhurst Australia, for AGL as submission number 22, Latrobe Planning Scheme Amendment C87: Traralgon Growth Area Review, April 2015 (the PSM Report).
2. Panel report on the Latrobe Planning Scheme Amendment C87: Traralgon Growth Area Review, 22<sup>nd</sup> June 2015 (the Panel Report).

These reports are considered individually. The Panel Report describes the reasoning for the proposed change in the buffer width, based on an assessment of the geotechnical issues provided in the PSM Report, including supplementary information through responses from this report's author, Mr Tim Sullivan, to questions from the Panel. Additional evidence to the panel by other contributors appears to have also relied on the evidence provided by Mr Sullivan.

The purpose of the TRB in reviewing both reports is to establish the background to the Panel's assessment of the geotechnical issues and then to assess the proposed change to the buffer width and associated recommendations based on the evidence presented to the Panel.

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**Report 1: PSM2690-001R**

This PSM report contains extensive discussion of ground movements due to mining that have taken place in the Latrobe Valley. Rather than consider all aspects of the report, key elements that are relevant to the definition of a buffer zone for the period of mining are addressed. The PSM paragraph numbering is used to identify the report section under consideration.

Para. 39 identifies stability incidents that have occurred in the last 15 years at the three brown coal mines of the Latrobe Valley.

*The TRB notes that these incidents are all located within 500 m of the crest of the mine batter to which they are associated. The major movements that have created significant concern (i.e. posed the greatest risk to the public and infrastructure) are principally located within the mine or within 250 m of the mine crest. Evidence of significant events beyond one kilometre is not presented and the TRB is unaware of any having occurred.*

Para. 41 identifies geotechnical factors critical to the understanding of the stability situation and risks in the Latrobe Valley. Of these six factors, the TRB accepts the validity of 1, 2, 4, 5 and 6.

*The TRB is not able to confirm the validity of factor 3 (inferred high in-situ horizontal stress). The TRB is unaware of data to support the presence of high in-situ stresses and the inference, albeit plausible, appears to be based on an untested model of ground movement.*

Para. 42 states that since batter and mine stability are very sensitive to water and the high in-situ stress, large movements do occur.

*The TRB agrees that large movements can occur but not necessarily generated by the presence of high in-situ stresses.*

Para. 50 states that the Latrobe Valley is impacted by two main mining related effects: movements caused by relief of the in-situ horizontal stress (which need not be high) and regional depressurisation of the aquifers.

*The TRB agrees with this statement.*

Para. 51 identifies the four types of movement that the mines and surrounding areas are potentially subject to.

*The TRB agrees with the descriptions of these movements.*

Para. 54 identifies two locations where the magnitude of the subsidence is not fully explained by the regional subsidence trends related to aquifer depressurisation.

*The TRB notes that the subsidence identified at these anomalies lies within the expected range for the subsidence of the coal but the difference in rate of decline at these locations relative to the regional subsidence may be related to one or a number of mechanisms whose contribution cannot be confirmed without a substantial program of investigation. The TRB does not view these anomalies to be sufficiently unusual to warrant specific investigation.*

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Para. 56 notes that uniform subsidence does not usually pose an issue but suggests that risks can arise in cases where the flows in man-made and natural drainage features are impacted.

*The TRB agrees with both observations and considers it to be important for drainage and utility networks to be designed to account for surface subsidence impacts and for existing drainage to be periodically assessed to ensure that it is functioning as designed and is not potentially adversely impacting local ground stability.*

Para 57 states that the subsidence is continuing and not showing signs of stopping or significantly reducing.

*The TRB agrees with this observation and expects the subsidence to continue to increase until aquifer pressures start to rebound following mine rehabilitation and cessation of aquifer pumping. The level of rebound of the ground surface following cessation of pumping is not yet known.*

Para. 58 states that the Latrobe Valley is a region of high seismicity and high inferred horizontal stress.

*The TRB agrees that the seismicity in the region is recognised by Geoscience Australia to be higher than the mean for Australia. However, it is not aware that special provisions beyond normal engineering practice are required to be adopted across the region. As previously noted in relation to Para 41, as far as the TRB knows, the existence of high horizontal stresses in the coal formations is unconfirmed.*

Para. 62 notes that unexpected and sudden adverse deformations occurred well outside Yallourn mine during the Latrobe Road incident in 2014 in spite of the monitoring.

*The TRB notes that the adverse deformations occurred within 250 m of the mine crest within a region of continuing horizontal differential strain as mining progressed. The trigger for the surface expression of movement that originated in the coal was a large rainfall event in the local catchment after it had been modified by forest clearing. The incident reflects a consequence of infrastructure being located in close proximity to the mine.*

Para. 63-66 describes the potential for long-term creep of the coal.

*The TRB agrees that creep mechanisms can be expected to cause continual, albeit slow, movement of the coal over the long term. It also notes that the Geotechnical and Hydrogeological Engineering Research Group are progressively building an understanding of creep mechanics and the environmental controls governing the creep behaviour of coal.*

Para. 67 discusses long-term slope instabilities due to the geological conditions and hydrogeological and creep controlled movements.

*The TRB agrees that slope instability in the vicinity of the mine is likely to continue to be an ongoing risk and that locating public and natural infrastructure close to a mine crest should be avoided.*

Para. 72 describes with the aid of Figure 16 how the vectors of movement have changed over time. It also suggests that variability in the movements contributes to risks.

*The TRB notes that Figure 16 lacks a movement scale for the vectors and does not address in a clear way the temporal relationships in the data. Therefore, from Figure 16 as it is presented, it is very difficult to see just how variable the movements are and if they are indeed significantly non-uniform.*

*The TRB is also unsure what risks are being considered in relation to the observed movements. However, the TRB agrees that variability can, under certain circumstances and under certain scales of movement, lead to risks of cracks and sinkholes as well as shear movements that could impact infrastructure. The magnitude of variable movement is the most important aspect to consider. This movement is a function of distance from the mine crest.*

Para. 73 identifies three movement zones with respect to distance from the toe of the batter based on an interpretation of Figure 5. Figure 5 presents data for one stability line, N5, north of Loy Yang mine. The zones are based on an interpretation of the magnitude of stress relief that has taken place.

*The TRB notes that the crest of the batter at this location is at about 500 m from the toe of the batter. As buffer distance is defined from the crest of the mine, it would be beneficial to adjust the zones to be referenced with respect to distance from the crest. In this case Zone 1 would be from 0 – 700 m; Zone 2 from 700 m – 1200 m and Zone 3 greater than 1200 m (based on the data in Figure 5). The selection of the boundary between Zone 2 and Zone 3 does not appear to be well defined and could justifiably be placed as low as 1000 m from the crest of the mine, being the current buffer distance employed in the Environmental Significance Overlay. The TRB sought the data provided by AGL Loy Yang for stability line N3. Based on this data, the TRB does not understand how a figure of 1500 m from the crest of batter for the limit of zone 2 for N3 has been identified by Mr Sullivan. Indeed, comparison of Figure 5 with the data for N3 and using the same strategy for zoning adopted by Mr Sullivan suggests a distance of about 800 m from the crest for the outer limit of Zone 2. The TRB notes that movements for both stability lines between 2006 and 2012 are all less than 0.1 m in Zone 2 and Zone 3 and that differential movements are very small. Between 2000 and 2006 movements in Zone 3 are less than 150 mm and differential movements are also very small. These movements would suggest that the rate of movement in Zone 3 is decreasing with time, even though mining has continued in the period, and that the differential movements that are likely to lead to significant risks are small and trending smaller.*

*From the data presented, the TRB suggests that the horizontal movements in Zone 3 are below the threshold that would warrant the total exclusion of all development inside the zone. The TRB also considers that there is no evidence at this point in time that an acceleration of movements will occur throughout the life of the mine to 2045. The TRB does acknowledge that movements after the end of mining and following rehabilitation of the mine will depend on the choice of rehabilitation plan and that due care and attention must be paid to the impacts of any rehabilitation plan on the long term stability of the ground at distances well beyond the current buffer.*

Para. 75 uses Figure 6 to schematically show the relationship between the mine, the Area of Influence, the environmental factors affecting movement in the Area of Influence and the link to movement adversely affecting infrastructure in the Area of Influence. The Area of Influence appears to be designated as the area up to the outer limit of Zone 2.

*The TRB accepts that the concept of an Area of Influence within which movements can be sufficiently large to result in adverse stability events is an appropriate concept. However, the location of the outer boundary of this Area of Influence is open to interpretation and debate. The schematic nature of Figure 6 makes the determination of the Area of Influence difficult to interpret, even qualitatively, and, therefore, what spatial limits should be placed reasonably on the Area of Influence north of Loy Yang.*

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*The evidence from the Latrobe Road incident suggests that differential horizontal strain is an important factor affecting the stability of infrastructure in the Area of Influence. Mr Sullivan has used inflection points (corresponding to a change in differential strain) to define the limits of zones but has not specified the magnitude of the differential strain that would be permissible in Zone 3. The differential strain across the Latrobe Road was measured to be in the range of 0.08 to 0.17% at the time of the adverse movement. Due to the short duration of time during which the differential strain at the Latrobe Road was permitted to manifest, the extent to which the time rate of strain accumulation might also have played a part is not clear. The TRB notes that while much of the southern area in Morwell is located in an Area of Influence of 1000 m from the mine, the major impacts have all occurred within 500 m of the mine crest. A similar observation can be made for infrastructure around the perimeter of Yallourn Mine.*

Para. 83 shows with the aid of Figure 15 that mine depth and batter height are not related to the distance limits for observed cracking.

*The TRB notes that the cracking data presented in Figure 15 are all located well within 500 m of the crest of the mine. The TRB also notes that the position of the boundary of the mine licence is not relevant to the location of adverse movements and therefore is not relevant to the issue of buffer distance.*

Para. 90 states that the Latrobe Road incident occurred some distance outside the mining licence.

*The TRB reiterates that distance beyond the mining license is not relevant to the determination of a buffer to mitigate the risks of mining impact on infrastructure. In the case of Latrobe Rd, the term ‘some distance outside the mining license’ translates on the ground to less than 100 m from the licence. It is also relevant to note that the Latrobe Road cracking was less than 200 m from the crest of the mine.*

Para. 90 – 110 present details on three incidents: namely, the Princes Freeway Incident, the Yallourn Batter Collapse, and the Lewis Anomaly. The descriptions illustrate the scale of movements and the impacts that are possible due to the lateral and vertical movements of the coal during and following mining.

*The TRB notes that the first two of these incidents occurred within 250 m of the mine crest and the third extended as far as 500 m from the mine crest. They all point to significant movements within close proximity to the mine but they do not demonstrate that comparable movements are feasible or likely to occur at larger distances from the mine crest.*

Para. 112 indicates the types of impacts that may occur within the Area of Influence and includes a list of high consequence events that could arise.

*The TRB is concerned that the observations of the types of impacts that may occur are presented without consideration of the location of such impacts within the Area of Influence. The TRB is unaware of any evidence that suggests that the high consequence events such as collapse, dislocation of structures, wide open cracks, sink holes or pipe breakage listed in this paragraph could occur at locations other than close to the mine crest (i.e. within 500 m) or in areas of high differential strain. The buffer zone must be sufficient to contain all of the area potentially liable to incur major impacts and potential future areas of high differential strain and therefore must be greater than 500 m. The Area of Influence assessment made by Mr Sullivan suggest a figure for the buffer width on the order of 1000 m to meet this requirement. The TRB considers that it will be impractical to define a buffer*

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*zone that meets the requirements to prevent minor impacts such as fine cracking of roads, areas of altered drainage and minor movement of foundations as these will be affected by vertical movements as well as horizontal movements and vertical movements are observed over very large distances from the mines.*

Para 116 identifies the change in the buffer size from 400 m to the requested extent of 750 m but concludes that even this buffer is too small from the data presented.

*The TRB agrees that the original buffer size was too low based on the evidence available today. The TRB is of the view that a buffer of at least 1000 m is required to give a reasonable level of assurance that with appropriate mitigation and remediation measures in place, there will be no major consequences for future urban development. Mitigation and remediation measures are well established and proven in the underground black coal sector in Europe, UK and Australia (reference, for example, the NSW Mine Subsidence Board).*

Para. 120 considers that a buffer of 1000 m is inadequate for Loy Yang.

*The TRB agrees that mining induced movements are very likely to occur well beyond a buffer width of 1000 m. However, experiences in the Latrobe Valley and other coalfields and theoretical considerations indicate that these movements dissipate with distance. Hence, the TRB expects that the risk of major adverse impacts beyond 1000 m are low and, with very few exceptions, capable of being adequately mitigated through appropriate engineering of the buildings and infrastructure. Exceptions relate primarily to structures that are extremely sensitive to tilt and differential movement for reasons of building function. Structures such as highways and residences are very unlikely to fall within this restricted category.*

### **Panel Report on the Latrobe Planning Scheme Amendment C87**

The Panel Report summarises the verbal comments that were made by Mr Sullivan in connection with his written submission. Only those points made in Mr Sullivan's verbal submission that are additional to the written comments discussed above are included in the following comments.

As the Panel Report has not numbered its paragraphs, page numbers and quotations will be used to identify the part of the report under discussion.

Page i. "In relation to the coal mines, geotechnical evidence indicates significant ground instability associated with the coal mine beyond the one kilometre coal buffer area and that existing monitoring is inadequate to determine the extent of this activity."

*The TRB is not aware of any evidence that supports this statement and no evidence is presented in Mr Sullivan's report that agrees with this commentary. The TRB acknowledges that ground movements are occurring well beyond the one kilometre boundary but these movements are not indicative of instability. The TRB is also concerned that the current technologies to monitor ground movements beyond 1000 m would not reliably pick up or predict the locations of adverse movements, even if these were to occur.*

Page i. "The panel concludes that the precautionary principle should be applied by excluding land within two kilometres of the coal mine of the coal mine from future urban expansion on an interim basis until better defined geotechnical evidence is available."

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*The decision to apply the precautionary principle is a matter for the planning authorities and is not a matter on which the TRB should make a conclusive statement. However, the TRB is concerned that there may never be a situation in the future where sufficient geotechnical evidence will be available to permit the withdrawal of the development exclusion unless new monitoring and assessment technologies are developed. The TRB suggests that the delivery of such technologies is not assured.*

Page ii, “The relevant authority is encouraged to implement better quality geotechnical monitoring without delay so that Council is provided with certainty about the future of areas south of the Princes Highway.”

*The TRB is unclear about who the relevant authority is but is clear that even with improved geotechnical monitoring, the Council cannot be provided with certainty about future movements in areas south of the Princes Highway.*

Page 13, “Mr Sullivan .... particularly noted that the batters of the Yallourn Eastfield open cut had been closely monitored, however, the failures along Latrobe Road (2014) and adjacent to the Latrobe River Flood Plain (2007) were unforeseen even though they involved very large mass earth movements.”

*The TRB observes that both of these adverse impacts were within 250 m of the mine crest. Thus, their relevance to adverse impacts at greater distances from the mine is not clear.*

*The TRB also notes that with current understanding such events are no longer ‘unforeseen’, but as yet cannot be predicted given the uncertainties in the strain movements that arise during mining and the uncertainties in the weather events that are the triggers for the event. The TRB considers that current knowledge can be used to define the types of events and possible magnitudes of events that may occur, but cannot be used to predict whether they will occur.*

Page 14, “The panel questioned whether engineering design codes could protect infrastructure and buildings from damage consequent upon ground movement. He agreed that this is possible but at a cost. Mr Sullivan added that there needs to sufficient data to provide a basis for damage risk mitigation designs.”

*The TRB considers that the additional costs needed to mitigate the movement risks beyond 1000 m should be assessed for different building and infrastructure types before assessing that these costs are unacceptable. The TRB considers that a risk assessment of the different modes of adverse movement that can take place beyond 1000 m should be undertaken as a way of providing the necessary ‘data’ to support this assessment. The TRB notes that most domestic properties in the Latrobe Valley are performing satisfactorily in areas of significant subsidence and, therefore, that the costs may not be as large as implied by the panel report. This is consistent with experience internationally in the underground black coal sector.*

Page 15, “ Mr Sullivan considered that the existing 1 kilometre buffer is too narrow and should be increased to provide at least a 50% safety factor. Further, he considered that increasing urban development and residential density as is proposed represents risks that are unacceptable and probably in excess of societal norms.”

*The TRB is not clear what is meant by ‘ to provide at least a 50% safety factor’ and therefore is concerned that this does not provide a clear, transparent basis for defining how far beyond a 1000 m buffer a new boundary should be established, even if the views on the scale of risks are accepted.*

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*However, the TRB is concerned with the decision to invoke 'societal norms' as a measure of acceptable risk for this case. Risk as a societal norm is highly subjective, location dependent, and culturally governed and as such is not well defined for specific cases. As an example, road accident risks far exceed the risks of adverse impacts due to mining in areas at greater than 1000 m distance from a mine yet the 'societal norm' is that road accidents remain a low but acceptable risk. What therefore is an unacceptable risk and what constitutes a 'societal norm' in relation to ground movements at distance from a mine? The TRB considers that 'societal norm' is being used here to define negligible risk and that this definition is inapplicable for the situation under consideration; many other mining related risks are tolerated that have a higher likelihood of occurrence than the foreseeable risks associated with mining at distances greater than 1000 m from the mine. The chosen limits of risk need to be much better understood in the context of the current recommendations and a formal risk assessment should be undertaken to establish the credible limits on risk that might arise beyond 1000 m from the mine crest after taking into account mitigation measures.*

Page 16, "To the north-east, the geology of the coal becomes more complex and fold crenulations are observed. There are, from experience, likely to represent areas of higher stress and potentially areas of greater concern in respect the ground stability."

*The TRB agrees that areas of significant folding can introduce different responses to unloading than other less altered strata and this should be considered in assessing the extent of mining induced movements.*

Page 16, "In relation to the mine, Mr Sullivan considered that if the mine operator altered the batter angles it is unlikely to modify the mass creep behaviour since these derive from some different factors of which the batter angle is but one. However, if the operator modified the direction of mine development away from an easterly and southerly direction this might influence ground stability in regard to mass creep"

*The TRB agrees with the observation concerning batter angle. However, it is unclear what issues are expected in relation to direction of mine development.*

Page 17, "While there may be strategic support for residential expansion through future rezoning towards the Loy Yang mine, the particular geotechnical circumstances and the associated significant risk to life and property do not appear to support this outcome."

*The TRB note that this conclusion by Mr McGurn is based on an assessment of the information provided by Mr Sullivan.*

*The TRB is concerned that the risks to life and property are over-stated and are not based on an objective assessment of the geotechnical data or evidence presented. This concern reinforces the need for a formal risk assessment to be completed for the proposed rezoning and that unsubstantiated references to significant or high risk should be omitted from consideration of the buffer width and replaced by a more considered analysis.*

Page 19, "Mr Sullivan's evidence regarding geotechnical risks and uncertainties that apply across the interface buffers between the township of Traralgon and the Loy Yang mine are accepted by the Panel. It is not only comprehensive and encompassing of the issues which relate to the Amendment, but is also accepted and supported by the government department with responsibility for mining."

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*The TRB considers the evidence provided by Mr Sullivan as a valuable starting point for the consideration of the geotechnical risks and uncertainties, but does not consider it to be comprehensive and encompassing of the issues which relate to the amendment. While the adverse effects have been identified, their likelihood of occurrence with distance has not been appropriately articulated.*

*As noted earlier, the TRB considers that the risk profile for the area beyond 1000 m has not been adequately assessed. While evidence of the adverse impacts that could arise in this zone has been presented, a detailed evaluation of the likelihood of the different adverse impacts has not been established. Without such an assessment, it is not possible to address the risks. The TRB notes that terms such as significant risk to life and property are adopted without adequate justification.*

In the remaining sections of the Panel report, the issues identified above are reiterated and discussed leading to the Panel's conclusion that the possible movement beyond the current buffer zone represent an unacceptable risk. The Panel also notes that in the absence of sufficient information to guide an assessment of costs to mitigate risks through engineering that the precautionary principle should be invoked.

### **Concluding remarks**

*The TRB has evaluated the Panel Report and the key supporting evidence presented by Mr Sullivan. Based on Mr Sullivan's evaluation, the Panel has concluded that the risks to infrastructure to be unacceptable within a 2000 m wide zone from the crest of the mine. It should be noted that Mr Sullivan did not specifically recommend 2000 m but stated that a 1000 m buffer is inadequate. The other contributors to the Panel's report adopt the conclusions of Mr Sullivan. The TRB has concerns about this assessment and the weight given to it by the Panel and Panel contributors for the following reasons:*

- 1. The likelihood relationship between type of adverse impact that may occur and distance from the mine has not been examined in sufficient detail.*
- 2. The mitigation costs for engineering out the risks beyond 1000 m have not been examined in adequate detail.*
- 3. Current monitoring methods using pins can provide data on regional movements but are unlikely to identify or predict localised adverse movements such as sinkholes or subsurface shear zones at distance from the mine. Spatially continuous monitoring methods for horizontal movements are not yet sufficiently sensitive and precise for these circumstances and may not become available in the current planning period.*
- 4. The costs of monitoring may outweigh the costs of engineering to control the risks but this assessment has not been made.*

*The TRB agrees that the buffer zone from the crest of the mine should not be less than 1000 m based on the available evidence of lateral and vertical movements. The question is therefore whether it is justifiable with the evidence provided to date to expand the buffer zone to 2000 m. The TRB does not accept that the current evidence is sufficient and recommends the following to overcome this deficiency.*

*A formal facilitated risk assessment process is undertaken to explore the geotechnical hazards that may arise in the 1000 m to 2000 m buffer zone and the likelihood of their occurrence.*

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1. *The formal assessment should explore the extent to which the geotechnical risks in this zone can be reduced by increased monitoring.*
2. *The formal assessment should consider both mining development to the completion of rehabilitation and the likelihood that the rehabilitation process will ensure the future stability of the zone after mine closure.*
3. *Analysis of the costs of mitigation of the risks identified by the risk assessment process should be undertaken to provide a sound basis for the adoption of either the precautionary principle without engineering or adopting the engineering solution to minimising the risk to the community.*
4. *Community Council and State Government stakeholders should address the determination of acceptable risk.*

*The TRB considers that there is sufficient knowledge and skills nationally to undertake this risk assessment effectively and for the outputs to be adopted confidently upon completion.*

If you have any queries in regards to this advice, please do not hesitate to contact me.

Yours sincerely



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Chair, Technical Review Board

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