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BY Email

Mr David Kitto
Executive Director
Resource Assessments and Business Systems
Department of Planning and Environment
G P O Box 39
SYDNEY NSW 2001

Dear Mr Kitto

Policy Framework for Biodiversity Offsets for Upland Swamps and Associated Threatened Species Impacted by Longwall Mine Subsidence (the Draft Swamp Offset Policy)

I refer to our recent discussions with representatives from the Department of Planning and Environment regarding the above Policy. I also refer to consultation undertaken with the NSW Minerals Council, and provide support for that submission.

Background

On 28 May 2015, the Department of Planning and Environment released for public comment the Draft Policy Framework for Biodiversity Offsets for Upland Swamps and Associated Threatened Species Impacted by Longwall Mine Subsidence (the **Draft Swamp Offset Policy**). This Policy is for the calculation and subsequent provision of offsets for subsidence related impacted of longwall coal mining on upland swamps. The Policy aligns with the framework outlined in the NSW Biodiversity Offsets Policy for Major Projects (the **Major Projects Policy**). Overarching these policies, there are six principles for offsetting in NSW, These principles are outlined in the Major Projects Policy and are underpinned by an overarching need to avoid and mitigate impacts prior to providing offsets.

Centennial has been working with the Department since early 2012 to progress a number of applications against which this Policy will directly affect project viability and job security. In the assessment pipeline are the Springvale Mine Extension Project and the Angus Place Mine Extension Project. Details on these Projects are included in **Attachment 1**.

It is unreasonable that, at the very end of the assessment process for these projects, a new policy using methodology not required in Director General Requirements or at any other time in the assessment process should be applied. Not only does this put access to significant coal resources at stake, it places proponents in the unenviable position of back calculation, reassessment and acquisition of land where time is critical to project development, particularly where, up until the 28th May 2015, the Major Projects Offset Policy specifically excludes a requirement to offset impacts from "*subsidence and cliff falls [from] mining developments*".

This submission highlights some of the proactive work undertaken by Centennial Coal to understand the nature and extent of upland swamps on the Newnes Plateau and surrounds, as well as the causal factors that could result in permanent loss of swamp communities.

Centennial's Approach to Offsetting Swamp Communities

In a Policy setting whereby subsidence related impacts were specifically excluded from offsetting, Centennial's approach has been to avoid and mitigate impacts to swamp communities through the application of specific mine design criteria. In Centennial's case, there are no predicted impacts to swamps as a result of these specific mine design criteria that would result in significant loss of swamp

communities. This has been tested through a comprehensive review (including peer review) of historical mining impacts on these communities.

Before an offset can be considered, the predicted impact must *be irreversible and complete*. In the Springvale Mine case, there is no evidence to support an argument that mining related impacts to swamps are either irreversible or complete. To the contrary, the swamps located above Centennial's existing mining operations are healthy, robust communities.

Under an existing EPBC approval for the Springvale Mine, Centennial has developed, and implemented a comprehensive Trigger Action Response Plan (TARP) for management and corrective actions related to swamps. Each TARP clearly outlines the process to be taken to manage impacts and, where an impact is determined to be severe (that is, a long term change in hydrology, ecology or quality), initiate corrective actions that deliver an overall improved or maintained conservation outcome. These TARPs were developed in consultation with the Department of Environment, and two independent peer reviewers. The TARPs were approved by the Department of the Environment and Centennial has been following these TARPs since they were approved in 2013.

By drawing on the mechanisms within these TARPs, Centennial has an extensive monitoring program premised on clearly defined triggers for potential impact investigation. This monitoring program has been designed taking into consideration our understanding of the nature and extent of the aquifers that support swamp development and persistence on the Newnes Plateau. It is this understanding, and the subsequent mine design that limits any impact to these aquifers, that forms the basis of Centennial's monitoring and management strategy. To suggest that a decline in groundwater level in an isolated piezometer (regardless of reason for decline), has resulted in a long term significant impact to any swamp community has not been supported by any evidence.

Because the swamp communities themselves are not removed as part of the proposed project, the question becomes one of establishing the circumstances that would or could lead to an irreversible and complete loss of community function. There are no circumstances outlined in the technical assessments supporting the EIS that suggest complete loss of groundwater or ecosystem function.

In the absence of a policy setting whereby residual subsidence impacts require direct offsetting, and to provide for a scientifically robust assessment of residual impact, Centennial analyses key indicators of ecosystem composition and health in a statistically robust manner, where impacts are clearly defined through ecologically meaningful criteria, with a clear framework for management actions (including triggers for the initiation of remediation measures and offsets). The *Flora Monitoring Methods for Newnes Plateau Shrub Swamps and Hanging Swamps* (**UQFM Handbook**) developed for Centennial by the University of Queensland is the source document for this. More detail on this methodology is outlined below and the UQFM Handbook is included at **Attachment 2**.

The Draft Swamp Offset Policy

The key factors that contribute to the expression of surface subsidence are well known, including depth of cover, height of extraction, longwall width, chain pillar size and the geological and geotechnical conditions. Industry has taken a proactive approach to modifying and adaptively managing those aspects of subsidence over which it has some level of control. Over time, Centennial has reduced the size and length of longwall panels to avoid or minimise surface impacts and has invested significant resources into the definition of geological and geotechnical conditions that could result in anomalous subsidence outcomes. This has, in turn, come at significant cost to both Centennial and the State (through lost royalty and other revenue streams). In Centennial's case, the mine design changes at the Springvale Mine alone have resulted in a revenue loss to the State of over $30M.

In previous documents furnished to the Department of Planning and Environment on the Springvale Mine Extension Project, Centennial has outlined the processes adopted by the Company to avoid and mitigate impacts to swamps located within its mining footprint (further detail on this is provided in **Attachment 3**). These have included, but are not limited to, an extensive research program targeted at understanding the mechanisms of impact and modifying the mine design to reduce these mechanisms, where practical. The Planning Assessment Commission, in the Review Report, acknowledge that changes to the mine plan have reduced the potential financial benefits to the Applicant, however, it believes that such an approach is necessary to provide an appropriate balance between the protection of environmental assets and the recovery of economic benefits.

A key element of the Draft Swamp Offset Policy is the recognition that longwall mining is not likely to result in a complete loss of an entire swamp. Rather, swamps may change in size, function,

composition and integrity in only part of a swamp. How these impacts are compensated for is a key requirement of the Draft Swamp Offset Policy that is still under review.

Research has shown that the consequences of subsidence, such as bedding plane separation or bedrock cracking, may temporarily result in a lowering of groundwater levels which in turn may increase the susceptibility of upland swamps to erosion, changes in ecosystem functionality or changes in species composition. For upland swamps on the Newnes Plateau, the evidence suggests that these consequences are no greater than those experienced during periods of rainfall deficit, making differentiation between mining related impacts based on hydrology only and climatic variations difficult.

To assist in understanding how to establish impacts to swamps, the University of Queensland have developed a Monitoring Handbook, titled Flora monitoring methods for Newnes Plateau Shrub Swamps and Hanging Swamps (2014) (UQFM Handbook). This UQFM Handbook identifies that there are three environmental factors which affect floristics:

1. Geology, through subsidence responses;
2. Hydrology (including water quality, groundwater level, flow and infiltration); and
3. Flora composition and condition.

The Monitoring Handbook identifies performance indicators for vegetation monitoring that take into consideration these factors and their effects on swamp health. Five monitoring parameters are used in detecting impacts in Newnes Plateau Shrub Swamp communities. These parameters include:

1. Reduction in the number of native swamp species present
2. Reduction in the condition of key species (qualitative scores 1-5)
3. Expansion of non-live ground cover (including bare ground and dead plant material)
4. Recruitment of non-swamp species (presently eucalypts)
5. Establishment of non-native weeds.

Based on the UQFM Handbook Centennial has developed an adaptive monitoring regime that includes a statistically valid sampling design, supported by clear monitoring objectives and trigger values that identify ecosystem trends where management intervention is required. An independent peer review of the Angus Place Temperate Highlands Peat Swamps on Sandstone Monitoring and Management Plan (THPSS MMP) conducted on behalf of the Federal Department of the Environment included a specific review of the UQFM Handbook (**Attachment 4**).

The monitoring programme established has been implemented by Centennial Springvale for monitoring of previously undermined swamps.

Issues with Use of Triggers Based on Standing Water Levels

A detailed investigation of the geology and hydrogeology of Newnes Plateau swamps was conducted by McHugh (2013), which identified and detailed the stratigraphy of the Burralow Formation, with its multiple fine grained aquitard plies, which overlies the Banks Wall Sandstone. The aquitards were found to retard the vertical movement of groundwater into underlying strata. Instead, much of the groundwater present within the Burralow Formation is redirected laterally down-dip to discharge points in nearby valleys (valley wall seepage), which creates a permanent water source for the formation and maintenance of the Newnes Plateau Hanging Swamps (NPHS). In the case of Newnes Plateau Shrub Swamps (NPSS), precipitation is supplemented by moisture from groundwater sources to form several discharge horizons along the course of the host creek in which a shrub swamp is located. Valley wall seepage, together with direct in-gully input of groundwater via aquitards, permits continuity of hydration for the THPSS during periods of drought. The presence of the Burralow Formation is essential to the formation and persistence of both hanging and shrub swamps (McHugh, 2013).

Corbett et al (2014) found that baseline data from swamp piezometers indicates that swamp hydrology is variable along individual swamps, and standing water levels are typically influenced by rainfall in the upper reaches and by groundwater in the lower reaches. The data from the swamp monitoring has shown that the hydrology of an individual swamp can be ‘periodically waterlogged’ or ‘permanently waterlogged’ or can vary along its length from ‘periodically waterlogged’ to ‘permanently waterlogged’, with transitional behaviour between.

The natural complexity and variability of swamp hydrology means that the use of changes to standing water levels in swamps (as measured by swamp piezometers) as triggers for offsetting entire swamps is not valid.

Linkage of Swamp Hydrology and Swamp Flora Species

Following the implementation of the University of Queensland Flora Monitoring (UQFM) at Springvale and Angus Place, baseline surveys have been conducted at a number of swamps on the Newnes Plateau. UQ (2015) reported that the results from this baseline survey also demonstrated that there are measurable differences in vegetation cover and condition between transects in areas with high, stable water tables and those in drier locations. This result corresponds with the findings of previous work (Johns et al., 2015) that shows that the monitoring variables used here do vary based on hydrology and should therefore be effective for detecting changes in NPSS vegetation associated with changes in hydrology.

UQ (2015) recognised that the NPSS have distinct groundwater regimes that may be stable or fluctuating. The condition and composition of vegetation communities in NPSS varies as a result and this fundamental factor needs to be incorporated into an effective monitoring program (through identification and selection of wetland areas with periodically waterlogged hydrology to act as controls for monitoring wetland vegetation cover and condition in periodically waterlogged impact sites)

Partial Impacts to Swamp Flora Communities

One of the specific findings of UQ (2015) was that changes were detected at Kangaroo Creek Swamp which were consistent with drier conditions relative to control swamps. These changes included:

- Dieback of wetland understorey plant species dependent on high soil moisture (e.g. G. dicarpa)
- Significantly higher non-vegetated area extent (26% compared to 1-23% for control swamps)
- Significantly lower live green vegetation cover (41% compared to 38-77% for control swamps)
- Wetland vegetation in Kangaroo Creek Swamp was also in generally poorer condition (overall condition score of 3 out of 5).

It was noted in (UQ 2015), that:

- that all wetlands appeared drier when surveyed in October 2014 compared to previous visits (both control and impact sites); an observation supported by Bureau of Meteorology data showing below-average rainfall in the preceding year.
- Kangaroo Creek has the highest percentage cover of large trees (31.4%) of all wetlands surveyed during January 2015.

Based on one reference point (KC1 piezometer) was described as having a high, stable water table in the past, but the high percentage of large trees at Kangaroo Creek Swamp is indicative of a variable hydrological regime. The dry conditions (in excess of 300mm rainfall deficit (~30% of annual rainfall) in the previous 12 months) may also have caused the observed dieback to G. dicarpa, which also suffered localised dieback (to a lesser extent) in control swamps.

It is emphasised that the UQ (2015) surveys were conducted for the purpose of baseline data gathering and analysis, and that the survey results were intended to be used as a reference dataset, for comparing the extent of changes in shrub swamp vegetation cover, composition and condition over time between undermined and control swamps.

Partial Offsets for Partial Impacts to Swamps

The analysis in UQ (2015) raises the issues of transition of swamp flora communities evolving over time as a result of transition from permanently to periodically waterlogging, characterised initially by a change in condition of wetland vegetation (particularly amphibious species), and then changes in community composition from amphibious to terrestrial damp and/or dry habitat.

UQ (2015) identifies a specific relationship between hydrology (periodically vs permanently waterlogged locations) and species present (amphibious / terrestrial damp / dry habitat). This implies that within the NPSS classification there could be flora species composition change, which could be used to calculate partial offsets within a swamp where changes to hydrological regime were measured (from permanently waterlogged to periodically waterlogged), but the swamp community remained within the NPSS classification. The FBA could be refined to accommodate these mechanisms, provided the underlying inadequacies around transparency and vegetation community characterisation could be overcome.

Specifically, changes in values of live green vegetation cover and non-vegetated area extent can both be indicative of drier conditions and/or vegetation dieback due to trampling or other disturbance.

These values could be used as triggers for partial offsetting and to calculate the extent of partial offsetting.

Conservation Status of Upland Shrub Swamp Communities

The Newnes Plateau shrub swamp communities are listed as endangered ecological communities. In order to achieve this listing a restricted geographical extent needs to be established. Two vegetation maps (VIS ID 2231 and VIS 977) contain polygons described as Newnes Plateau shrub swamps which combined cover approximately 450sqkm. Swamps to the northeast of the Newnes Plateau shrub swamp have been recognised as also being the same community however; mapping has not been made publically available.

Vegetation maps are constructed for a range of purposes which affect extents as well as spatial and thematic scales. As a result no consistent vegetation map covering New South Wales or the Blue Mountains currently exists. In order to address this issue, Centennial Coal commissioned the University of Queensland to conduct research into the extent, nature and conservation status of upland shrub swamp type communities in the Greater Blue Mountains.

A thorough and extensive flora survey based on currently accepted vegetation survey methodology was conducted on the Newnes Plateau and across the Blue Mountains region using experienced field ecologists. Floristic variables for identifying communities similar to Newnes Plateau shrub swamps included vegetation map unit descriptions and flora monitoring plot data from Newnes Plateau and across the Blue Mountains region. Environmental metadata for identifying communities similar to Newnes Plateau included elevation, temperature range, rainfall average and variability, aspect and slope.

Following data collection and analysis, a report was prepared which includes extensive floristic data sets collected in consistent and extensive field programs. This floristic data, covering almost 120 survey plots (400m2) in more than 80 communities is combined with existing publically available vegetation mapping spatial products from Office of Environment and Heritage NSW; Bureau of Meteorology spatial data for rainfall and temperature across the Blue Mountains; ASTER Global Digital Elevation Model and LandSat 8 scene collected September 2014. These data provide a previously uncollated overview of shrub swamp type vegetation extents backed with new and highly detailed floristic data covering the Greater Blue Mountains region.

When vegetation plot composition is assessed by dominant plant species representing the core structure of shrub swamp communities the range of variability within shrub swamp core composition was greater across the monitoring plots on the Newnes Plateau than identified across the region. This demonstrates that the fundamental floristic structure of Newnes Plateau shrub swamps is also found across the broader Blue Mountains region. Identification of a Newnes Plateau shrub swamp community type relied on observational categories such as large, north facing in order to distinguish from other communities across the region (Tierney et al., 2015)

As part of the assessment of suitability of identified similar swamp communities for the purpose of offsetting potentially impacted communities adjacent to mining areas proposed in the Springvale and Angus Place Mine Extension Projects, their proximity to existing conservation estates was measured. Communities which occur in close proximity to existing conservation estates in the Blue Mountains region may be conserved through incorporation with existing conservation areas. Consistent with the extensive nature of conservation estates in the region and the corridor nature of most development more than half of all identified communities above 900m AMSL were located within 1km of a conservation estate.

Remediation and Rehabilitation of Swamp Communities

The Draft Swamp Offset Policy does not take into consideration the fact that swamp communities are not lost as a result of longwall mining. Centennial Coal has recently undertaken rehabilitation of the East Wolgan Swamp located above the Springvale Colliery Remediation works for East Wolgan Swamp incorporated the remediation methodology developed by the Save Our Swamps Program and included the development of a monitoring plan designed to measure the success of restoration actions, integrity of engineering structures, vegetation monitoring, and water and soil moisture monitoring. Rehabilitation methods included the following:

- Excavation, examination of bedrock cracking and piping within the swamp sediments and implementation of an approved plan (developed in consultation with OEH representatives) for sealing cracked bedrock and piping. Sealing of preferential flow paths caused by bedrock cracking and extensive piping within the swamp sediments was conducted using bentonite (a

naturally occurring clay material which is often used for that application in dam repairs and other civil works).

- Excavation of peat / soil and filling of areas affected by erosional slumping. Coir logs laid in the excavated areas level, with sand used to pack voids and cover logs. Retention and placement of the upper peat / soil (containing the native seed bank and vegetative propagules) in its correct profile. Jute mesh was placed over the top to create shade and retain moisture to encourage plant growth
- Brush matting of area to prevent some of the animal grazing on regenerating plants (which is apparent throughout the area is a factor impeding the natural regeneration of the swamp).
- Use of level spreader structures in the deeper areas of channelisation present in the swamp to spread some of the surface flows out over the swamp rather than concentrated flows.
- Direct seeding of the areas surrounding the slumping sites using seed collected from the adjoining swamp vegetation. The natural regeneration of the swamp vegetation is being monitored to assess the need if any for supplementary planting of indigenous species.
- A regular weed control program has been implemented to monitor the establishment of both annual and perennial weed establishment and control these where they are hindering the regeneration processes.

The remediation program for East Wolgan Swamp was supervised by officers from the Office of Environment and Heritage and the rehabilitation activities were reviewed by members of the International Mire Conservation Group. These works have demonstrated an ability to sensitively remediate not only the surface integrity of an impacted swamp (regardless of the impact), but also sub-surface and bedrock impacts through the application of bentonite.

Attempting to Define the Offset Requirement under the Draft Swamp Offset Policy

Despite the underlying flaws within the Draft Swamp Offset Policy, as an example Centennial has undertaken as assessment, using the current Framework for Biodiversity Assessment, of the potential worst case scenario liability for one swamp. The following summarises the approach taken, and resultant outcomes of this assessment.

The assessment undertaken has used a best fit vegetation community[1] because of limitations in the vegetation classifications under the Framework for Biodiversity Assessment. This in turn produced seven (7) vegetation communities within the FBA that could be used to offset impacts[2].

There is no current mechanism within the FBA to assess either indirect or partial impacts. To compensate for this inadequacy in the framework tool, a condition reduction score of one (1) was applied (this results in a 30% reduction in habitat values, a reduction that is considered to be overly conservative as reductions in swamp functionality due to longwall mining at the Springvale Mine have not been seen to date). As a result, the 12.35 hectares of this example swamp would result in 427 required ecosystem credits, equating to around 46 hectares of offset land required[3].

As described above, Centennial has previously mapped 300,000 hectares of the Greater Blue Mountains Region through a research program with the University of Queensland to identify potential land with lot sizes greater than 20 hectares that could be used to provide suitable offset land. This exercise mapped over 990 hectares of swamps across 106 private lots.

Neither the Biobanking Assessment Methodology nor the FBA contemplate a strict like for like offset expectation and the reality is the FBA identifies a much broader suite of potential vegetation communities that could be used as offsets meaning more offset land is likely to be available.

The Office of Environment and Heritage has made it clear to proponents that the only acceptable form of security for offsetting under the Major Project Policy is a Biobanking Agreement and the Draft Swamp Policy requires the use of a Biobanking Agreement to secure offset credits for impacts.

According to the Office of Environment and Heritage website *BioBanking enables 'biodiversity credits' to be generated by landowners who commit to enhance and protect biodiversity values on their land through a biobanking agreement. These credits can then be sold, generating funds for the management of the site. Biobanking Agreement*. Whilst it is entirely feasible that a mining company

[1] This community was HN633

[2] It should be noted that these communities can be located within the Wollemi-Hawkesbury/Nepean IBRA subregion and any adjoining subregion.

[3] The FBA does not provide a mechanism to determine equivalent land area for offsetting. Following consultation with the OEH Biobanking Team, the FBA Credit Convertor was used as the only measure to provide context around the relationship between credit requirements and land requirements.

could apply for a Biobanking Agreement over its own land to secure and retire credits for itself, practicality of achieving this is unclear and unstated in either the Major Project Policy or the Draft Swamp Offset Policy.

Biobanking assumes a market is available to secure credits. There is no current market for swamp communities. This leaves only two options for securing offsets. Purchase of land to include in the national estate or purchase of land to place an encumbrance over it (for example a Voluntary Conservation Agreement or s88B covenant under the Conveyancing Act).

It is important to note that there are underlying inadequacies within the Framework for Biodiversity Assessment, not just for the calculation of swamp offsets. These inadequacies include, but are not limited to, incomplete or poorly defined vegetation mapping/communities that underpin the assessment calculations and a lack of transparency around the underlying assumptions used in the calculation. This results in a high level of subjectivity around the calculation of offset liabilities, particularly when the Office of Environment and Heritage provide their own calculations to proponents.

The intent of the FBA was, and is, to provide a greater level of certainty for the calculation and security of offset liabilities and remove the case by case assessment approach currently in play. This is not the case.

Conclusion

In conclusion, Centennial considers that the application of the Draft Swamp Offset Policy to Projects currently in the assessment process as inappropriate and that there are a number of fundamental elements to the Draft Swamp Offset Policy that require further refinement.

Notwithstanding this, Centennial has undertaken a detailed review of the Draft Swamp Offset Policy and its application to our projects. Whilst there are underlying inadequacies within the FBA and its supporting tools, we believe we have described within this submission and robust, sensible approach to applying the Draft Swamp Offset Policy. We have undertaken considerable research into the geological, hydrological and ecological values inherent to upland swamp communities. As such, the broad understanding obtained has informed not only our mine design but also our approach to detecting swamp impacts (from a variety of sources) and responding to these impacts.

I trust that you will take this submission into consideration when finalising the Draft Swamp Offset Policy. Should you have any enquiries regarding the attached, please contact me at maryanne.crawford@centennialcoal.com.au.

Yours sincerely

Mary-Anne Crawford
General Manager Environment and Approvals

Attachment 1: Summary of Centennial Projects
Attachment 2: *Flora Monitoring Methods for Newnes Plateau Shrub Swamps and Hanging Swamps*
Attachment 3: Springvale Mine Extension Project: Summary of Mine History, Swamp Management and Mitigation
Attachment 4: Peer Review of Angus Place Revised THPSS Monitoring and Management Plan by Dr David Goldney
Attachment 5: List of References

ATTACHMENT 1: SUMMARY OF CENTENNIAL PROJECTS

SPRINGVALE MINE EXTENTION PROJECT

Operating for 19 years (established in 1995), Centennial Coal's (Centennial) Springvale Mine (Springvale) is an underground coal mine in the Lithgow area. Centennial is seeking to extend the life of the mine for an additional 13 years (2028) by renewing its current planning consent which expires in September 2015.

It is proposed Springvale will continue to operate 24 hours per day, seven days per week, producing up to 4.5 million tonnes of coal annually, using the current workforce and not significantly altering the existing operations.

As a result of the knowledge gained from over 30 years of mining in the area Centennial has a wealth of experience in understanding mine design principles and requirements for the protection of surface features, and management of potential environmental impacts. This has been supported by the wide range of technical reports used to compile the Environmental Impact Statement (EIS), response to submissions and various other documents used in the planning assessment process.

If approval is granted by the NSW Department of Planning and Environment, Springvale will optimise the recovery of coal while concurrently minimising any potential environmental impacts and in turn; secure employment for the current workforce of over 300 while also directly injecting approximately $901 million into the local, state, regional and national economies for the life of the Project (13 years).

Springvale Mine is an underground coal mine located 15km northwest of Lithgow. Using longwall mining methods Springvale produces up to 4.5 million tonnes of coal annually for the local power stations and export markets. Operating 24 hours a day seven days per week the operation is supported by a workforce of just over 300 full time employees.

ANGUS PLACE MINE EXTENSION PROJECT

Operating for over 30 years (established in 1979), Centennial Coal's (Centennial) Angus Place Mine (Angus Place) is an underground coal mine in the Lithgow area. Centennial is seeking to secure the mines future by gaining approval from the NSW Department of Planning and Environment for the Angus Place Mine Extension Project.

The Project proposes to extend its mining operations, using longwall mining techniques, to the east of the existing operations at Angus Place. It is proposed Angus Place will continue to operate 24 hours per day, seven days per week, producing up to 4 million tonnes of coal annually, using the current workforce and not significantly altering the existing operations.

As a result of the knowledge gained from over 30 years of mining in the area Centennial has a wealth of experience in understanding mine design principles and requirements for the protection of surface features, and management of potential environmental impacts. This has been supported by the wide range of technical reports used to compile the Environmental Impact Statement (EIS).

The Project, if approved, will optimise the recovery of coal while concurrently minimising any potential environmental impacts and in turn; secure employment for the current workforce of 300 while also directly injecting approximately $752 million into the local, state, regional and national economies for the life of the Project (25 years).

Angus Place is an underground coal mine located 15km northwest of Lithgow. Using longwall mining methods Angus Place produces up to 4 million tonnes of coal annually for the local power stations. Operating 24 hours a day seven days per week the operation is supported by a workforce of 300 full time employees and contractors.

ATTACHMENT 2

ATTACHMENT 3

1.0 OVERVIEW OF MINING HISTORY

Longwall mining commenced at the Angus Place Colliery in 1979 and at the Springvale Mine in 1995. Prior to this, underground bord and pillar mining had been undertaken in the region since the early 1950s. In 2002, Centennial Coal acquired these assets from the State owned corporations. Centennial recognised the need to develop robust groundwater modelling to understand the nature and extent of the potential impacts of longwall mining on groundwater resources. This later translated to the potential for groundwater impacts on groundwater dependent ecosystems, specifically the Temperate Highland Peat Swamps on Sandstone (comprising the State listed Newnes Plateau Shrub Swamps and Newnes Plateau Hanging Swamps).

Investigations commencing in 2003 and extending into 2015 are documented below. The following list includes the studies that have been undertaken to date into geology, hydrogeology, surface and groundwater and flora on the Newnes Plateau.

1.1 Historical Groundwater Modelling (2003-2008) Longwall Panels 408-412

The hydrogeology in the Springvale and Angus Place Colliery region was investigated by CSIRO between 2003 and 2008 and is described in ACARP reports C14033 (Guo, H, Adhikary, DP and Gabeva, D (2007) Hydrogeological response to longwall mining) and C18016 (Adhikary, DP and Wilkins, A (2012) Reducing the Impact of longwall extraction on groundwater system). In those studies, the distribution of porewater pressures within the Springvale region was investigated using more than 100 vibrating wire piezometers installed at Springvale Colliery.

Connell Wagner (later Aurecon) (Forster, I. and Hilyard, D.) monitored water level monitoring bores and swamp piezometers on the Newnes Plateau from 2005 to 2013 and prepared Groundwater Monitoring reports for SMSR compliance. Since October 2013, RPS monitored water level monitoring bores and swamp piezometers on the Newnes Plateau from 2005 to 2013 and prepared Groundwater Monitoring reports for SMSR compliance.

1.2 East Wolgan Swamp Investigation (2009) Longwall Panel 411 – 412

Subsidence Status Management Reports (SMSR) compiled by Springvale in 2008, indicated that discharge waters were not being recorded at the downstream monitoring location. Springvale made a commitment to carry out a detailed investigation to determine the cause of this phenomenon. The following reports were prepared as part of the East Wolgan Swamp investigation:

Holt, G. (2009) Review Of Anomalous Subsidence Over Longwall Panel 411, Springvale Colliery (G E Holt & Associates Pty Limited)

Forster, I. (2009) Stormwater Modelling East Wolgan Swamp (Aurecon Report Ref:7049)

Forster, I. (2009) Geotechnical Investigation Report Wolgan East Investigation (Aurecon Report Ref: 208354)

Lembit, R.(2009) Inspection of East Wolgan Swamp to assess vegetation health in the lower section of East Wolgan Swamp (Gingra Ecological Surveys)

Kates, S. conducted routine photo-monitoring and reporting of NPSS sites (Craven, Elliston Hayes)

Grundy, S., (2010) East Wolgan Swamp Remediation Proposal (The Bush Doctor (NSW) Pty Ltd)

Forster, I., (2009) Newnes Plateau Shrub Swamp Management Plan Investigation of Irregular Surface Movement in East Wolgan Swamp (Aurecon Report Ref:7049-010)

Goldney, D., Mactaggart B., and Merrick, N. (2010) Determining Whether Or Not A Significant Impact Has Occurred On Temperate Highland Peat Swamps On Sandstone Within The Angus Place Colliery Lease On The Newnes Plateau

Speer, J., (2011) Alpha GeoScience Report, Final Report: AG-293 Geophysical Survey Ground Penetrating Radar And Resistivity Investigation Of East Wolgan Swamp On The Newnes Plateau

1.3 EPBC 2011/5949 Approval (2011-2013) Longwall Panels 414-416

Preparation of the Referral of EPBC 2011/5949 and subsequent Response to Submissions (2011 - 2012) required studies including:

Ditton, S. (2011) Subsidence Prediction and Impact Assessment for the Proposed Longwalls 415 to 417 at Springvale Colliery, Wallerawang (DgS Report No. SPV-003/1)

Hill, D. (2011) Partial Extraction at Depths of >300m (Strata Engineering Report No. 03-123-AGP-39b)

Preparation of Preliminary Documentation to support the application for approval of EPBC 2011/5949 (2011-12) required studies including:

Forster, I. (2011) Angus Place and Springvale Groundwater and Surface Water Monitoring (Aurecon Report 208354)

Stone, I. (2011) Angus Place & Springvale Mines Geological Structure Zones (Palaris Report CEY858-03)

Ditton, S. (2011) Review of Geological Structure on Predicted Mine Subsidence Effects and Environmental Impacts for the Proposed Angus Place LWs 900W - 910 and Springvale LWs 415 - 417 (Ditton Geotechnical Services Report ANP-002/2)

Ditton, S. (2012) Response to Submissions Regarding the SEWPAC Referral on Impacts to Temperate Highland Peat Swamps on Sandstone Due to the Proposed Angus Place LWs 900W / 910 and Springvale LWs 415 - 417 (Ditton Geotechnical Services Report ANP-002/3)

In order to support the application to continue mining beneath THPSS on the Newnes Plateau (2013) further studies were conducted. These included:

Tobin, C. (2013)Regional Geological Modelling in the Southern Part of the Western Coalfield (Palaris Report CEY1504-02)

Tobin, C. (2013) Stratigraphic Setting – Angus Place and Springvale Collieries (Palaris Report CEY 1535-01)

McHugh, E. (2013) The Geology of the Shrub Swamps within Angus Place/Springvale Collieries

Lembit, R. (2013) East Wolgan Swamp Review of Ecological Condition & History (Gingra Ecological Surveys)

Ditton, S. (2013) Further Discussion on the Potential Impacts to Sunnyside East and Carne West Temperate Highland Peat Swamps on Sandstone due to the Proposed Springvale LWs 416 to 417 (Ditton Geotechnical Services Report SPV-003/6)

Fennell, J., Tierney, D. and Andersons, Z. (2013) Swamp Delineation Study (RPS Aquaterra Report 001b)

Fletcher, A., Brownstein, G., Blick, R., Johns, C., Erskine, P. (2013) Assessment of Flora Impacts Associated with Subsidence

Springvale Coal Pty Ltd (2013) EPBC Approval 2011/5949 Application to Allow Longwall Mining Under Temperate Highland Peat Swamps on Sandstone on the Newnes Plateau – Supplementary Data Volume 1 – 3 and Appendices

1.4 Angus Place and Springvale Mine Extension Projects (2013-14)

Angus Place and Springvale Colliery Operations Groundwater Assessments were prepared by CSIRO, based on the extensive history of groundwater modelling at the site. RPS prepared the Groundwater Impact Assessment for the Angus Place and Springvale Mine Extension Projects based on the CSIRO report. Below is a list of reports prepared regarding subsidence effects on groundwater and Newnes Plateau swamp communities:

Adhikary, D. and Wilkins, A. (2013) Angus Place and Springvale Colliery Operations Groundwater Assessment (CSIRO) Ditton, S. (2014) Subsurface Fracture Zone Assessment above the Proposed Springvale and Angus Place Mine Extension Project Area Longwalls (DgS Report SPV-003/7b)

Fletcher, A. and Erskine, P. (2014) Monitoring surface condition of upland swamps subject to mining subsidence with very high-resolution imagery (ACARP Project - C20046)

Corbett, P., White, E., Kirsch, B., (2014) Hydrogeological Characterisation of Temperate Highland Peat Swamps on Sandstone on the Newnes Plateau

Corbett, P., White, E., Kirsch, B., (2014) Case Studies of Groundwater Response to Mine Subsidence in the Western Coalfields of NSW

Brownstein, G., Johns, C., Blick, R., Fletcher, A., Erskine, P., (2014) Flora monitoring methods for Newnes Plateau Shrub Swamps and Hanging Swamps

Peer Review of Groundwater and Height of Continuous Fracturing Models

There has been extensive consideration of modelling of the the groundwater effects of subsidence, calibration of models to measured groundwater response and peer review of methodologies and models prepared. Peer reviews have been conducted for all Groundwater and Height of Continuous Fracturing Models for work conducted at Angus Place and Springvale.

The COSFLOW groundwater model was peer reviewed by Noel Merrick. The following is an excerpt from the final peer review: "*A brief peer review is provided here to finalise a long process that dates back to April 2012 when the reviewer was first called upon to review the geotechnical-groundwater COSFLOW model under development by CSIRO. A review report written in June 2012 recommended substantial expansion of the model's groundwater capabilities and a shift in focus from near-field mine inflow to far-field environmental effects. It also alerted the authors to best practice expectations articulated within Australian groundwater modelling guidelines. Model expansion and focused reporting was duly undertaken by CSIRO in February 2013, resulting in a successful incorporation of groundwater and near-surface processes into what had primarily been a geotechnical model. Another review report was written in April 2013. This review listed 81 technical and editorial matters that required attention. CSIRO has attended to these matters in the May 2013 version of the report*."

In order to supplement the COSFLOW numerical model, it was decided to also utilise the Pi-Term model developed by Ditton Geotechnical Services (DgS) and Hydrosimulations to predict the Height of Continuous and Discontinuous Fracturing which would result from proposed longwall mining activities at Angus Place and Springvale mines beneath the Newnes Plateau. The decision to use the Pi-Term Model was made after due consideration of alternative models, including the Tammetta (2012) model.

A review of the Tammetta (2012) model as presented in Commonwealth of Australia 2014, *Temperate Highland Peat Swamps on Sandstone: longwall mining engineering design—subsidence prediction, buffer distances and mine design options* (Knowledge report, prepared by Coffey Geotechnics for the Department of the Environment, Commonwealth of Australia) was conducted by Hydrosimulations

(attached to the Response to the Response to Submissions). In part, the review by Hydrosimulations concluded:

1.The treatment of fractured zone algorithms in the literature reviews is inadequate as the work of Ditton, documented in Ditton and Merrick (2014), is ignored;

2.The Ditton model for fractured zone height is considered superior to the Tammetta algorithm due to a basis in geotechnical theory, a correct trend for sensitivity to mining height, calibration to Australian conditions, and inclusion of a host geology term;

3.The association of the Collapsed Zone in the Tammetta model with complete desaturation is disputed, given the retention of significant volumes of water in the matrix of the rock material in this zone, and statistical correlation of the height of this zone with the B-Zone altitude in the Ditton model, which marks the top of a zone that has disconnected fractures;

4.The treatment of fracture permeabilities in the literature review (in Report A) is inadequate as the substantial body of work on discrete fracture networks is ignored;

5.The estimates for fracture permeability are simplistic and grossly overstated, due to lack of consideration of fracture connectivity influenced by closure or truncation;

6.The conclusion that "a few small cracks through the swamp substrate can lead to substantial vertical drainage" is invalid, due to over-reliance on the cubic law for relating water flow to aperture size, and lack of consideration of the relative sizing of water-holding cracks and the water stored within intact swamp sediments.

Due to the fact that the Pi-Term Model is based on a geomechanical model which specifically models subsidence "zones" (based on subsidence induced strain), and then relates historical measured groundwater response for different subsidence "zones" to modelled areas, it was considered appropriate for a peer reviewer with expertise in the field of subsidence to review the Height of Continuous Fracturing Model prepared by DgS. The peer review of the Height of Continuous Fracturing Model was conducted by MSEC and concluded in part: *"MSEC has reviewed the above referenced CSIRO and DgS Reports and found that they provide detailed information on the existing environment, the groundwater systems, the overburden and the presence of layers of low permeability for this Western Coalfields area. The selection and use of both numerical and empirical models which have been calibrated to site data over many years and used for the Angus Place and Springvale Mine Extension Projects, are believed to represent the current "industry best practice". MSEC has reviewed these reports and, in our opinion, we consider the assessments of the HoCF for the proposed longwalls at Angus Place and Springvale Collieries that are included in these reports are reasonable for this particular geological region."*

These peer review reports were appended to the Springvale Mine Extension Project Response to Submissions (submitted in October 2014) and the Springvale Mine Extension Project Response to the Response to Submissions, submitted in December 2014.

2.0 HISTORY OF SWAMP MANAGEMENT AND MITIGATION

In 2011, Springvale Mine and Angus Place Colliery referred (separately) longwall extraction actions to the then Department of Sustainability, Environment, Water, Population and Communities (SEWPaC, now Department of the Environment, DotE) (referred to as EPBC 2011/5949 and EPBC 2011/5952 respectively). To support these applications, a significant body of work, referred to as the Preliminary Documentation, was submitted in 2011 to SEWPaC and placed on public exhibition during the assessment process. The Preliminary Documentation included discussion on:

- The area of THPSS within the proposed mining areas, including the angle of draw;
- The cumulative impacts to THPSS resulting from past and potential mining activities, including how these activities might impact THPSS in a regional context;

- The area of habitat for listed threatened fauna species within the proposed mining areas, including the angle of draw;
- Evidence as to why alternative mining methods including bord and pillar methods, cannot be used, in particular whilst mining under THPSS;
- Information and clarification on whether water is treated prior to discharge; and
- How each operation would ensure that ecosystem health of the THPSS would remain intact, and include ensure that mining would not result in the need to implement ecological community recovery measures. This report included:
    - Information on how the impacts of mining would be assessed, including the use of appropriately scaled statistical analysis (Before-After-Control-Impact, or BACI) with a minimum of 2 years of baseline data
    - A description of the predicted impacts (direct and indirect) and management mechanisms designed to ensure that predicted impacts are avoided in the first instance, where impacts are unavoidable, mitigation and remediation measures were included in the report.
    - Information on the indicators of change, established trigger levels and management responses, including mitigation and remediation measures to protect THPSS.
    - An independent peer review by two experts with expertise in hydrology, water quality, ecology and geomorphology of THPSS (Dr Grant Hose and Dr Kirsty Fryirs) who were approved by the Department.

In 2012, based on the information provided to the Department, these actions were conditionally approved by the Minister. The key conditions of approval for the Springvale Mine[1], relevant to the RTS, were:

1. Unless otherwise agreed by the minister in writing, longwall mining is not to be undertaken in areas directly below known **high quality** sites of temperate highland peat swamps on sandstone or within approved buffer zones (as per condition 2) If at anytime the person taking the action seeks the **minister's** agreement to vary this condition the person taking the action must demonstrate in writing that a proven technology or engineering methodology will be used for the proposed longwall mining that prevents **severe impacts** of **subsidence** on temperate highland peat swamps on sandstone, or that would allow any **severe impacts** on temperate highland peat swamps on sandstone to be remediated[2].
2. Within three months of the date of this approval, the person taking the action must submit details of proposed buffer zones around **high quality** temperate highland peat swamps on sandstone for the **minister's** approval. The buffer zones must be approved by the **minister** before mining of longwalls 416 and 417 can commence.

[1] There were no similar conditions for Angus Place, as the referred action was not mining directly under THPSS.

[2] **High quality** is defined as those parts of Sunnyside East and Carne West swamps marked on the relevant Appendix to the approval. **Severe impact** is defined as impacts to THPSS that indicate a long term change in swamp hydrology, water quality of flora composition. This includes fracturing of the rock strata beneath the swamp, evident through an extended (longer than that recorded in reference sites during the same period) reduction in groundwater levels. **Subsidence** is defined as any and all ground movements that result from mining. **Minister** is defined as the Minister administering the Environment Protection and Biodiversity Conservation Act 1999 and includes a delegate of the Minister.

Throughout 2012 and 2013, Centennial undertook investigations to satisfy these conditions and in 2013 and 2014, Centennial submitted a substantial body of work to the Department of the Environment, including:

- Justification for the selection of a 26.5 degree angle of draw buffer, including background information on the buffer zone selection.
- Application to Mine within Buffer Zones, supported by three volumes of supplementary information, including nine (9) swamp case studies, and various reports on swamp geology, results of ground penetrating radar (GPR) and resistivity studies on East Wolgan Swamp, critical analysis on the different mine geometries between longwall 411 (East Wolgan Swamp impacts) and longwalls 415 to 417, geotechnical investigation into East Wolgan Swamp, and others.
- Various case studies on remediation measures taken to remediate impacts to swamp communities.
- Springvale Mine Temperate Highland Peat Swamps on Sandstone Monitoring and Management Plan.
- Angus Place Colliery Temperate Highland Peat Swamps on Sandstone Monitoring and Management Plan.

This body of work is extensive, comprehensive and supported by various levels of peer review. For example, both the Springvale Mine Temperate Highland Peat Swamp on Sandstone Monitoring and Management Plan and the Angus Place Colliery Temperate Highland Peat Swamps on Sandstone Monitoring and Management Plan were peer reviewed by Dr David Goldney and Dr Grant Hose. Dr Hose was an expert who had previously been approved by the Department of the Environment to peer review previous swamp reports. Dr David Goldney was the expert who had undertaken an independent investigation into the impacts of mining on swamps at Angus Place Colliery for the then Department of Environment, Water, Heritage and Arts (DEWHA).

As a result of investigations into THPSS hydrogeology and interactions with mine subsidence, changes to the mine design were made, based on reduced mining void widths and increased chain pillar widths. The changes have been made in the context of cover depths in proposed future mining areas in the vicinity of THPSS and are designed to a criterion of sub-critical panel geometry. Subsidence modelling indicates that the design changes will result in very significant reductions to total subsidence and differential subsidence movements. These changes were made specifically to reduce the environmental impacts of longwall mining under the Newnes Plateau, and demonstrate Centennial's commitment to sustainable mining practices.

Since the Interim IESC advice was issued in February 2012, and as identified above, Centennial Coal has prepared, and submitted to the Department of the Environment, numerous documents to demonstrate compliance with the conditions of EPBC approvals for Springvale Mine and Angus Place Colliery, EPBC 2011/5949 and EPBC 2011/5952 respectively. These documents are available on the Centennial Coal website, www.centenniacoal.com.au.

Based on the reports provided to it, on 21 October 2013, the Department of the Environment approved mining beneath THPSS under the terms of EPBC 2011/5949 Condition 1. The mine design approach for all future longwall mining described in the Springvale MEP EIS and the Angus Place MEP EIS in the vicinity of THPSS is consistent with that approved for longwall mining beneath THPSS by DotE under EPBC2011/5949, and is summarised below.

This body of work has been relied upon, and supplemented with additional work, for the Springvale MEP EIS and the Angus Place MEP EIS.

In undertaking this work, Centennial Coal has recognised the conservation values that the Newnes Plateau and Ben Bullen State Forest currently holds and will hold in the future following cessation of forestry and mining activities. These conservation values have been identified through consultation with a number of stakeholders and a literature review of stakeholder documentation, including:

- The Greater Blue Mountains World Heritage Area Strategic Plan (2009 to 2019)[3];
- 'Save our Swamps' documentation (2010);
- Review of Piezometer Monitoring Data in Newnes Plateau Shrub Swamps and their Relationship with Underground Mining in the Western Coalfield, DECCW (2010);
- Coalpac Consolidation Project Planning Assessment Commission Report, (2013);
- The Geoheritage and Geomorphology of the Sandstone Pagodas of the North-western Blue Mountains region (NSW), Washington et al, (2011);
- The Gardens of Stone Park Proposal: Stage 2, the Western Escarpment, Airly-Genowlan Mesa, Newnes Plateau and related Crown lands, (2005)[4];
- The Impact of Coal Mining on the Gardens of Stone, Colong Foundation for Wilderness, (2010); and
- Alteration of Habitat Following Subsidence due to Longwall Mining – Key Threatening Process Listing, Office of Environment and Heritage, (2005).

This review identified the common theme and desire to protect, conserve, preserve and rehabilitate the environmental values of the Newnes Plateau for recreation and tourism purposes. This includes consideration of:

- Threats to conservation values that include (but are not limited to) fire, pests and weeds;
- Methods to establish the health status of swamp communities to guide management decisions, as discussed in Chapter 10.3 of the EIS;
- Impacts of mine water discharge on swamp communities, as discussed in Chapter 2 and Chapter 8 of the EIS;
- Value of pagoda systems that occur within the Banks Wall and Burra Moko Head Sandstones, as discussed in Chapter 2 and Chapter 10.1 of the EIS[5];
- Impacts of mining related activities to areas with potential conservation value, including construction of access roads and utility corridors, historical cliff collapses, potential changes to hydrology; as discussed in Chapter 2 and Chapter 10.1, 10.2 and 10.3 of the EIS;
- Support by Centennial Coal Company Ltd for the reservation of Mugii Murum-ban State Conservation Area in a State Conservation Area in 2011;
- A heritage assessment for the Mount Airly Oil Shale Ruins, completed by Centennial Airly Pty Ltd in 2013;

[3] A full list of references is available in the Regional Biodiversity Strategy, appended to the Response to Submissions

[4] Including *The Gardens of Stone Park Proposal Stage Two Illustrated: A proposal to extend the Gardens of Stone and Blue Mountains National Parks and create a Gardens of Stone Conservation Area and a Western Escarpment State Conservation Area*, Blue Mountains Conservation Society and the Colong Foundation for Wilderness, 2005.

Seeing the Gardens…the other Blue Mountains: Nature based tourism and recreation in the Gardens of Stone Stage Two Park Proposal, Blue Mountains Conservation Society and the Colong Foundation for Wilderness, 2009

[5] The EIS refers to the Environmental Impact Statement of the Springvale Mine Extension Project and the Angus Place Colliery Extension Project, unless specified otherwise.

- A heritage assessment of the St Johns Church, Wallerawang, completed as part of the Lidsdale Siding Upgrade Project;
- Discharge of water away from the World Heritage Area and reuse of water for industrial purposes, as discussed in Chapter 10.2 of the EIS;
- Subsidence protection zones whilst maintaining economically viable operations, as discussed in Chapter 8 of the EIS;
- Collection of real time and relevant data to inform understanding of the biodiversity and geo-diversity values, as discussed in Chapter 2 and Chapter 10 of the EIS;
- Management and monitoring of underground mining operations to achieve predicted height of fracturing, thereby minimising to the greatest extent possible surface related impacts, as discussed in Chapter 2 and Chapter 8 of the Springvale Mine Extension Project EIS and the Angus Place Mine Extension Project EIS; and
- Recognition of the geo-diversity of pagoda systems and avoidance of impacts to these systems within the EIS (Chapter 8)

By taking into consideration the measures identified above, the conservation values of the Newnes Plateau, and the Ben Bullen State Forest, and the management strategies to avoid and mitigate impacts, the mining operations at Angus Place and Springvale can be managed to achieve a future conservation outcome.

On 7th August 2014, the Independent Expert Scientific Committee (IESC) released three reports on Temperate Highland Peat Swamps on Sandstone (THPSS). These reports were commissioned in 2012 by the then Interim Independent Expert Scientific Committee in response to advice sought by SEWPaC on the referrals described above. The Interim IESC advice concluded that:

Given the likelihood that further longwall developments will be proposed in areas containing the listed endangered ecological community, the Interim Committee agreed that it would seek approval from the Minister to commission a program of independent research into issues such as: the capacity to predict subsidence-related impacts on peat swamps from longwall mining; mitigation and remediation techniques, including self-amelioration; the hydrological and hydrogeological characteristics of the temperate highland peat swamps on sandstone community; and the relationship of the orientation and dimensions of longwall mine plans to potential subsidence risk.

These reports are:

- Temperate Highland Peat Swamps on Sandstone: longwall mining engineering design – subsidence prediction, buffer distances and mine design options, knowledge report (Coffey Geotechnics).
- Temperate Highland Peat Swamps on Sandstone: ecological characteristics, sensitivities to change, and monitoring and reporting techniques, knowledge report (Jacobs SKM).
- Temperate Highland Peat Swamps on Sandstone: evaluation of mitigation and remediation techniques, knowledge report (University of New South Wales).

The reports were heavily referenced in the advice provided by the IESC on the Springvale MEP and the Angus Place MEP on the 25 August 2014.

At the request of the Department of Planning and Environment, Centennial Coal has prepared a response, supported by further technical assessment by subsidence and hydrogeological experts, to the three reports produced by the IESC. Responses to the comments raised by the IESC in the advice of 25 August 2014 are included in the Springvale Mine Extension Project Response To Submissions.

In general the IESC Reports:

- Do not consider all of the relevant publicly available information in developing arguments about the effects of longwall mining on Temperate Highland Peat Swamps on Sandstone communities (THPSS).
- Where publicly available data has been used in the preparation of the reports certain data has been excluded where it does not support the position argued in the IESC reports.
- Certain reference sources cited in the IESC report contain material which is not based on data and is biased against coal mining.

As noted above, Centennial Coal has invested substantial time and resources into meeting, and exceeding, its compliance obligations under existing approvals, and will continue to do so in the future. Centennial Coal has done this in five broad areas:

1. Investigation of impacts to THPSS, namely East Wolgan Swamp and the consequent Enforceable Undertaking entered into in 2011;
2. Development of an adaptive management framework and response, following the conclusion of investigations;
3. Comprehensive analysis and review of the mine design at both the Springvale and Angus Place operations;
4. Further analysis and review of the potential for impacts to THPSS; and
5. Investigation into the potential impacts of water discharged from the underground mining operations on the receiving environment.

The first four (4) of these areas are discussed further below, and are comprehensively addressed in the Springvale MEP EIS, the Angus Place MEP EIS and **Section 3.1.15** of the RTS.

2.1 Investigating Impacts to THPSS

Centennial acknowledged in Chapter 2 and Chapter 8 of the Springvale MEP EIS and the Angus Place MEP EIS that longwall mining has caused impacts to certain THPSS, however, as identified in these documents, this has not been the case in all instances.

Chapter 2 of both the Springvale MEP EIS and the Angus Place MEP EIS acknowledged that subsidence impacts to swamp hydrology have been noted at two swamps (Kangaroo Creek Swamp and East Wolgan Swamp). Where impacts to certain THPSS on the Newnes Plateau have occurred, Centennial has conducted extensive research to understand the causes of the impacts. Centennial has used the findings of the research to avoid and mitigate both past and future impacts of longwall mining and related activities to THPSS on the Newnes Plateau.

Extensive research and investigation, lead primarily by work commissioned by the then DEWHA (the Goldney 2010 Report), has shown that impacts to THPSS on the Newnes Plateau have been caused primarily by:

- Licenced discharge of mine water through THPSS; and
- Changes to swamp hydrology caused by cracking of rock substrate beneath THPSS as a result of mine subsidence.

The Goldney 2010 Report found that *the principal cause of impacts* to East Wolgan Swamp and Narrow Swamp was water discharged from the underground mining operations. This finding has been reinforced by research conducted by the University of Queensland, most recently an ACARP report published in July 2014 on monitoring upland swamps the subject of mine subsidence using high resolution imagery. As a result of the finding, Centennial has not discharged mine water through THPSS on the Newnes Plateau since 2010 and is committed to managing mine water through the Water Transfer Scheme (WTS), which transfers mine water off the Newnes Plateau. The finding of major impacts caused by mine water discharge is not acknowledged in the IESC Reports. Further,

neither these reports (the Goldney 2010 Report and the University of Queensland research), nor Centennial's response to the findings, have been referenced in the IESC Reports.

Following completion of the DEWHA investigation and the Goldney 2010 Report, in November 2011, Centennial (through its Joint Venture) and the Minister for the Environment entered into an Enforceable Undertaking under section 486DA of the Environment Protection and Biodiversity Conservation Act 1999. Under this Enforceable Undertaking, the Joint Venture entered into a research agreement with the Australian National University to undertake a comprehensive research program into THPSS[6].

It should be noted that within the Enforceable Undertaking, Centennial did not concede to breaching the EPBC Act, however, acknowledged that the Minister considered that the actions taken by Angus Place Colliery and Springvale Mine has resulted in a significant impact to THPSS, specifically, Narrow Swamp, Junction Swamp and East Wolgan Swamp.

More detail on the investigations undertaken by Centennial Coal into the impacts to THPSS is included in Chapter 2 of the Springvale EP EIS and Chapter 2 of the Angus Place MEP EIS and within the Response to Submissions, including:

- case studies on all swamps mined under at both Angus Place and Springvale;
- The role of high flow through swamps, in particular, water discharged from underground mining operations;
- The role of major geological fault structures;
- How the longwall orientation and in-situ stress direction/magnitude affects the expression of surface subsidence; and
- The importance of mine design criteria, in particular the use of sub-critical width longwall panels, to reduce the height of continuous fracturing above the longwall.

2.2 Adaptive Management Framework

Uncertainty in natural systems needs to be accounted for in any adaptive management framework, and can include, amongst other things, the inherent environmental variation found in natural systems and the uncertainty around resource definition.

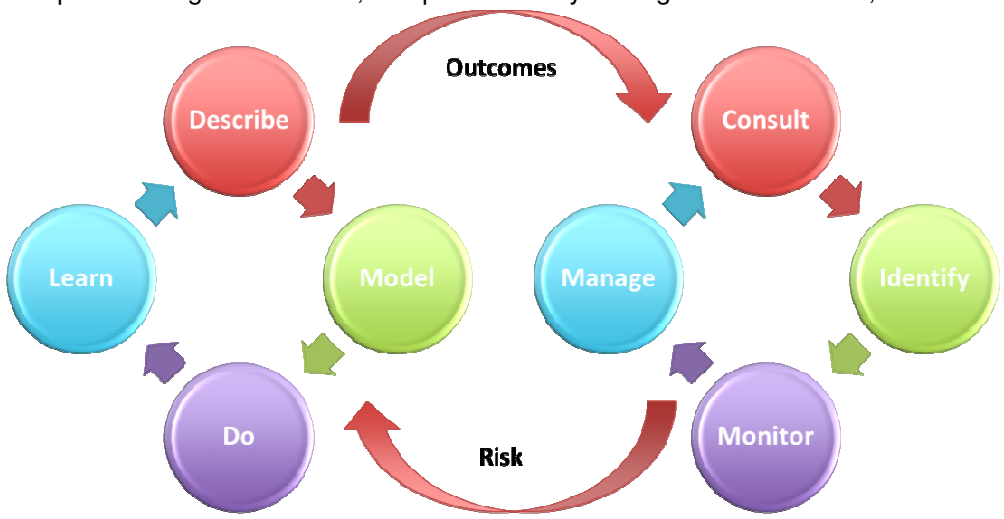
To account for this uncertainty, adaptive management is the structured process of learning through doing, and adapting based on what is learned (Williams, 2011). Williams (2011) suggests that the National Research Council (2004) definition of adaptive management provided a clear understanding of the intent behind an adaptive management framework, notably, one of flexible decision making, adjusted to consider uncertainties, as management outcomes are understood. Monitoring of these outcomes is essential to both scientific understanding as well as iterative management decision making.

Within the Springvale MEP EIS and the Angus Place MEP EIS, new information and the use of new, improved technology have informed Centennial Coal's decision to modify its mine design criteria, currently adopted for Longwall 415 to 417 at Springvale Mine. The outcomes of the information

[6] It should be noted that in this report, a reference to the federally listed endangered ecological community Temperate Highland Peat Swamps on Sandstone, includes a reference to the State listed endangered ecological communities incorporating the Newnes Plateau Shrub Swamps and Newnes Plateau Hanging Swamps. The extent to which these communities have been described under these listings is discussed further in response to the IESC Report on ecological characteristics of THPSS.

collected from previous longwalls and the longwalls 415 to 417 has been used to inform the mine design used for the Springvale MEP EIS and the Angus Place MEP EIS.

Following the significant body of work undertaken to gain approval under the EPBC Act for the Springvale Mine and Angus Place Colliery described above, in 2012, Centennial Coal commenced a process of establishing an Adaptive Management Framework to each environmental value being assessed through the environmental impact assessment process. This framework consisted of the traditional adaptive management model, complemented by management outcomes, as identified below:



The Framework was described in detail in the Response to Submissions Reports. The outcomes derived from the Framework and supporting technical assessments are translated into management plans and/or management commitments.

An example of this adaptive management approach in practice within Centennial Coal was the management of *Persoonia hindii* on the Newnes Plateau following approval of the Springvale Bore 8 Project and the Angus Place Ventilation Facility Project. Both projects were approved to clear 93 and 1269 *P. hindii* respectively. By adopting a management strategy that included maximising avoidance of this threatened species, no plants were removed for the Bore 8 Project and 91 were removed for the Ventilation Facility Project, a reduction of 94%.

The Springvale MEP EIS and the Angus Place MEP EIS included the outcomes of this in several key specialist studies and commitments. These are described further below.

The Adaptive Management Framework is a triple bottom line framework in that, as well as the environmental consequences of the project, it includes consideration of socio-economic impacts and benefits, the costs of these on local and regional communities and the residual consequences of net impacts/benefits on local and regional economies. These assessments include the costs and benefits of the management commitments made within the EIS, and allows for monitoring of the social response to these management actions in the implementation and operational stages of the Projects. As an example of this, further analysis is included Chapter 6 of the Springvale MEP EIS and the Angus Place MEP EIS.

The Centennial Coal Adaptive Management Framework is underpinned by risk. Several risk assessments have been undertaken throughout the development of the Projects to establish a risk profile and ensure that adequate management controls were identified and implemented such that risk and uncertainty could be reduced. Whilst not exhaustive, the key risk areas for the Springval MEP and the Angus Place MEP are:

- Mine design, and its associated subsidence effects resulting in significant or unexpected environmental and social consequences.
- Impacts to State and Federally listed groundwater dependent ecosystems, namely THPSS.

- Impacts to ecosystems of the Upper and Lower Coxs River from water discharges, including impacts to the Sydney Drinking Water Catchment.

As these key risk areas have also been identified by the IESC and the questions presented to that Committee by the joint submission from the Department of Planning and Environment and the Department of the Environment, generalised consideration of these has been included in this section of the RTS. The specific issues raised in submissions on these risk areas are dealt with under **Section 3.1.15** of the RTS.

Other impacts and benefits, including amenity, traffic and agricultural suitability are dealt with individually within the RTS.

2.3 Mine Design

Underground mining at the Angus Place Colliery commenced in 1979, whilst underground mining at the Springvale Mine commenced in 1993. Monitoring of the environment on the Newnes Plateau substantially commenced in 2002. Monitoring of the underground mining conditions has been ongoing since the mining operations commenced.

Monitoring data is collected using a range of techniques as detailed below.

Monitored Parameter	Methodology Used
Geological and geotechnical constraints	Landsat photo imagery interpretation Aerial photo interpretation Aeromagnetic data interpretation Surface lineament trends Geological mapping Geotechnical mapping Extensometer data trends (including the use of underground telltales) Longwall support hydraulic pressure trends Internal reports on underground mining conditions Exploration borehole data (cores, geophysical logging)
Surface water (commenced in 2002)	Flow gauges
Groundwater (commenced in 2002)	Standpipe piezometers Vibrating wire piezometers
Ecology (commenced in 2003)	Unmanned aerial vehicle surveys LiDAR Ground truthing using quadrats/transects Standpipe piezometers Ecotoxicology testing
Subsidence (ongoing since 1995)	LiDAR Subsidence lines

As detailed in Chapter 2 and Chapter 8 of the Springvale MEP EIS and the Angus Place MEP EIS, this data is analysed to establish the extent to which geological and geotechnical factors can influence

subsidence outcomes on sensitive surface features. By adopting these multiple lines of evidence, changes that occur at one location in space can be placed into the context of the surrounding environment.

As described in Chapter 8 of the Springvale MEP EIS and the Angus Place MEP EIS, both the Angus Place Colliery and the Springvale Mine have had a history of difficult geotechnical conditions. Due to these conditions, significant effort has been expended on understanding the underground mining conditions that could result in roof failures, thereby placing personnel and equipment at risk.

Roof conditions are generally poorest where major geological structures are present within the mined seam and high vertical and horizontal stresses occur. Coincident with this, surface expression of subsidence is greatest when geological structures have strong surface expression (typically as deep valleys/gorges) and, in the case of Springvale Mine and Angus Place Colliery, are recognised as basement faults from aeromagnetic data.

For both the Springvale Mine Extension Project and the Angus Place Mine Extension Project, Centennial Coal has implemented a management strategy to avoid or minimise the impacts to sensitive surface features:

1. Avoid mining under the sensitive surface feature; or
2. Where avoidance is not possible, mine design under the sensitive surface feature has a sub-critical void width.

A sub-critical void width of 261 metres with chain pillars at least 55 metres wide will be implemented at Springvale Mine for longwalls 416 to 431.

An extensive history of variable longwall widths has been implemented at both the Angus Place Colliery and the Springvale Mine. The following table summarises this history (tables have been offset for timing). Importantly, monitoring of subsidence across variable longwall widths has been ongoing since the 1980s and the monitoring of underground geotechnical conditions has been ongoing since 1998. As such, there is a significant set of data that has been used to calibrate the subsidence predictions under various mine designs.

Springvale Longwalls

Longwall	Width (m)	Start Date	Finish Date
No 1	254	10/02/95	31/01/96
401	256	31/03/96	31/01/97
402	255	28/02/97	30/11/97
403	255	31/01/98	30/11/98
404	265	31/01/99	28/02/00
405	265	10/04/00	26/03/01
406	265	27/05/01	23/01/02

Angus Place Longwalls

Longwall	Width (m)	Start Date	Finish Date
1	144	31/08/79	25/05/80
2	144	26/08/80	8/12/80
3	144	16/02/81	6/07/81
4	144	11/08/81	13/11/81
5	144	16/02/82	15/06/82
6	144	13/07/82	18/11/82
7	144	17/01/83	1/08/83
8	214	10/08/83	14/12/84
9	214	28/03/85	8/07/86
10	214	18/08/86	27/08/87
11	214	10/11/87	24/10/88
12	212	8/12/88	2/09/89
13	212	28/09/89	25/06/90
16	212	24/10/90	9/09/91
17	212	4/11/91	28/10/92
18	212	4/01/93	13/12/93
19	212	19/03/94	5/03/95
20	230	25/04/95	7/05/96
21	260	17/06/96	17/10/97
22	260	2/12/97	11/12/98
23	260	4/01/99	26/11/99

407	265	28/03/02	9/01/03	24	260	20/12/99	29/12/00
408	266	20/02/03	18/12/03	25	260	21/02/01	19/12/01
409	266	18/02/04	10/12/04	26	260	14/02/02	11/12/02
410	315	9/02/05	19/01/06	26N	260	20/02/03	30/09/03
411	315	10/03/06	26/10/07	(27) 920	252	2/03/04	18/10/05
412	315	14/12/07	22/06/09	930	252	19/12/05	11/02/07
413A	315	7/08/09	1/04/10	940	252	27/03/07	23/06/08
413B	315	20/05/10	29/12/10	950	283	8/08/08	15/02/10
414	315	11/02/11	21/11/11	960	284	7/04/10	5/07/11
415	261	15/03/12	16/09/13	970	284	24/08/11	8/10/12
416	261	23/09/13	19/08/14	980	268	29/11/12	11/03/14
417	261	11/10/14	30/06/15	900W	284	30/04/14	15/02/15

Sub-critical longwall extraction void widths will be implemented at the Angus Place Colliery in the vicinity of sensitive surface features. The majority of sensitive surface features have been avoided during the mine design phase of the Angus Place MEP.

Of critical importance to the sub-critical void width is the subsequent management of the continuous height of fracturing as a result of this mine design change. A significant body of work undertaken over the last 40 years on the issue of hydraulic connection and underground mining has been used as evidentiary input into the height of fracturing model undertaken by DgS (2014) for the Springvale MEP and Angus Place MEP. Reference to work undertaken by Holla (1987, 1989, 1991), Mills and O'Grady (1998), Gale (2008) and Mills (2011), amongst others, was included in the peer review of the DgS model undertaken by MSEC (2014). Research published by the Australian Coal Association Research Program (ACARP) and undertaken by CSIRO (2007) (ACARP C14033) and SCT (2008) (ACARP C13013) highlights that the impact of mining induced fractures depends on a complex combination of the mining geometry and the lithology and geology of the overburden strata.

This conclusion contrasts significantly with that of Tammetta (2014) and the IESC Reports. Notably, these reports ignore the work of DgS, which is considered by several peer reviewers as a superior model due to its basis in geotechnical theory, alignment with Australian conditions and inclusion of geological stratigraphy as a key variable in determination of height of continuous and discontinuous fracturing.

This approach has avoided direct impacts to 97% of cliffs and pagodas, 5 shrub swamps (and numerous hanging swamps), all major water courses (including Carne Creek and Wolgan River) and all but four (4) aboriginal archaeology sites. Centennial acknowledges that indirect impacts, particularly to THPSS and the tributaries of major watercourses, have the potential to occur within the Springvale MEP and Angus Place MEP Project Application Areas, and beyond. These indirect impacts have been considered in detail within the respective subsections of Chapter 10 of each EIS, and further detailed in specific responses in the RTS.

The following table illustrates the variable longwall widths proposed to be utilised for the Angus Place MEP and Springvale MEP.

Springvale Longwalls

Longwall	Width (m)
418	261
419	261
420	261
421	261
422	261
423	261
424	261
425	261

Angus Place Longwalls

Longwall	Width (m)
1002	293
1001	293
1003	293
1004	261
1005	261
1006	261
1007	360
1008	360

Springvale Longwalls

Longwall	Width (m)
426	261
427	261
428	261
429	261
430	261
431	261
432	229
501	261
502	243
503	236

Angus Place Longwalls

Longwall	Width (m)
1009	360
1010	360
1011	360
1012	360
1013A	360
1013B	360
1014A	360
1014B	360
1015	360
1016	261
910	210

All documentation supporting this research, investigations and outcomes is available on the Centennial Coal website, www.centennialcoal.com.au.

2.4 Impacts to State and Federally Listed Endangered Ecological Communities

Centennial Coal has acknowledged the importance of the THPSS in the landscape. Research conducted over the last 5 years (2009 to 2014) by the University of Queensland has worked towards quantifying the nature and extent of the community across the Newnes Plateau. Further work undertaken through the Enforceable Undertaking has been targeted towards:

- The nature and extent of THPSS;
- THPSS water balances;
- Functionality of swamps;
- Environmental history and origins;
- Ecology/biodiversity of major structural species;
- Contribution to the landscape;
- Condition status/mapping;
- Monitoring of selected reference sites; and
- Thresholds for recovery.

Details of the Enforceable Undertaking, and the underlying Research Program are available on the Department of Environment website at http://www.environment.gov.au/news/2011/10/21/centennial-coal-fund-145-million-research-program

The University of Queensland is currently conducting research on communities identified as temperate treeless palustrine swamps in a 268 square kilometre area which includes the Newnes Plateau. Based on publicly available combined mapping from the temperate zone of New South Wales and manual interpretation of the numerous vegetation classifications used, a region containing more than 1000 shrub swamp communities per degree of latitude/longitude was identified which contained the communities mapped as Newnes Plateau shrub swamps. A report based on the research will be published and finalised in 2015.

In 2010, the University of Queensland, via funding from the Australian Coal Association Research Program (ACARP) commenced an investigation into the potential of small unmanned aerial vehicle (UAV) platforms to capture imagery of THPSS. The purpose of the research was to establish whether

this technology could be used to develop monitoring tools for detecting change in condition and composition of THPSS communities that may then be correlated to potential impacts from underground mining. The project was successful in generating multi-spectral orthophoto mosaics with resolutions of less than 10 centimetres, resulting in greater coverage of THPSS communities in remote and difficult to access locations. The ACARP report was published in September 2014.

Further research published in 2015 by the University of Queensland includes:

- Brownstein, G, Blick, R, Johns, C, Bricher, P, Fletcher, A, Erskine, P.D. *Optimising a Sampling Design for Endangered Wetland Plant Communities: Another Call for Adaptive Management in Monitoring,* Wetlands 35 (2015) 105 to 113.

- Johns, C, Brownstein, G, Fletcher, A, Blick, R, Erskine, P.D. *Detecting the effects of water regime on wetland plant communities: Which plant indicator groups perform best?* Aquatic Botany 123 (2015) pp 54 to 63.

These papers identify the need to move away from point source monitoring towards a more adaptive monitoring regime supported by clear monitoring objectives and trigger values that identify ecosystem trends where management intervention is required.

Ultimately, it is the swamp condition and health that will determine whether there has been a significant impact. To assist in understanding how to establish impacts, the University of Queensland have developed a Monitoring Handbook, titled Flora monitoring methods for Newnes Plateau Shrub Swamps and Hanging Swamps (2014). This Monitoring Handbook identifies that there are three environmental factors with affect floristics (1) geology, through subsidence responses, (2) hydrology (including water quality, groundwater level, flow and infiltration) and (3) flora composition and condition. The Monitoring Handbook identifies performance indicators for vegetation monitoring that take into consideration these factors and their effects on swamp health. Three trigger levels have been established and will be used to determine impacts, when measured against a baseline:

- Reduction in live vegetation cover of more than 20% within the community, compared with baseline data;
- A single patch of non-vegetative cover greater than 400m^2 doubles in size compared with baseline data; and
- A significant increase in exotic species cover compared with the baseline data.

The Monitoring Handbook includes a statistically valid sampling design capable of recording change as a result of exceedance of these triggers.

Chapter 2 of the Springvale MEP EIS and the Angus Place MEP EIS describes in detail the research and monitoring outcomes that have been undertaken by Centennial Coal on THPSS of the Newnes Plateau since 2002. This body of data, complemented by a specific exploration drilling program conducted in 2011 and 2012 (incorporating 17 fully cored holes and analysis of a further 84 existing exploration holes with geophysical data) has confirmed a number of assumptions regarding the formation of THPSS, including:

- There are over 3200 THPSS in the Blue Mountains and Southern Highlands, forming over 15000 years ago, and ranging in size from 400m^2 to 42 hectares (Fryirs, 2013).
- Geology plays a critical role in the formation of swamps, as evidenced by the comprehensive exploration program of the upper geological sequence.
- THPSS typically form where aquitards within the Burralow Formation (highest geological unit on the Newnes Plateau) direct groundwater flow laterally into incised valleys and gorges.
- The YS4 (SP4 in CSIRO COSFLOW Model) aquitard within the Burralow Formation plays a significant role in separating the upper and lower perched aquifers on the Newnes Plateau and is the aquitard above which most THPSS form.

- The thicker the Burralow Formation, the larger the THPSS.
- THPSS also form within the Banks Wall Sandstone, below the Burralow Formation, however, these swamps are generally narrower and less extensive than those that form within the Burralow Formation.
- THPSS have variable hydrology, ranging from periodically waterlogged in the upper reaches and permanently waterlogged in the lower reaches.
- Vegetation characteristics of THPSS[7] are closely associated with local hydrology, meaning that the vegetation within a swamp can be as diverse and the vegetation between swamps.
- Changes in water level within, and around a swamp, have not been found to result in a long term change to ecosystem health (noting that some swamps on the Newnes Plateau have been monitored for over 10 years).
- The difference in pre and post mining groundwater levels are attributable to near surface aquitards of the Burralow Formation as evidenced through the calibration and validation pf piezometric data.
- Measured strains at Springvale and Angus Place have been in excess of 0.5mm/m tensile and 2mm/m compressive, without causing measurable impacts to groundwater levels in THPSS.
- Impacts to THPSS have occurred where measured strains have been above 5mm/m tensile and 10mm/m compressive, which has occurred only where longwall panel width is in the critical range.
- Swamp water level fluctuations show a strong correlation to the cumulative rainfall deviation and no relationship to longwall mining.
- Water discharged from underground mining operations is the primary contributing factor to mining related impacts on THPSS.
- There is no evidence of severe impacts to THPSS health as a result of mining related subsidence.

A comprehensive analysis of the impacts of mining on THPSS of the Newnes Plateau was included in Chapter 2 of the Springvale MEP EIS and the Angus Place MEP EIS, and has been detailed further in response to the IESC Reports in the Response to Submissions. Specifically, a number of factors must occur together in order for a mining related impact to manifest within THPSS. These are detailed in Chapter 2 of the Springvale MEP EIS and the Angus Place MEP EIS, and are further discussed in **Section 3.2.8** of the RTS. In summary:

- Prolonged surface flows at rates of up to 12Ml/day (in the case of impacts to East Wolgan Swamp, this was through licensed discharge from the underground mining operations);
- intersection of major geological fault structures;
- orientation of the longwall panel sub-parallel to the major structures;
- steepness and depth of the valley within which the swamp occurs;
- prevailing in-situ stress direction and magnitude (for example, Springvale longwalls sub-perpendicular to principal horizontal stress direction);
- critical width longwall panel design;

[7] The State listed Newnes Plateau Shrub Swamps (NPSS, MU50) and Newnes Plateau Hanging Swamps (NPHS, MU51) were described in the 2006 listing as low dense fern-dominated communities usually perched on a hillside with few trees present and are groundwater dependent. The listing for NPHS was based on two sites, the listing for NPSS was based on seven sites.

- location of the geological structure close to the permanent barrier pillar; and
- interaction of adjacent mine workings and subsidence effects due to close proximity.

Removing any one of these factors will reduce the likelihood and severity of mining related impacts on THPSS. Through the removal of two of these factors, prolonged surface flows through licensed discharge and implementation of sub-critical longwall panel design, the likelihood and severity of impacts on THPSS is reduced to negligible. An impact that is not negligible in this case is defined as an impact that results in a long-term change in swamp hydrology, water quality or floristic composition. This would include fracturing the rock strata beneath the swamp, evident through an extended (longer than that recorded in reference sites during the same period) reduction in groundwater levels.

Centennial's investment in understanding the nature, extent, occurrence and functionality of THPSS has spanned over a decade and run into many millions of dollars. This has resulted in a high level of confidence in the modelled outcomes, management actions and mitigation strategies adopted and implemented at both the Springvale Mine and Angus Place Colliery. As such, the risk of significant impact to THPSS has been reduced to negligible.

Despite the evidence to support that the changes to the mine design will provide an adequate level of protection for THPSS (that is, not result in a significant impact), Centennial has undertaken to provide a hierarchical management strategy for the THPSS within the respective Project Application Areas for the Springvale MEP and the Angus Place MEP. This management strategy is premised on no direct impacts to THPSS, therefore there is no requirement to provide a direct/like for like offset for the community[8].The Regional Biodiversity Strategy includes a management strategy (detailed below) for the management of indirect and residual impacts to THPSS where mitigation measures are not successful.

This management strategy, and the approach to developing it, is described in detail in the RTS, and summarised below:

- To ensure impacts to THPSS are within those predicted within the Springvale MEP EIS and the Angus Place MEP EIS, Centennial will:
    - Undertake annual monitoring for ecosystem health using the University of Queensland Monitoring Handbook (Flora monitoring methods for Newnes Plateau Shrub Swamps and Hanging Swamps, 2014) or its latest version.
        - The objectives of the University of Queensland Monitoring Handbook include, amongst other things:
            - A focus on vegetation community structure and diversity, including biological indicator species.
            - Trigger values focussed on detecting impacts of subsidence and/or changes in groundwater and surface water flows, including information on how the triggers were derived.
            - A sampling design that is statistically capable of detecting changes in the indicator variables.
            - An adaptive management mechanism for refining trigger values and determining the length of time a THPSS is monitored.
        - The following figure, taken from the Monitoring Handbook, identifies how the data collected will be used to inform management decision making.

[8] This is consistent with the application of the EPBC Offsets Policy and the NSW Offsets Policy for Major Projects.

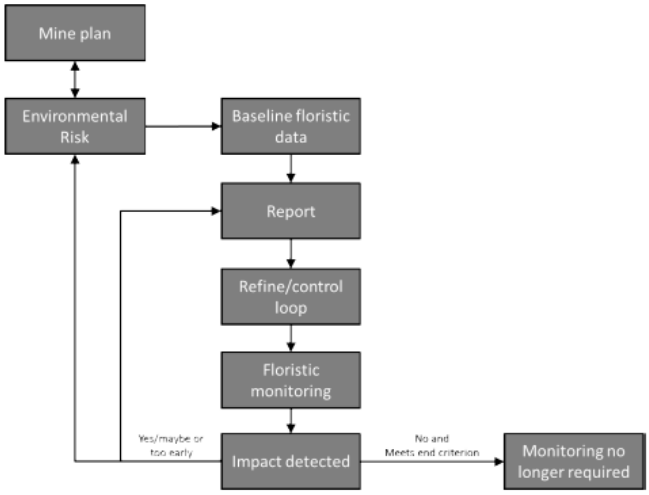


Figure 4.1: Conceptual framework showing how data from flora monitoring informs the environmental risk assessment and monitoring conclusions.

- Where this monitoring identifies mining related impacts, mitigation measures will be implemented (including soft and hard engineering measures discussed further in the RTS).
- Reconcile the annual monitoring every five (5) years (to allow for trend analysis to occur).
  - Where impacts, attributable to mining, are above triggers, additional mitigation will be undertaken.
  - Where impacts are attributable to mining and cannot be mitigated, or mitigation is not successful, offsets for the residual impacts will be provided.

Residual impacts may result in complete or partial loss of a swamp community. The mechanism to measure the extent of this loss is defined within the University of Queensland Monitoring Handbook through figure 4.1 above. This mechanism may equate to a reduced condition score for the swamp community.

A residual impact in this case is defined as an impact that indicates a long-term change in swamp hydrology, water quality or floristic composition. This would include fracturing the rock strata beneath the swamp, evident through an extended (longer than that recorded in reference sites during the same period) reduction in groundwater levels[9].

The Springvale and Angus Place Mine Extension Projects include 96.6 hectares of THPSS, comprising those listed in the following table, noting that this includes THPSS within the 26.5 degree angle of draw.

MU	Swamp Type	Size (ha)	Swamp Name	Comments
SPRINGVALE				
50	Newnes Plateau Shrub Swamp	22.77	Gang Gang Swamp East / Gang Gang Swamp South West	Mapped as one combined swamp system
50	Newnes Plateau Shrub Swamp	12.35	Marrangaroo Creek Swamp	
50	Newnes Plateau Shrub Swamp	12.24	Carne West Swamp	
50	Newnes Plateau Shrub Swamp	6.67	Paddy's Creek Swamp	Extends outside of the subsidence extents and PAA

[9] As defined by the EPBC 2011/5949 definition for severe impact.

MU	Swamp Type	Size (ha)	Swamp Name	Comments
				an additional 0.64 ha
50	Newnes Plateau Shrub Swamp	2.7	Sunnyside East Swamp	
50	Newnes Plateau Shrub Swamp	2.62	Pine Swamp	Nine Mile Swamp and Pine Swamp are mapped as one combined swamp system, with a total area of 17.05 ha; 2.18 ha of which is outside SV SA/PAA
50	Newnes Plateau Shrub Swamp	1.67	Pine Upper Swamp	
50	Newnes Plateau Shrub Swamp	0.92		
50	Newnes Plateau Shrub Swamp	0.74	Nine Mile Swamp	Nine Mile Swamp and Pine Swamp are mapped as one combined swamp system, with a total area of 17.05 ha; 2.18 ha of which is outside SV SA/PAA
Total	**9**	**62.68**		
51	Newnes Plateau Hanging Swamp	2.21	Marrangaroo Slopes Hanging Swamp	
51	Newnes Plateau Hanging Swamp	1.52		Swamp attached to Paddy's Creek shrub swamp system. Extends outside subsidence extents and totals approximately 5.32 ha
51	Newnes Plateau Hanging Swamp	1.23		
51	Newnes Plateau Hanging Swamp	1.14	Carne West Hanging Swamp	
51	Newnes Plateau Hanging Swamp	0.96	Pine Swamp Hanging	
51	Newnes Plateau Hanging Swamp	0.9		
51	Newnes Plateau Hanging Swamp	0.85		
51	Newnes Plateau Hanging Swamp	0.71		
51	Newnes Plateau Hanging Swamp	0.7		
51	Newnes Plateau Hanging Swamp	0.41		
51	Newnes Plateau Hanging Swamp	0.41		
51	Newnes Plateau Hanging Swamp	0.36		
51	Newnes Plateau Hanging Swamp	0.33		
51	Newnes Plateau Hanging Swamp	0.25		
51	Newnes Plateau Hanging Swamp	0.24		
51	Newnes Plateau Hanging Swamp	0.23	Pine Swamp Hanging	
51	Newnes Plateau Hanging Swamp	0.21		Extends outside of the subsidence extents; total swamp size 1.15 ha
51	Newnes Plateau Hanging Swamp	0.2	Gang Gang South Hanging	
51	Newnes Plateau Hanging Swamp	0.18		Extends outside of the subsidence extents; total swamp size 0.95 ha

MU	Swamp Type	Size (ha)	Swamp Name	Comments
51	Newnes Plateau Hanging Swamp	0.16		Extends outside of the subsidence extents; total swamp size 0.31 ha
51	Newnes Plateau Hanging Swamp	0.1		Originally mapped as a shrub swamp by DEC (2004). System extends to the south of subsidence extents and totals approximately 1.73 ha
Total	**21**	**13.31**		
52	Newnes Plateau Rush - Sedge - Snow Gum Hollow Wooded Heath	0.58		
Total	**1**	**0.58**		
Combined Total	**31**	**76.57**		
ANGUS PLACE				
50	Newnes Plateau Shrub Swamp	4.29	Trail Six (Japan) Swamp	Was originally mapped as a hanging swamp by DEC (2004); Groundtruthed as shrub swamp by RPS
50	Newnes Plateau Shrub Swamp	1.83	Twin Gully	Swamp extends outside the subsidence extents to the west; is approximately 2.91 ha in total
50	Newnes Plateau Shrub Swamp	4.16	Tri-Star Swamp	
50	Newnes Plateau Shrub Swamp	0.05		Part of a swamp that extends to the south of subsidence extents and totals 0.34ha
Total	**4**	**10.33**		
51	Newnes Plateau Hanging Swamp	1.19		Swamp extends outside the subsidence extents to the south; totals approximately 4.81 ha.
51	Newnes Plateau Hanging Swamp	0.49		
51	Newnes Plateau Hanging Swamp	0.4		
51	Newnes Plateau Hanging Swamp	0.22		
51	Newnes Plateau Hanging Swamp	0.79		
51	Newnes Plateau Hanging Swamp	0.12		Swamp extends outside the subsidence extents to the west; totals approximately 0.27 ha
51	Newnes Plateau Hanging Swamp	0.95	Trail Six (Japan) Swamp	Swamp extends slightly outside the subsidence extents to the north; totals approximately 1.02 ha
51	Newnes Plateau Hanging Swamp	0.23		
51	Newnes Plateau Hanging Swamp	0.16		
51	Newnes Plateau Hanging Swamp	0.58		
51	Newnes Plateau Hanging Swamp	0.19		
51	Newnes Plateau Hanging Swamp	0.57		
51	Newnes Plateau Hanging Swamp	0.28		
51	Newnes Plateau Hanging Swamp	0.1		

MU	Swamp Type	Size (ha)	Swamp Name	Comments
51	Newnes Plateau Hanging Swamp	0.46		
51	Newnes Plateau Hanging Swamp	0.08		
51	Newnes Plateau Hanging Swamp	0.13		
51	Newnes Plateau Hanging Swamp	0.43		Swamp extends slightly outside of the subsidence extents to the east; totals approximately 0.54 ha
51	Newnes Plateau Hanging Swamp	0.16		Swamp extends slightly outside of the subsidence extents to the east; totals approximately 0.39 ha
51	Newnes Plateau Hanging Swamp	0.18		
51	Newnes Plateau Hanging Swamp	0.11		
51	Newnes Plateau Hanging Swamp	0.41		
51	Newnes Plateau Hanging Swamp	0.18		
51	Newnes Plateau Hanging Swamp	0.21		Part of a swamp that extends to the east of subsidence extents that totals 1.21 ha
51	Newnes Plateau Hanging Swamp	0.19		Part of a swamp that extends to the south of subsidence extents that totals 1.11 ha
51	Newnes Plateau Hanging Swamp	0.9		Swamp extends outside of subsidence extents to the west; totals approximately 1.66 ha
Total	**26**	**9.71**		
Combined Total	**30**	**20.04**		
SV/AP Combined	**61**	**96.6**		

Within the Newnes State Forest there are over 345 hectares of swamps that have not, and will not be mined under. The following table summarises the proportion of THPSS within and outside the Project Application Areas and outside the 26.5 degree angle of draw. These data do not include THPSS that occur over the Clarence Colliery, which may or may not be mined under.

Area	Swamp Type	Size (ha)	Comments
Outside PAAs and Subsidence	Shrub Swamp	91.33	
Outside PAAs and Subsidence	Hanging Swamp	56.05	
Total		**147.38**	
Within PAAs/Outside Subsidence	Shrub Swamp	83.88	These numbers do include some swamps that partially extend into predicted subsidence extents, and therefore the whole system may be potentially impacted upon. Some swamps also extend outside the PAA, but calcs are only for those areas within the PAA.

Area	Swamp Type	Size (ha)	Comments
Within PAAs/Outside Subsidence	Hanging Swamp	66.47	These numbers do include some swamps that partially extend into predicted subsidence extents, and therefore the whole system may be potentially impacted upon. Some swamps also extend outside the PAA, but calcs are only for those areas within the PAA.
Within PAAs/Outside Subsidence	Rush/Sedge Wooded Heath	47.99	
Total		**198.34**	

In recognition of the uncertainty regarding securing land for an offset, additional analysis of available metadata across an area of 300,000 hectares has been undertaken by the University of Queensland. By using a range of environmental metadata, including elevation, temperature, rainfall, aspect/slope, vegetation mapping characteristics, flora monitoring data, structural floristic composition as well as proximity to existing conservation areas and lot sizes. This has identified a number of potential swamps held on private land.

Before offsets are provided, mitigation measures must have failed. Centennial Coal has undertaken an extensive remediation program on the Newnes Plateau. This program has included contributing to the Save our Swamps Program, administered through the Blue Mountains City Council, and undertaking direct remediation works for Narrow Swamp and East Wolgan Swamp. These works incorporated the remediation methodology developed by the Save Our Swamps Program and included the development of a monitoring plan designed to measure the success of restoration actions, integrity of engineering structures, vegetation monitoring, and water and soil moisture monitoring.

The remediation program for East Wolgan Swamp was supervised by officers from the Office of Environment and Heritage and the rehabilitation activities were reviewed by members of the International Mire Conservation Group. These works have demonstrated an ability to sensitively remediate not only the surface integrity of an impacted swamp (regardless of the impact), but also sub-surface and bedrock impacts through the application of bentonite.

The combination of ecosystem health monitoring, the mitigation measures described above, and the THPSS management strategy (including offsets for residual impacts) is considered to adequately compensate for the indirect impacts to THPSS.

ATTACHMENT 4

CENWEST ENVIRONMENTAL SERVICES
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ABN 39 146 443 847

Mr Alex Taylor
Assistant Director
EPBC Compliance Monitoring Team
Compliance and Monitoring Branch
Environment Assessment and compliance Division.
24th September 2014

Dear Mr Taylor,

Re: Peer Review of Angus Place Revised THPSS Monitoring and Management Plan

As you would be aware SEWPAC engaged Cenwest Environmental Services in 2010 to provide independent advice to determine whether or not a significant impact had occurred on Temperate Highland Peat Swamps on Sandstone (THPSS) within the Angus Place Colliery Lease on the Newnes Plateau. Cenwest[1] identified significant and adverse impacts to some Temperate Highland Peat Swamps, but not to all THPSSs that had been undermined by Long Wall Mining in both Angus Place and Springvale Collieries. Such adverse impacts were not evident in control sites that had not as yet been undermined or would not be undermined. Cenwest's report detailed a number of criticisms re the then THPSS monitoring program including the sub-optimal practice of relying on a single 20m square quadrat/swamp to determine any potential impacts from Long Wall Mining. That particular monitoring program was and is incapable of detecting either short or long-term potential impacts on THPSSs. Nevertheless it was accepted by various compliance agencies as an appropriate methodology.

Since mid-2013 I have been engaged from time to time by Centennial Coal to advise them re minimising or avoiding adverse impacts in future longwall mining operations where there is a potential for an adverse impact on THPSSs as well as peer reviewing various reports relevant to the monitoring of swamp health. These included the development of a robust floristic monitoring program within THPSSs,[2] understanding the proposed revised long-wall mining configuration to minimise subsidence, familiarising myself with the monitoring of predicted subsidence dynamics below swamps and the monitoring of within swamp hydrological dynamics using piezometer arrays. I am writing to you regarding my peer review of the Angus Place EPBC 2011/5952 THPSS Monitoring and Management Plan (MMP).

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[1] Goldney, David, Mactaggart, Barbara and Merrick, Noel (2010) Determining whether or not a significant impact has occurred on Temperate Highland Peat Swamps on Sandstone within the Angus Place Colliery lease on the Newnes Plateau. Cenwest Environmental Services.

[2] Gretchen Brownstein, Caitlin Johns, Ray Blick, Andrew Fletcher, Peter Erskine, Centre for Mined Land Rehabilitation, *University of Queensland, Flora Monitoring methods for Newnes Plateau Shrub Swamps and Hanging Swamps* ("**UQ Flora Monitoring Handbook**"), May 2014 University of Queensland Report.

The following two reports commissioned by Centennial Coal have been particularly valuable in providing important insights into developing robust and repeatable monitoring of THPSSs since our 2010 report:

1. Fletcher and Erskine (2014) [3]
   This pivotal paper outlines a robust and rigorous methodology for monitoring THPSSs using a range of methods including the use of small UAV platforms to capture remotely sensed imagery of a shrub swamp community thereby enabling the detection of change in condition and composition of a THPSS that can be correlated with potential impacts from longwall underground mining. This technology is integrated with an equally robust field monitoring program using distributed - mini-plots, randomised and stratified and designed to minimise trampling impacts by field scientists. The outcome is a robust and achievable monitoring program with the power to determine if an adverse impact has occurred within a particular THPPS as a result of longwall mining.

2. McHugh (2013)[4] has demonstrated the importance of recognising the Burralow geological formation in the Narrabeen series in regard to swamp formation and integrity. McHugh demonstrated the greater than expected thickness of the Burralow Formation, the presence of aquitards in the formation and hence the more-or-less permanent water sources important for the formation and maintenance of hanging swamps. The aquitards are also an important source of water for maintaining the Newnes Plateau Shrub Swamps. Hence it is not surprising that the majority of the shrub swamps are located within the confines of the Burralow formation, occurring in much broader and gently sloping depressions that are usually waterlogged in the lower reaches. In contrast Banks Wall-type and 'mixed-type' shrub swamps are generally smaller in area and located on steep-sided gullies and have less access to seepage at discharge points. Furthermore McHugh rightly argues that 'The occurrence of the Newnes Plateau Shrub Swamps are multifactorial involving a complex interplay between topography, hydrological regimes and geology'.

It follows from these understandings that programs designed to monitor THPSSs need to integrate contemporary understandings of geology, hydrology and ecology of THPSSs. Some of the research carried out during the course of the development of the monitoring program has already been published in peer reviewed journals and more such peer-reviewed papers are to come or in the pipeline. Furthermore the THPSS MMP monitoring program is also embedded in a wider program seeking to better understand variability within swamps as well as across the landscape.

Centennial Coal well understands that any changes to the vegetation of a THPSS is a tertiary response and therefore it follows that it is important to integrate vegetation monitoring with groundwater and subsidence monitoring, as well as with longwall design aimed to minimise or completely avoid adverse impacts on THPSSs. This integration of monitoring methods is achieved in the integrated management plan.

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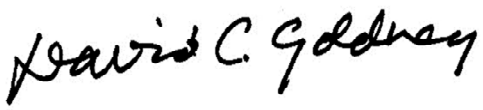
[3] Fletcher, Andrew and Erskine, Peter (2014) Monitoring surface condition of upland swamps subject to mining subsidence with very high-resolution imagery. Centre for Mined Land Rehabilitation, University of Queensland, St Lucia 4072.

[4] McHugh, E. (2013) The Geology of Shrub Swamps within Angus Place/Springvale Collieries.

I have much pleasure in commending the proposed **UQ Flora Monitoring Handbook** to you. Further, in the light of the positive advances in the Handbook, I am able to advise you that I have now completed my Peer Review of the THPSS MMP as required.

I would also like to congratulate Centennial Coal Pty Ltd for readily embracing and facilitating this new and robust monitoring paradigm that will likely lead to safeguarding THPSS integrity and health within their mining domain.

Yours Sincerely



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ATTACHMENT 5: LIST OF REFERENCES

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