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16 July 2015

Mr Howard Reed
Manager Mining Projects
NSW Department of Planning & Environment
GPO Box 39
SYDNEY NSW 2001

Dear Mr Reed

Re: Springvale Mine Extension Project – Response to OEH Submission

Following a meeting between the NSW Office of Environment and Heritage (OEH) and the Department of Planning and Environment (DP&E) on 25 May 2015 in relation to the Springvale Mine Extension Project, a submission from OEH on the DP&E Preliminary Assessment Report and draft conditions of consent was made. The submission, dated 12 June 2015, identified a number of issues that have previously been addressed in documentation provided to DP&E in relation to the Project, mainly the Response to Submissions report submitted in October 2014, along with additional issues not raised by OEH in previous submissions made throughout the assessment process.

Springvale Coal has attached, Attachment 1, a response to the key issues raised in the OEH submission and, where applicable, provided a reference as to where they have been previously addressed.

If you have any questions in regards to this matter, please contact me on my mobile 0407 207 530.

Yours sincerely

James Wearne
Group Approvals Manager

Attached

- **Attachment 1 – Response to OEH Submission on Springvale Mine Extension Project dated 12 June 2015**

Attachment 1

Response to OEH Submission on Springvale Mine Extension Project dated 12 June 2015

Response to Office of Environment and Heritage Submission on Springvale Mine Extension Project dated 12 June 2015

1. Impacts to Newnes Plateau Shrub Swamps

Issue

OEH has consistently stated that it does not support the direct undermining of Newnes Plateau Shrub Swamps EEC using the longwall mining technique unless there has been a modification to the mining techniques that will ensure that impacts will be prevented.

Response

This issue was raised by OEH in its submission on the EIS. In that submission a comparison was made between Springvale Mine's longwall mining and Clarence Colliery's bord and pillar / partial extraction mining methods with the self-imposed subsidence of 100 mm to avoid impacts to Newnes Plateau Shrub Swamps (NPSS). A detailed response was provided in the RTS (refer Section 3.1.14, page 122) to the issue raised.

The alternative bord and pillar and partial extraction mining method has been investigated at Springvale Mine (refer Hill (2011; Strata Engineering (2010))), and the conclusion drawn in these investigations was that the geotechnical environment at Springvale does not lend itself to bord and pillar and partial extraction mining methods. The investigation noted that there is no precedent, in Australia at least, for a safe and viable partial extraction operation in a geotechnical environment similar to Springvale Mine.

The geotechnical environment at Springvale (which mines coal from the Lithgow seam) differs markedly from that at Clarence Colliery, which mines coal from the Katoomba seam. The Katoomba seam lies approximately 100 m higher than the Lithgow seam. The depths of cover at Springvale range from a minimum of 180 m (LW501 and LW502) to a maximum of 420 m above the northern end of the proposed LW416 and the southern ends of the proposed LW417 and LW419. The depths of cover at Clarence Colliery fall in the range 130-320 m (typically 240 m).

Bord and pillar mining with partial pillar extraction is dependent on the structural competency of the roof (strata overlying the coal seam) and the stress environment (which is a function of the depth of the coal seam below the surface). The structural competency of the roof, as described in detail on Section 3.1.14 of the RTS, is assessed using the Coal Mine Roof Rating (CMRR) system. In the case of Springvale Mine the CMRR data gathered from a number of locations falls in the range 31–35. The roof at Springvale Mine is classed as weak under the CMRR system and therefore partial extraction technique is not considered safe. On the other hand the CMRR for Clarence Colliery sandstone roof falls in the range 50–60 and is considered a strong roof allowing bord and pillar mining with partial pillar extraction to be undertaken at that mine safely. Conversely, it is because of the strong roof at Clarence Colliery that longwall mining is not amenable at that mine.

As discussed in a Section 8.3.3 of the EIS and Section 3.1.14 of the RTS Centennial Coal has used a risk-based approach to mine planning, mine design and subsidence management to prioritise avoidance and reduction of potential impacts and constraints of surface features and geological and geotechnical issues, while considering mine safety and feasibility. A number of longwall mine layouts were investigated. A few were discarded as they did not represent a viable business case for Springvale Coal. The current mine plan was arrived at through many iterations of longwall geometries (panel dimensions, chain pillar widths) to offer an optimal balance between maximum resource recovery and minimal impacts to the environment.

Springvale Mine has used width-to-depth ratios (expressed as the longwall void width divided by the depth of cover of strata above the seam) to inform future mine design as they are the most important predictors of subsidence behaviour. Results of a sensitivity of void widths on subsidence behaviour for void widths between 150 m and 315 m at two depths of cover (DoC) 360 m and 400 m are presented in **Attachment 1**. Key points to note are as follows.

- Only marginal subsidence reductions for longwall void widths occurs between 150 m and 260 m while the greatest reductions can be made from 315 m to 260 m void widths (refer **Figure 1**, **Attachment 1**).

- The greatest reductions in compressive and tensile valley strains occur for a reduction in void widths from 315 m to 260 m followed by marginal changes from 260 m to 150 m (refer **Figures 2** and **3**, **Attachment 1**).

The data presented in **Attachment 1** show that narrowing the void width widths to significantly less than 261 m does not significantly reduce subsidence to afford additional environmental advantages, however, comes at a cost to the business viability at Springvale Mine.

Issue

- *OEH considers Aurecon (2009) report to be relevant to the potential interaction of fracturing and lineaments when using the longwall mining technique. The EIS largely avoided any discussions of the findings of Aurecon (2009) in relation to fracturing and cavity formation underneath East Wolgan Swamp.*
- *Section 3.1.14 of the RTS states "As identified in Section 2.6.2.7 of the EIS "Subsidence effects to aspects of swamp hydrology have been noted at two swamps (Kangaroo Creek Swamp and East Wolgan Swamp). In both of these cases investigations have revealed that mine design was the primary causative factor". Aurecon (2009) and more recently DgS (2014) concluded that the lineament under East Wolgan Swamp was a primary causative factor in impacts and water movements down to 80 m.*

Response

Aurecon (2009) was one of the first few investigations undertaken by Centennial Coal to understand the decline in the East Wolgan Swamp groundwater level and the fate of surface water entering the swamp. Between 2008 and 2010 there was surface water loss observed at the swamp and Aurecon (2009) hypothesised (refer Section 4.1.1 of Aurecon (2009)) from observations of piezometer monitoring data that the water flows underground (although not into the mine workings) through a cavity developed beneath the swamp and into bedding partings in the near surface strata over the longwall panels up to 60 m below the base of the swamp. Section 4.1.2 of Aurecon (2009) discusses the likely mechanism for the formation of a cavity underneath the East Wolgan Swamp due to extraction of Springvale's LW411. The report notes that the cavity formation was not a result of normal mine subsidence-related strains over Springvale LW411. The report concludes the observed abnormal movements in the East Wolgan watercourse, were most likely due to subsidence-induced movement on a pre-existing geological structure, exacerbated by one or more additional co-incident factors. Similar abnormal movements had not been previously observed anywhere in the Western Coalfield. The coincident factors include:

- intersection of major structures
- orientation of the longwall panel relative to the major structures
- steepness and depth of East Wolgan Swamp valley at northern end
- prevailing in-situ stress direction and magnitude
- location of the geological structure (Wolgan Rover Lineament) close to the permanent barrier pillar.

These coincident conditions are all listed in Section 8.2.4 of the EIS (although the reference source (Aurecon (2009)) has not been quoted) as likely factors related to cavity formation at East Wolgan Swamp. Section 8.2.4 of the EIS notes that, although the above listed combination of factors do not occur elsewhere on the Springvale Mine or Angus Place Colliery proposed mine plans, the findings of the Aurecon (2009) investigation provides a robust basis for mine design in the vicinity of sensitive surface features such as shrub swamps, discussed in Sections 8.3.2 and 8.3.3 of the EIS.

Further to Aurecon (2009) investigation subsequent analyses of piezometer and extensometer data from Springvale in DgS (2013) concluded that two additional factors may have contributed to the cavity formation (also listed in Section 8.2.4 of the EIS):

- critical width longwall panel design of LW411 with significantly higher measured subsidence in comparison to the earlier sub-critical width panels

- overburden influenced interaction of Angus Place and Springvale mine workings and subsidence effects due to close proximity. DgS (2013) note “the strain profile after LW412 (Springvale) and LW950 (Angus Place) were commenced shows a reversal from a compressive strain of 12 mm/m to a tensile strain of 1 mm/m. This change was probably caused by the development of 250 mm to 300 mm of subsidence over the barrier pillar under additional loading between LW411 and LW950. Normal convex bending deformations would have occurred in response to the strata cantilevering out across the two adjacent goafs.”

An understanding of the causal factors contributing to the anomalous subsidence behaviour at East Wolgan Swamp discussed above, the impacts of mine water discharge also discussed in Aurecon (2009), in conjunction with other factors controlling subsidence (eg. critical width panel design, subsidence interaction of adjacent Angus Place and Springvale workings) has been used to develop management responses in the mine design to prevent recurrence. These management responses are listed in Table 2.6 of the EIS. Table 2.6 notes that all longwalls proposed under the swamps will be sub-critical panel design and the longwalls proposed at Springvale Mine and Angus Place Colliery will be separated by over 500 m to avoid interaction. MSEC has provided an assessment of the cumulative subsidence effects due to the interactions of the proposed mine plans in the respective extension projects at the two mines in Section 3.1.5 of the RTS. This was raised as an issue by OEH on the exhibition EIS. MSEC’s conclusion was “The predicted vertical subsidence at the surface between the two mine extension projects and outside the respective Study Areas (i.e. 26.5 degree angle of draw lines), is less than 20 mm due to the extraction of the proposed longwalls at both collieries. The natural and built features in this location are not expected to be adversely impacted by the conventional ground movements.”

As part of the RTS, DgS (2014) has undertaken further analyses of piezometric response (Borehole SPR39) to Springvale Mine’s LW411 and LW412 extraction in the vicinity of the East Wolgan Swamp. These monitoring data had been previously analysed in Aurecon (2009). DgS (2014) has been able to use the response of the piezometers in borehole SPR39 to mining effects and emergency mine water discharges in 2009 to confidently define the heights of fracturing zones. DgS (2014) was also able to determine the depth of Wolgan River Lineament fault dilation due to interaction with LW411 and LW412 subsidence deformations from the piezometer responses. Investigations reported in DgS (2014) indicate that it is very unlikely that the fault dilation extended to depths >240 m below East Wolgan Swamp due to the pressure head increases observed but that the fault was probably open near the surface and allowed surface water (including mine water discharges) to move deeper into the strata than it normally would have. Aurecon (2009) has estimated that the discharge waters may have reached a depth of 60 m below the East Wolgan Swamp. DgS (2014) concludes the fault dilation that occurred above LW411 allowed the mine water discharges along East Wolgan Creek to penetrate into the strata to depths between 80 m and 140 m. Aurecon (2009) noted that the water pooled within the B-Zone (zone of discontinuous fracturing and strata dilation) and allowed piezometric pressures to almost recover to pre-mining values. Despite the fault allowing surface waters to move deeper into the strata than they normally would have, the B-Zone has not been ‘connected’ directly to the A-Zone (zone of continuous subsurface fracturing) because of it.

DgS (2014) concluded the Wolgan River Lineament dilation that occurred above LW411 allowed mine water discharges along East Wolgan Swamp to penetrate into the strata to depths between 80 m and 140 m. The Aurecon (2009) report concludes the observed abnormal movements in the East Wolgan watercourse were most likely due to subsidence-induced movement on a pre-existing geological structure, however was exacerbated by one or more additional co-incident factors. As noted above the mine design was a primary causative factor since the LW940 and LW950 overlying the East Wolgan Swamp was of critical panel width. In addition Subsidence monitoring at Springvale over previously extracted longwalls of void widths 254 m to 315 m (see below) show that narrower sub-critical longwalls (LW1, LW401 – LW409, with void widths in the range 254 – 266 m) had significantly less subsidence than the wider, critical longwalls (LW410 – LW415 with void widths of 315 m).

Other impacts (see below) observed at East Wolgan Swamp, discussed in Section 2.6.2.6 of the EIS have been attributed to the mine water discharges into East Wolgan Swamp. Analysis of piezometric data indicates that this swamp is highly influenced by discharge, with piezometer levels falling to basement levels when mine discharge was not occurring, indicating that this swamp is only periodically waterlogged prior to mining.

The impacts attributable to mine water discharges are:

- dieback of vegetation (along path of mine water flows)
- possible changes to swamp soil/water chemistry (changes due to elevated EC(800 µS/cm – 1000 µS/cm) and high pH (8-9) of mine water flows)
- changes in swamp hydrology (wetting / drying cycles due to mine water discharge)
- erosion (along path of mine water flows)
- elevated sediment loads (along path of mine water flows)
- slumping of peat due to erosion of sub-surface sediments (in two locations)..

Goldney et. al. (2010) confirm the impacts to East Wolgan Swamp vegetation and stability are attributable to both subsidence and mine water discharge. The impacts to East Wolgan Swamp were also investigated by the University of Queensland (Fletcher and Erskine, 2014) which found that "*The primary cause for vegetation loss appears to be the flow path of mine discharge water through the studied shrub swamp community. This conclusion is supported by the presence of shrub swamp species surrounding impacted areas caused by discharge events.*"

The findings of Aurecon (2009) and DgS (2013) on East Wolgan Swamp investigations are discussed in detail in Section 6.1 of Corbett et al (2014a). In relation to observed impacts at the East Wolgan Swamp this report concluded "The combined impacts of long-term and then intermittent high flow mine water discharge, incised valleys with steep slopes, major geological structure zones, mine design and mine subsidence caused formation of a cavity which led to the loss of surface water flows between 2008 and 2010. The history of the mine water discharges, with several years of consistently low flows followed by a series of rapid drying and high flow wetting events, had a profound impact on the swamp vegetation and peat material in the path of the water flows. The cracking which caused the cavity appears to have subsequently infilled through natural sedimentation processes and surface water has been recorded downstream of the cavity since August 2010."

In contrast the Narrow Swamp, which is located in similar geological structure zone within the Wolgan River Lineament as East Wolgan Swamp, did not experience the anomalous subsidence effects and cavity formation as that occurred at the East Wolgan Swamp. According to Aurecon (2009) (Section 4.1.3) this observation was supported by the monitoring data at Angus Place (using two piezometers NS1 and NS2), which show that the three longwall panels that have passed under the Narrow Swamp (LW920 in 2004, LW940 in 2007 and LW950 in 2005) have caused no significant loss of flow in the watercourse through mining-induced subsidence impacts (cracking). While subsidence has occurred underneath Narrow Swamp (and consistently along the lineament) this did not change the swamp hydrology. Section 4.1.3 of Aurecon (2009) and Section 9 of Corbett et al (2014a) note that some of the contributing factors relevant to East Wolgan Swamp were not relevant or active in the vicinity of the Narrow Swamp. Impacts to vegetation at Narrow Swamp were principally due to the mine water discharges (Goldney et al (2010)). An analysis of the pre-mining baseline data (between March 2007 and March 2008) undertaken in Corbett et al (2014a) showed the swamp was periodically water-logged prior to mining. It remains periodically water-logged following mining.

Sections 2.6.2.6 and 2.6.2.7 of the EIS noted that subsidence effects have impacted on the swamp hydrology at Kangaroo Creek, a periodically water-logged swamp. The Kangaroo Creek Swamp (undermined by Angus Place LW940 and LW950) impacts are discussed in detail in Section 10 of Corbett et al (2014a). Monitoring of two piezometers at this swamp indicate that at the piezometer KC2 location there have been no significant impacts to swamp hydrology in response to longwall mining and that at this location the swamp is periodically water-logged. Groundwater levels at KC1 appear to have been affected by the longwall mining of Angus Place LW940, which was below the lower reaches of the swamp, as there was a sudden reduction in groundwater levels in June 2008, unrelated to rainfall. Measured groundwater levels respond to rainfall events, and standing water levels reach pre-mining levels after significant rainfall events. However, for KC1 measured groundwater levels have yet to completely return to pre-mining levels.

It is important to note that Kangaroo Creek Shrub Swamp is fed by a perennial spring. which in turn is fed by the aquifer-aquitard systems within the Burralow Formation. This system was unaffected by mining and the creek remained permanently wet below the spring. This, together with the presence of healthy hanging swamps along the valley walls surrounding Kangaroo Creek Shrub Swamp, indicates that the water supply from the spring and valley wall seepage has not been interrupted by longwall mining and that groundwater inputs to the swamp hydrological system remain intact.

With regards to impacts on vegetation at Kangaroo Creek Swamp Corbett et al (2014a) note that Flora monitoring at the swamp indicated no trend of decreasing condition and that species abundance is not declining. The available evidence indicates that underground mining has not resulted in adverse impacts on Kangaroo Creek Shrub Swamp.

Goldney et al (2010) concluded, based on an assessment of the hydrographs of the piezometer KC1 which was undermined in 2008, that the impacts to Kangaroo Creek Swamp were due to mining–induced subsidence.

Investigation of mining related impacts at Kangaroo Creek Swamp by Corbett et al (2014a) showed that high levels of differential subsidence movements were measured, including strains (up to 6 mm/m tensile and 26 mm/m compressive) and tilts (up to 13 mm/m). Corbett et al (2014a) have concluded that for the Kangaroo Creek Swamp, the presence of major fault zones (Kangaroo Creek Lineament) and incised valleys in combination with mine design factors resulting in elevated levels of subsidence caused localised hydrological impacts.

Despite the sudden reduction in groundwater level observed in June 2008 at KC1 (downstream of Kangaroo Creek Waterhole), unrelated to rainfall, the photo monitoring undertaken at this location shows no loss of water from the swamp ecosystem. Photo-monitoring is being undertaken at three locations along the Kangaroo Creek listed below for periods noted:

- Kangaroo Creek Dam (30 December 2009 to 8 June 2012) located downstream of Kangaroo Creek Swamp South – showed dam has contained water on 22 out of 24 monitoring occasions (conducted monthly or bi-monthly).
- Kangaroo Creek Waterhole (from July 2005 onwards) located within the Kangaroo Creek Swamp – showed only three monitoring events out of 41 monthly or bi-monthly monitoring events where there was no water in the waterhole (February 2014, June 2014 and August 2014), and these events show strong correlation to deficit in rainfall in the period.
- Kangaroo Creek Downstream (30 August 2012 to 18 September 2013) location is not mined as yet and is downstream from the Kangaroo Creek Waterhole (see above). Photo monitoring at this location over the period shows presence of water at the location on all monitoring occasions confirming no water has been lost from the Kangaroo Creek ecosystem.

Section 3.1.14 of the RTS provides details of the photo monitoring undertaken and the photographs of Kangaroo Creek Dam and Kangaroo Creek Waterhole over the monitoring periods noted above are included in Appendix 11 of the RTS.

Lastly, the management responses and the recommendations of Aurecon (2009) were used to develop Springvale Mine's *Temperate Highland Peat Swamp on Sandstone Monitoring and Management Plan* required as a condition of approval EPBC 2011/5949, dated 14 March 2012, in relation to EPBC Act referral on Longwalls 415 – 417. This Monitoring and Management Plan was approved by the then SEWPAC (now DoE) on 21 October 2013. It is noted the Monitoring and Management Plan was peer reviewed by both Dr David Goldney and Dr Grant Hose. Dr Hose was an expert who had previously been approved by the Department of the Environment to peer review previous swamp reports. Dr David Goldney was the expert who had undertaken an independent investigation into the impacts of mining on swamps at Angus Place Colliery for the then Department of Environment, Water, Heritage and Arts (DEWHA).

<u>Issue</u>

- *It is OEH's view that, despite longwall mining having significantly damaged Newnes Plateau Shrub Swamps (NPSS) in the past, the EISs do not provide any definitive evidence or guarantee that further NPSS will not be impacted by the current mine plan or future longwalls given the following*

  - *Bedrock fracturing and impacts to pool and swamp aquifers have already been demonstrated to occur above existing longwalls.*
  - *Predicted subsidence levels (stress, upsidence, valley closure) are much greater than thresholds for bedrock fracturing.*
  - *A number of important NPSS lie above Type 1 & 2 geological structures (lineaments) – similar to the impacted East Wolgan, Narrow and Kangaroo Creek Swamps*
  - *At least some of the previous impacts occurred with 262 m wide longwalls.*
- *These concerns are supported by Subsidence Impact Assessment (MSEC (2014)) which state "The swamps that are located above the proposed longwalls are predicted to experience tensile strains greater than 0.5 mm/m and compressive strains greater than 2 mm/m. It is expected therefore, that fracturing would occur in the top most bedrock beneath these swamps." OEH considers there is significant potential for the fracturing and drainage of the THPSS and significant alteration of the hydrology/hydrogeology of these systems.*
- *Once damaged, there is no scientific evidence or industry based results to indicate that such impacts to THPP can be successfully remediated.*

<u>Response</u>

Issues noted above were raised by OEH in their submission on the EIS and responses were provided in the RTS. Subsidence predictions and predictions of bedrock fracturing do not necessarily lead to impacts or environmental consequences. In Section 3.1.20 of the RTS MSEC noted the following.

> "Fracturing of bedrock due to mine subsidence does not necessarily imply that there will be loss of surface or standing water. Bedrock contains natural joints and discontinuities due to erosion and weathering processes.
>
> Subsurface monitoring by Mills (2003 and 2007) and Mills and Huuskes (2004) along the Waratah Rivulet found that the fracture network beneath the stream extended to a depth of 12 m and bed separation and dilation extended to a depth of 20 m. For subcritical longwalls with sufficient depth of cover to develop a constrained zone, the diverted surface water flows are confined in the shallow network which then re-emerges further downstream after sufficient fall of the stream bed elevation.
>
> Examples of this include the Bargo River above Tahmoor LW14 to LW19 and the Waratah Rivulet at Metropolitan Colliery, where the surface water flows which were diverted into the fracture networks beneath these streams re-emerged further downstream of the impact site.
>
> Southern Coalfield Inquiry (DoP, 2008) stated that there is "No evidence was presented to the Panel to support the view that subsidence impacts on rivers and significant streams, valley infill or headwater swamps, or shallow or deep aquifers have resulted in any measurable reduction in runoff to the water supply system operated by the Sydney Catchment Authority or to otherwise represent a threat to the water supply of Sydney or the Illawarra region. However, this does not discount the possibility that a reduction in runoff may be realised under certain conditions, including downwards leakage to mining operations, especially where a shallow depth of cover prevails or a structural feature provides a conduit for flow".

With regards to OEH's comment:

- *A number of important NPSS lie above Type 1 & 2 geological structures (lineaments) – similar to the impacted East Wolgan, Narrow and Kangaroo Creek Swamps*

the role of the lineaments in the impacted East Wolgan, Narrow and Kangaroo Creek Swamps has been discussed above.

With regards to OEH's comment (which relates to Angus Place LW940 underlying Kangaroo Creek Swamp):

  - *At least some of the previous impacts occurred with 262 m wide longwalls.*

Centennial Coal has provided a response previously on this issue raised by the Department of the Environment on the EIS (refer Section 3.1.14 of the RTS). Kangaroo Creek Swamp is located above the already extracted Angus Place LW940 and LW950 which had widths of 262 m and 292 m, respectively. The depth of cover at this swamp varies between 265 m at the downstream end to 280 m at the upstream end. The width-to-depth ratios at this swamp, therefore, vary between 0.97 above LW940 to 1.04 above LW950 and these longwalls are categorised as critical longwalls.

On the other hand, the depths of cover over the proposed longwalls LW416 – LW432 (excluding LW501 – LW503 because they are not overlain by or are in the vicinity of shrub swamps) range from 360 – 420 m (refer Section 3.1.4 of the EIS). Beneath the shrub swamps the width-to-depth ratios range from 0.70 to 0.75 and hence the longwalls are sub-critical panel design compared to the critical panels LW940 and LW950 beneath Kangaroo Creek Swamps.

It is agreed that subsidence related impacts have been observed at Kangaroo Creek Swamp undermined by the 262 m wide LW940). However, the major difference between the location of LW940 and the proposed longwalls in the northern and southern mining areas at Springvale is topography. As noted above the depths of cover are significantly lower over LW940 and the LW940 was a critical longwall design. DgS (2013) has demonstrated that critical width longwall panel design give rise to significantly higher measured subsidence in comparison to sub-critical width panels. This is consistent with the subsidence monitoring undertaken at Springvale Mine over previously extracted longwalls of varying void widths in the range 254 – 315 m. This is discussed in detail below.

With regards to OEH’s comment:

- *Once damaged, there is no scientific evidence or industry based results to indicate that such impacts to THPP can be successfully remediated.*

this is the same issue that was raised by Department of the Environment in their submission on the EIS. A response was provided in the RTS (refer Section 3.1.14). Centennial Coal is currently undertaking remediation and rehabilitation works at the East Wolgan Swamp using the methodology developed in the ‘Save our Swamps’ project initiated in 2008 jointly by Blue Mountains City Council (BMCC) and Lithgow City Council restore Temperate Highland Peat Swamps (THPSS) on Sandstone across both LGAs. The project has been supported by grant from the Urban Sustainability program of the NSW Environmental Trust and federal ‘Caring for Country’ grant to expand the program to incorporate Wingecarribee Shire Council and Gosford City Council.

BMCC, in collaboration with Lithgow City Council, Gosford City Council, Wingecaribee Shire Council has developed a practical set of guidelines entitled "Soft engineering solutions for swamp remediation – the ‘How to guide’. This publication comprehensively covers soft engineering swamp rehabilitation applications, techniques and materials. It also covers background information on swamp geomorphology, threats and impacts to Temperate Highland Peat Swamps on Sandstone swamps.

The ‘How to guide’ includes case studies on successful implementation of remediation to THPSS comprising:

- Braeside Swamp located in the Blue Mountains LGA;
- Marmion Swamp located in the Blue Mountains LGA;
- Wentworth Falls Swamp located in the Blue Mountains LGA;
- Happy Valley Swamp located in the Lithgow LGA;
- Ellem Gully Swamp located in the Gosford LGA; and
- Paddys River Swamp located in the Wingecarribee LGA.

Centennial Coal is currently undertaking remediation and rehabilitation works at the East Wolgan Swamp using the ‘How to guide’, based on the successful remediation of the above-noted swamps. The remediation works at East Wolgan Swamp included the development of a monitoring plan designed to measure the success of restoration actions, integrity of engineering structures, vegetation monitoring, and water and soil moisture monitoring.

The remediation program for East Wolgan Swamp was supervised by officers from OEH, and the rehabilitation activities were reviewed by members of the International Mire Conservation Group. Both hard engineering techniques (for the repair of cracking of underlying rock at the base of the swamp) and soft engineering techniques (surface impacts) have been used for the remediation works. These works have demonstrated an ability to sensitively remediate not only the surface integrity of an impacted swamp (regardless of the impact), but also sub-surface and bedrock impacts through the application of bentonite.

Details of the techniques and works undertaken are discussed in Section 3.1.14 of the RTS. The progress made to date on the rehabilitation works is provided in Figure 3 of the RTS.

<u>Issue</u>

Given the mapped lineaments directly underneath THPSS in the Springvale proposed mining area and the lack of discussion of important documents such as Aurecon (2009) in the EIS and the RTS main report, OEH's view is that a rigorous and potential assessment of the potential for the lineaments to increase the risk and severity of subsidence in their vicinity of THPSS has not been undertaken.

<u>Response</u>

Following on from investigations undertaken in Aurecon (2009), which recognised the role that a geological structure (Wolgan River Creek Lineament) may have played in the anomalous subsidence behaviour which resulted in the cavity formation at the base of East Wolgan Swamp, Centennial Coal commenced numerous studies, notably those undertaken by Palaris, CSIRO, SRK Consulting, to provide details of surface lineaments within the Angus Place and Springvale mining lease boundaries. These studies, described in Section 2.6.2.2 and Section 2.6.2.4 of the EIS, have used aerial and remote imaging techniques such as imagery LiDAR and Landsat photo imagery to determine the extents and trends of lineaments based on topography and surface or vegetation trends and their coincidence with poor underground mining conditions. Of relevance to the Springvale mine extension project is the mapped Deanes Creek Lineament Zone (Type 1 geological structure, refer EIS Section 2.6.2.4) oriented on a NE:SW and N:S strike and overlie LW415 – LW419 and LW432, and Wolgan River Lineament which occurs in close proximity to LW501 – LW503. Two Type 2 geological structure zones have also been mapped within the proposed mining area. All geological structure zones mapped within Springvale project area are shown in EIS Figure 2.13.

The subsidence impact assessment (attached as Appendix D to the EIS) prepared for the project (MSEC, 2013) took into consideration the existence of the mapped lineaments within the mining area when determining the subsidence effects arising from the proposed longwalls. The geological structures are discussed in Section 1.8 of MSEC (2013) and the standard Incremental Profile Method used in the subsidence impact assessment was calibrated using measured locally increased vertical subsidence over Angus Place Colliery's LW940 – LW960 and Springvale LW411, all located in close proximity to the Wolgan River Lineament Zone (refer Section 3.6.2 of MSEC (2013). To account for the presence of these Type 1 and Type 2 surface lineaments within the proposed mining area and their effects on subsidence parameters MSEC (2013) have increased the maximum predicted conventional subsidence parameters by 25% in the location of the lineaments over the longwalls. This increase is consistent with the observed localised vertical subsidence increase over the predicted maximum subsidence for Angus Place's LW940 – LW960 and Springvale's LW411.

As part of Springvale's RTS, a study on the geology of the shrub swamps within the Angus place and Springvale project areas was undertaken (McHugh, 2014) appended to the RTS as Appendix 18. This study discusses in detail the role of the upper geological strata of Newnes Plateau on the occurrence and morphology of the shrub swamps on Newnes Plateau. , and included the influence of the surface lineaments. This study, which has reviewed and analysed the latest geological and groundwater monitoring results from both Angus Place and Springvale, presents a thorough understanding of the influence of the upper geological strata, especially the Burralow Formation, on the formation and functioning of shrubs swamps.

Centennial Coal have mitigated the potential risk and severity of anomalous subsidence at the geological structures (Deanes Creek Lineament Zone, Wolgan River Lineament and two Type 2 geological structure zones noted above) through their proposed mine design criteria (refer Chapter 8.6 of the EIS). The rationale for the criteria adopted is discussed in Sections 8.3.2 and 8.3.3 of the EIS. The following management controls have been applied through the mine design process at Springvale Mine to minimise impacts to the environment.

- Proposed longwalls LW501 to LW503 have been positioned between clusters of cliffs; only one cliff lies over LW501. Previously approved LW419 to LW422 have been shortened to avoid cliffs and pagodas. No shrub swamps overlies these longwalls.

- The mine plan has been modified to avoid most of the pagodas, however pagodas exist above LW501 and LW502.

- The proposed longwalls in the Project Application Area which lie beneath Newnes Plateau Shrub Swamps (LW416 – LW432) are designed to be sub-critical panels with void widths of 261 m resulting in void width to depth of cover (W/H) ratios <1.00 falling in the range 0.65 – 0.75, and chain pillars at least 55 m wide.

The shrub swamps to be undermined are Sunnyside East, Carne West, Gang Gang South West, Gang Gang East, Pine Swamp, Pine Swamp Upper, Marrangaroo Creek, Marrangaroo Creek Upper and Paddys Creek Swamps. The longwalls beneath these swamps are sub-critical panels and not likely to cause subsidence impacts.

Centennial Coal well understands that any changes to the vegetation of a THPSS is a tertiary response of mining-induced impacts to surface water and groundwater. For this reason it will integrate vegetation monitoring with groundwater and subsidence monitoring. The proposed monitoring in conjunction with the proposed mine design criteria of the longwalls will aim to minimise or completely avoid adverse impacts on THPSSs.

With regards to proposed vegetation monitoring University of Queensland in collaboration with Centennial Coal, has recently developed sophisticated field-based vegetation sampling methodologies for Newnes Plateau Shrub Swamps (Brownstein et al (2014); Tierney et al (in press); John et al (2015) and monitoring methodologies using very high resolution imagery (Fletcher and Erskine (2014)). These methodologies will be employed in the future by Centennial Coal for monitoring of shrub and hanging swamps to detect any adverse impacts as early as possible and to allow adaptive management measures to be implemented as appropriate soon after. Acquisition of baseline data using the above noted methodologies has already commenced on mapping the shrub swamps proposed to be mined under, and swamps outside the mining area that will act as reference or control sites.

In addition to surface monitoring Centennial Coal will continue to undertake underground monitoring. While Landsat photo imagery provides detail on the extent of surface lineaments, based on topography and surface or vegetation trends mapping geological features and mining conditions monitoring in the underground workings enables the identification of trends in geological structures. Springvale, because of its history of difficult geotechnical conditions, has for the last 17 years been monitoring the roof strata with respect to geotechnical conditions. This has been crucial as mining at the mine has progressed in areas with higher depth of cover. A huge volume of data has been collected during the monitoring period. Basic data processing software has always been available for the preparation of geological and geotechnical hazard identification plan to enable proactive planning processes. This software has till recently been used at Springvale.

Recently a newly developed web-based software (ExtoChart Visual) has become available, which allows time-scaled visualisation of monitoring data in the context of longwall and development face positions and installed strata support (Corbett et al, 2014b). It can be used proactively in the identification of geotechnical risk factors and their interaction with the mining process to allow a more robust geotechnical hazard process. It interfaces directly with the widely used ExtoChart database software and can be presented with scale drawings of geological / geotechnical data to allow correlation of monitoring data with risk factors.

Centennial Coal proposes to use the software to analyse new underground monitoring data and in addition re-analyse the previous monitoring underground data to better understand the effect of geological structures on mining conditions.

Issue

OEH disagrees with the proponent's statement that they have used past experience to "avoid and mitigate both past and future impacts of longwall mining and related activities to THPSS"

Response

Centennial Coal's statement in the RTS and the EIS quoted by OEH is not false. Both avoidance and mitigation measures have been incorporated in the project to ensure negligible impacts to THPSS.

As noted in Section 2.6.2.6 of the EIS subsidence impacts to swamp hydrology have occurred at two swamps (Kangaroo Creek Swamp and East Wolgan Swamp). Further discussions on the subject have been included in the responses to the IESC Reports appended as Appendices 13 – 15 of the RTS. As discussed above Aurecon (2009) first highlighted the coincident factors responsible for the impacts to the East Wolgan Swamp hydrology. Other than factors that led to the anomalous subsidence behaviour resulting in the cavity formation at the base of the swamp, mine water discharge into the swamp was also a contributing factor. As noted in Section 3.1.14 of the RTS investigations have identified that erosional and flora dieback impacts at East Wolgan Swamp (as well as at Narrow Swamp North, Narrow Swamp South and Junction Swamp) were caused by changes to swamp hydrology related to mine water discharge and were not related to subsidence.

Goldney et al (2010), an independent report commissioned by the then Department of the Environment, Water, Heritage and Arts (now Department of the Environment), concluded the following with regard to East Wolgan Swamp:

> "Site 10 (East Wolgan Samples a and b): There has been a significant and catastrophic impact on this swamp, where ecological and geomorphic thresholds have been exceeded. Shrub components had disappeared, a significant thickness of peat had been washed away and a heavy deposit of patchy sand of unknown origin was deposited over what remains of the swamp bed. We attributed this swamp's destruction principally to mine water discharge. However, we are unable to determine the role of longwall mining as a contributing factor since mine water discharge impacts have very likely masked the longwall mining impacts. We have determined that these impacts were very likely significant."

Goldney et al (2010) findings have been reinforced by ongoing research conducted by the University of Queensland, most recently by Fletcher and Erskine (2014) (ACARP project report C20046) published in July 2014.

In view of the findings of Aurecon (2009) and Goldney et al (2010) Centennial Coal has not discharged mine water through emergency licensed discharge points LDP004 and LDP005 (EPL3607) on the Newnes Plateau since April 2010 and is committed to managing mine water through the Springvale Delta Water Transfer Scheme, which transfers mine water off the Newnes Plateau. This is the avoidance measure noted in the Centennial Coal statement quoted by OEH.

Based on extensive research and investigations, monitoring data on previously extracted longwalls discussed in EIS Sections 2.6.2.2 – 2.6.2.7 and in conjunction with mine design constraints (refer Section 8.2 of the EIS) management and mitigation measures have been incorporated into the mine design at Springvale (refer Section 8.6 of the EIS and Section 3.1.11 of the RTS). The following management controls have been applied through the mine design process at Springvale Mine to minimise impacts to the environment.

- Proposed longwalls LW501 to LW503 have been positioned between clusters of cliffs; only one cliff lies over LW501. Previously approved LW419 to LW422 have been shortened to avoid cliffs and pagodas.

- The mine plan has been modified to avoid most of the pagodas, however pagodas exist above LW501 and LW502.

- The proposed longwalls in the Project Application Area which lie beneath Newnes Plateau Shrub Swamps (LW416 – LW432) are designed to be sub-critical panels with void widths of 261 m resulting in void width to depth of cover (W/H) ratios <1.00 falling in the range 0.65 – 0.75, and chain pillars at least 55 m wide.

The shrub swamps to be undermined are Sunnyside East, Carne West, Gang Gang South West, Gang Gang East, Pine Swamp, Pine Swamp Upper, Marrangaroo Creek, Marrangaroo Creek Upper and Paddys Creek Swamps. The longwalls beneath these swamps are sub-critical panels and not likely to cause subsidence impacts.

<u>Issue</u>

Page 111 of the RTS reports states "The mine design consequence is that narrower panels (261 m void widths) are proven to minimise impacts on sensitive surface features.". OEH notes this was not the case for Angus Place LW940 (262 m wide longwall) where the perched aquifer in the Kangaroo Creek Swamp was lost.

<u>Response</u>

The major difference between the location of LW940 and the longwalls in the northern and southern mining areas at Springvale is topography. Kangaroo Creek Swamp is located above Angus Place LW940 and LW950 which had widths of 262 m and 292 m, respectively. The depth of cover at this swamp varies between 265 m at the downstream end to 280 m at the upstream end. The width-to-depth ratios at this swamp, therefore, vary between 0.97 above LW940 to 1.04 above LW950 and these longwalls are categorised as critical longwalls.

On the other hand, the depths of cover over the proposed longwalls LW416 – LW432 (excluding LW501 – LW503 because they are not overlain by or are in the vicinity of shrub swamps) range from 360 – 420 m (refer Section 3.1.4 of the EIS). Beneath the shrub swamps the width-to-depth ratios range from 0.70 to 0.75 and hence the longwalls are sub-critical panel design compared to the critical LW940 and LW950 beneath Kangaroo Creek Swamps.

Previous subsidence monitoring at Springvale Mine has been used to develop and validate a predictive model of subsidence for the proposed mining area at Springvale. This model has a high level of confidence in its predictions and is built upon a significant dataset comprising geological and geotechnical data acquired in relation to previously extracted longwalls (LW1, LW401 – LW415) with varying void widths (refer Section 8.3.3. of the EIS). A conclusion drawn from the data acquired to date is that the previously mined narrower sub-critical longwalls (LW1, LW401 – LW409 with void widths in the range 254 – 266 m) had significantly less subsidence than the wider, critical longwalls (LW410 – LW415 with void widths of 315 m) that contributed to unpredicted environmental consequences above Springvale Mine. The mine design consequence is that narrower panels (261 m void width) at depths of cover >300 m are proven to minimise impacts on sensitive surface features.

<u>Issues</u>

- *OEH raised the issue of connective fracturing in its response to the EIS. Appendix 6 (DgS (2014)) provides a very good analyses of methodologies and previous data in relation to the connective fracturing issue. However it is noted the results specific to Springvale and Angus Place are largely based on only two extensometer records for the whole of previous mine layouts.*
- *There are also some major differences between the height of fracturing methodologies used by DgS. MSEC, Forster and Tammetta.*
- *The final estimates of the heights of continuous fracturing in DgS (2014) do not include the potential for lineaments to increase heights of fracturing above their "credible worst-case U95%CL) heights of continuous fracturing" despite their acknowledged importance in previous impacts to NPSS EEC.*

<u>Response</u>

As OEH notes, it raised the issue of connective fracturing in its submission on the EIS. In response Centennial Coal engaged Ditton Geotechnical Services Pty Ltd to undertake an assessment in relation to fracturing over the proposed longwalls. The report (DgS (2014)) was appended as Appendix 6 of the RTS and discussed in Section 3.1.20 of the RTS.

OEH notes that the results specific to Springvale and Angus Place are largely based on only two extensometer records for the whole of previous mine layouts. Centennial Coal clarifies that DgS (2014), in determining the results for Springvale and Angus Place proposed longwalls, utilised three monitoring data sources (refer Section 2.0 of DgS (2014) as follows:

- The observed strata responses measured with borehole extensometer and vibrating wire piezometers installed above Springvale LWs 409, 411 and 412.
- Water table monitoring in stand pipe piezometers on the ridges above Angus Place LW 950 and Springvale LWs 411, 415 and 420.
- The results of sub-surface fracture (micro-seismic event) monitoring above LW413.

Centennial Coal is in agreement with OEH's comment that there are major differences between the height of fracturing methodologies used by DgS. MSEC, Forster and Tammetta. Models developed to determine height of continuous fracturing (HoCF) have been undergoing continual refinements over many years.

Centennial Coal engaged Noel Merrick from Hydrosimulations to undertake a review of the Tammetta Model for ground deformation above a caved longwall panel. This model is featured in two out of the three research reports (refer pages 118-119 of report #2 and at pages 36-37 of report #3), listed below, released by the Office of Water Science (OWS) in the Commonwealth Department of the Environment Report and endorsed by IESC.

1. Commonwealth of Australia 2014, *Temperate Highland Peat Swamps on Sandstone: ecological characteristics, sensitivities to change, and monitoring and reporting Techniques, Knowledge report*, prepared by Jacobs SKM for the Department of the Environment, Commonwealth of Australia
2. Commonwealth of Australia 2014, *Temperate Highland Peat Swamps on Sandstone: evaluation of mitigation and remediation techniques, Knowledge report*, prepared by the Water Research Laboratory, University of New South Wales, for the Department of the Environment, Commonwealth of Australia
3. Commonwealth of Australia 2014, *Temperate Highland Peat Swamps on Sandstone: longwall mining engineering design—subsidence prediction, buffer distances and mine design options, Knowledge report*, prepared by Coffey Geotechnics for the Department of the Environment, Commonwealth of Australia.

Noel Merrick's review report was appended as Appendix 17 to the RTS while Centennial Coal's responses to the three OWS reports as they pertained to Springvale and Angus Place were appended as Appendices 13 to 15 to the RTS.

The existing models for HoCF assessments, prior to the development of the Geology Pi-Term Model (by Steve Ditton from DgS and Noel Merrick from Hydrosimulations and presented at the Australian Earth Sciences Convention in July 2014), did not attempt to incorporate the influence of geology on the height of continuous fracturing, although it has been recognised for a while that it is a contributing factor and that geological structure and overburden disturbance (pre-mining) can also increase height of fracturing.

The Pi-Term Model has been used in DgS (2014) to assess the height of continuous fracturing for all proposed longwalls in the Angus Place and Springvale mine extension projects. The new methodology recognises the key fracture height driving parameters of panel width (W), cover depth (H), mining thickness (T), and local geology factors (t'), which represents the effective thickness of strata at height of A-Zone to estimate the A-Zone and B-Zone horizons above a given longwall panel. These subsidence zones are defined in DgS (2014) and also summarised in Section 3.1.20 of the RTS.

The Pi-Term Model is superior to the existing models as it recognises geology from a geotechnical perspective. The Pi-Term empirical model is based on an extensive database of 34 case studies from all NSW and two Queensland coal mines. The Geology Pi-Term model used in DgS (2014) was peer reviewed by Don Kay from MSEC and the peer review report was included in Appendix 7 of the RTS. MSEC's peer review was undertaken in conjunction with the reviews of two ACARP reports:

- CSIRO, Guo, Adhikary & Gaveva, (2007), ACARP C14033, "Hydrogeological Response to Longwall Mining",
- SCT, Gale, (2008), ACARP C13013 "Aquifer Inflow Prediction above Longwall Panels".

MSEC (Don Kay) has noted the following in respect of the Geology Pi-Term model developed for the Angus Place and Springvale Mine Extension Projects (DgS (2014)) and the CSIRO and SCT reports noted above:

> "MSEC has reviewed the above referenced CSIRO and DgS Reports and found that they provide detailed information on the existing environment, the groundwater systems, the overburden and the presence of layers of low permeability for this Western Coalfields area. The selection and use of both numerical and empirical models which have been calibrated to site data over many years and used for the Angus Place and Springvale Mine Extension Projects, are believed to represent the current "industry best practice".
>
> MSEC has reviewed these reports and, in our opinion, we consider the assessments of the HoCF for the proposed longwalls at Angus Place and Springvale Collieries that are included in these reports are reasonable for this particular geological region.
>
> It is noted that these reports have provided geologically adjusted and calibrated predictions and assessments of the likely HoCF over the proposed longwalls at Angus Place and Springvale Collieries, which, in our opinion, appear to be appropriate for this geological region and, hence, should provide a satisfactory estimate for the impact assessments on the groundwater systems from the proposed mining for this particular geological region."

OEH notes the final estimates of the heights of continuous fracturing in DgS (2014) do not include the potential for lineaments to increase heights of fracturing above their "credible worst-case U95%CL) heights of continuous fracturing" despite their acknowledged importance in previous impacts to NPSS EEC. Section 4.2.4 of DgS (2014) acknowledges that the increases in subsidence over previously extracted longwalls at Springvale are attributed to mining geometry changes (void width increases from 254 m to 315 m) and the influence of geological structure. This section further notes that the influence of geological structure on height of fracturing development (and future predictions) has been assessed from the extensometer and piezometer data for LWs 409 to 412 collected to-date and that the data is presented in Section 5 of the report. Centennial clarifies that DgS (2014) does include the influence of geological structure in the HoCF data presented for Springvale and Angus Place proposed longwalls.

Given MSEC's peer review comments on the Geology Pi-Term model and HoCF data presented in DgS (2014) Centennial Coal believes there is a high level of certainty in the HoCF data calculated for the proposed longwalls for Springvale and Angus Place mine extension projects. Centennial Coal considers peer review of assessments by leaders in the field as best practice.

<u>Issue</u>

Page 127 of the RTS makes the statement that "Centennial Angus Place and Springvale Coal contest Department of the Environment's claim that water losses from the Kangaroo Creek Swamp system have occurred due to longwall mining". OEH notes that this view is contradicted by a previous groundwater monitoring report (Connell Wagner (2008)) and Subsidence Management Status Reports for the period 2009 – 2011.

<u>Response</u>

Centennial Coal, in its response to Department of the Environment's EIS submission *"… longwall mining (conducted under EPBC approval 2011/5952- Angus Place Colliery) resulted … significant impacts on Kangaroo Creek Swamp (undermined, with water losses from the ecosystem)."* provided evidence in the RTS that <u>significant</u> water losses from the Kangaroo Creek Swamp ecosystem have not occurred. Section 3.1.14 of the RTS (and discussed briefly above) provides a photographic monitoring that has been undertaken at two monitoring locations on Kangaroo Creek Swamp. The results presented confirm that significant water losses from the Kangaroo Creek Swamp ecosystem have not occurred.

The previous groundwater monitoring report (Connell Wagner (2008)) and Springvale and Angus Place Subsidence Management Status Reports for the period 2009 – 2011 do acknowledge consistently that groundwater level in the piezometer KC1 has been influenced by the previous mining activity initially observed in June 2008. This information is also provided in the EIS (refer Section 2.6.2.6) with hydrographs of the two piezometers KC1 and KC2 installed in Kangaroo Creek Swamp presented in Figure 2.17. These hydrographs show that, while mining induced subsidence has resulted in the lowering of the groundwater level at KC1, no significant impacts to swamp hydrology have been observed at the KC2 location (where the swamp is periodically water-logged).

The fact that groundwater level has been lowered at the KC1 location (over the pre-mining level) and has not returned to the pre-mining level does not necessarily mean that the functioning of the swamp ecosystem has been compromised. As noted above total loss of water from the ecosystem has not occurred. Section 2.6.2.6 of the EIS notes that Kangaroo Creek Shrub Swamp is fed by a perennial spring. This spring, which in turn is fed by the aquifer-aquitard systems within the Burralow Formation, was unaffected by mining and the creek remained permanently wet below the spring. This, together with the presence of healthy hanging swamps along the valley walls surrounding Kangaroo Creek Shrub Swamp, indicates that the water supply from the spring and valley wall seepage has not been interrupted by longwall mining and that groundwater inputs to the swamp hydrological system remain intact. EIS Photograph 2.11, Photograph 2.12 and Photograph 2.13 illustrate the Burralow Formation aquifer / aquitard system have not been affected by longwall mining evidenced by the spring, the Kangaroo Creek Waterhole and Hanging Swamps surrounding Kangaroo Creek Shrub Swamp. Flora monitoring at Kangaroo Creek Shrub Swamp indicated no trend of decreasing condition or the species abundance is declining. The available evidence indicates that underground mining has not resulted in any negative effects on Kangaroo Creek Shrub Swamp.

Notwithstanding the above, University of Queensland in collaboration with Centennial Coal, has recently developed sophisticated field-based vegetation sampling methodologies for Newnes Plateau Shrub Swamps (Brownstein et al (2014); Tierney et al (in press); John et al (2015)) and monitoring methodologies using very high resolution imagery (Fletcher and Erskine (2014)). These methodologies will be employed in the future by Centennial Coal for monitoring of shrub and hanging swamps to detect any adverse impacts as early as possible and to allow adaptive management measures to be implemented as appropriate soon after. Acquisition of baseline data using the above noted methodologies has already commenced on mapping the shrub swamps proposed to be mined under, and swamps outside the mining area that will act as reference or control sites.

Centennial Coal well understands that any change to the vegetation of a THPSS is a tertiary response to impacts to water resources and for this reason it will integrate vegetation monitoring with groundwater and subsidence monitoring. The proposed monitoring in conjunction with the proposed mine design criteria of the longwalls will aim to minimise or completely avoid adverse impacts on THPSSs.

2. Gardens of Stone and Blue Mountains National Parks

Issue

- *Potential fracturing of the bedrock in streams and swamps overlying the mining area, predicted in the Subsidence Impact Assessment (MSEC, 2014, means that water is likely to be diverted away from the streams which subsequently flow to the Blue Mountains National Park. The EIS and the RTS provide no scientific evidence that any redirected water re-emerges in these areas and Aurecon (2009) and DgS (2014) both identified that water in East Wolgan Swamp moved down 80 m to a lower aquifer.*
- *OEH does not believe the surface water flow monitoring detailed in the EIS is either adequate or that current flow monitoring implemented for the project has the capacity to unambiguously detect change as a result of subsidence impacts.*

Response

The issue of potential fracturing of streams and swamps leading to diversion of water away from streams has been previously raised by OEH on the EIS submission. A response was provided in Section 3.1.20 of the EIS. MSEC notes the following:

> "Fracturing of bedrock due to mine subsidence does not necessarily imply that there will be loss of surface or standing water. Bedrock contains natural joints and discontinuities due to erosion and weathering processes.
>
> Subsurface monitoring by Mills (2003 and 2007) and Mills and Huuskes (2004) along the Waratah Rivulet found that the fracture network beneath the stream extended to a depth of 12 m and bed separation and dilation extended to a depth of 20 m. For subcritical longwalls with sufficient depth of cover to develop a constrained zone, the diverted surface water flows are confined in the shallow network which then re-emerges further downstream after sufficient fall of the stream bed elevation.
>
> Examples of this include the Bargo River above Tahmoor LW14 to LW19 and the Waratah Rivulet at Metropolitan Colliery, where the surface water flows which were diverted into the fracture networks beneath these streams re-emerged further downstream of the impact site.
>
> Southern Coalfield Inquiry (DoP, 2008) stated that there is "No evidence was presented to the Panel to support the view that subsidence impacts on rivers and significant streams, valley infill or headwater swamps, or shallow or deep aquifers have resulted in any measurable reduction in runoff to the water supply system operated by the Sydney Catchment Authority or to otherwise represent a threat to the water supply of Sydney or the Illawarra region. However, this does not discount the possibility that a reduction in runoff may be realised under certain conditions, including downwards leakage to mining operations, especially where a shallow depth of cover prevails or a structural feature provides a conduit for flow"."

As noted above the mining layout at Springvale Mine has also been designed to reduce the potential impacts on the shrub swamps resulting from mine subsidence movements, in particular, the proposed longwalls in the Project Application Area which lie beneath Newnes Plateau Shrub swamps (LW416 – LW432) are designed to have sub-critical W/H ratios and chain pillars at least 55 m wide.

Section 5.12 of the Subsidence Assessment (MSEC (2013), provided as Appendix D to the EIS, provides a detailed assessment of the potential impacts to shrub swamps and hanging swamps as a result of the Project. In regards to OEH's comment on potential bedrock cracking MSEC (2013) notes

> "Predicted post mining grades are similar to the natural grades within the shrub swamps. There are no predicted significant reductions or reversals of grade. The hanging swamps are located on the sides of the valleys and, therefore, that natural gradients are greater than those shown for the shrub swamps. It is not expected, therefore, that there would be any adverse changes in ponding or scouring within the swamps resulting from the predicted mine subsidence movements. It is also not anticipated that there would be any significant changes in the distribution of the stored surface waters within the swamps as a result of the mining induced tilt or vertical subsidence.
>
> Fracturing of the uppermost bedrock has been observed in the past, as a result of longwall mining, where the tensile strains have been greater than 0.5 mm/m or where the compressive strains have been greater than 2 mm/m. The swamps which are located outside the extents of the proposed longwalls, including Sunnyside Swamp and Nine Mine Swamp, are predicted to experience tensile strains less than 0.5 mm/m and compressive strains less than 2 mm/m due to the proposed mining. It is unlikely, therefore, that the bedrock beneath these swamps would experience any significant fracturing.
>
> Although some minor and isolated fracturing could occur in the bedrock beneath the swamps located outside the extents of the proposed longwalls, it is unlikely to result in any adverse impacts on these swamps.
>
> The swamps which are located directly above the proposed longwalls are predicted to experience tensile strains greater than 0.5 mm/m and compressive strains greater than 2 mm/m. It is expected therefore, that fracturing would occur in the top most bedrock beneath these swamps.

> The surface cracking across the mining area is expected to be generally isolated and minor in nature, due to the reasonable depths of cover which typically vary between 350 m and 400 m, and due to the plasticity of the surface soils which allows them to more readily absorb the ground strains. Surface crack widths are expected to be similar to those observed above the previously extracted longwalls at Angus Place and Springvale Collieries, which were typically between 5 mm and 25 mm, but with isolated surface cracking in some locations greater than 50 mm.
>
> The shrub swamps have peat layers which overlie the shallow natural surface soils and underlying bedrock along the alignments of the drainage lines. In most cases, cracking would not be visible at the surface within these swamps, except where the depths of bedrock are shallow or exposed. The shrub swamps comprise significant quantities of sediment and, therefore, fracturing of shallow bedrock beneath these swamps are likely to be filled with soil during subsequent flow events along the drainage lines.
>
> The hanging swamps have soft soil or peat layers which overly the bedrock on the valley sides. It is expected that the potential for fracturing in these locations would be less when compared to the bases of the valleys, where higher compressive strains occur due to the valley related movements, and due to the higher depths of cover along the valley sides.
>
> Whilst some minor surface cracking could occur in the swamps resulting from the extraction of the proposed longwalls, the previous experience of mining beneath swamps at Angus Place, Springvale and in the Southern Coalfield indicate that the likelihoods and extents of these impacts are very small.
>
> The dilated strata beneath the drainage lines, upstream of the swamps, could result in the diversion of some surface water flows beneath parts of the shrub swamps. It is noted, however, that the drainage lines upstream of the swamps are generally ephemeral and, therefore, surface water flows occur during and shortly after rainfall events. Any diverted surface water flows are expected to remerge short distances downstream, due to the limited depth of fracturing and dilation and due to the high natural stream gradients."

No impacts on the Gardens of Stone and Blue Mountains National Park are expected.

A Water Management Plan for the project will be prepared in consultation with the relevant stakeholders. At that time the adequacy of the current and proposed water monitoring will be reviewed.

<u>Issue</u>

- *Issues with the proposed construction of dewatering bores in close proximity to the Blue Mountains National Park boundary and the creation of new access tracks. OEH is concerned that damage could be caused by the recreational use of these tracks and the potential for these tracks to create new access points to the Blue Mountains National Park.*

<u>Response</u>

Two dewatering bores (Bore 9 and 10) and associated access tracks are proposed for the Springvale project. As discussed in Section 4.9.3 of the EIS existing access tracks are proposed to be upgraded for access to these proposed bore sites. Access to Bore 9 will require the creation of a new section of the access track.

Centennial Coal notes that Bores 9 and 10 are located at least seven kilometres from the Gardens of Stone and Wollemi National Parks. As such, there is no potential for the proposed access tracks to the bores to create new access points to the Blue Mountains National Park.

3. Exploration

<u>Issue</u>

The draft consent conditions allow for the undefined exploration, as presented in the EIS, to occur without the requirement for a Part 5 assessment. This will potentially result in greatly reduced environmental assessment of exploration activity compared with the current requirements.

Response

Both the EIS (Section 4.2) and the RTS (Section 3.1.6) have already noted that due diligence assessments (comprising targeted surveys during field inspections and impact assessments) will be undertaken for the boreholes once the locations have been identified. An acoustic assessment will only be prepared by exception, should proposed drillholes be located within an envelope likely to potentially impact residential receptors. These assessments will be undertaken by appropriately qualified consultants and will reference appropriate industry and legislative guidelines and policies in force at the time. The assessments will be provided to DPE and Forestry Corporation of NSW. DRE will be notified of the exploration activity and will be provided with the due diligence assessments if requested. The revised Statement of Commitments included as Section 5 of the RTS has committed to providing the due diligence assessments to the relevant stakeholders.

The EIS and the RTS have also noted the borehole locations will be optimised to avoid threatened flora, hollow bearing trees, endangered ecological communities and archaeological sites. Vegetation clearing will be minimised, impacts to watercourses will be minimised through implementation of appropriate erosion and control measures, and bushfire risk will be minimised.

The proposed mitigation measures and the level of assessments that will be undertaken will be commensurate with the level of assessment required to be undertaken for a Part 5 assessment. Springvale Coal can confirm that the level of assessment that will be undertaken will not be greatly reduced to that currently undertaken for exploration activities under Part 5 approvals..

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Attachment 1

Sensitivity Analyses of P Widths on Subsidence Effects

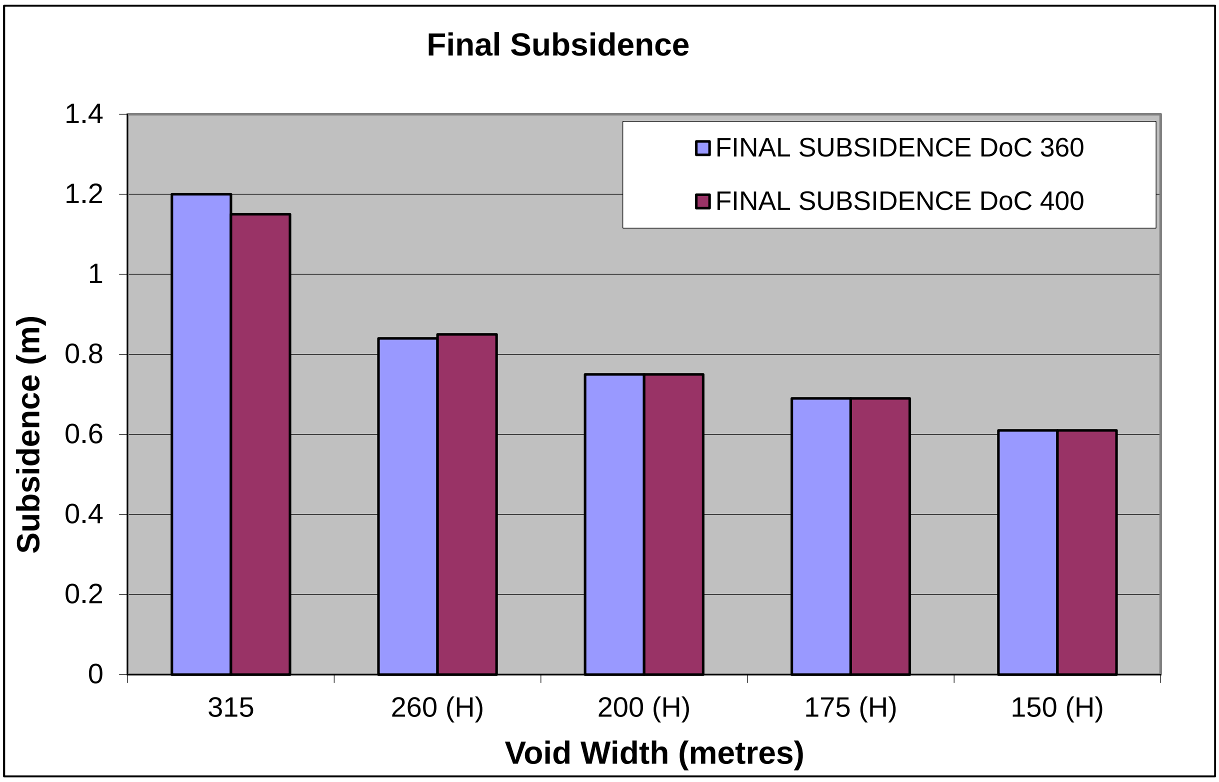

Figure 1 – Sensitivity of Void Widths on Subsidence at DoC 360 m and 400 m

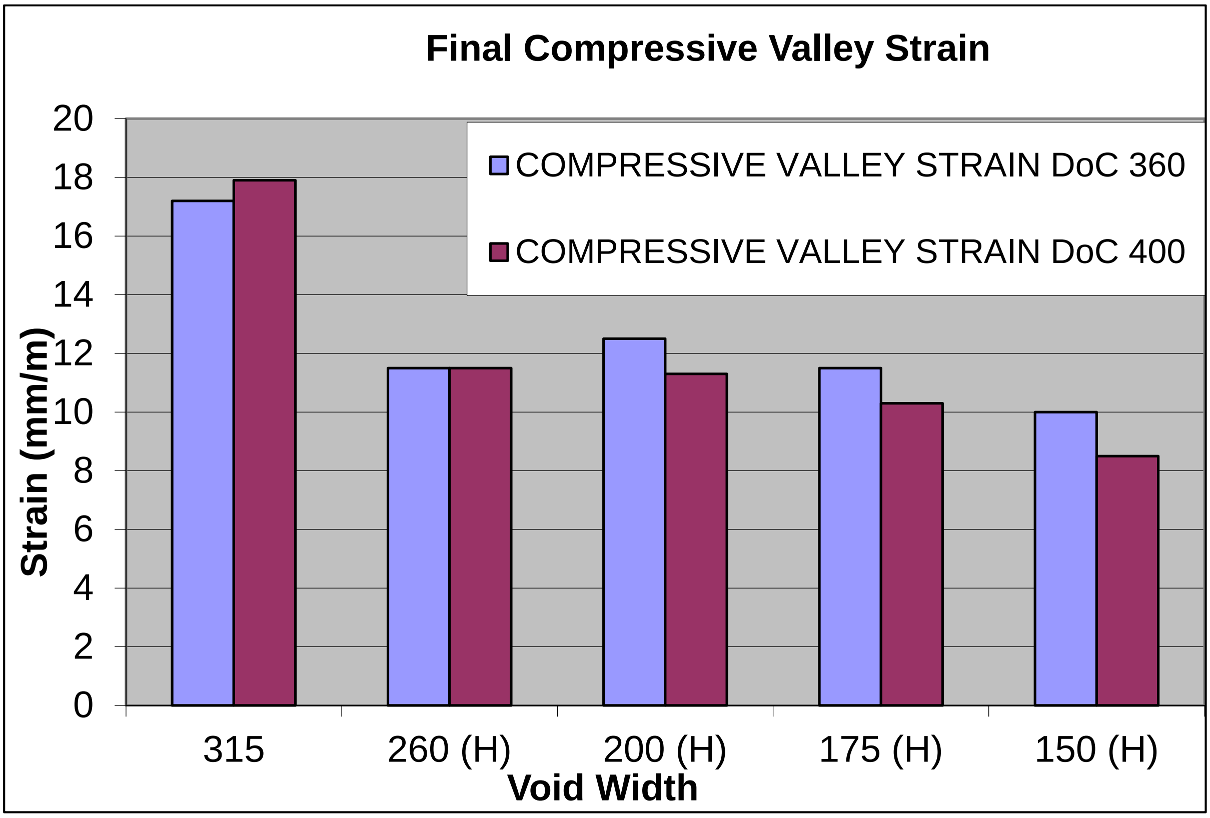

Figure 2 – Sensitivity of Void Widths on Compressive Valley Strain at DoC 360 m and 400 m

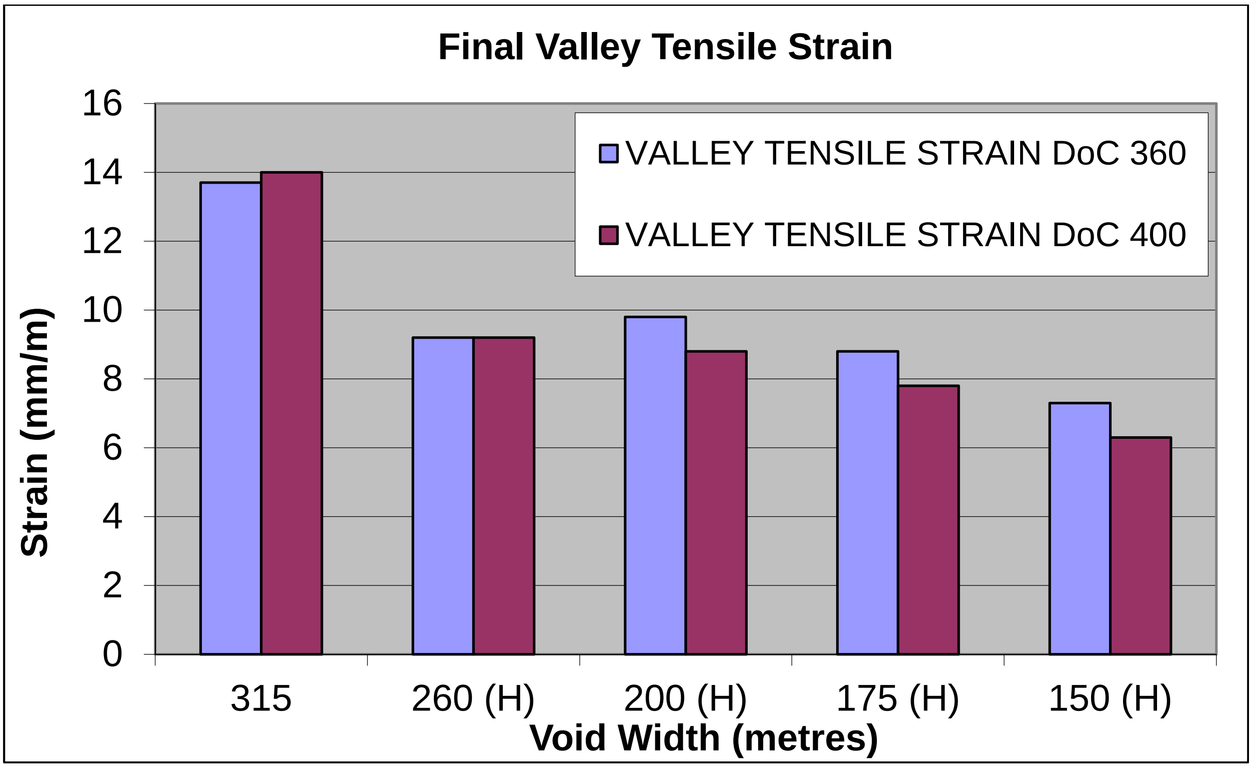

Figure 3 – Sensitivity of Void Widths on Tensile Valley Strain at DoC 360 m and 400 m