Attachment B

OEH Science Division

Review of Springvale and Angus Place Mine Extension EISs

1 Background

Centennial Coal has applied for two new development consents under Division 4.1 of the *Environmental Planning and Assessment Act 1979 (*EP&A Act) for two major expansions: the Springvale and Angus Place Mine Extension Projects.

A request from OEH Regional Operations and Heritage Group to review the two EISs was received by Science Division. A site inspection of the LDP009 & LDP010 discharge sites was undertaken (by Martin Krogh OEH Science Division) in company with Centennial representatives and Daryl Clift (EPA) on 8 May 2014. Areas above the mine plan, including a number Newnes Plateau Shrub Swamp endangered ecological communities (EECs), were inspected on 23 March 2014 and again on 26 May 2014. The following comments are made with particular reference to the potential impacts to EECs, endangered, threatened and vulnerable species as well as the increase in discharge and contaminant loads to the receiving environment.

2 Summary

OEH has consistently stated that it does not support the direct undermining of Newnes Plateau Shrub Swamp Endangered Ecological Community (EEC) using the longwall mining technique unless there has been a modification to the mining techniques that will ensure that impacts will be prevented. This is because of the direct and long-term damage that has already occurred to a number of Newnes Plateau Shrub Swamps (NPSS) EECs as a result of previous Springvale and Angus Place mining operations. OEH refers to the claim made for the 2006 Springvale mining application:

> *Given the available data and previous experience, there can now be a high level of confidence that the shrub swamps will suffer no long-term adverse impacts from the proposed mining. At worst there may be minor transient changes to groundwater and surface water flow, which may produce minimal short-term impacts*. Connell Wagner (2005).

Mining-related damage has occurred to shrub swamps on the Newnes Plateau. In OEH's view, the current EISs for Springvale and Angus Place expansions contain very similar conclusions to the 2006 application, despite the now well-documented scientific evidence to the contrary.

It is also important to note that Centennial has already agreed to an enforceable undertaking ($1.4M) for impacts to Temperate Highland Peat Swamps on Sandstone (Commonwealth Government 2011). Despite having significantly damaged Newnes Plateau Shrub Swamp EECs in the past, Centennial have not provided any definitive evidence or guarantee that further NPSS will not be impacted by the current mine plan or future longwalls given:

- Bedrock fracturing and impacts to pool and swamp aquifers have already been demonstrated to occur above existing longwalls
- Predicted subsidence levels (stress, upsidence and valley closure) for the proposed longwalls 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 262m wide longwalls.

These concerns are supported by the Subsidence Predictions and Impact Assessments for Springvale and Angus Place, (MSEC 2014a and 2014b) which state:

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 irreversibility of impacts to EECs are a significant consideration for OEH. If the relatively impermeable base of the Newnes Plateau Shrub Swamps or Hanging Swamps is fractured, then any perched aquifer is likely to drain downwards into the fracture network, thereby altering natural groundwater levels within the swamp and leading to increased desiccation.

Desiccation of swamps can lead to increased oxidation and subsidence of peat deposits; increased drying potential and a consequent increase in fire risk, changes in hydraulic conductivity and a loss of recharge potential (the swamp peat loses some of its absorption capacity), 'flashier' flooding during storm events, and an increased tendency for the catchment valley to dry up faster in post rainfall periods, that is an increase in the number of cease to flow days (Balek and Perry 1973, Worsten et al ; Rielly 2007; Schlotzhauer and Price 1999).

These impacts have already been demonstrated for Centennial's longwall operations at both Springvale and Angus Place mines. They have also been well documented in the Southern Coalfield for coastal upland swamps (DECCW 2010, Gibbins 2003, Krogh 2012, Krogh 2013, Heritage Computing 2012, 2013 amongst others). In contrast to the experience at Springvale and Angus place mines, OEH notes the comparative lack of impact at Centennial's Clarence Colliery operations which uses an alternative mining methodology[1].

OEH's view is also supported by the Interim Independent Expert Scientific Committee on Coal Seam Gas and Coal Mining (IESC 2011) who provided advice for the Mining of Longwalls 415, 416 & 417 at Springvale Colliery, NSW (EPBC 2011/5949) and Mining of Longwalls 900 and 910W at Angus Place Colliery, NSW (EPBC 2011/5952). This advice is provided in Appendix 1.

Mining is proposed directly underneath (or in the vicinity of) ten of the largest and most important NPSS (Sunnyside East, Carne West, Gang Gang West, Gang Gang East, Marrangaroo, Pine Swamp, Paddys Swamp, Tri-star, Twin Gully, Trail 6 Swamp)[2] on the Newnes Plateau. Collectively these swamps make up approximately 12-15% of the known NPSS EEC.

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[1] The recently approved 900 Series at Clarence Colliery are located just on the other side of the Pine Plantation from the proposed Springvale mine longwalls and operates in similar depths of cover. Subsidence at Clarence Colliery is of the order of 100mm compared to 1500-2000mm at Springvale and Angus Place.

[2] Using the 10th percentile for size of NPSS as a criteria for importance, the following swamps would be considered to be amongst the most important swamps on the Newnes Plateau because of their size: Swamp 67 (approximately 27 Ha), **Broad Swamp** (26.6 Ha; referred to as Barrier Swamp by Centennial); Upper Dingo Creek Swamp (24.8 Ha); **Pine Swamp** (17.8 Ha); **Carne West Swamp** (13.8 Ha); Swamp 55 (13.6 Ha); **Gang Gang East Swamp** (12.8 Ha). Collectively, these 7 swamps make up approximately 21% of the 650Ha of Newnes Plateau Shrub Swamp EEC in existence. The current Springvale plans threaten **Broad Swamp** (2nd largest NPSS), **Pine Swamp** (3rd largest), **Carne West Swamp** (5th largest) and **Gang Gang East Swamp** (7th largest). Areas are preliminary and approximate and dependent on the current boundary mapping of individual swamps and will be refined once the Macquarie University swamp mapping project is completed.

Based on the available information, it is concluded that the current expansion at Springvale Mine represents a considerable risk to some of the most important NPSS EECs on the Newnes Plateau. It also represents a threat to populations of the State and Nationally endangered Blue Mountains Water Skink, one of the rarest lizards in NSW and Australia. In addition the potential impacts to important populations of Giant dragonflies (State listed as endangered) and *Boronia deanei* (State listed as vulnerable) are also considered high. OEH considers that there is a significant risk of fracturing of bedrock beneath these swamps and drainage of the perched aquifer down into the fracture network. This risk is exacerbated further by the Type 1 and 2 lineaments that lie directly underneath a number of the NPSS EECs.

The proposed Springvale & Angus Place mine expansion plans also represents a potential threat to Newnes Plateau Hanging Swamps (nationally listed under the EPBC Act as THPSS) where they are located directly above the longwall panels.

It is concluded that the current expansion at Angus Place Mine could be modified so that there was no direct undermining of the NPSS (only two swamps Trail 6 Swamp and Tri-Star Swamp lie directly above the planned longwalls). Shortening of longwalls to avoid adverse geological conditions has been common practice in the past at Springvale and Angus Place mines and OEH believes this should be applied to the two NPSS located directly above the proposed Angus Place longwalls.

Due to the extremely wide longwalls (360m) proposed at Angus Place, OEH also expects there will be widespread fracturing of cliffs, steep slopes and drainage lines (potentially similar to cliff and drainage line impacts at Baal Bone Colliery and earlier Angus Place operations).

OEH believes contingency plans must be put in place to remediate such impacts if they occur for ecological health reasons. Consideration should also be given to the aesthetics of potential cliff/rockfalls immediately adjacent to the World Heritage listed Blue Mountains National Park.

OEH considers that,

- Mining at Springvale should either avoid Newnes Plateau Shrub Swamps and Hanging Swamps or use the panel and pillar technique used at Clarence Colliery.
- The mine plan at Angus Place should be modified to avoid Trail 6 and Tri-Star Swamps
- Contingency plans should be put in place to monitor and remediate impacts on cliffs, steep slopes and drainage lines.

3 Conservation Values of Swamps on the Newnes Plateau

Swamps on the Newnes Plateau have high conservation value, as demonstrated by the NSW Scientific Committee's listing Newnes Plateau Shrub Swamps (NPSS) as an Endangered Ecological Community (EEC) under the *Threatened Species Conservation Act 1995* (TSC Act) in 2005.

Newnes Plateau Hanging Swamps also occur in the project area and these along with the NPSS communities have been given Commonwealth Government protection under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as the Temperate Highland Peat Swamps on Sandstone Endangered Ecological Community (THPSS).

A number of threatened groundwater dependent biota (plants *Boronia deanei* subsp. *deanei and Dillwynia stipulifera,* the Giant Dragonfly *Petalura gigantea,* and the Blue Mountains Water Skink *Eulamprus leuraensis*), are also found in these swamps and are obligate swamp dwellers (Benson and Baird 2012).

Newnes Plateau Shrub Swamps are likely to be the key habitat of the nationally endangered Blue Mountains Water Skink and the State endangered Giant Dragonfly (Henson 2010). The conservation value of these swamps has been recognized in numerous publications including development applications for mining operations in the area. For example, as early as 1982 (Birds Rock Colliery Proposal), Woodward and Gilpin, Commissioners of Inquiry, (1982) stated,

> *Swamps on the Plateau and adjacent areas play a part in regulating the headwater stream flow. They may also act to filter sediment from surface run-off flowing through them. In effect, they are probably of considerable hydrological importance as well as being of notable floral and faunal value.*

The majority of NPSS occur outside of any national park estate and are therefore potentially subject to a variety of adverse landuse impacts (e.g. NPWS 1981, Henson 2010, Benson & Baird 2012). The swamps are water dependant ecosystems which are highly susceptible to threats from any loss of groundwater, the current major one being the impact of damage to the confining aquicludes, aquitards, aquifers and peat substrates as a result of subsidence associated with longwall mining (Goldney et al 2010, DECCW 2010, Benson & Baird 2012). Further impacts on these swamps could also result from changes to hydrology through damming of creeks, mine waste water discharge, increased moisture competition from pine plantations, recreational motorbike and off-road vehicle tracks and climate change (Benson & Baird 2012; Keith et al, in review).

Approximately 650 ha of NPSS occur on the Newnes Plateau, of which only 160 ha are protected in the conservation estate (Henson and Mahony 2010). None of the highest elevation NPSS occur in the conservation estate.

There are approximately 70 to 80 NPSS in total and so therefore the NPSS EEC is a much rarer community than the Upland Swamp EEC considered in the Bulli Seam Assessment. A project funded under the Commonwealth Enforceable Undertaking (Macquarie University) is currently mapping all Newnes Plateau Shrub Swamps and Hanging Swamps. This project when complete is likely to provide the definitive number of swamps and their area on the Newnes Plateau.

Many of the NPSS were assessed in Henson's (2010) review[3] which found that of the swamps surveyed only 24.2% (n=21) of swamps had no visible impacts (i.e. good condition score). The remaining 75.8% of the swamps (n=70) exhibited varying degrees of degradation with 23% (n=22) showing minor damage, 25.3% (n=23) showing moderate damage and a further 27.2% (n=25) showing severe damage from one or more sources of degradation (Henson 2010). This reinforces the increased value of those NPSS still considered to be in good condition.

Many NPSS contain known threatened or endangered species protected under both State and Federal legislation. Swamps specifically over the Springvale Mine domain with known threatened species include:

- Broad[4] Swamp (Bd, BMWS, GDF, Ds)[5],
- Carne West (Bd, BMWS, GDF),

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[3] There were a mix of Newnes Plateau Shrub Swamps, Newnes Plateau Hanging Swamps and other swamp types included in Henson's assessment. The Macquarie University study should provide the definitive number and area of each of these swamps on the Newnes Plateau.

[4] Referred to by Springvale as Barrier Swamp.

[5] Bd = *Boronia deanei*; BMWS = Blue Mountains Water Skink *Eulamprus leaurensis*; GDF=Giant Dragonfly *Petalura gigantea*; Ds=*Dillwynia stipulifera*.

- Gang Gang East (Bd, BMWS, GDF),
- Gang Gang West (BMWS),
- Carne Central (Bd, BMWS),
- Paddys Swamp (Bd, Ds),
- Pine Swamp (BMWS).

There is potential for the Giant Dragonfly to also be found in Marrangaroo Swamp and Pine Swamp (Benson & Baird 2012). There remains the potential for further surveys to identify yet other threatened/endangered species in individual swamps.

4 Other Values of Swamps on the Newnes Plateau

Although community valuations for Newnes Swamps have not been calculated, in the southern coalfields, Choice modelling for the Bulli Seam Operations valued coastal upland swamps (EEC under the TSC Act) at $2M per ha (BHPBIC 2009). Given their comparative rarity, Newnes Plateau Shrub Swamps and NPSS would likely receive a similar or potentially higher community valuation.

If this were the case, then the ten NPSS potentially affected by the Springvale and Angus Place mine extensions would have a community value of at least $157M ($2M/Ha X 78.75 Ha). For example:

- Carne West Swamp alone would potentially have a community valuation[6] of approximately $27M ($2M/Ha X 13.8 Ha).
- Gang Gang East Swamp would potentially have a community value of $25.6M ($2M/Ha X 12.8 Ha).
- Trail 6 Swamp above the Angus Place proposal would potentially have a community value of $12.8M ($2M/Ha X 6.4 Ha).

It is also noted that as a group, most of the swamps above the proposed Springvale Colliery longwalls are within the category considered to be in the best condition (Benson and Baird 2013, Henson 2010) and they form an important cluster of swamps; with Gang Gang East and Gang Gang West swamps being almost contiguous with one another.

5 Subsidence Predictions

5.1 Subsidence Impacts on Swamps

OEH considers that the NPSS are clearly at risk of bedrock fracturing from the proposed mine plans. This is supported by the subsidence predictions and impact assessments for both projects which state the following regarding subsidence related to swamps:

<u>For Springvale</u> (MSEC 2014a, page 4)

The shrub swamps are predicted to experience subsidence up to 1650 mm, tilts up to 13 mm/m, and curvatures up to 0.20 km-1 hogging and 0.35 km-1 sagging. These swamps are located near the bases of valleys and, therefore, are also predicted to experience upsidence up to 750 mm and closure up to 1000 mm. The hanging

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[6] If a similar technique is used for Sunnyside East swamp EEC, then Sunnyside East Swamp would be valued at approximately $6.4M ($2M/Ha X 3.2 Ha). The unnamed NPSS over the starting end of longwall 417 would be valued at approximately $1.2M ($2M/Ha X 0.6 Ha).

swamps are predicted to experience subsidence up to 1500 mm, tilts up to 13 mm/m, and curvatures up to 0.20 km-1 hogging and 0.35 km-1 sagging.

Fracturing of the bedrock is expected beneath the swamps which are located directly above the proposed longwalls.

For Angus Place (MSEC 2014b, pages 4-5)

The shrub swamps are predicted to experience subsidence up to 1900 mm, tilts up to 20 mm/m, and curvatures up to 0.30 km-1 hogging and 0.35 km-1 sagging. These swamps are located near the bases of valleys and, therefore, are also predicted to experience upsidence up to 750 mm and closure up to 1000 mm. The hanging swamps are predicted to experience subsidence up to 1450 mm, tilts up to 11 mm/m, and curvatures up to 0.20 km-1 hogging and sagging.

Fracturing of the bedrock is expected beneath the swamps which are located directly above the proposed longwalls.

The NPSS are clearly at risk of bedrock fracturing from the proposed mine plan. The presence of Type 1 & 2 lineaments directly under a number of NPSS EECs clearly increases the potential for such impacts to occur. As identified earlier, the NPSS EECs have high scientific and community value (swamps above the mine expansion potentially have a community value of at least $157M). Any impacts that do eventuate as a result of conventional and non-conventional subsidence are likely to be irreversible. There are no proven remediation measures capable of replacing perched aquifers within swamps once fractured and drained as a result of mining subsidence (WRL Draft 2013).

As well as the impacts on the swamps themselves, OEH is concerned about the impacts of swamp drying on threatened species such as *Boronia deanei*, Blue Mountains Water Skink and Giant Dragonfly. The Springvale Flora and Fauna Assessment (RPS 2014a) states,

Assessments of impacts have been undertaken for those species that are dependent upon the swamp habitats. These species include B. deanei, Giant Dragonfly and Blue Mountains Water Skink. Assessment of impacts have concluded that the predicted changes in baseflow and average standing water levels are not of a magnitude that would cause the swamp habitats to become unsuitable for these species. Consequently, the Project is unlikely to significantly impact upon those threatened species that rely on the swamp habitats.

OEH considers that fracturing of bedrock has the potential to modify swamp habitats, rendering them unsuitable for obligate swamp dwellers.

5.2 Predictions for Stress, Upsidence and Valley Closure

MSEC (2014a) states:

Adopting a linear relationship between curvature and strain provides a reasonable prediction for the conventional tensile and compressive strains. The locations that are predicted to experience hogging or convex curvature are expected to be net tensile strain zones and the locations that are predicted to experience sagging or concave curvature are expected to be net compressive strain zones. In the Western Coalfield, *it has been found that a factor of 10 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional strains.*

OEH notes that in previous subsidence assessments for the southern coalfield, MSEC has used a factor of 15 to estimate conventional strains based on predicted maximum curvatures (e.g. see MSEC 2009). MSEC has provided no data, statistical analysis or graphics to support the factor of 10 X maximum curvature used in their stress calculations. OEH notes the large differences between the estimates of stress obtained by the DgS (2014) methodology for longwalls 416-418 and the estimates of stress obtained using a factor of 10 X maximum curvature and used by MSEC for the same longwalls.

If MSEC's 95% or 99% confidence intervals for strain above the goaf are considered, then these actually approach those of the DgS (2014) derived maximum strains and levels of stress that have been measured previously at Angus Place and Springvale. OEH believes it is more appropriate to use these estimates than the "average" strains produced using the 10 X maximum curvature calculation.

Of significant note is that MSEC (2014a,b) predicts significant levels of non-conventional subsidence, with 75 – 750mm upsidence and 100-1000mm closure within the swamps. These non-conventional subsidence movements exceed thresholds for demonstrated impacts on swamps (e.g. Bulli Seam PAC) and for closure, are up to 5 times the industry suggested threshold for such impacts (i.e. 200mm closure).

Additionally, MSEC (2014b) state:

Type 1 and Type 2 geological structure zones have been identified within the Extension Area, which are shown in Drawing No. MSEC593-07. It is expected, that locally increased subsidence and compressive strains will be observed in these locations.

And

The potential for impacts generally result from differential movements (i.e. curvature and strain), rather than from vertical subsidence. It is expected that the compressive strains at the lineaments above the proposed LW1001 to LW1019 will be similar to those observed above the previously extracted longwalls at Angus Place and Springvale Collieries, which were typically between 5 mm/m and 15 mm/m.

Given that stresses will be similar to previously extracted longwalls, OEH believes that impacts will not necessarily be lower under the current mine plans than what has been demonstrated to occur over existing operations. While Springvale longwalls have been reduced to a width of 261m, the EIS fails to point out that impacts to one NPSS (ie Kangaroo Creek Swamp) occurred as a result of earlier longwalls that were 262m wide (LW940). Since the longwalls at Angus Place have actually increased their width by over 18% (to 360m), there is a significant potential for increased impacts as a result of the Angus Place proposed longwall layout. OEH notes that the predictions lines for Angus Place (A1 & A2) appear to miss the majority of incised drainage lines and steep slopes that lie above the proposed Angus Place mine.

OEH considers that the derived maximum strains and levels of stress obtained by the DgS (2014) methodology be used for subsidence predictions rather than the 10x maximum curvature calculation.

5.3 Surface to Seam Fracturing

MSEC (2104b) identifies that:

- *The extraction of longwalls results in deformation throughout the overburden strata. The terminology used by different authors to describe the strata deformation zones above extracted longwalls varies considerably and caution should be taken when comparing the recommendations from differing authors.*

- *While there are many factors that may influence the height of fracturing and dilation, it is generally considered by various authors, e.g. Gale (ACARP C13013, 2008) and Guo et al (ACARP C14033, 2007), that an increase in panel width will generally result in an increase in the height of fracturing and dilation.*

- *It can be seen from Fig. 4.11, that the MSEC theoretical model and Gale's suggested factors of 1.0 and 1.5 provide similar estimates for the height of fracturing based on panel width. As described previously, however, it is necessary to undertake a more detailed review of the site specific geology and permeability before determining whether these heights are reasonable for this site.*

At Springvale Mine it is stated that:

- *The proposed LW416 to LW431 have overall void widths of 261 metres and have chain pillar widths of 58 metres. The depths of cover directly above these proposed longwalls varies between a minimum of 290 metres and a maximum of 420 metres, but are typically within the range of 350 metres to 400 metres. The width-to-depth ratios for these proposed longwalls vary between 0.6 and 0.9, but are typically within the range of 0.65 and 0.75 and, therefore, are less than those for the previously extracted longwalls at Angus Place and Springvale Collieries.*

- *The proposed LW432 and LW501 to LW503 have void widths of 229 metres to 261 metres and chain pillar widths of 35 metres or 58 metres. The depths of cover above these proposed longwalls varies between a minimum of 180 metres and a maximum of 400 metres, but are typically in the range of 250 metres to 350 metres. The width-to-depth ratio for these proposed longwalls* *are typically between 0.7 to 1.0 and, therefore, are similar to but slightly greater than those for the previously extracted longwalls at the collieries.*

At Angus Place it is stated that:

- *The proposed LW1001 to LW1006 have overall void widths of 260 metres or 295 metres and have chain pillar widths of 55 metres. The depths of cover directly above these proposed longwalls varies between a minimum of 280 metres and a maximum of 430 metres, but are typically within the range of 330 metres and 420 metres. The width-to-depth ratios for these proposed longwalls are typically within the range of 0.60 to 0.85 and, therefore, are slightly less than those for the previously extracted longwalls at Angus Place and Springvale Collieries.*

- *The proposed LW1007 to LW1019 have void widths of 360 metres and chain pillar widths of 55 metres. The depths of cover above these proposed longwalls varies between a minimum of 380 metres and a maximum of 450 metres, but are typically in the range of 360 metres to 420 metres. The width-to-depth ratio for these proposed longwalls are typically within the range of 0.85 to 1.0 and, therefore, are similar to or slightly greater than those for the previously extracted longwalls at the collieries.*

There is clearly a risk of connective fracturing from the wider panels (360m) at Angus Place where depth of cover is the least. There is also a risk of connective fracturing over Springvale mine where the depth of cover goes down to 180m (LW432 and LW501 to LW503).

The EIS does not provide information on the height of fracturing that has already occurred as a result of earlier Springvale and Angus Place mining operations. No extensometer data is reported, but it is noted that a wide range of impacts have been measured on groundwater aquifer levels over both Springvale and Angus Place mines (see summary in Adhikary and Wilkins 2013; Appendix E Part 4 of the EISs).

5.4 Description and Assessment of 3rd Order streams

The assessment of potential subsidence impacts to streams in the EIS is considered inadequate.

For Springvale, MSEC 2014a only discusses Wolgan River and Carne Creek specifically, with all other streams included under the generalized term “drainage lines”. This is despite 3rd order stream sections occurring within and downstream of Gang Gang East and Marangaroo Creek swamps which will be directly mined beneath (see Figure 1).

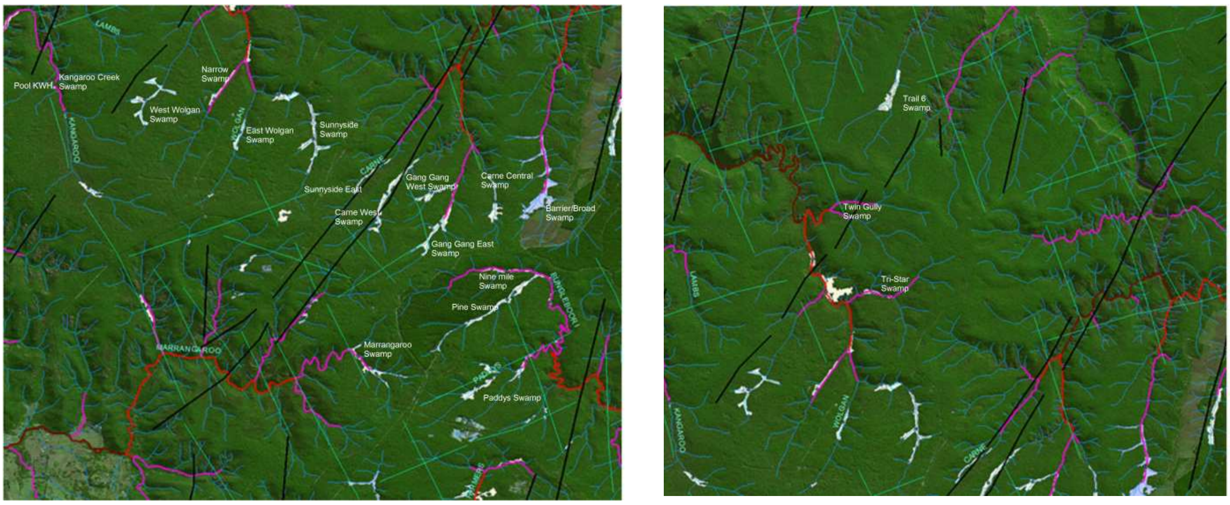

Figure 1. Streams and stream order above Springvale (left) and Angus Place (right) Mines (Pink=3rd order; Red=4th order; Brown=5th order; Blue =2nd and 1st order). Black lines represent lineaments and green lines regional joint sets mapped by Shepherd and Huntingdon (1981) Source: Shepherd and Huntingdon (1981), Spot satellite imagery and DWE stream layer.

OEH considers that these streams have the potential to be fractured and drained. OEH notes no detail or specific predictions for these 3rd order streams (apart from point estimates for swamps) or any commitment to remediate these 3rd order streams if impacts occur. It is highly likely that fracturing of bedrock under the swamps and drainage of perched aquifers will also lead to a loss of flow in these 3rd order streams (see Figure 2 for the flow coming out of Gang Gang East Swamp on 26 May 2014, despite the seasonally unusual warm weather patterns prevalent at the time). There is no appropriate monitoring of flow in these streams which is capable of testing the veracity of the claims made in the EIS of no impact to flows.

Figure 2. Flow coming out of Gang Gang East Swamp (left) and Carne West Swamp (right) on 26 May 2014. This is despite one of the most unusually long and seasonally warm weather patterns recorded in recent times.

For Angus Place mine, MSEC 2014b also only discusses Wolgan River and Carne Creek specifically with all other streams included under the generalized term “drainage lines”. This is despite 3rd order stream sections occurring above, within and downstream of Twin Gully and Tri-Star swamps which will be directly mined beneath (see Figure 1).

OEH considers that these streams have the potential to be fractured and drained. OEH notes no detail or specific predictions for these 3rd order streams (apart from point estimates for swamps) or any commitment to remediate these 3rd order streams if impacts occur. It is highly likely that fracturing of bedrock under the swamps and drainage of perched aquifers will lead to a loss of flow in these 3rd order streams. There is no appropriate monitoring of flow in these streams which is capable of testing the veracity of the claims made in the EIS of no impact to flows.

5.5 Errors and Omissions from MSEC (2014) reports with regard to Wononora Plateau swamps.

MSEC (2014a, b) provided a section in both the Springvale and Angus Place subsidence assessments entitled "*History of Mining beneath Swamps*" which contains what appear to be omissions, factual inaccuracies and unsubstantiated opinions. MSEC (2014) states that:

It appears from these studies, that whilst over 500 swamps have been directly mined beneath on the Woronora Plateau, impacts have been observed in only a few swamps.

OEH has mapped just over 1,000 coastal upland swamps on the Woronora Plateau. If MSEC's statement above was correct then this would mean that approximately 50% of the upland swamp EEC on the Woronora Plateau has been directly undermined. OEH does not believe this is the case.

OEH suspects that it is likely that this number (500) includes the 226 swamps assessed for the Bulli Seam proposal located in areas which were subsequently excised from the approved mine plan. Clearly these 226 swamps have not been "*directly undermined*". Some of the other suggested (500) swamps were also potentially only "*partially*" undermined (e.g. Swamp 36 at Elouera).

For swamps which were actually "*directly undermined*", many were actually undermined by older bord and pillar operations with very low levels of subsidence. These swamps appear to have been combined with a subset of swamps above longwall mining, but the most recent experiences of swamp impacts at Dendrobium mine have received no mention at all.

This is of concern as MSEC completed the last two end of block reports for Dendrobium (LW7 & LW8) and should be aware of documented and unequivocal impacts to coastal upland swamp EEC aquifers above the Dendrobium mine (eg Heritage Computing 2012, 2013; see also Krogh 2012). OEH has also recently been monitoring swamps above Dendrobium mine and these data demonstrate unequivocal swamp impacts due to the Dendrobium mine on Swamp 1B [drainage of perched aquifer in the swamp, increased desiccation (loss of soil moisture) of peaty sediments and lack of flow to the creek at the bottom of the swamp (Krogh 2013, see Figures 3-5)]. Similar impacts have also occurred at Swamp 15b, Swamp 1A, Swamp 5 and possibly Swamp 8 (e.g. Heritage Computing 2012, 2013; BHPBIC 2013).

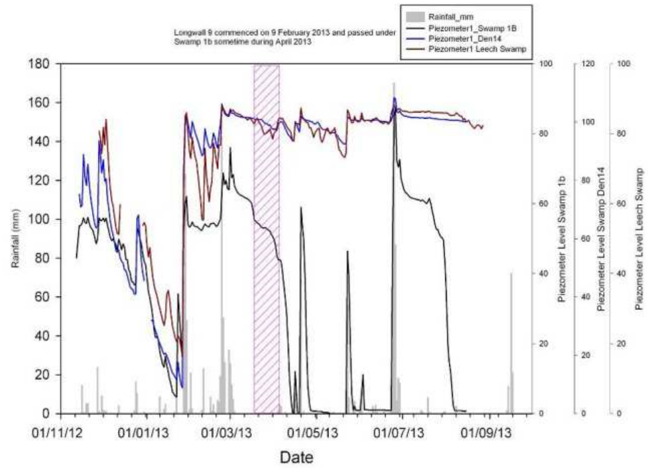

Figure 3. Longwall mining impacts on piezometer levels in Swamp 1b (undermined; black line) compared to reference swamps (Den14 – blue line; Gallhers Tributary ["Leech"] Swamp – red line) . Source: Krogh (2013).

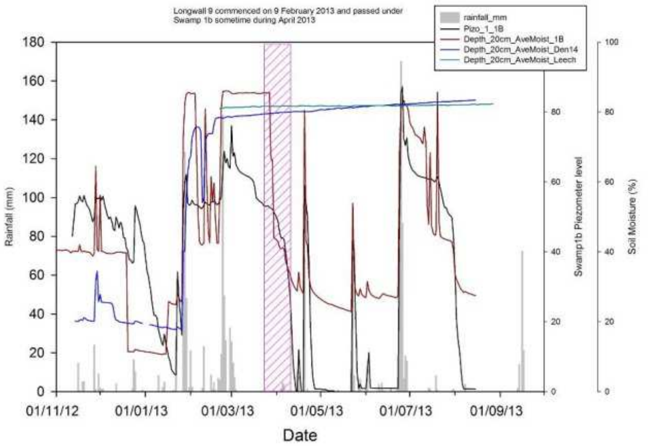

Figure 4. Longwall mining impacts on piezometer levels and soil moisture at 20cm in Swamp 1b (piezometer level - black line; soil mositure –red line) compared to soil moisture at 20cm in reference swamps (Den14 – blue line; Gallhers Tributary ["Leech"] Swamp – light blue line). Source: Krogh (2013).

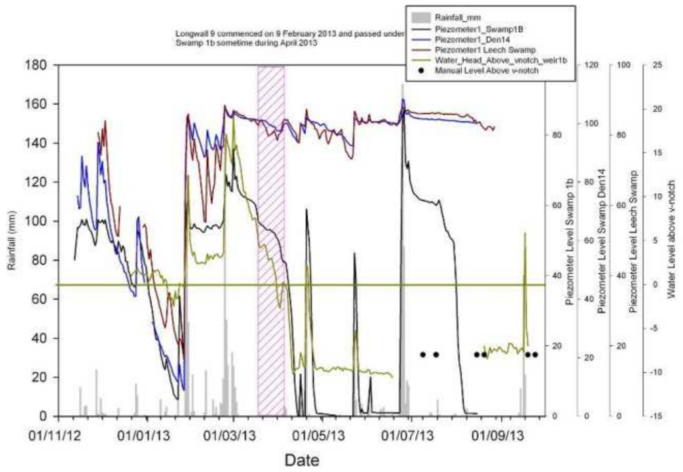

Figure 5. Longwall mining impacts on piezometer levels in Swamp 1b (undermined; black line) compared to reference swamps (Den14 – blue line; Gallhers Tributary ["Leech"] Swamp – red line). Level above v-notch weir (horizontal olive line) indicates flow to creek system downstream of swamp. [Weir damaged in June 2013 high Rainfall Event, repaired August 2013]. Source: Krogh (2013).

Table 5.8 also contains a number of factual inaccuracies given the Dendrobium LW8 panel was 305m wide, not the stated 250m. Areas of Wongawilli and other mines were also not all "total extraction" underneath swamps as is implied in Table 5.8.

5.6 Discussion of previous impacts arising from Springvale and Angus Place Collieries.

Section 5.12.3 of the Subsidence Impact Assessment detailing the history of mining beneath Angus Place and Springvale Collieries also omits any discussion of the mining impacts to Kangaroo Creek Swamp[7] (Figure 6) or its upstream "permanent" waterhole KWH (Figures 7 & 8). The EIS reports also neglect to point out that LW940 was 262m wide and yet mining of this longwall still led to the loss of the permanent perched aquifer in Kangaroo Creek Swamp.

[7] Even though this is mentioned earlier in the report.

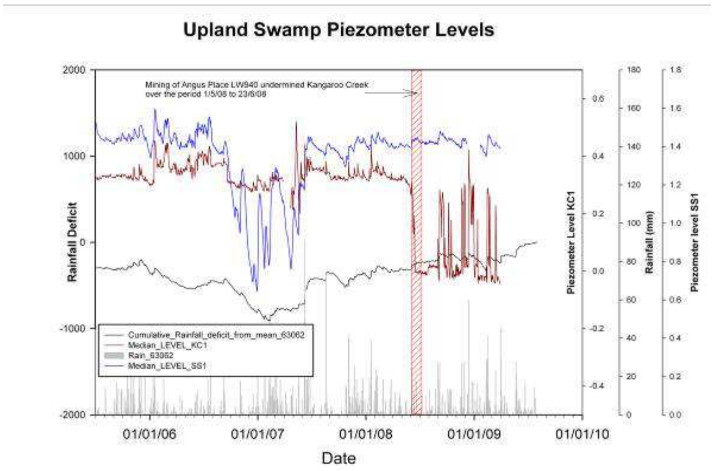

Figure 6. Longwall mining impacts on groundwater levels within Kangaroo Ck Swamp (Red Line) compared to natural water level fluctuations in a reference swamp (Sunnyside Swamp; blue line), rainfall (vertical grey bars) and rainfall deficit (Black line). Source: DECCW 2010.

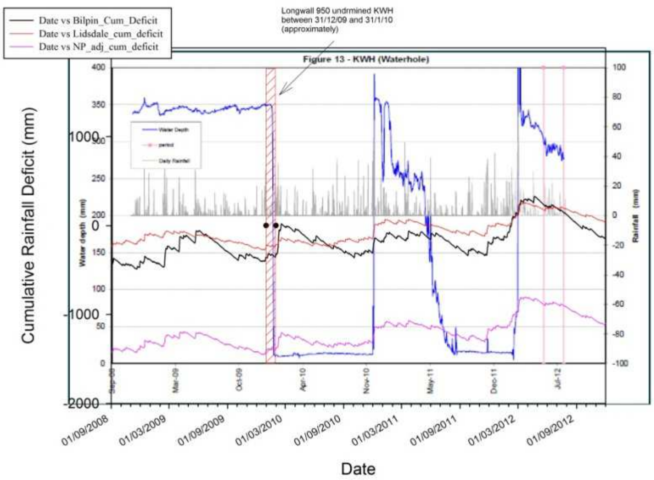

Figure 7. Longwall mining impacts on groundwater levels within Kangaroo Ck Pool KWH (Blue Line) compared to rainfall deficit (Black line - Bilpin BoM rainfall; Red Line - Lidsdale BoM rainfall; Pink Line – Newnes Plateau). Source: Adhikary and Wilkins 2013 and OEH based on BoM rainfall data.

Figure 8 Pool KWH Kangaroo Creek. ***Left*** photo from Centennial Coal (August 2013) NB Centennials report to the Commonwealth Government describes KWH as a “permanent waterhole” - now permanent no longer. ***Middle and Right*** at the last OEH visit (28 March 2014) when it was completely dry. In the photo at right you can see the pvc pipe which held the monitoring equipment for KWH levels.

Figure 9 Spring on Kangaroo Creek. ***Top Left*** photo from Centennial Coal (August 2013) NB Centennials report to the Commonwealth describes the Spring as “*unaffected by Longwall Mining*”. ***Top Right*** Spring flowing during OEH visit 2/3/11; ***Bottom Left*** flowing during OEH visit 16/2/12; and ***Bottom Right*** not flowing at the last OEH visit 28 March 2014.

In addition, no mention is made of the fact that the spring which used to exist upstream of Kangaroo Creek Swamp is no longer flowing or that the dam further upstream is almost dry (Figure 9). Since these latter features have been directly undermined but inadequately monitored there are no details on the timing of these changes or whether they are related to specific longwall effects.

MSEC's (2014) *History of Mining beneath Swamps* Section also neglects to discuss the Aurecon (2009) report detailing an extensive fracture network beneath East Wolgan Swamp. Aurecon (2009) have previously stated that,

The most likely mechanism for the formation of the cavity [beneath East Wolgan Swamp] *is that there has been some form of shear failure on a pre-existing planar geological structure.*

Further, Aurecon (2009) stated,

If the structure had any asperities on its surface, a translational movement could have resulted in the structure being propped open so that a cavity is formed. If the planar structure is steeply dipping, this could have resulted in a cavity to some depth.

OEH points out that, based on Centennial's own flow monitoring data, the fracture network under East Wolgan Swamp was capable of absorbing approximately six Olympic swimming pools of mine water per day (up to 12 ML/day), with no passage of this water to the downstream creek system. Aurecon (2009) have previously stated that this water moved 70 m down to a lower aquifer[8].

There is no scientific evidence that fracture networks of such capacity simply '*self-remediate*' and the hydrology of East Wolgan swamp has now been significantly altered and remains so. This is why in seeking to rehabilitate East Wolgan Swamp, Centennial's consultant (Bush Doctor) has identified significant difficulties in actually "re-wetting" the swamp. OEH revisited East Wolgan Swamp on 28 March 2014 noting further declines in condition (see photo), a lack of soil moisture and no flow in the downstream drainage line (Wolgan River) despite reasonable rainfall over the preceding fortnight. The drainage line which received the minewater is a 'dead zone' with little if any live above ground vegetation. The sediments are also extremely desiccated (see Figure 10). OEH believes this is a result of both the minewater exerting a toxic effect on the vegetation and the fracture network underneath the swamp draining all rainfall and groundwater away from the peaty sediments. OEH believes it is unlikely that the swamp can ever be rehabilitated if the fracturing and cavity underneath East Wolgan Swamp is not addressed.

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[8] OEH notes that neither of the subsidence assessments by MSEC reference Aurecon (2009).

Figure 10 East Wolgan Swamp exhibiting slumping (left), desiccation and the drainage path with little if any live, above ground vegetation.

5.7 Relationship between geological structures and impacts on swamps

The *History of Mining Beneath Swamps* section of the Subsidence Impact Assessments also fails to discuss the interaction of geological structures and swamp impacts even though MSEC states earlier that,

Elevated strains can also occur in the locations of the surface lineaments. The lineaments are generally coincident with the locations of the streams, as the lineaments are zones of weakness which weather more easily to form the valleys. Higher compressive strains can occur within the valleys, therefore, due to both valley related closure movements and the effects of the lineaments.

Given the existence of Type 1 and 2 Geological structures directly underneath swamps proposed to be undermined by the Springvale and Angus Place extensions (e.g. Sunnyside East, Carne West, Gang Gang East and Marrangaroo Swamp) there is obviously an increased risk of subsidence impacts in these areas.

DgS (2014) have also previously stated that,

The presence of Type 1 structural lineaments and moderate topographical relief were identified as key drivers of non-systematic subsidence effects within the valleys.

Three Type 1 structure zones were recognized in the Angus Place Colliery and Springvale Mine existing workings (including the Kangaroo Creek lineament, Wolgan River lineament and the Deanes Creek lineament). It is notable that significant hydrological impacts have already been identified at those swamps which both lie above a lineament and have been directly undermined (i.e. Kangaroo Creek lower, East Wolgan and Narrow swamps).

At the proposed Springvale mine MSEC (2014a) notes:

There are two Type 1 structures which have been identified within the extents of the proposed longwalls, which are collectively referred to as the Deanes Creek Lineament Zone. The NNE trending surface lineaments are coincident with Carne Creek and an associated tributary above the proposed LW416 to LW419.

The eastern arm of the Deanes Creek Lineament Zone also extends past the western side of the proposed LW432.

The southern extensions of the Wolgan Lineament are located either side of the proposed LW501 and to the east of the proposed LW502 and LW503.

There are two Type 2 structures which have been identified within the extents of the proposed longwalls. One is a NNE surface lineament coincident with a tributary to Carne Creek above the proposed LW422, and the other is a NE surface lineament coincident with a tributary to Marrangaroo Creek above the proposed LW430 and LW431.

At the proposed Angus Place mine MSEC (2014b) notes:

There is one Type 1 structure: a NNE trending lineament is coincident with a tributary to Carne Creek above the proposed LW1011 to LW1014B.

There are three short Type 2 structures which have been identified within the extents of the proposed longwalls, which are:-

- *NW trending lineament which is coincident with a tributary to the Wolgan River and Tri Star Swamp above the western end of the proposed LW1006,*
- *NE trending lineament which is coincident with a tributary to Carne Creek above the eastern end of the proposed LW1008, and*
- *NNE trending lineament which is coincident with a tributary to Carne Creek, referred to as Drainage Line 3 in this report, above the middle of the proposed LW1010 to LW1012.*

As a result of the apparent omissions and factual errors in the *History of Mining beneath Swamps* section OEH is not confident that MSEC's historical review of swamp impacts is either rigorous or reflective of what will likely occur if these swamps are directly mined beneath by 261m or 360m wide longwalls. In addition, the past impacts to swamps located over lineaments identify a significant potential for further irreversible impacts to NPSS EECs where they lie above mapped lineaments such as the Deanes Creek lineament. This risk is especially acute for swamps in the Carne Creek catchment.

6 Cliffs and Steep Slopes

In section 5.7.1 of the Subsidence Impact Assessments, MSEC have stated,

For the purposes of discussion in this report, a cliff has been defined as a continuous rockface having a minimum height of 10 metres, a minimum length of 20 metres and a minimum slope of 2 to 1, i.e. having a minimum angle to the horizontal of 63º.

Minor cliffs have been defined as continuous rockfaces having heights between 5 metres and 10 metres, minimum lengths of 20 metres and a minimum slope of 2 to 1.

The definition of cliff and minor cliff in the proposal have an arbitrary length specification of 20m before any features qualifies. It is noted that the Geographical Names Board describes a cliff as simply *"A perpendicular or steep face of rock considerable in height, either inland or along the coast"* (Geographical Names Board 2013).

There is no science validating an arbitrary cliff definition related to length and no evidence that a cliff feature of 15m (or lower) will respond in a different way to a cliff of 20m length when undermined. The specification that a cliff or minor cliff must be greater than 20m means that there are potentially numerous features in the project area which have not received adequate assessment for impact in the current proposal, simply because they are less than the 20m threshold length. Pagodas in particular are often less than the arbitrary 20m figure and have not been individually assessed (eg see Figure 11). OEH does not support the arbitrary nature of the cliff definition used in the EISs.

Figure 11 Pagoda and cliff at the junction of Carne Creek (below Sunnyside East Swamp) and tributary to Little Sunnyside East swamp.

Given that many of the Angus Place longwalls in particular are proposed to be 360m wide (over 18% wider than any other longwalls extracted in the area), OEH believes there will be widespread rock fracturing, potentially of a magnitude that even exceeds earlier operations at Angus Place and Baal Bone collieries (eg see cliff collapses in Figure 12). It needs to be remembered that these areas are adjacent to the World Heritage listed Blue Mountains National Park. Government Approval Agencies should also be very wary of the impacts to steep slopes and cliffs not just from an aesthetics angle but also due to the risk to Public Safety given the level of public access to Newnes State Forest and adjacent areas.

Figure 12 Cliff collapses over previous longwall mining areas, Western Coalfield. Photos by NPWS.

In particular, there is likely to be significant fracturing within the cliffs and steep slopes where they are directly mined beneath by 360m wide longwalls over Angus Place (e.g. see the very good discussion of cliff impacts in the Western Coalfields by SCT 2007[9]). The cliff APCL2 and the pagodas above LW1009 & LW1010 would appear to be particularly at risk. The EIS for the Springvale and Angus Place mines do not cite SCT (2007) nor do they adequately assess the potential for cliff falls similar to those already evident at Baal Bone and earlier Angus Place operations.

OEH considers that, if the mine is approved, Cliff APCL2 and the pagodas above LW1009 & LW1010 should have a negligible impact criteria applied.

7 Fracturing of bedrock in drainage lines

Significant fracturing is also likely in the bedrock in drainage lines 1, 2 & 3 as well as the drainage line for Tri-star Swamp.

As noted earlier many of the 3rd order stream sections occurring above, within and downstream of Twin Gully and Tri-Star swamps and (for Springvale) Gang Gang East and Marangaroo Creek swamps, which will be directly mined beneath, are considered to have received inadequate assessment in the EISs. Lastly, the recent experiences with mining under steep slopes in Sugarloaf SCA should also be kept in mind.

[9] SCT 2007. Review of subsidence monitoring and impacts of mining on sandstone cliff formations at Baal Bone Colliery. BB03259. Report to Xstrata Coal. April 2007.

MSEC actually state:

It is expected that fracturing of the bedrock would occur beneath some sections of the drainage lines which are located directly above the proposed longwalls. Where the beds of the drainage lines have exposed bedrock, there may be some diversion of surface water flows into the dilated strata beneath them. It is unlikely that there would be any net loss of water from the catchment, however, as any diverted surface water is likely to re-emerge into the catchment further downstream.

MSEC provide no scientific evidence that diverted surface water re-emerges in the catchment. Water drainage from East Wolgan Swamp was stated to have moved down to 70m (Aurecon 2009). There is also no mention in the EIS of the flow monitoring at Junction Swamp or explanation for why, post-mining of LW409, there has been virtually no flow in the creek line below Junction Swamp, except after heavy rain or a “balance tank overflow” (Figure 13). It is probable that flows in the creek line were once reasonable to warrant the size of the V-notch weir installed below Junction Swamp (Figure 13).

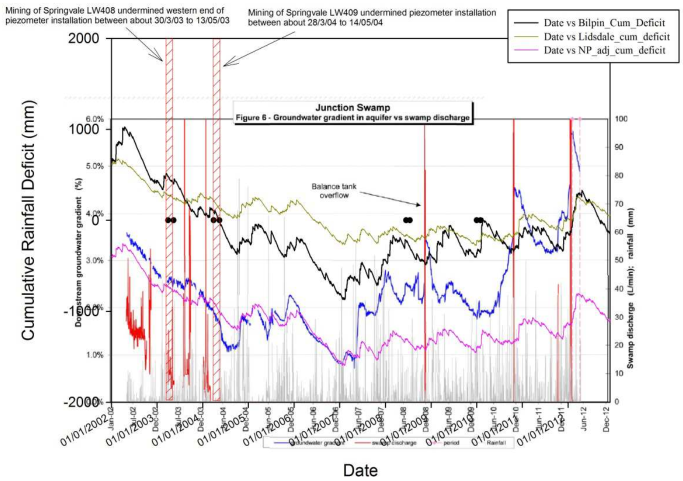

Figure 13. Flow in creekline immediately below Junction Swamp (Red Line) overlaid on rainfall deficit (Black line - Bilpin BoM rainfall; Red Line - Lidsdale BoM rainfall; Pink Line – Newnes Plateau rainfall). V-notch weir in creek line immediately below Junction Swamp (right). Source: Aurecon (2012)[10] and OEH based on BoM rainfall data.

While there is little to suggest that LW408 impacted flows from Junction Swamp, no flow was recorded at the v-notch weir downstream of the swamp after the passage of LW409 and for approximately 6 years afterwards (discounting the balance tank overflow). Apart from the “balance tank overflow” [minewater?] around December 2008, some (assumed) rainfall related spikes in flow appear to have occurred close to December 2010, November 2011, and around March-April 2012. The recession of flows at these latter periods are very different (very abrupt) compared to pre-mining data. This is similar to what has actually been measured downstream of Swamp 1b after it was directly undermined and impacted by Dendrobium LW9 in the Southern Coalfields (Krogh 2013).

[10] Aurecon (2012). Groundwater monitoring report for April - May 2012 Angus Place and Springvale groundwater monitoring program Centennial Coal. Report ref: 208362/208354 21 June 2012 Revision 0

There is mounting evidence of loss of flow in a number of the Newnes Plateau catchments affected by mining, but this has generally not been monitored appropriately (eg using a BACI design), often with little if any baseline data prior to mining (or the release of minewater into swamps). The cumulative loss of water within the drainage lines (and some 3rd order streams) as a result of mining in the current proposal could actually be significant and potentially mean dry creek/river beds for kilometres downstream except after heavy rain. This will potentially be exacerbated if the perched aquifers within the swamps are drained as well, since these swamps are likely providing the majority of the baseflow to these streams.

8 Aquatic Ecology Assessment

OEH considers the Aquatic Ecology assessment for Springvale mine to be inadequate because of its low level of survey effort on the Newnes Plateau where the majority of subsidence related impacts will occur. Figure 4.1 of Cardno Ecology Lab (2014) shows only one aquatic ecology sample site (CCxdn) for the whole of the Springvale Colliery expansion. This is despite 3rd order stream sections occurring within and downstream of Gang Gang East Swamp and in Marangaroo Creek. These streams are likely to be impacted by mining operations but have no baseline aquatic ecology sampling.

The sampling effort for Angus Place is better with sites located downstream of Tri-star, Twin gully and Birds Rock swamps, but notably not Trail 6 Swamp. Given the significant potential for Trail 6 Swamp to be impacted, monitoring downstream of this swamp should also have been undertaken.

The Springvale Aquatic Ecology Assessment report (Cardno Ecology Lab 2014) states,

Descriptions are provided of the aquatic ecology of the upper reaches of the Coxs River, Wolgan River and Carne Creek, and of the drainages downstream of several Shrub Swamps and Hanging Swamps that could potentially be impacted by the Project. The descriptions are based on information compiled from biannual baseline aquatic ecology surveys of these watercourses undertaken by Marine Pollution Research Pty Ltd (MPR).

Based on this paragraph, it is unclear whether the consultants writing the report (Cardno Ecology Lab) visited the sites that formed the basis for the baseline surveys (undertaken by MPR). Further, Cardno state:

Carne West Swamp, however, has recently been classified as an ephemeral rather than a perennial system (Adhikary and Wilkins 2013).

OEH does not concur with Adhikary and Wilkins' (2013)[11] assumption of "ephemeral", as Carne West Swamp maintains a permanent perched aquifer that is very stable over long periods of time (see piezometer data for lower sections of Carne West swamp which have never fallen to the base of the piezometer since records first

[11] It appears Adhikary and Wilkins did not visit Carne West Swamp to assess the veracity of their assumption.

began). Carne West swamp has been flowing each time that OEH has visited this site, which suggests that it is far from an “ephemeral” watercourse. In addition, RPS (2013b) have previously stated,

A pool depth monitor was installed at the bottom end of Carne West Swamp on 30 May 2012. Pool data depths show characteristic spikes which correspond to rainfall (Figure 18). Pool depths were generally low during the reporting period, and regularly dropped below the level of the gauge, consistent with below-average rainfall. Despite pool water level falling below the level of the sensor, there is still flow observed coming out of the lower end of Carne West Swamp. It is noteworthy that spikes in pool depth do not always have a clear, immediate relationship to individual rainfall readings. Progressive increases in pool depth during periods of below average rainfall indicate that there is considerable storage retained in the swamp alluvium/peat, and a delayed release of this water to the stream is occurring. The lag appears to vary between a few days to a few weeks.

Cardno Ecology Lab (2014) also state:

The water that accumulates in the underground mine workings will be managed by transferring it to the SDWTS and by discharge into the Coxs River via LDP009. The transfer of water to the SDWTS will result in a significant reduction in the potential impact of any discharges into the Coxs River.

Under previous arrangements, Centennial had an agreement with Delta Electricity to supply minewater to Wallerawang Power Station for cooling water purposes and the SDWTS was the means of supplying this minewater. With the sale and subsequent shutdown of Wallerawang Power Station, there is now no demand for Springvale and Angus Place waste minewater and the SDWTS is currently shut down. Waste minewater is currently being discharged through LDP009 (potentially up to approximately 30 ML/day) with a very low level of treatment to the Coxs River catchment. The EIS overall and Aquatic Ecology assessment in particular has not been updated to reflect this major and highly significant change to operations and minewater disposal for Springvale and Angus Place mines. The Aquatic Ecology assessment does not adequately consider the environmental health effects of discharging 30ML/day (rising to 50ML/day if both mine projects are approved) of poorly treated minewater into the Coxs River catchment.

Cardno Ecology Lab (2014) identified that,

As there are no records of flows from LDP009 it is difficult to put the likely changes before 2019 into context.

And

Data on the current quality of the discharge at LDP009 is limited.

OEH believes it is the responsibility of the Proponent to gather the data necessary to assess the impact its major development will have on the environment. The EIS is clearly deficient in regard to the characterisation of the LDP discharge and therefore its impact on downstream ecoystems (and the drinking water supply for the township of Wallerawang).

The Aquatic Ecology assessment does, however, recognise that the release of mine water make via LDP009 will have impacts which,

would change the quality of the water in the river at and downstream of the discharge point. EC, total dissolved solids, aluminium levels in the river would be increased.

However it is also suggested that,

The aquatic biota will thus be exposed to salinity conditions they have not previously experienced. These may result in direct toxic effects on some organisms and indirect effects on others through modification of species composition of the ecosystem. In Australian freshwater systems direct adverse biological effects are unlikely to occur unless EC levels exceed 1,500 µS/cm. Although this suggests that the aquatic biota in the river is unlikely to be impacted by the salinities resulting from the discharge, the rapidity of the changes may be problematic.

OEH notes that there is no discussion of the recent studies on the toxicity of bicarbonate to aquatic fauna, even though bicarbonate in the mine water has been measured at levels above cited literature values (Farag & Harper 2012, OEH 2012) with the potential to cause adverse impacts to sensitive species (discussed further in Licensed Discharge Section). It also disregards their own findings in the Cardno (2010) ACARP report which found salinity levels often needed to be well below 1500Us/cm in some areas to protect 95% of species. As discussed later, preliminary EPA/OEH toxicity results for the existing LDP009 discharge indicates direct toxicity to at least one species.

Cardno Ecology Lab (2014) also discuss fish and frogs in various places in the Aquatic Ecology assessment but there are no details on the methodologies used. The low level of sampling effort overall, and the likelihood that electrofishing was not used to survey fish, would account for the fact that the Aquatic Ecology assessment report cites for many of the sampling locations, "*No fish were caught or observed during the aquatic ecology surveys*".

Since no methodology for frog surveys was provided, it appears likely that any frogs or tadpoles mentioned were incidental observations or captures during macroinvertebrate surveys (using dipnets). If this is what actually occurred, then OEH does not consider this an objective method for assessing the presence or absence of frog species with any degree of reliability. It is considered likely that the fish and frog sampling on the Newnes Plateau (as described in the Aquatic Ecology assessment) is incapable of confirming the presence or absence of any species with an appropriate level of certainty. It is also likely to be inadequate in terms of assessing any loss of frog or fish species due to potential mining-related impacts on the Newnes Plateau.

In relation to subsidence induced fracturing of streams, Cardno Ecology Lab (2014) suggest that:

- *If minor, superficial, isolated, discontinuous fracturing of the riverbed does occur, it could lead to drainage of overlying pools and loss of aquatic habitat and associated biota in localised areas. During dry weather there could potentially be loss of connectivity between pool habitats. The presence of large amounts of sediment in the river bed (See Section 4.2.1), suggests that any shallow cracks that do form are likely to be infilled by sediment.*

- *Impacts on pool habitats and biota are consequently expected to be localised and temporary persisting until the cracks are infilled and overtopping of flows is resumed.*

- *Fracturing of bedrock may result in some diversion of surface water flows into the dilated strata beneath them, but these are expected to re-emerge further downstream, so there is unlikely to be a net loss of water from the catchment.*

Cardno Ecology Lab (2014) provide no scientific evidence or examples where *Impacts on pool habitats and biota are …….. localised and temporary persisting until the cracks are infilled and overtopping of flows is resumed*

or that

diversion of surface water flows into the dilated strata beneath them …….. re-emerge further downstream

OEH is not aware of any evidence that demonstrates that Australian streams naturally 'self-remediate' after mining induced fracturing and that all water diverted to the subsurface fracture network actually "re-emerges further downstream". There are many areas in the Southern and Western coalfields where this has not been found to have occurred despite decadal periods of time since mining impacts were first recognised (e.g. see Krogh 2007; Jankowski and Knights 2010; and earlier sections clearly detailing impacts that in some cases stretch back over a decade in the Western Coalfield).

As a result of fracturing and the formation of a cavity underneath East Wolgan Swamp, surface flows of minewater (and by inference rainwater and groundwater) were found to move down to 70m (Aurecon 2009). Surface water connections to Dendrobium mine in the southern coalfields have also been suggested (Ziegler and Middleton 2011, Coffey 2012). The difficult and expensive remediation operation at Waratah Rivulet WRS3 (sand curtain and later polyurethane grouting) and the findings of Jankowski and Knights (2010) regarding loss of flow in Waratah Rivulet also casts significant doubt on the veracity of these claims.

Cardno Ecology Lab (2014) also repeats a variation on the earlier RPS (2014) statement:

It should be noted that shallow subsidence caused by previous mining operations has not reduced surface flows in the swamps or shallow groundwater levels. There is consequently unlikely to be any detectable effects on aquatic ecological attributes in the watercourse immediately downstream of the swamps.

As identified earlier, this statement is inaccurate (see earlier demonstrated impacts to Kangaroo Creek pool KWH, Kangaroo Creek Swamp, East Wolgan Swamp, and Junction Swamp flows amongst others).

9 Stygofauna

Cardno Ecology Lab (2014) identified the significant limitations of the preliminary Stygofauna survey.

The assessment of potential impacts on stygofauna is limited by the lack of information on their occurrence in the aquifers within the Project Area, their response to environmental perturbations and likely conservation significance.

Despite these limitations it is important to note that stygofauna (and potential stygofauna) were actually found. Since this was the first survey of its kind for stygofauna in the area, there is the potential for the species collected to be unique. Unfortunately the taxonomic level of identification is currently inadequate to investigate whether these animals are new to science, and the implications of potential impacts from longwall mining affecting groundwater aquifers in which the stygofauna exist cannot be ascertained. Further assessments of stygofauna need to be undertaken.

10 Groundwater

OEH considers the groundwater model developed by CSIRO (Adhikary and Wilkins 2013) to be one of the best it has seen in relation to a mining proposal. It is particularly impressive because it clearly and openly articulates important assumptions and limitations that affect their model and its performance.

While OEH is largely comfortable with the predictions for the hard rock aquifers above the mine (excluding areas under the influence of faults and lineaments which are discussed further below), OEH has significant concerns about the modelling of swamp aquifers, their baseflow delivery to streams and their interaction with shallow regional groundwater aquifers before and after mining. This is largely due to inadequate data available to calibrate these components in the model and the necessity of simplifying assumptions which are openly recognized and discussed by Adhikary and Wilkins 2013.

For example, Adhikary and Wilkins 2013 identifies the following in regards to swamps:

- *the mesh size used in this study may not be suitable for reliably predicting the behaviour of swamps that are being supported by perched groundwater* *systems. The model reliability could be improved by simulating the behaviour of the perched groundwater fed swamps/streams using fine scale micro models.*

- *depending upon whether a swamp/stream is permanently water-logged or not, the swamp/stream node is either assigned a constant staging height (perennial condition) or a drain (ephemeral) condition as shown in Table 5 as described in Section 2.8.*

- *a conductance of 0.085 day^{-1} per unit area of riverbed was assumed for all the streams and swamps.*

- *river conductance is assumed to remain constant throughout the modelling process. The possibility of change in the conductance of a losing stream with time is not considered explicitly.*

- *the model does not consider the dynamic interaction between the surface water and the groundwater. Groundwater discharge to streams or loss of water from streams due to leakage is not considered in the calculation of change in staging heights.*

- *the model suffers from a lack of calibration in this regard: the only Type-C swamp which has been undermined and has baseflow and piezometric data available is Kangaroo Creek Swamp, and comparing the model results with observations has proved difficult due to a lack of knowledge about the upstream Kangaroo Creek which feeds the swamp, and the complicated nature of the swamp and its nearby spring and pool*

- *a more detailed understanding of the nature (continuity and thickness) of semi-permeable layers underlying the important swamps would be useful for understanding these swamps' response to undermining. There is enough evidence to suggest that the underlying semi-permeable layers largely dictate a swamp's response to mining. This can be seen in the response of Kangaroo Swamp to undermining by Angus Place LW940 and LW950, as described in Appendix A, Section 5. Geological investigation conducted by the mine indicated that YS6 outcrops just above the swamp, but below the spring. Hence the swamp is not supported by YS6, but the spring is, which could be the reason the swamp is affected by the extraction of LW940, but the spring is not. Thus it is important to better understand the structure of semi-permeable layers underlying the important swamps. In the current model, the YS layer has been assumed to be continuous, extending over the whole domain. If this is not so, the response of the groundwater systems lying above the YS6 layer could differ.*

- *in Section 2.9 baseflow values were also quoted for Kangaroo Creek. However, these cannot be directly compared with the model, as we do not know which parts of Kangaroo Creek are perennial and which parts are ephemeral, and whether baseflow from one part of the creek ends up at the*

Kangaroo Creek weir (flow monitoring point), or whether it contributes to leakage in another part of the creek.

- *anecdotal evidence suggests the spring which feeds the small pool has not been greatly affected by mining, and yet both the swamp and pool were affected. The swamp was affected by LW940, and yet the pool seems only affected by LW950. The pool's level suddenly rises in late 2010 which isn't clearly correlated with mining activity or rainfall.*

- *given enough input data, these observations could be explored by a high-resolution model of the swamp region, however, the Model of this report cannot capture such fine-scale effects. The model simply shows a decrease in baseflow to Kangaroo Swamp in response to longwall mining.*

OEH believes the mesh size is indeed unsuitable for modelling swamp behaviour in response to mining induced fracturing and draining of aquifers. The conductance of 0.085 day^{-1} per unit area of riverbed is also a very strong assumption in the model; one that is unlikely to be appropriate if significant fracturing of the bedrock beneath swamps and within streams occurs.

Adhikary and Wilkins 2013 discuss the impacts to Kangaroo Creek Swamp and Pool KWH as a result of Angus Place LW940 (262m wide) and LW950 (290m wide). This frank discussion of impacts contrasts with other areas of the EIS and also contradicts statements identified above which claim "*previous mining operations has not reduced surface flows in the swamps or shallow groundwater levels".*

OEH believes that further consideration of pool recession rates might lead to a different conductance assumption for Pool KWH which could then potentially be used to model impacts in other areas of the model domain (ie in the swamps and streams directly above the proposed longwalls). Unfortunately Adhikary and Wilkins (2013) appear to accept that the spring above Pool KWH has not been affected based on "anecdotal evidence". As mentioned earlier, at OEH's last visit (May 2014) the spring was no longer flowing and Pool KWH was empty (as was the dam upstream). OEH has additional concerns about Adhikary and Wilkins (2013) assuming Carne West Swamp has ephemeral flows to CA4. OEH has consistently found water flowing from the downstream end of Carne West Swamp. Such a flow is supported by the relatively constant saturation of swamp sediments (high water level measured in lower Carne West Swamp piezometers). It is also supported by flow monitoring (by Aurecon 2011 [fortnightly pigmy flow meter records] and RPS 2013 [pool depth monitor, frequency not stated, but potentially daily or less; see Figure 14]).

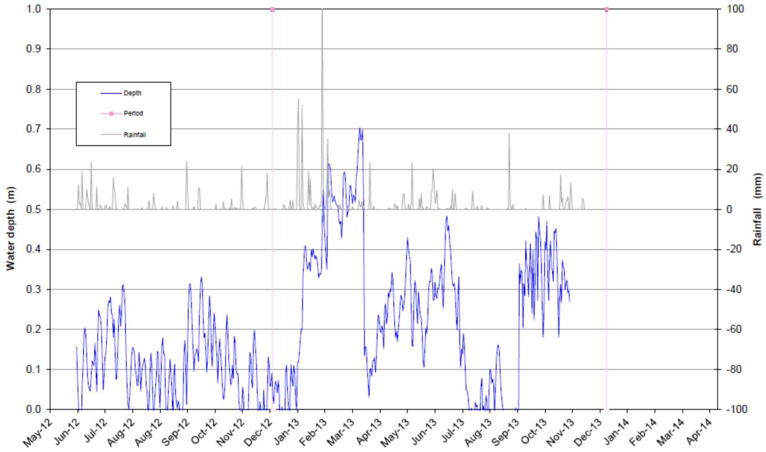

Figure 14. Water levels monitored in Carne Creek (CWP Waterhole). Source: RPS 2013.

Adhikary and Wilkins (2013) suggested that:

The simulated loss of water within the weathered zone can be attributed partially to climate effects as discussed in Section 3.6.2, where the reference is made to Table 24 in explaining the deficit in rainfall recharge during the transient validation period.

While there appears to be some relationship with rainfall deficit, the response suggested for the modelled response of the weathered zone appears to be much more complicated than a simple correlation with rainfall deficit – see Figure 15. For example, the model output appears to become increasingly sensitive to rainfall deficit as time (and presumably extent of mining) increases. Declines in water levels within the weathered zone could actually have important implications for NPSS and baseflow to streams. It would be interesting to see if this modelled effect is real or a function of model assumptions.

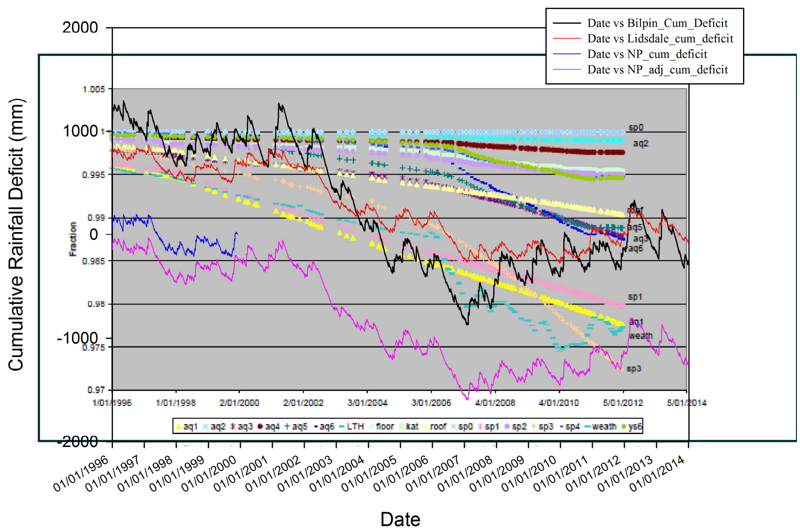

Figure 15. Simulated loss of water within the weathered zone (Adhikary and Wilkins 2013) overlaid on rainfall deficit (Black line - Bilpin BoM rainfall; Red Line - Lidsdale BoM rainfall; Pink & Dark Blue Lines – Newnes Plateau rainfall). Source: Adhikary and Wilkins (2013) and OEH based on BoM rainfall data.

OEH also has considerable concern about geological structural features, particularly within the Springvale mining domain, because of their potential to increase the level of subsidence impacts in NPSS. Adhikary and Wilkins (2013) identified that:

- *they* [Geological structural features] *are not included in the model due to a lack of adequate data on their characteristics e.g. exact location, exact orientation, exact extent both laterally and vertically, persistency and hydraulic properties. A number of piezometers installed at the AP and SV mining region can be seen to be exhibiting an anomalous behaviour (i.e. rising or falling water heads with time) that cannot be attributed solely to the effect of mine dewatering, but could possibly be attributed to the mining induced deformations along geological structure.*

As described by Aurecon (2009), geological structures were clearly associated with the impacts to East Wolgan Swamp creating a cavity and fracture network under the swamp which was capable of absorbing up to 12 ML/day of minewater (and by inference any rainfall and groundwater flows to the swamp upstream of the fracture network and cavity). Lineaments are also likely to have had some influence on the impacts to Kangaroo Creek Swamp and Narrow Swamp (e.g. Aurecon 2009 discusses the interaction of subsidence and stress at Narrow Swamp). Since some of the most important NPSS EECs on the Newnes Plateau lie above mapped lineaments (Sunnyside East, Carne West, Gang Gang East and West and Marrangaroo Swamps) and are proposed to be directly undermined by longwalls of panel widths similar to those that affected Kangaroo Creek Swamp, the model appears ill-equipped to assess the likelihood of significant impacts to the hydrogeology and hydrology of NPSS where they lie above geological structures.

Overall, because of data and model limitations, OEH is not satisfied that the CSIRO model does an adequate job of representing swamps aquifer levels and baseflow to the streams or the potential for this to change as a result of subsidence induced fracturing. OEH therefore falls back on the previous experience base of impacts to NPSS EECs (ie. Kangaroo Creek Swamp, East Wolgan Swamp, Junction Swamp and Narrow Swamp), impacts to Upland Swamps in the southern coalfield (especially the most recent impacts over Dendrobium) and the observed subsidence levels associated with impacts for previously extracted longwalls and predicted subsidence levels for the proposed mine expansions.

11 Management of LDP009 at Springvale Mine

As stated in the Aquatic Ecology Assessment section of this review much of the EIS, and in particular the Surface Water Impact Assessment, is based on a stated demand for contaminated minewater which in reality does not exist. Under previous arrangements Centennial had an agreement with Delta Electricity to supply minewater to Wallerawang Power Station for cooling water purposes. With the sale and subsequent shutdown of Wallerawang Power Station, there is now no demand for Springvale and Angus Place waste minewater. This minewater is currently being discharged through LDP009 (up to approximately 30 ML/day) with a very low level of treatment to the Coxs River catchment (see Figure16).

Figure 16. Settling ponds for minewater from the SDWTS (top and bottom left, top right). Note the flocculants behind boom. LDP009 discharge (bottom right).

The EIS has not been updated to reflect this major and highly significant change to operations and minewater disposal for Springvale and Angus Place mines. The EIS does not adequately consider either the environmental health effects of discharging 30ML/day (rising to 50ML/day if both mine projects are approved) of poorly treated minewater into the Coxs River catchment.

The EIS states,

As part of this development consent, the discharge limit at Springvale|LDP009 is required to be increased from the current value of 30ML/d to 50ML/d to cover the circumstance that the SDWTS is unavailable and all transfer from the SDWTS will be directed to Lake Wallace via Sawyers Swamp Creek/Coxs River. This discharge limit encompasses the cumulative impact of both the extension at Springvale Mine and extension of the adjacent project at Angus Place Colliery.

Since the SDWTS is now unavailable all the time, the proposal is likely to result in discharge of 30ML/day (rising to 50ML/day if both mine projects are approved) of minewater into a drainage line that is directly connected to the Coxs River.

OEH considers that the EIS and associated documents need to be revised to take into account the closure of Wallerawang Power Station. In particular, the expected discharges and associated impacts on the Coxs River need to be re-assessed.

In addition, OEH considers that the Proponent should develop a strategic approach to the treatment and discharge of large volumes of wastewater produced by Centennial's multiple operations throughout the upper Coxs River catchment, with a focus on minimising negative impacts.

11.1 Potential Contaminant Concentrations at LDP009

The surface water impact assessment provides a very poor characterisation of the effluent discharged through LDP009. No time series for water quality or flow for LDP009 discharges are provided in the EIS.

This makes the environmental impact assessment of LDP009 discharge concentrations and loads difficult. As a result, EPA/OEH collected water samples from the LDP009 discharge on 8 May 2014. The results of this sampling are currently awaiting finalisation, however, preliminary toxicity screening results indicate that the LDP009 discharge was toxic to at least one species (cladoceran).

Of note is that, based on the limited data that is available, LDP009 already exceeds ANZECC (2000) default water quality criteria for Conductivity and Aluminium (for protection of 95% of species). Springvale LDP001 often exceeds ANZECC (2000) default water quality criteria for Conductivity, Total Nitrogen and Ammonia-N; and at times Copper, Nickel and Zinc for protection of 95% of species. Angus Place LDP001 has at times exceeded ANZECC (2000) default water quality criteria for Conductivity, Total Nitrogen, total Phosphorus and Ammonia-N; and Aluminium, Copper, Cadmium and Zinc for protection of 95% of species. Angus Place LDP002 has at times also exceeded ANZECC (2000) default water quality criteria for Cadmium, Copper, Nickel and Zinc for protection of 95% of species. If mine bore water results are assessed, then untreated minewater also has the potential to exceed other ANZECC water quality criteria. Additionally there is no discussion of the recent studies on the toxicity of bicarbonate to aquatic fauna, even though bicarbonate in the mine water has been measured at levels above cited literature values (Farag & Harper 2012, OEH 2012) with the potential to cause adverse impacts to sensitive species.

Farag and Harper (2012) constructed a database of toxicity evaluations of sodium bicarbonate ($NaHCO_3$) on aquatic life and used these data to establish acute and chronic criteria for the protection of aquatic life[12]. Chronic toxicity was observed at concentrations that ranged from 450 to 800 milligrams $NaHCO_3$ per litre (also defined as 430 to 657 milligrams HCO_3- per litre or total alkalinity expressed as 354 to 539 milligrams $CaCO_3$ per litre) and the specific concentration depended on the sensitivity of the four species of invertebrates and fish exposed. Acute and chronic criteria of 459 and 381 milligrams $NaHCO_3$ per litre, respectively, were calculated to protect 95 per cent of the most sensitive species (Farag and Harper 2012). Bicarbonate alkalinity has previously been measured at 620-630 mg/L in the Springvale Emergency Discharge Point - LDP5 (EPA unpublished data). It has also been measured at 510-530 mg/L in Kangaroo Creek upstream of the Wolgan Road bridge (i.e. downstream of Angus Place LDP001[13]; EPA unpublished data).

The assessment of the potential toxicity of the mine water discharges at Springvale and Angus Place is considered to be deficient. It is recommended that detailed toxicity testing is undertaken on all Angus Place and Springvale discharges; in particular those now flowing form LDP009. It is also noted that Nickel, Cadmium, Copper and Zinc are not currently included on the EPL for Springvale LDP001 or LDP010 or Angus Place LDP001 and LDP002 and so the Proponent is actually not licensed to discharge metal concentrations of the magnitude recorded in the effluent at these LDPs. This is the same issue that beset Delta Electricity for their blowdown discharge and which involved intensive litigation through the Land and Environment

[12] This was for US species, but see also OEH (2012). The ACARP report (Cardno 2010) on impacts of mine water salinity also investigated toxicity issues associated with saline mine water discharges.
[13] Angus Place LDP001 dominates flow in Kangaroo Creek at most times of the year.

Court. The EPA subsequently placed licence limits for metals on the Blowdown discharge and Delta elected to treat their water to a higher standard (reverse osmosis plant at Mt Piper) and ultimately committed to the cessation of the blowdown discharge to the Coxs River. The current EIS's for Springvale and Angus Place simply propose to discharge potentially contaminated and/or toxic water to the Coxs River upstream of Lake Wallerawang without adequate attention to the impact on the receiving environment.

11.2 Potential Contaminant Loads at LDP009

Apart from the potential toxicity of mine water concentrations, there is also a major issue with contaminant load since the minewater flows to the Coxs River and then into Lake Wallerawang (drinking water supply for the township of Wallerawang). Some of this water also ultimately flows to Warragamba Dam.

Monitoring of flows at the NSW Office of Water (NOW) gauging station on the Coxs River upstream of Lake Wallerawang indicate that median flow in the Coxs River at this point is approximately 13.3 ML/day[14]. The proposed discharge from LDP009 **(**30ML/day rising to 50ML/day if both mine projects are approved) means that the discharge is approximately twice the median flow in the Coxs River at this point and is projected to increase to almost 4 times the median flow in the Coxs River at this point. Further, some of the flows measured at the NOW gauge actually already include discharges from Centennial's other operations in the upper Coxs River catchment (i.e. Angus Place and Lamberts Gully). Additional discharges are also likely if the Centennial Neubecks Open Cut proposal proceeds.

It is noted that if the EIS discharge averages of 30 ML/day increasing to approximately 50 ML/day is accepted, then this represents a considerable increase in the load of contaminants to the receiving environment. If these flow estimates together with measured contaminant loads in discharge waters are used to calculate loads, then the proposed discharge through LDP009 will likely lead to the following effects on the downstream system:

- An additional input of 7,500 tonnes of salt per year rising to 13,000 tonnes of salt with a 50 ML/day discharge[15] (approximately)
- An additional input of the order of 530-980 tonnes of Sulphate per year (approximately)
- An additional input of the order of 10-20 tonnes of Total Nitrogen per year (approximately)
- An additional input of the order of 0.06-0.155 tonnes of Arsenic per year (approximately)
- An additional input of 0.3-0.6 tonnes of Barium per year (approximately)
- An additional input of 0.2-0.4 tonnes of Molybdenum per year (approximately)
- An additional input of 0.025-0.075 tonnes of Nickel per year (approximately)
- An additional input of 0.1-0.7 tonnes of Zinc per year (approximately)

[14] Cardno Ecology Lab (2014) stated a median of 12.2 ML/day.

[15] Load calculations based on concentrations measured by EPA for LDP5 and flow rates of 30ML/day and 50Ml/day. These loads will be recalculated once the results from the recent sampling are available.

It is clear that the EIS has not appropriately considered the potential impacts of such loads to the receiving environment. The current or future proposed method of disposal of unwanted minewater in the EIS is not considered to be appropriate or sustainable. Further, it poses a significant threat to aquatic ecosystem health.

11.3 Additional Discharges

While the discharge through LDP009 is the major issue due to its volume, toxicity and contaminant levels, discharges at other LDPs are also of concern. Springvale LDP001 has a median flow of 475 kL/day and a maximum flow of 7974 kL/day (Table 4.6 RPS 2014c). According to Table 4.6 (RPS 2014c) LDP001 has a limit of 10,000 kl/day but Figure 20[16] suggests over 60,000 kL/day was released around May-June 2010. An explanation of this apparent discrepancy between actual discharge and licensed level is required; whether these releases represented a breach of the relevant licence conditions; and, if so, whether this was reported to the EPA.

Angus Place LDP001 has a median flow of 3290 kL/day and a maximum flow of 20,400 kL/day (Table 4.6 RPS 2014d). Angus Place LDP002 has a median flow of 8 kL/day and a maximum flow of 3620 kL/day (Table 4.6 RPS 2014d). The Angus Place EIS states that,

Discharge limit on LDP001 recently amended by OEH from 30,000kL/d to 2,000kL/d. As part of the Project Approval, the new LDP is required to have a discharge limit of 30,000kL/d.

OEH does not support a return to a 30,000 kl/day limit for Angus Place LDP001. This discharge represents the first major impact of mine discharges on the Coxs River. Conductivity in Kangaroo Creek is increased from a median level of 51 (µS/cm) upstream of LDP001 to 900 uS/cm downstream of LDP001 (GHD 2010; Figures of 65µS/cm upstream and 770 µS/cm upstream are given in the EIS Table 3.9). This represents a 12-fold to 18-fold increase in median conductivity in Kangaroo Creek as a result of the Angus Place LDP001 discharge. Median concentration in the Coxs River upstream of the Kangaroo Creek confluence was 107 µS/cm while median concentration in the Coxs River downstream of the Kangaroo Creek confluence was 513 µS/cm (Angus Place EIS Table 3.9). This represents an almost 5-fold increase in median conductivity in the Coxs River likely to be due in large part to the Angus Place LDP001 discharge.

These facts have largely been ignored in the assessment of environmental impact of the Angus Place mine or its proposed extension on aquatic biota. Macroinvertebrate sampling by DECC downstream of LDP001 in 2009 actually found the site on Kangaroo Creek downstream of the Angus Place discharge to have an impoverished macroinvertebrate fauna (Krogh and Miller 2011). In addition, if the median flow rate from Angus Place LDP001 (3.29 ML/day) was put in context of the median flows in the Coxs River at the NOW Wallerawang gauging station (13.3 ML/day NOW gauge data; note in the EIS the median flow figure is actually lower at 12.2 Ml/day), then excluding losses due to evaporation etc, LDP001 potentially represented close to

[16] The plots of flows through LDP004 are also highly misleading and brings into question the consultants understanding of what actually occurred with LDP004 “emergency” flows.

25% of the median flow in the Coxs River recorded at Wallerawang[17]. Such a potential impact is not discussed in the EIS for either Springvale or Angus Place Mine expansions.

The cumulative impact of all Centennial's operations on the aquatic biota of Coxs River have not been appropriately assessed in either EIS, both of which simply propose to increase licensed discharges in an effort to dispose of unwanted waste minewater.

12 Environmental Impact of Industrial Discharges in the Upper Coxs River catchment

In July 2008 and February 2009 the Department of Environment, Climate Change and Water (DECCW) and the Sydney Catchment Authority (SCA) undertook a joint sampling program of the upper Coxs River catchment. The samples were analysed for an extensive range of contaminants including heavy metals. The results of this sampling indicated that a number of chemical elements were present at concentrations greater than ANZECC/ARMCANZ (2000) default trigger values (hereafter referred to as the ANZECC guidelines). These elements included aluminium, boron, copper, nickel and zinc[18]. Articles in the Sydney Morning Herald (Sydney Morning Herald, 2nd December 2008, p.5; Sydney Morning Herald, 18th June, 2009, p.1; Sydney Morning Herald, 19th June, 2009, p.1) highlighted potentially toxic concentrations of other contaminants, for example arsenic and fluoride, from the Wallerawang power station discharge.

To address the concerns about the impact of salinity and other contaminants from the Wallerawang power station (and other discharges) on the aquatic ecology of the Coxs River above Lake Lyell, 30 sites in the Coxs River catchment were sampled by DECCW scientists in September - October 2009. Samples were collected for water quality analysis as well as an assessment of the macroinvertebrate communities present at these sampling sites. This program included sampling sites upstream and downstream of licensed discharges, as well as reference sites in the Coxs River and its tributaries. The results of this study were reported in Krogh and Miller (2011).

The major conclusions from this study were that:

- The water quality analyses showed that dissolved and total metals were generally highest in waters downstream of the Wallerawang blowdown discharge, Neubecks Creek and Sawyers Swamp Creek below the ash dam.
- High salinity and metal levels appeared to extend for at least 6-7 km downstream from the blowdown source.

[17] Further modelling is required on a daily basis to ascertain the real impact of Angus Place LDP001 on flows in the Coxs River at Wallerawang. Additional discharges from Mt Piper and Centennial's Lambert Gully mine also need to be considered in such an assessment since they also flow to the Coxs River via Neubecks Creek. Proposed expansions at Neubecks Creek open Cut (Centennial Coal) and Pine Dale, if approved, will also need to be considered in the future in this context.

[18] Levels compared to ANZECC (2000) guideline trigger values for freshwater; 95% level of protection (% species) – Table 3.4.1.

- It was evident that salinity levels in parts of the Coxs River catchment have been increased above natural levels by discharges from power generation and mining activities.
- Delta's blowdown discharges were around 2500 µS/cm conductivity, while those of the minewater discharges were typically around 1200 µS/cm[19].
- Upstream areas have much lower conductivity levels (typically between 20 and 200 µS/cm).
- Since the period 1980s -1990s salinity levels have increased in the Coxs River at locations upstream of the Wallerawang Power Station, downstream of the Great Western Highway, at and downstream of Lake Lyell, and at Duddawarra.
- These impacts on water quality appear to be influencing the aquatic macroinvertebrate assemblages, which were dominated by pollution-tolerant taxa such as worms and/or chironomids or supported fewer taxa at most sampled sites on the Coxs River between the Neubecks Creek inflow and Lake Lyell, Farmers Creek downstream of the STP and Lithgow township, in Neubecks Creek and in Sawyers Swamp Creek (below the ash dam).
- The site on Kangaroo Creek downstream of the Angus Place discharge had an impoverished macroinvertebrate fauna.

Rather than decrease the impacts of highly saline minewater on the environment in the Upper Coxs River catchment, the Proponent is currently proposing to release a very large volume of high salinity, high metal concentration minewater to the Coxs River catchment for the next 30 years. Rarely is the water quality from the LDPs contrasted with appropriate upstream sites, however if this is undertaken using available data there is a clear separation of minewater, LDP discharge water and upstream water quality sites (Figure 17). Similar results were found for the broader Upper Coxs River catchment (e.g. see Krogh and Miller 2011, GHD 2010).

[19] The default ANZECC guideline trigger value for conductivity for upland rivers ranges up to 350 µS/cm.

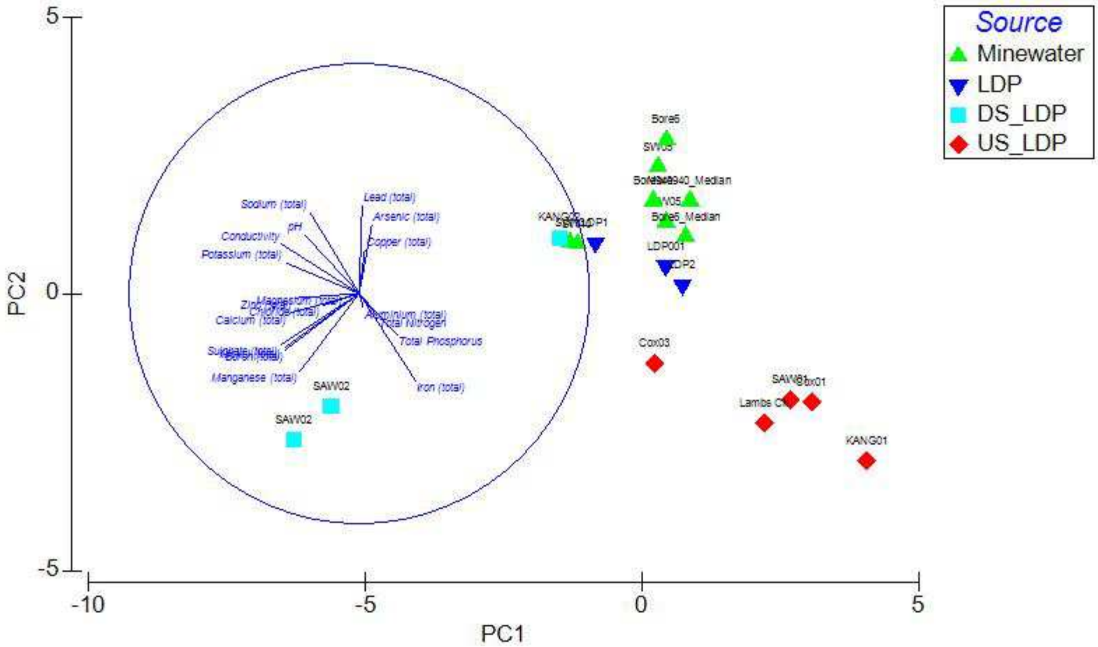

Figure 17. Principal components analysis of water quality variables from sites associated with Springvale and Angus Place mine discharges. Data are median values from Centennial Springvale and Angus Place EIS and Krogh and Miller (2011). LDP = Licensed discharge point; DS_LDP = sites downstream of LDP; and US_LDP = sites upstream of LDP.

13 Water and Salt Balance Modelling

Both the Angus Place and Springvale EISs have sections detailing water balance and salt balance modelling for mine water discharges. However, since both models have assumed that there are transfers via the SDWTS and the SDWTS is now unavailable, the modelling and subsequent conclusions are flawed. Water and salt balances for the Coxs River catchment need to be redone under the real proposed scenario which is direct discharge of 30ML/day (rising to 50ML/day if both mine projects are approved) of poorly treated, high salinity minewater into the Coxs River catchment.

Appendix 1

Advice from the Interim Independent Expert Scientific Committee on Coal Seam Gas and Coal Mining (IESC 2011)

1. *The Interim Committee notes that based on the limited information provided in relation to the proposed projects and the very short timeframe available for preparation of advice:*

   a. *There appears to be a high risk of severe impact to the EPBC Act listed (endangered) Temperate Highland Peat Swamps on Sandstone that is present directly above or laterally adjacent to the proposed longwall panels associated with the Centennial Coal mining proposal; with this risk being greater for the proposed Springvale Colliery than the Angus Park Colliery;*

   b. *The evidence that longwall mining under the Newnes Plateau may have at least partially contributed to previous damage to the listed endangered ecological community in that area suggests that the likelihood of the risk being realised is also high;*

   c. *The mitigation measures proposed by the proponent are unlikely to reduce the risk or the likelihood of the risk being realised to an acceptable level;*

   d. *There is little evidence that the suite of remediation measures proposed would be effective in repairing damage to the endangered ecological community if the proposed longwall mining did lead to impacts such as fracturing of a peat swamp basin. Previous experience with implementation of such remediation measures has shown little or no success.*

2. *Should a decision be taken to approve the proposed actions, the Interim Committee suggests that:*

   a. *Draft condition 1 (which restricts longwall mining in areas directly below known high quality sites of temperate highland peat swamps on sandstone) is likely to significantly enhance the mitigation measures proposed by the proponent and may potentially reduce the risk of unacceptable impacts on the endangered ecological community, particularly if appropriate buffers that reflect the local geological characteristics are incorporated between the longwall mining panels and high quality swamps. The Interim Committee supports the proposal that this condition could be revisited if the proponent is able to demonstrate that a proven technology or engineering methodology can be used that prevents the risk of subsidence in the listed ecological community, or that would allow any subsidence related impacts to be remediated.*

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