INDEPENDENT EXPERT ADVISORY PANEL FOR MINING

INTERIM ADVICE RE:

CLARENCE COLLIERY COAL MINE

918 & 920 PANELS

EXTRACTION PLAN

19 August 2024

Report No: IEAPM2024-08-1

EXECUTIVE SUMMARY

On 8 April 2024, the Director Resource Assessments, NSW Department of Planning, Housing and Infrastructure (DPHI – the "Department") requested the Independent Expert Advisory Panel for Mining (IEAPM – "the Panel") to provide advice in relation to the Extraction Plan proposed by Centennial Coal Pty Limited ("Centennial") for secondary coal extraction in the 918 and 920 Panels within the Katoomba Seam at the Clarence Colliery.

The scope of the Advice sought from the Panel was:

- *The Panel's level of confidence in the proposed mine design to achieve the subsidence limits and performance measures established under the consent;*
- *The scale and likelihood of potential subsidence impacts, effects, and environmental consequences to sensitive environmental features;*
- *Whether the proposed monitoring program and TARP is adequate to identify subsidence trends and enable timely adaptive management to prevent impacts and related environmental consequences to sensitive environmental features;*
- *Any recommendations to the Panel to support a robust adaptive management approach, including recommendations relating to:*
    - *Additional monitoring;*
    - *The frequency and timing of monitoring, review and reporting;*
    - *The staging of mining; and/or*
    - *Cease mining triggers.*

The Panel should feel free to provide any other advice it considers would assist the Department in reviewing the extraction plan.

The Extraction Plan runs to some 1225 pages and to almost 1400 pages with Centennial's 154 page response to the Panel queries. The sections concerned with mine design to limit subsidence comprise nearly half of this material. The Panel's review is ongoing but in the light of responses to the Panel's queries of Centennial to date, their potential impact on the Department's assessment of the EP and the timely progression of that assessment, the Panel has prepared this interim advice. The advice is concerned primarily with presenting in summary form, the more critical outcomes of the Panel's review to date in relation to the mine design as this is the foundation for addressing the Department's request for advice. Whilst it is considered at this time that completion of the Panel's review will not change the nature of this interim advice, the issues raised in it should not be treated as finalised advice from the Panel.

The matter is unusual and complicated by the fact that the Development Consent (DC) was granted in 2006 and reflects the approach adopted at that time of specifying Subsidence Impact Assessment Criteria rather than Performance Measures. Significantly, these criteria were stipulated only in terms of the maximum permissible levels of *subsidence effects*, being vertical displacement, tilt and strain components of surface ground movement above mine workings and were managed under the umbrella of a *Subsidence Management Plan*. This approach to consent conditions was found unsatisfactory (and in some cases, unworkable) and was changed sometime around 2008. However, Centennial is still left with the challenge of designing partial extraction mine workings to restrict surface subsidence to 100 mm.

This interim advice is focussed on assessing the level of confidence that can be placed in the design of 918 and 920 panels not resulting in more than 100 mm of surface subsidence which, importantly, must take account of factors that influence subsidence development in the long term. For over 50 years, an international subsidence knowledge base has existed that confirms in the case of 918 and 920 Panels that:

- the satisfaction of all Subsidence Impact Assessment Criteria (subsidence, tilt and strains) will be automatically assured by not exceeding the limit placed on surface subsidence.
- the satisfaction of this subsidence criteria will result in benign subsidence impacts and environmental consequences at the surface (that would automatically satisfy a Performance Measure of negligible), except for any consequences at the surface of subsurface subsidence adversely impacting and groundwater systems.

Designing to achieve close to but not exceeding 100 mm of vertical surface subsidence above partial extraction workings presents serious challenges because geotechnical engineering is an imprecise science characterised by pervasive uncertainty and an absolute subsidence limit of 100 mm for a partial mining system provides little latitude to accommodate this uncertainty.

The Panel has critiqued the EP and raised a number of queries with Centennial. This process has resulted in some significant clarifications and modifications concerning Centennial's approach to designing and executing the extraction of 918 and 920 Panel. The company has advised that:

1. *Whilst Strata^2 provides subsidence predictions for the 918 and 928 panels, Centennial confirms that ultimately the EP does not rely on Strata^2 subsidence predictions and instead relies on the more conservative UNSW predictions*.
2. *Based on more recent subsidence surveys, the UNSW two-dimensional numerical modelling has been found to have both underpredicted and overpredicted subsidence.*
3. *The under prediction, as noted above, could have occurred as a result of post extraction flooding, the extraction of the neighbouring 906 panel (with extraction occurring beneath the 900D line in October 2022) and/or time related subsidence development.*
4. *Clarence has identified that in comparing the data from the 13 May 2024 subsidence monitoring survey and the model validation run, the model has under predicted subsidence by around 22%. Clarence has identified that the more recent subsidence surveys fall outside the 20% model tolerance, noting that monitoring of the 900D survey line in March 2023 fell within the model tolerance of 20%.*
5. *Clarence has reviewed its panel layout to the following extraction sequence for three sub-panel voids only:*
    - *extract 918A sub-panel (918L) on advance; then*
    - *extract 918B sub-panel (918R) on retreat; then*
    - *following sufficient time to allow for subsidence to develop over the 918 panel, post extraction of 918A (918L) and 918B (918R), develop 920 panel (First Workings),*
    - *then extract 920B sub-panel (920R) ONLY on retreat; noting that;*
    - *920A sub-panel would not be extracted unless it can be demonstrated that long term subsidence will not exceed the 100mm criteria. Clarence accepts the risk of potentially not being able to extract the 920A sub-panel*
6. *Clarence accepts that a recalibration of the UNSW numerical model will likely change the subsidence trigger values presented within the "918 and 920 Panels Subsidence Monitoring Program" as submitted and may also change the height of fracturing triggers. To this end, Clarence will review the "918 and 920 Panels Subsidence Monitoring Program" to amend triggers and maximum subsidence predictions after the model recalibration is completed. However, the Adaptive Management Procedure as set out will remain a fundamental control to ensure subsidence does not exceed the 100mm criteria.*

Any endorsement of the final mine layout needs to include adequate provision for not exceeding the 100 mm subsidence limit in the long term. This is a critical issue as it is extremely unlikely that given the very low level of tolerable subsidence, the small margin between predicted subsidence and maximum tolerable subsidence, and the nature of the causes of additional subsidence in the long term, that any practical and effective intervention procedures can be implemented in time to prevent an exceedance of the subsidence limit. Long term stability receives mention in a range of documentation

contained with the EA. The Panel is of the view that these references currently raise a number of questions that are not yet adequately addressed.

The Panel concludes at this point in time that:

1. The satisfaction of the subsidence criteria will result in benign subsidence impacts and environmental consequences at the surface that would automatically satisfy a Performance Measure of 'negligible' under contemporary approval conditions, except possibly if subsurface subsidence impacts on groundwater systems were to impact the surface.
2. The Panel is yet to review mine design from a hydrogeological perspective but concurs that the height of mining-induced fracturing is very unlikely to extend up to the Mt York Claystone.
3. The proposed mine design may satisfy the prescribed Subsidence Impact Assessment Criteria.
4. At this point in time, however, a greater level of certainty is required regarding some design aspects, in particular:
    a. How factors that could potentially result in an increase in subsidence in the long term have been appropriately accounted for in the subsidence predictions.
    b. The confidence limits associated with subsidence predictions, especially given the significant increases in predicted stress levels in the spine pillars since moving to 3-dimensional numerical modelling.
5. Given the incremental manner in which subsidence develops as the overall lateral extent of mining increases and the (low) order of magnitude of subsidence predicted after the extraction of only 918 Panel, there is potential to extract 918 Panel before concluding the design of 920 Panel.
6. The sub-panels of 918 and 920 should be extracted sequentially.
7. There is a legacy issue associated with the Subsidence Assessment Impact Criteria that could theoretically result in partial extraction operations resulting is a breach of the criteria applying to first workings.

The Panel recommends at this point in time that:

1. Should the Department require the Extraction Plan to be updated to reflect the recent developments that impact on the design and extraction of 918 and 920 Panels to satisfy the Subsidence Impact Assessment Criteria:
    a. The updated EP should be focused on providing a single account of the methodology that now informs the mine design.
    b. This methodology should include an account of how it addresses long term stability.
2. In any event, the EP should be updated in a manner that removes confusion created by using terminology to refer to incremental and cumulative subsidence in some sections of the EP that is not consistent with established subsidence engineering terminology.
3. The Department should give consideration to the legacy issue associated with the Subsidence Assessment Impact Criteria that could theoretically result in partial extraction operations resulting is a breach of the criteria applying to first workings.

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1.0 NATURE OF THIS ADVICE

On 8 April 2024, the Director Resource Assessments, NSW Department of Planning, Housing and Infrastructure (DPHI – the "Department") requested the Independent Expert Advisory Panel for Mining (IEAPM – "the Panel") to provide advice in relation to the Extraction Plan proposed by Centennial Coal Pty Limited ("Centennial") for secondary coal extraction in the 918 and 920 Panels within the Katoomba Seam at the Clarence Colliery.

The scope of the Advice sought from the Panel was:

- *The Panel's level of confidence in the proposed mine design to achieve the subsidence limits and performance measures established under the consent;*
- *The scale and likelihood of potential subsidence impacts, effects, and environmental consequences to sensitive environmental features;*
- *Whether the proposed monitoring program and TARP is adequate to identify subsidence trends and enable timely adaptive management to prevent impacts and related environmental consequences to sensitive environmental features;*
- *Any recommendations to the Panel to support a robust adaptive management approach, including recommendations relating to:*
    - *Additional monitoring;*
    - *The frequency and timing of monitoring, review and reporting;*
    - *The staging of mining; and/or*
    - *Cease mining triggers.*

The Panel should feel free to provide any other advice it considers would assist the Department in reviewing the extraction plan.

The Panel's review is ongoing but in the light of responses to the Panel's queries of Centennial to date, their potential impact on the Department's assessment of the EP and the timely progression of that assessment, the Panel has prepared this interim advice. The advice is concerned primarily with presenting in summary form, the more critical outcomes of the Panel's review to date. The detailed documentation of these is still a work in progress. Whilst it is considered at this point in time that completion of that work will not change the nature of this interim advice, the issues raised in it should not be treated as finalised advice from the Panel.

2.0 NATURE OF THE MATTER

The matter is unusual and complicated by the fact that the Development Consent (DC) was granted in 2006 and reflects the approach adopted at that time of specifying Subsidence Impact Assessment Criteria rather than Performance Measures. Significantly, these criteria were stipulated only in terms of the maximum permissible levels of *subsidence effects*, being vertical displacement, tilt and strain components of surface ground movement above mine workings and were managed under the umbrella of a *Subsidence Management Plan*. This approach to consent conditions was found unsatisfactory (and in some cases, unworkable) and changed around 2008. It contrasts with contemporary approvals which are framed around specifying Performance Measures which define limits on *subsidence impacts* and *environmental consequences* and place the onus on the mine operator to determine the tolerable level of *subsidence effects* to comply with these Performance Measures. Under these approvals, subsidence is a subset of a range of Performance Measures that now fall under the umbrella of an *Extraction Plan*.

A modification to the Consent Conditions for Clarence Colliery in 2021 now requires Centennial Coal Pty Ltd to also *prepare an Extraction Plan for all second workings on the site that are not covered by an existing approved Subsidence Management Plan*. The 918 and 920 Panels fall within this requirement, however the criteria that the mine design is still required to satisfy continue to be dictated by the Subsidence Impact Assessment Criteria determined in 2006.

The location of mining panels relevant to this Panel advice, supplied in response to the Panel's queries (Q1) are shown in Figure 1. The proposed mining dimensions for 918 and 920 Panels are shown in Figure 2 and the Impact Assessment Criteria which apply to these panels are recorded in Table 1. The depth of mining for 918 and 920 Panels ranges between 175 m and 325 m.

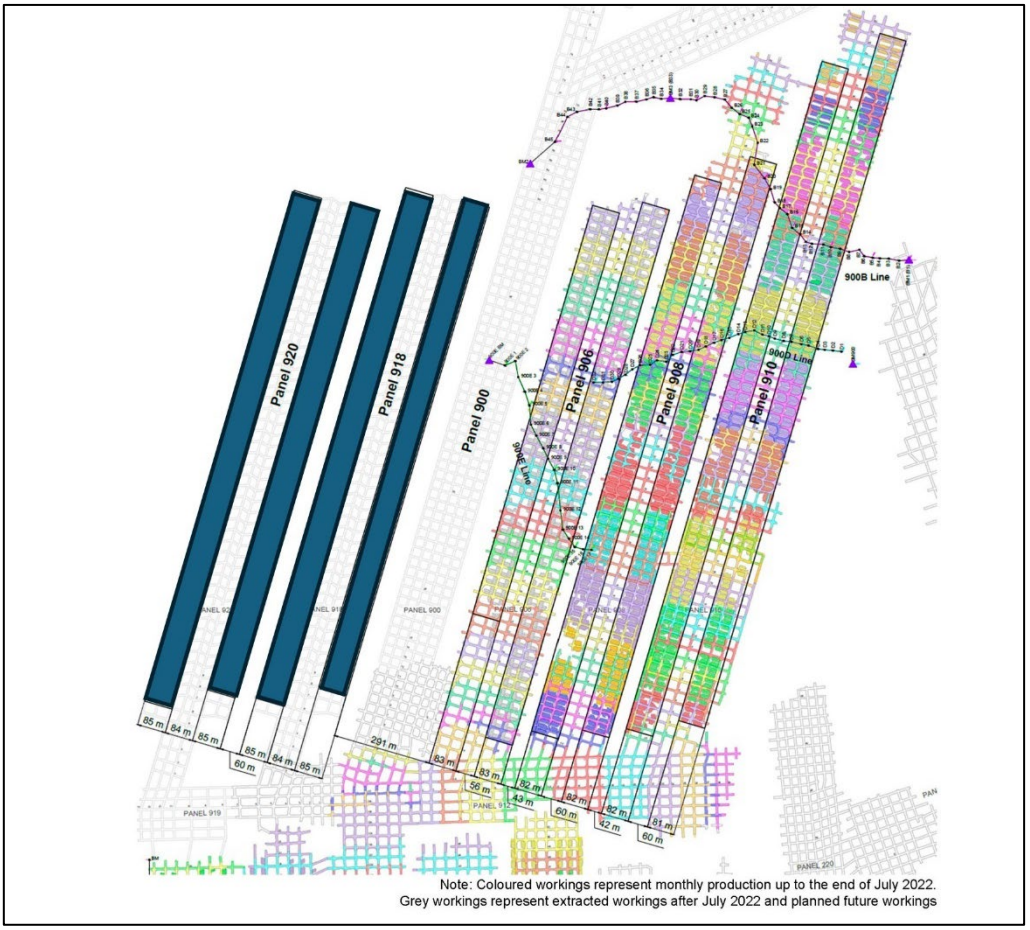


Figure 1: Existing and future panels at Clarence Colliery as at end of July 2022. (Centennial, 2024) (blue shading of Panels 918 and 920 goaves added by IEAPM Panel)

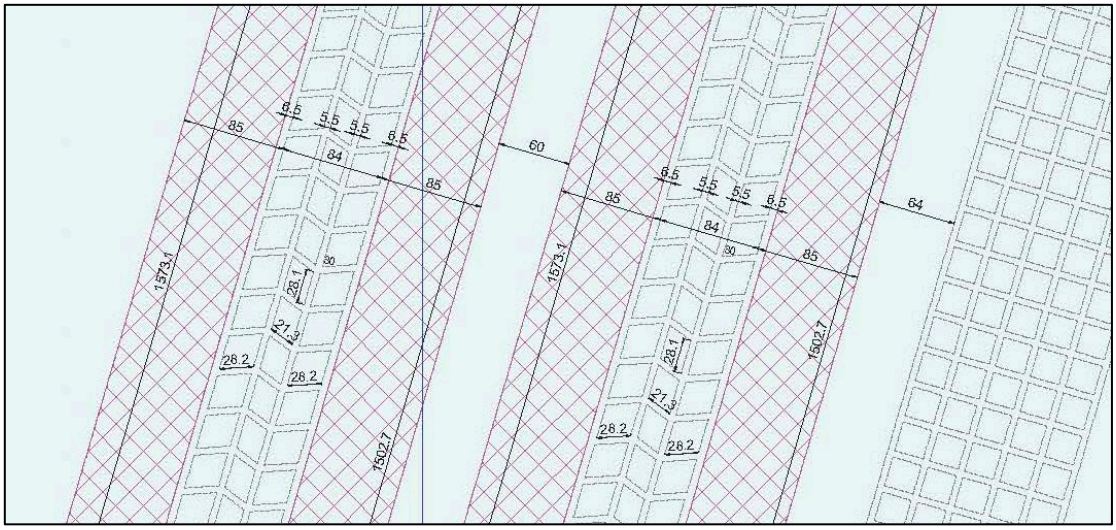


Figure 2: Mining dimensions associated with Panels 918 and 920 (adapted from Centennial (2024))

Table 1: Subsidence Impact Performance Criteria that apply to 918 and 920 Panels.

Level of Extraction	Subsidence	Tilt	Horizontal Strain (compressive and tensile)
First Workings	20 mm	1.0 mm/m	1.0 mm/m
Partial Extraction	100 mm	3.0 mm/m	2.0 mm/m

For at least the last 50 years, an international subsidence knowledge base has existed that enables it to be predicted to a very high level of confidence that in the case of 918 and 920 Panels:

- the satisfaction of all Subsidence Impact Assessment Criteria (subsidence, tilt and strains) will be automatically assured by not exceeding the limit placed on surface subsidence.
- the satisfaction of this subsidence criteria will result in benign subsidence impacts and environmental consequences at the surface (that would automatically satisfy a Performance Measure of negligible), except for any consequences at the surface of subsurface subsidence adversely impacting and groundwater systems.

Hence, from a subsidence perspective the key factors in this matter reduce to designing the mine workings to restrict surface subsidence to 100 mm and assessing subsurface subsidence impacts on groundwater systems and their associated environmental consequences.

This interim advice is focussed on assessing the level of confidence that can be placed in the design of 918 and 920 Panels not resulting in more than 100 mm of surface which, importantly, must take account of factors that influence subsidence development in the long term. If 918 and 920 Panels had been conditioned to contemporary standards, the design and the EP would not be obsessed with this threshold value of subsidence.

3.0 ELEMENTS OF SUBSIDENCE ASSESSMENT

Designing to achieve close to but not exceeding 100 mm of vertical surface subsidence presents serious challenges because geotechnical engineering is an imprecise science characterised by pervasive uncertainty and an absolute subsidence limit of 100mm for a partial mining system provides little latitude to accommodate this uncertainty.

Recognition of the following four potential main contributors to surface subsidence over 918 and 920 Panels provides a basis for understanding the Panel's advice:

1. Subsidence (or sag) of the overburden over the 85 m wide extracted side panels due to a loss of stiffness as a result of caving and fracturing of some of the overburden. This type of permanent deformation is referred to an inelastic behaviour. A component of sag is also attributable to elastic deformation (stretching or compressing) that does not result in yielding or failure of the rock.
2. Elastic compression of the coal pillars and the underlying and overlying strata under the additional weight of the undermined upper spanning strata and the lower strata cantilevering out into the goaf.
3. Localised inelastic deformation of portions the coal pillar system, but which can still have minimal impact on the pillars not performing their support function.
4. Inelastic deformation of coal pillar systems to the extent that they no longer perform their intended function.

The stability of the three rows of central pillars in each panel, referred to as 'spine' pillars in the EP, is a particularly important element of the panel design as these pillars are one principal control on the magnitude of subsidence development, both in the short term and the long term. However, as in all but one special circumstance which does not apply in this case, the load acting on these pillars and their roof and floor foundations cannot be definitively determined. The main design options available to deal with this are:

1. Empirical, which relies on an extensive field database of outcomes associated with very similar mining layouts and dimensions in very similar conditions, 'similar' being the operative word on this occasion due to the very low tolerance for error in subsidence predictions.
2. Analytical, which utilises mathematical solutions based on first principles of physics and mechanics and that are in the case of geomechanics, often informed by and calibrated from an empirical database.
3. Numerical, based on simulating rock mass behaviour using mathematical equations founded on analytically derived formulae, or algorithms.

All three techniques feature in subsidence predictions provided by consultants to inform the EP, the principal consultants being Strata^2, UNSW, SCT and MSEC. The Panel critiqued the various consultants' reports and submitted a list of queries on these and other matters to Centennial Coal. These constitute Attachment 1 and Centennial's responses constitute Attachment 2. Summary outcomes follow.

4.0 CONSULTANTS REPORTS

4.1. STRATA2

Strata2 (2023) constitutes Appendix 5 of the Extraction Plan and is Rev. 5 of the base document, with Rev. 3 and Rev. 4. having been peer reviewed by Emeritus Professor Bruce Hebblewhite (Hebblewhite, 2023a, 2023b) (Appendix 10). The mine design approach was initially based on empirical subsidence data, of which only a limited amount is presented in Appendix 5, and an analysis of the strength of the in-panel pillars or spine pillars, as these are both major controls for restricting subsidence (in the short term and in the long term) and are the weakest link in the support system. However, the pillar analysis was based only on the strength of the in-seam elements of the coal pillar system and had no regard to the strength of the surrounding strata and the contribution to subsidence from yielding and permanent deformation of that strata.

In responding to the Panel's queries, Centennial has advised that:

> *Whilst Strata^2 provides subsidence predictions for the 918 and 928 panels, Centennial confirms that ultimately the EP does not rely on Strata^2 subsidence predictions and instead relies on the more conservative UNSW predictions.*

The Panel considers this to be a sensible approach. It cautions on the meaning of the term 'conservative' and suggests that 'realistic' is a more apt description.

Points arising out of the first peer review (Hebblewhite (2023a) that remain pertinent include those listed below in italics. Any follow up responses by the peer reviewer in his second peer review (Hebblewhite, 2023b) are noted in **bold** italics, after each point. The Panels comments are underlined.

- *The immediate floor is uniformly moderately strong (40 to 70MPa) but in the NE corner of the Extraction Plan Area, the Katoomba Seam overlies the Middle River Seam, just 2m – 3m below. It is noted that this can result in reduced floor stiffness, resulting in increased levels of subsidence. This is noted as having been problematic in previous 906 to 910 Panel extraction. However, Strata2 concludes that "the floor is not weak in the Extraction Plan Area".*

    - ***No change has been made by Strata2. I stand by my observation that it would be prudent and appropriate to maintain careful awareness of floor conditions in the 918/920 Panels***

    - <u>This matter goes to long term stability and will need to be considered when assessing the ultimate mine design irrespective of what design process is adopted.</u>

- *Based on the above concerns* [re the determination of pillar loads across the spine pillars]*, I believe that pillar stability analysis is far more suited to numerical analysis study, rather than this empirical approach which relies on too many assumptions. And numerical analysis would also enable a more meaningful consideration of the stone pillar tops where pillar height exceeds seam thickness.*

    - ***My opinion expressed above remains, hence relying more on the results of numerical analysis and the strategy to empirical calculations (whilst not dismissing them in any sense)***

    - <u>The Panel concurs and notes that the final design by others is based on this approach.</u>

The surface subsidence profile predicted by the Strata^2 numerical model is shown in Figure 3(a). A basic limitation with the numerical modelling is that it is based on an elastic model; that is, a model which does not permit any strata failure. Both the peer reviewer and SCT (SCT (2023) identified this issue in their advices to Centennial.

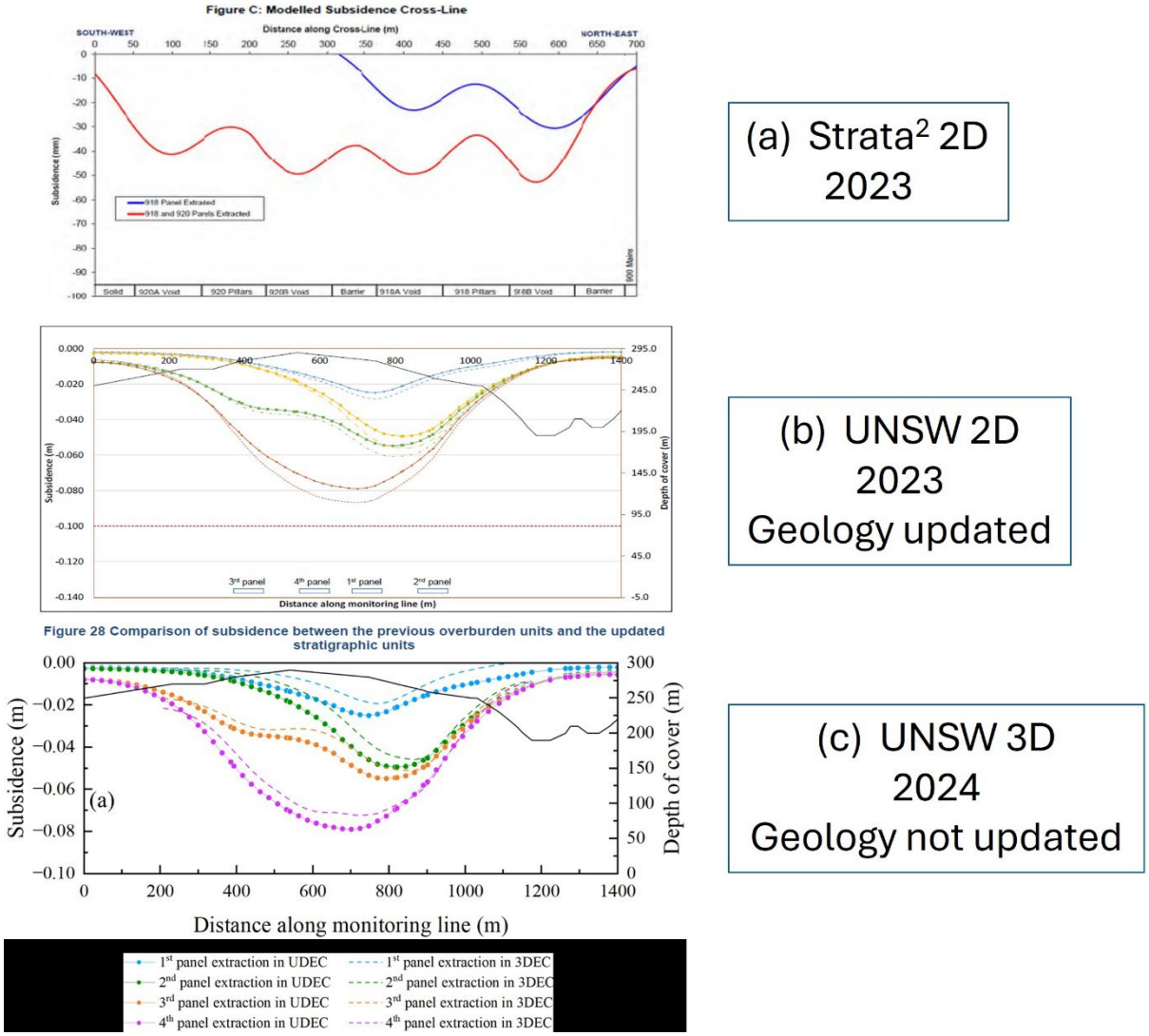


Figure 3: The three surface subsidence profiles and magnitudes predicted in the EP.

4.2. UNSW

4.2.1. General

There are now three UNSW reports in the system that inform the Extraction Plan, being

1. UNSW (2023) – 62 pages - that comprises Appendix 6 of the EP which presents the result of 2-dimensional numerical modelling for a wide range of mine layouts and parametric studies.
2. UNSW (2024b) – 64 pages – which constitutes Appendix 2 of Centennial's response to the Panel's queries and is an amended version of UNSW (2023) to correct subsidence terminology (Q6-iv), report subsidence predictions over 900 Panel (Q8) and include additional mine plans (Q6-i &Q6-ii).
3. (UNSW, 2024a) – 10 pages - which constitutes Appendix 3 of Centennial's response to the Panel's queries and presents the early outcomes of the transition to 3-dimensional modelling.

The reader needs to be aware that UNSW (2023) incorrectly refer to *incremental subsidence* as *cumulative subsidence*. The Panel found this confusing and in its queries of Centennial it suggested that Centennial give consideration to editing the Extraction Plan to rectify this. Centennial has advised that

> *Centennial does not consider the mis-use of terminology in this instance to be a fatal flaw. For this reason, Centennial does not propose to edit the supporting documentation to replace "incremental subsidence" with "cumulative subsidence". To do so, would result in the requirement for thorough review, edits and resubmission of the Extraction Plan in its entirety. However, from a technical perspective, UNSWs report has been reviewed to correct the mis-use of terminology. The amended UNSW Report is provided in* ***APPENDIX 2***

The amended report constitutes (UNSW, 2024b). The Panel is not convinced that this approach may not have made the situation more confusing, especially for the general reader.

4.2.2. UNSW (Appendix 6, UNSW (2023))

UNSW (2023) presents the results of a range of 2-dimensional numerical modelling undertaken by UNSW that covers a range of mine layouts and parametric studies. Whilst all of these are relevant to informing mine design, the Panel is of the view that much of this information is not required to be included in the Extraction Plan. Rather, the key relevant issue is the mine design that Centennial is putting forward as an outcome of undertaking these and other studies.

The UNSW numerical modelling predicts a maximum subsidence of 87 mm over 918 and 920 Panels, as shown in Figure 3(b). This value is based on updated geological information. However, some sections of this and the other two UNSW numerical modelling reports continue to make reference to the previous value of 79 mm. The latest subsidence predictions based on the new 3-dimensional modelling being undertaken by UNSW (UNSW, 2024a) and presented in Figure 3(c) appear to revert to back to the superseded value of 79 mm as the point of reference.

In response to the Panel's queries (Q7), Centennial has advised that the UNSW numerical model detailed in UNSW (2023), being Appendix 6 of the Extraction Plan, was validated on the basis of subsidence monitoring undertaken on 14 October 2020 and 18 October 2021 along survey line 900D over 908 and 910 Panels. The locations of these Panels and the survey line are shown in Figure 1. However, in its response, Centennial has gone to advise that:

> *Throughout the duration of the UNSW modelling and the finalisation of the mine design, Clarence has continued to monitor the 900D line. Importantly, three further subsidence surveys were carried out on:*
>
> - *18 July 2022;*
> - *23 March 2023; and*
> - *13 May 2024.*

Relative to the validated model data (approximated from Figure 26 of the UNSW Report that was submitted as Appendix 6 of the Extraction Plan), the model appears to:

- *overpredict subsidence near the model extents due to model boundary effects; and*
- *underpredict subsidence (Pegs D7 to D27) by up to 31mm (for the worst case scenario of "case a"), as compared to the 13 May 2024 survey, which equates to more than 12 months after the completion of mining of 906 Panel.*

*Centennial engaged MSEC (see **APPENDIX 1 – MSEC (2024)**) to review the subsidence data from the 900D and 900B lines as monitoring during and after the extraction of Panels 908 and 910 provide the most relevant case study for assessment of potential subsidence movements due to the extraction of the 918 and 920 panels. Whilst it is acknowledged that vertical subsidence exceeded 100 mm of subsidence, MSEC found that the measured mining-induced tilts along the 900B and 900D Lines have been substantially less than the prescribed limit of 3 mm/m, including after Panel 906 was extracted and up to 139 mm of vertical subsidence has been measured…… ……*

……

The under prediction, as noted above, could have occurred as a result of post extraction flooding, the extraction of the neighbouring 906 panel (with extraction occurring beneath the 900D line in October 2022) and/or time related subsidence development.

*It is noted, for clarity, that the 900D line, and the 906-910 panels, are located within the area originally approved by Lithgow City Council referred to as the 1976 consent area, IRM.GE.76. This is outside of and to the east of the DA504-00 boundary consented 100mm criteria. The authorisation for secondary extraction of these three panels lies within the 900 Area Subsidence Management Plan (**SMP**) approval which predicted an upper subsidence limit of 100mm. Clarence acknowledges that the 906-910 panels did not achieve the predicted 100mm subsidence set out within the SMP and this non-compliance has been reported as per the SMP requirements.*

The Department is referred to Attachment 2 for the full response.

Significantly, through this advice, issues arise in relation to subsidence outcomes in the long term.

Later, in response to the Panel's Q9 regarding if Centennial has factored into its subsidence predictions the ± 20% accuracy limitations associated with the UNSW numerical model, Centennial has advised that:

*Clarence has identified that in comparing the data from the 13 May 2024 subsidence monitoring survey and the model validation run, the model has under predicted subsidence by around 22%. Clarence has identified that the more recent subsidence surveys fall outside the 20% model tolerance, noting that monitoring of the 900D survey line in March 2023 fell within the model tolerance of 20%. The subsequent survey data from 2022, 2023 and 2024 is now acknowledged within the amended UNSW Report (see Figure 26 of **APPENDIX 2 – UNSW (2024a)).***

In terms of secondary extraction mining under the 900D line, panel timing is set out below:

- *Secondary extraction of 910 Panel underneath the 900D line was carried out in April 2020,*
- *Secondary extraction of 908 panel underneath the 900D line was carried out in July 2020 and*
- *Secondary extraction of 906 Panel underneath the 900D line was carried out in October 2022 and the panel was completed in mid 2023.*

The late extraction of the 906 panel in October 2022 and its subsequent flooding over the first half of 2023, along with the flooding of the 908 and 910 panels over 2022/2023 is likely to have influenced the ongoing subsidence development along the 900D line.

Clarence is confident that the May 2024 subsidence monitoring results represent long term subsidence movement as it is:

- *Post flooding of all three panels;*

- *One year and seven months post extraction of 906 panel;*
- *Four years post extraction of 908 panel; and*
- *Four years post extraction of 910 panel.*

The Panel does not accept that timeframes of only two to four years provide an adequate basis for concluding that no further subsidence will occur in the long term. The strength of rock under sustain load can be time dependent, especially that associated with sedimentary strata. It has already been noted that the peer reviewer stated it would be prudent and appropriate to maintain careful awareness of floor conditions in the 918/920 Panels.

Centennial goes on to state that:

> *Based on the above findings, Clarence has identified an opportunity to improve the model outputs by recalibrating the model to the 13 May 2024 subsidence results. This has the potential to result in a change to the proposed geometry of the two panels (and the four sub-panels). In light of this potential (and in the absence of the recalibrated model outputs) as well as the concerns raised by the IEAPM regarding extraction sequence of the four proposed voids (see Sec**tion 1.6** below),*
>
> *Clarence has reviewed its panel layout to the following extraction sequence for three sub-panel voids only:*
>
> - *extract 918A sub-panel (918L) on advance; then*
> - *extract 918B sub-panel (918R) on retreat; then*
> - *following sufficient time to allow for subsidence to develop over the 918 panel, post extraction of 918A (918L) and 918B (918R), develop 920 panel (First Workings),*
> - *then extract 920B sub-panel (920R) ONLY on retreat; noting that;*
> - *920A sub-panel would not be extracted unless it can be demonstrated that long term subsidence will not exceed the 100mm criteria. Clarence accepts the risk of potentially not being able to extract the 920A sub-panel.*

Important points arising from this response are:

1) The recalibration of the numerical model and the potential for this to change the proposed mine geometry is a significant development that raises the question of whether the Department would consider that mine planning is sufficiently refined for the purposes of the Extraction Plan.
2) The Panel endorses Centennial's revised approach, which also addresses another query raised by the Panel (Q12) in regard to the capacity of the proposed subsidence monitoring program to be able to detect and prevent an impending exceedance of the Subsidence Impact Assessment Criteria given the proposed order of extraction of the panels. The basis for the concern is apparent in Figures 3(b) and 3(c), which show that if the sub-panels are extracted out of order as previously proposed, being 918L, 918R, 920L and then 920R, a step increase in subsidence of the order of 50% increase occurs when 920R is finally extracted. In these circumstances, it is considered very unlikely that a subsidence monitoring plan could detect an impending exceedance of the 100 mm subsidence limit in time to prevent it from occurring.

4.2.3. UNSW (Appendix 2, Responses to IEAPM, UNSW (2024b))

UNSW (2024b) is an amended version of UNSW (2023) and comment arising from the amendments has been covered in other sections of this report.

4.2.4. UNSW (Appendix 3, Responses to IEAPM, UNSW (2024a)

UNSW (2024a) was prepared in response to a query raised by the Panel (Q10i) regarding reports that long term monitoring above Clarence Colliery partial extraction panels indicates that typically an additional 15-20 mm of subsidence can be attributed to eventual flooding. The report presents some outcomes arising out of UNSW reverting to 3-dimendional modelling. One of the significant effects of this change is that the spine pillars are no longer modelled as being infinitely long but, rather, as a series of parallelogram shaped pillars (because the cut-throughs have been added).

The Panel has compiled Figure 4 in order to compare the differences in stress magnitudes and distributions in the spine pillars predicted by the 2-dimensional model of Strata^2 (which did not permit the strata to fail and is now not relied upon) and the 2-dimensional and 3-dimensional models of UNSW (both of which permit strata to fail). The predicted profiles have been arranged in Figure 4 in a manner which results in them having approximately the same horizontal and vertical scale.

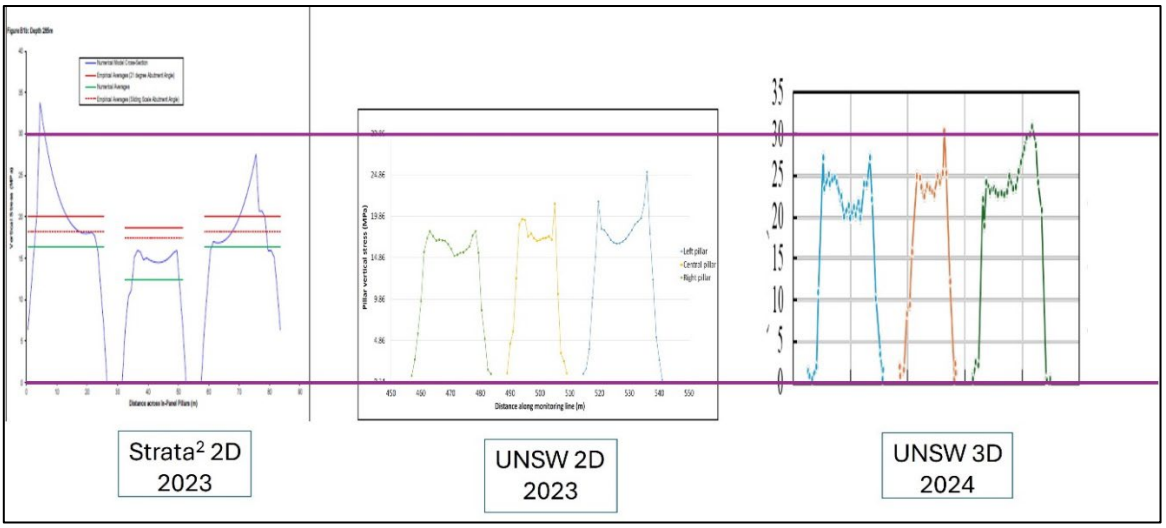


Figure 4: Predicted stress profiles across the spine pillars of 918 and 920 Panels showing the significant increase stress magnitudes with the progression to numerical models that are more representative of field conditions.

The difference in the stress magnitudes and distributions is pronounced (noting, however that the Strata^2 may be modelling pillar load at a different depth of mining to that of the two UNSW models). The 3-dimensional model predicts over a 30% increase (compared to the UNSW 2-dimensional model) in average pillar stress in the outer two spine pillar and over a 20% increase in average pillar stress in the centre spine pillar. It also predicts yielding of the floor strata to a depth of 4 to 6 m and the yielding of the pillar ribs to a depth of 5 m. Since, as is to be expected from subsidence engineering theory and practice and confirmed by the UNSW numerical modelling, pillar load and surface subsidence develop incrementally in the Clarence circumstances due to the stiffness of the roof strata being reduced with each incremental increase in overall panel width, it is quite plausible that the additional subsidence recently measured over 908 and 910 Panels could in part or total be due to the extraction of 906 Panel.

4.3. SCT (SCT, 2023)

This high-level review informs the mine design process. Advice points of particular note arising out of the report and the peer review of it are:

- The need to accommodate inelastic behaviour in numerical modelling. This has been responded to in the move to the UNSW numerical modelling.

- Changing the extraction sequence in 918 and 920 Panels such that the panels are extracted sequentially from left to right. In response to the Panel queries, Centennial is now proposing to adopt this approach.
- The lack of a fully comprehensive local empirical data base to inform the design of 918 and 920 Panels. This is apparent from subsequent and yet to be concluded developments in the design process and the response to the Panel's query on this topic (Q1).

4.4. MSEC (MSEC, 2023)

This report is concerned with:

1. processing the UNSW 2-dimensional modelling predictions of subsidence, calibrated to 908 and 910 Panels, to produced profiles of incremental subsidence associated with the extraction of each sub-panel in 918 and 920 based on the order in which the EP reports that they are to be extracted; and
2. generating predictions of tilt, tensile strain and compressive strain from these profiles.

The report is taken as read, noting that Centennial responded to the Panel's request that the contour interval be reduced from 20 mm to 10 mm (given the low level of subsidence and the closeness of the predicted maximum subsidence (87 mm) to the threshold value of 100 mm).

4.5. MSEC (MSEC, 2024)

This report was prepared in response to requests from Centennial to amongst other things, provide tilt and strain predictions and comment on the likelihood of (surface) strata fracturing resulting from ground movements. MSEC based its advice on the outcomes of the UNSW 2-dimensional modelling, as well an analysis of 37 measured strains as a basis for also accounting for irregular and anomalous ground movements (which are inevitable when dealing with natural material that contains defects). Key conclusions were:

- Maximum predicted tilt of 0.5 mm/m based on UNSW modelling'.
- Maximum predicted strains of 0.2 mm/m for both tensile and compressive strains based on UNSW modelling.
- Mean measured strains above extracted panels of 0.2 mm/m for both tensile and compressive strain.
- Maximum measures strains based on a 95% confidence level of 0.4 mm/m tensile and 0.7 mm/m compressive.
- Predicted localised strains along the alignment of steams, resulting from valley-related effects, of less than 1 mm/m, due to the predicted subsidence being less than 100 mm.
- Surveys from the NSW coalfields indicate that surface cracking and fracturing of the topmost bedrock are rarely observed where predicted strains are less than 0.5 mm/m in tension and less than 2 mm/m compressive.
- It is therefore expected that the occurrence of surface cracking and fracturing of the topmost bedrock would be rare with only minor and isolated cracking. The typical crack with is less than 10 mm.

The Panel concurs with the scale of these predictions. They are not inconsistent with subsidence outcomes across a broad range of coalfields around the world.

5.0 OTHER MATTERS ARISING

5.1. GROUNDWATER IMPACTS

The Panel notes that unlike contemporary approvals, the Subsidence Assessment Impact Criteria make no provision for limiting subsurface subsidence which can impact on groundwater systems and, hence, have potential consequences for surface ecology. The Panel is yet to review mine design from a hydrogeological perspective but concurs that the height of mining-induced fracturing is very unlikely to extend up to the Mt York Claystone.

5.2. FIRST WORKINGS SUBSIDENCE LIMITATIONS

There is a technicality associated with the Subsidence Assessment Impact Criteria that is a legacy issue. This relates to the fact that the extraction of 918 and 920 Panels could result in some surface subsidence over (proposed or existing) first workings comprising 900 Panel sufficient to cause total subsidence over this Panel to exceed 20 mm. In fact, Figure 4 of the Subsidence Monitoring Plan shows that the extraction of 918 and 920 Panel is predicted to result in the 20 mm subsidence contour for these workings extending over a portion of 900 Panel. Further, it is very likely that due to the mining of partial extraction Panels 906, 908 and 910, more than 20 mm of surface subsidence has already occurred above the proposed 900 first workings Panel.

The net result is that not only could the total surface subsidence above the 900 Panel first workings ultimately end up being more than 20 mm but, importantly, due to interaction between mining panels, the incremental increase in surface subsidence when 900 Panel is driven could exceed 20 mm and thus constitute a clear breach of the approval conditions.

Based on its experience, the Panel expects that the 20 mm limit was originally intended to serve an administrative purpose (as a criterion for determining if mine layouts needed to be subjected to a detailed review process prior to approval) and not as a subsidence management tool. There is no environmental management purpose in restricting subsidence to 20 mm in the same conditions and environment as adjacent workings which are permitted to result in up to 100 mm subsidence.

The Panel recommends that the Department gives consideration to this issue and provides clarity to Centennial.

6.0 PRIMARY CONCLUSIONS

The Panel's primary conclusions at this point in time are:

1. The satisfaction of the subsidence criteria will result in benign subsidence impacts and environmental consequences at the surface that would automatically satisfy a Performance Measure of negligible under contemporary approval conditions, except possibly if subsurface subsidence impacts on groundwater systems were to impact the surface.
2. The Panel is yet to review mine design from a hydrogeological perspective but concurs that the height of mining-induced fracturing is very unlikely to extend up to the Mt York Claystone.
3. The proposed mine design may satisfy the prescribed Subsidence Impact Assessment Criteria.
4. At this point in time, however, a greater level of certainty is required regarding some design aspects, in particular:
    a. How factors that could potentially result in an increase in subsidence in the long term have been appropriately accounted for in the subsidence predictions.
    b. The confidence limits associated with subsidence predictions, especially given the significant increase in predicted stress levels in the spine pillars since moving to 3-dimensional numerical modelling.
5. Given the incremental manner in which subsidence develops as the overall lateral extent of mining increases and the (low) order of magnitude of subsidence predicted after the extraction of only 918 Panel, there is potential to extract 918 Panel before concluding the design of 920 Panel.
6. The sub-panels of 918 and 920 should be extracted sequentially.
7. There is a legacy issue associated with the Subsidence Assessment Impact Criteria that could theoretically result in partial extraction operations resulting is a breach of the criteria applying to first workings.

7.0 PRIMARY RECOMMENATIONS

The Panel's primary recommendations at this point in time are:

1. Should the Department require the Extraction Plan to be updated to reflect the recent developments that impact on the design and extraction of 918 and 920 Panels to satisfy the Subsidence Impact Assessment Criteria:
    a. The update EP should be focused on providing a single account of the methodology that now informs the mine design.
    b. This methodology should include an account of how it addresses long term stability.
2. In any event, the EP should be updated in a manner that removes confusion created by using terminology to refer to incremental and cumulative subsidence in some sections of the EP that is not consistent with established subsidence engineering terminology.
3. The Department should give consideration to the legacy issue associated with the Subsidence Assessment Impact Criteria that could theoretically result in partial extraction operations resulting is a breach of the criteria applying to first workings.

8.0 REFERENCES

Centennial. (2024). Clarence Colliery. 918 and 920 Panels Extraction Plan. Response to IEAPM. July 2024

Hebblewhite, B. K. (2023a). Peer Review: Various Reports - Geotechnical Design and Subsidence - Proposed 918 and 920 Shortwall Panels - Clarence Colliery. BK Hebblewhite Consulting. 11 July 2023. Report No: 2304/01.1B.

Hebblewhite, B. K. (2023b). Peer Review: Various Reports - Geotechnical Design and Subsidence - Proposed 918 and 920 Shortwall Panels - Clarence Colliery. Summary of Responses to Peer Review. B K Hebblewhite Consulting. 9 August 2023. Report No: 2304/01.3.

MSEC. (2023). Centennial - Predicted Subsidence Contours for Panels 918 and 920. Mine Subsidence Engineering Consultants. 13 November 2023. Reference: MSEC1393.

MSEC. (2024). Centennial - Supplementary Information for Panels 918 and 920. Mine Subsidence Engineering Consultants. 19 February 2023. Reference: MSEC1393 - Addendum 1.

SCT. (2023). High Level Review of Likely Subsidence and Groundwater Impacts from Mining 918-920 Panels, Clarence Colliery. 13 July. Reference: CLR5492C.

Strata2. (2023). Geotechnical Design and Subsidence Report for the 918 and 920 Panels. September 2023. Report No: CLA-053-Rev5.

UNSW. (2023). Numerical Modelling Assessment of Mine Subsidence Related to Shortwall Extractions. Prepared by Dr Chengguo Zhang. July 2023. Report No: 2023CL01.

UNSW. (2024a). Assessment of Pillar Behaviour Using 3D Modelling. Prepared by Dr Chengguo Zhang. June 2024. Report No: 2024CL01. UNSW.

UNSW. (2024b). Numerical Modelling Assessment of Mine Subsidence Related to Shortwall Extractions. Prepared by Dr Chengguo Zhang. July 2024. Report No: 2023CL01. UNSW.

ATTACHMENT A: IEAPM REQUEST FOR FURTHER INFORMAITON

1.0 SUBSIDENCE

1.1. PREAMBLE

It is common in all forms of underground mining for the mine working to comprise an irregular layout of excavations of variable dimensions and an irregular layout of pillars of variable dimensions. The behaviour of these types of layouts is determined by the interaction between the stiffness of the individual pillars and the stiffness of the surrounding strata. It is a fundamental rock mechanics principle that the resulting ground response to irregular mine layouts, such as the 918/920 panel and pillar layout, cannot be reasonably determined by an empirical approach based on a consideration of the pillar system only. The situation is statically indeterminate and requires appropriate numerical analysis to arrive at reasonable estimates of ground responses, such as vertical displacement (subsidence).

1.2. STRATA^2 ASSESSMENT

The SMP includes two peer reviews of the work undertaken by Strata^2. The Panel notes that the first peer review (by Em. Prof. Bruce Hebblewhite) dated 11 July 2023, was of Rev3 of the Strata^2 report dated 22 May 2024. In relation to pillar design, the peer reviewer stated that:

1) *based on the above concerns, I believe that pillar stability analysis is far more suited to a numerical analysis study rather than this empirical approach which relies on too many assumptions. A numerical analysis would also enable a more meaningful consideration of the stone pillar tops where pillar height exceeds seam thickness.*

and

2) *I therefore do not reject the Strata2 development pillar analysis outcomes outright but believe the stability analysis warrants further support from a complementary numerical model (see consideration of the subsequent UNSW Report).*

With respect to Strata^2's calculation of *'overall system (panel) stability':*

3) *I do not accept this as a meaningful parameter – in simple terms, because the system is only as strong as its weakest link. I therefore do not accept this set of calculations and suggest that, if not deleted from the report altogether, they should be disregarded by any readers of this report, as I do not believe they add any value to the design.*

The second peer review (by Em. Prof. Bruce Hebblewhite) dated 9 August 2023, was of Rev4 of the Strata^2 report dated 21 July 2024. The peer reviewer stated in relation to the points numbered above:

1) *My opinion expressed above remains, hence relying more on the results of numerical analysis than the Strata2 empirical calculations (whilst not dismissing them in any sense)*

2) *As noted above – see section 2.3 below re UNSW Report*

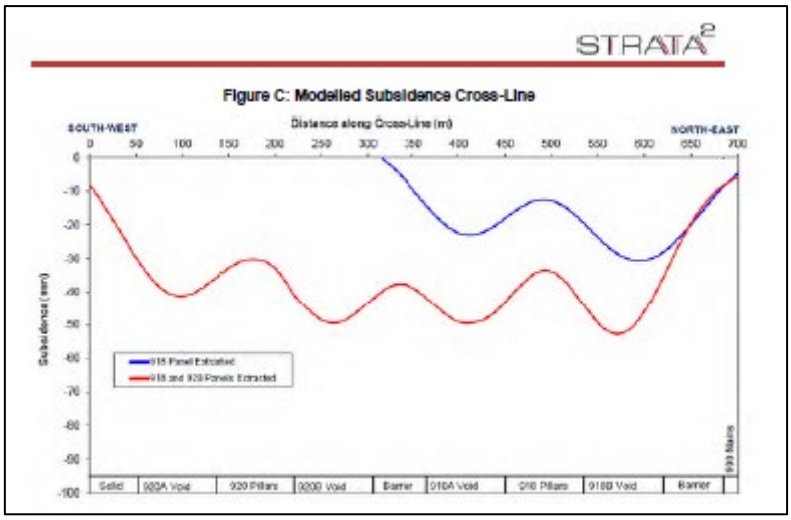
3) *My opinion of this set of calculations* [overall pillar system stability] *remains unchanged and I recommend that the results be disregarded*

The Strata^2 report relied upon in the SMP is Rev 5, dated 27 September 2023. The SMP does not include a peer review of this report. The Panel notes that this report:

1. Includes a numerical model

2. Persists with placing reliance on the calculation of overall pillar system stability

The two plots below are extracted from the SMP and show the subsidence behaviour over 918 & 920 Panels as predicted by the Strata^2 numerical model and that as predicted by the UNSW numerical model of July 2023, which was also peer reviewed by Em. Prof Hebblewhite.



The profiles were then developed based on a cross-section through the southern ends of the panels where the depths of cover vary between approximately 180 m and 260 m. The predicted profiles of vertical subsidence for Panels 918 and 920 are provided in the Excel spreadsheet in the email from the University of NSW (UNSW, 2023b) which has been reproduced in Figure 5 below.

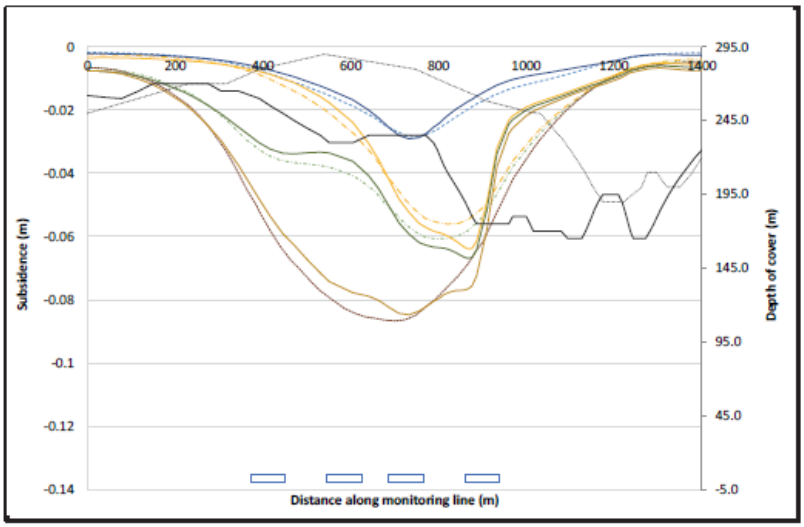


Figure 5 Predicted profiles of subsidence for Panels 918 and 920 (southern ends of panels)

Against this background, the Panel requests the following clarifications:

1. What field data was used to calibrate the Strata^2 numerical model?

2. Has the Strata^2 numerical model been peer reviewed?

3. How does Centennial reconcile placing reliance in its SMP on the outcomes of both numerical models given the very significant disparity between the subsidence profiles and magnitudes predicted by each model?

4. How does Centennial reconcile the SMP continuing to place weight on the concept of overall pillar system stability when it has been rebutted so strongly by the peer reviewer?

5. The SMP (p.29) states that

   Based on a combination of empirical and numerical models, Strata2's estimated subsidence effects are predicted as follows:

   i. *Short-term (i.e. single panel) subsidence of 10-30mm*

   ii. *Long term (i.e. multi-panel) subsidence of 20-60mm*

   The Panel queries: the use of the use of the term 'long-term' to describe subsidence that is predicted to occur at the time of extraction.

1.3. UNSW NUMERICAL MODELLING

1.3.1. Short Term Stability

6. The UNSW numerical modelling outcomes throughout the report are presented in the form of plots of predicted ground displacements for mine workings comprising panels and pillars of various widths. These workings are depicted on each plot by marking the position of each panel at the seam horizon and/or by numbering of the form *-P1 -P2 -P3….* The predictions are referred to almost universally as predictions of *incremental subsidence*. The peer reviewer for Centennial (Em. Prof. Bruce Hebblewhite) commented on the need for labelling to clarify the mine layout and mining sequence to which each plot of predicted vertical displacement relates. That advice has been responded to in some sections of the UNSW report but, overall, the response is still not considered adequate or sufficiently informative, even for an informed reader. The Panel requests that:

   i. the mine layout to which each suite of subsidence plots pertains be clearly identified on each figure, including the location and dimensions of each panel and each pillar.

   ii. that the extent of mining to which each subsidence curve relates and the sequence of extraction that generated the curve be clearly identified (i.e. Panel 918L extracted; Panels 918L, 918R and 920L extracted, etc).

iii. that the curves be coloured consistently throughout the report in respect of the order in which panels are extracted.

iv. Centennial give consideration to having the UNSW report and other supporting documentation (for example, p10, Section 6.2.2 of the SMP) edited such that the term *incremental subsidence* is not used to refer to what, in subsidence engineering terms, is *cumulative subsidence*. In subsidence engineering in Australia, the term 'incremental subsidence' describes the difference in subsidence before and after extracting a panel; that is the additional subsidence that develops when a panel is extracted and not the resultant cumulative subsidence (as in the UNSW report). This distinction is demonstrated in the MSEC report commissioned by Centennial for the project, which is concerned with generating profiles of incremental subsidence from the UNSW predictions of cumulative subsidence.

7. There is a lack of clarity as to which field experience has been used to calibrate the numerical model and which field experience has then been used to validate the calibrations (arising out of there being multiple ways in which a numerical model can calibrated to a specific field performance, some of which may not prove appropriate). Please:

   i. clarify the sources (mine workings) used for the purpose of calibrating the UNSW numerical model

   ii. clarify the sources (mine workings) used to validate the UNSW numerical model

   iii. for both i) and ii) above, provide plans showing the location and lateral extent of the survey lines and the respective measured subsidence profiles utilised for calibration and validation purposes.

8. Based on the IEAPM Panel scaling dimensions off drawings, the UNSW numerical model results shown in Figure 7 predict an angle of draw of about 32°, while an angle of draw of about 12°is associated with the field data that the model is attempting to replicate. An angle of draw of about 27°appears to be associated with the eastern end (918 Panel end) of the predicted final subsidence profile for the 918/920 layout shown in Figure 13. These values have two potentially serious implications for the mine design, namely:

   - The maximum permissible surface subsidence of 20 mm over the proposed 900 Panel first workings will have been exceeded even before the workings are formed.

   - The lateral extent of the UNSW model needs to be increased to take into the account the contribution of the 900 Panel workings to additional subsidence over the 918/920 layout. This contribution is very likely to be greater than that which can already be derived from the predicted angle of draw because the 900 workings will soften the abutment of sandstone beam bridging across the 918/920 layout.

   These concerns might be rebutted by justifying that the numerical model predictions of angel of draw are inaccurate. However, should this prove to case, it does not resolve a related matter in the SMP that has the same two implications as above. This is that the

SMP for 918/920 contains a number of drawings across a range of documents which show that the 20 mm limit of subsidence associated with the extraction of 918/920 will extend over the proposed 900 Panel workings. This value will increase when the area is softened by the formation of the 900 Panel pillars. Further, the 906/908/910 Panel layout may also have already contributed to subsidence over the yet undriven 900 Panel.

Against this background, the IEAPM Panel requests that:

i. If possible, the UNSW numerical model be extended and re-run to include at the least the 900 Panel workings.

ii. The impact of bridging strata on the angle of draw associated with partial extraction workings (not longwall or total pillar extraction) be clarified and a consistent assessment of impacts associated with angle of draw be provided.

9. The UNSW report provides detailed and transparent information on the assumptions, approximations and limitations associated with the construction and operation of the numerical model. These include that it does not address long term stability and that *the numerical modelling can have tolerance of model predictions of ± 20%.*.

i. The UNSW numerical model predicts a maximum vertical displacement (subsidence) of 87 mm at the time of mining, which compares to an approved long-term limit of 100 mm over panel and pillar workings. This raises the question of whether the predicted level of 87 mm provides sufficient latitude to cater for inaccuracy in model predictions and further development of subsidence in the long-term.

a. Has Centennial factored these considerations into dimensioning the mine layout and, if so, how?

1.4. LONG TERM STABILITY

10. The Panel has identified the following matters that may impact on whether the proposed mine design will result in less than 100 mm subsidence in the long term and requests that Centennial specifically address them:

i. The Strata^2 report titled *Geotechnical Design and Subsidence Report for the 918 and 920 Panels, CLA-053-Rev5,* reports (p.19) that *'Long term subsidence monitoring above Clarence Colliery partial extraction panels indicates that typically an additional 15-20mm of subsidence can be attributed to eventual flooding of the workings.*

ii. In his peer review of 11July 2023, Em Prof. Hebblewhite has noted that *'The immediate floor is uniformly moderately strong (40 to 70 MPa) but in the NE corner of the Extraction Plan Area, the Katoomba Seam overlies the Middle River Seam, just 2m – 3m below. It is noted that this can result in reduced floor stiffness, resulting in increased levels of subsidence. This is noted as having been problematic in previous 906 to 910 Panel extraction. However, Strata^2 concludes that "the floor is not weak in the Extraction Plan Area'. It would be prudent and recommended to maintain a particular watch on floor conditions in this area, nevertheless.'*

while in his second review of 9 August 2023, the peer reviewer states:

> *I stand by my observation that it would be prudent and appropriate to maintain careful awareness of floor conditions in the 918/920 Panels*

iii. The SCT report notes (p6) that:

> *By July 2022, a further subsidence survey of 900D line conducted showed subsidence had increased to 104 mm. In this period the 910-908 workings were flooded and 906 Panel had been developed nearby. It is difficult to determine whether the 11 mm increase in subsidence is due to flooded workings, survey tolerance, some geological anomaly, additional subsidence from 906 development, or a combination of all of these. Whatever the course, the 910-908 panel geometry has not been able to maintain maximum subsidence over the panel at less than the required 100 mm.*

iv. There is general alignment between SCT's advice to Centennial, the UNSW numerical modelling outcomes and the peer reviewer's reports that the strata in and about the coal pillars in 918/920 will experience a degree of non-elastic deformation and yielding. As the strength of strata under high load can be time dependent, how has the potential for this time-dependent deformation in the long term been accounted for in the mine design?

1.5. MSEC SUBSIDENCE CONTOUR CONSTRUCTION

The subsidence contours derived by MSEC on the basis of the UNSW numerical modelling predictions are identified in Figures 10 and 11 as coloured contours based on 20mm intervals, and starting from the 20mm contour. Given the low magnitude of predicted subsidence and the minimal margin for tolerable subsidence over both first workings and panel and pillar workings, it is requested that:

11. Subsidence contours be plotted at 10mm intervals, are labelled, and include the predicted 10 mm subsidence contour.

1.6. SUBSIDENCE MONITORING PLAN

12. The order of extraction (918L, 918R , 920L and then 920R) results in a step change (~doubling) in subsidence development during the extraction of the final sub-panel, 920R. This is a result of the sub-panels not being extracted in a sequential order.

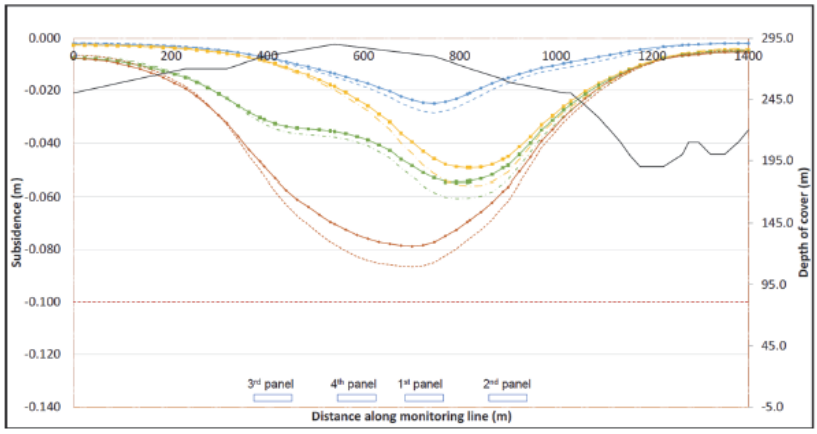


Figure 4 Predicted profiles of subsidence for Panels 918 and 920 (mid-lengths of panels)

i. How feasible is it to detect and prevent an exceedance of the approval condition based on the proposed monitoring program if, due to the order of extraction of the panels, an impending exceedance develops quickly as a step change?

ii. Is it feasible to extract the sub-panels in sequential order (918R, 918L, 920R, 920L – or – 918L, 918R, 920R, 920L) in order to more effectively monitor the development of subsidence so as to avoid exceeding approval conditions? The Panel notes that SCT recommended extracting the panels in sequential order *so that subsidence increases incrementally, and controls can be implemented if subsidence appears likely to exceed the subsidence limit'* (p1).

13. The SMP states that *'It is therefore not necessary that the ground monitoring installations in general be extended beyond the 26.5° for Panels 918 and 920 (MSEC, 2024).* The Panel questions if this conclusion adequately accounts for monitoring cumulative subsidence over 900 Panel to verify that it does not exceed 20 mm as a result of mining Panel 910, 908, 906, 900, 918 and 920.

2.0 GROUNDWATER AND SURFACE WATER

14. Plans and Maps

i. Please provide a geological map of the whole region area and showing the Y series outcrop of the Burralow Formation.

ii. What is the significance of the First Workings Protection Zone marked on 'Clarence 918-920 EP_Graphical Plan 5_existing workings in other seams'?

15. Lineaments

i. Please confirm which lineaments (if any) are known to propagate through the Triassic strata to surface?

ii. Are there any surface expressions of lineaments/faults in the immediate vicinity of 918/920 Panels?

iii. Figure 4 of the Main Report shows Type 2 lineaments outside the 918-920 area but Type 4 within the area. It would be helpful to have the lineaments mapped

with width bands around them, as done at Springvale Mine, and to show the lineaments across both Springvale Mine and Clarence Mine, rather than over a relatively small area as at present

iv. Where and how close is the nearest Type 1 lineament to 918/920 Panels?

16. Hydrographs

i. Please provide the latest hydrographs and associated stats for each of the standpipes and VWP monitoring locations included in Table 2.4 and shown on Figure 2.3 of GHD's 918/920 Water Management Plan (both for Clarence and Springvale), for the hydrographs reported in Appendix C, and for the recently completed standpipes at CLRP40, CLRP41 and CLRP42R.

3.0 BIODIVERSITY

17. Gardens of Stone Conservation Area.

i. Could the Panel be supplied with a map showing the boundaries of Gardens of Stone Conservation Area and National Park.

ii. What monitoring has been done to date above Clarence Colliery within the area of Gardens of Stone Conservation Area? The Biodiversity Management Plan Fig 1 shows GoSCA above workings and in this area, both Newnes Plateau Hanging and Newnes Plateau Shrub Swamps (Nine Mile Lower) are marked.

18. Swamps

i. The stratigraphic sequence in Figure 3 of the Extraction Plan indicates that the Mount York Claystone is incised around Clarence Colliery. Can Centennial confirm that none of the shrub swamps within the Extraction Plan Area sit below Mount York Claystone. A focused stratigraphic section through the mine plan would be useful.

ii. The swamps are proposed to be monitored using the BAM. Cover/abundance monitoring can be unreliable as an indicator of change. Can further justification be provided for use of the BAM, rather than another method (e.g., the transect sampling method from Brownstein et al., 2014)

REFERENCES

Brownstein, G., Johns, R., Blick, R., Fletcher, A., & Erskine, P. (2014). Flora Monitoring Methods for Newnes Plateau Shrub Swamps and Hanging Swamps. Centre for Mines Land Rehabilitation, University of Queensland.

ATTACHMENT B: CENTENNIAL COAL PTY LTD RESPONSE TO INFORMATION REQUEST

CENTENNIAL

CENTENNIAL COAL

Clarence Colliery

918 and 920 Panels Extraction Plan

Response to IEAPM

July 2024