



FINAL REPORT

Peer review of economic assessment

Angus Place, Springvale and Airly Mine Extension Projects

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Summary

The CIE has been engaged by the NSW Department of Planning and the Environment (The Department) to peer review the economic assessments produced by Aigis Group (Aigis) for three coal mine projects (the Projects):

- Springvale Colliery Mine Extension Project,
- Angus Place Colliery Extension Project, and
- Airly Coal Mine Extension Project.

Overview of the Aigis Group's analysis

Table 1 below provides a summary of the Cost Benefit Analyses (CBA) of the Projects conducted by Aigis. The Cost Benefit Ratio (CBR) is intended to provide a summary of the overall value for money of each project. The Angus Place and Springvale Coal Mine Extension Projects were assessed to have a CBR of 10.8 and 11.6 respectively, indicating that the economic, environmental, and social benefits are over 10 times greater than the costs. The Airly Coal Mine Extension Project was estimated to have a more modest CBR of 4.0. Across the Projects, the Aigis Group's analysis suggest that the economic benefits of employment wages and coal royalties, in particular, are expected to significantly outweigh the environmental and social costs associated with reduced soil and land capability, biodiversity, and heritage.

1 Magnitude of the costs and benefits quantified

Parameter	Angus Place	Springvale	Airly Mine
	NPV (\$ million)	NPV (\$ million)	NPV (\$ million)
Economic benefits			
Employment wages	473	648	102
Coal royalties	203	201	120
Government taxes	55	22	86
Mitigation provisions	38	30	35
Economic costs			
Noise	0.39	1.5	1.5
Subsidence	14.3	16.4	20.1
Soil and land capability	16.4	16.4	20.1
Surface water & groundwater	14.3	16.4	20.1
Air	0.26	0.3	0.3
GHG emissions	10.1	6.4	1.4

Parameter	Angus Place	Springvale	Airly Mine
	NPV (\$ million)	NPV (\$ million)	NPV (\$ million)
Heritage	14.4	16.5	20.1
Biodiversity	0.61	3.5	0.6
Visual amenity	0.42	0.2	0.6
Cost benefit ratio	10.8	11.6	4.0

Sources: Aigis Group, Angus Place Colliery Extension Project, Economic Impact Assessment, March 2014, Springvale Colliery Mine Extension Project, Economic Impact Assessment, March 2014, Airly Mine Extension Project, Economic Impact Assessment, August 2014.

CIE's findings

- Overall, the CBAs for the Projects have been undertaken in a manner that is inconsistent with well-established principles and the NSW Government's November 2012 *Guideline for the use of CBA in mining and coal seam gas proposals*. The analysis presented also lacks transparency and it is, therefore, difficult to verify the calculations undertaken.

Inconsistency with NSW Government guidelines

The economic impact assessment of the Airly Mine Extension Project notes that:

The approach taken in this report may be considered as being unorthodox in the context of the use of cost benefit analysis techniques. However, the intent is to produce material, which facilitates 'lay' stakeholders to better comprehend the analysis presented, as it relates to project impacts likely to be of greater significance to such stakeholder groups.¹

This approach was also adopted in their review of the Angus Place Mine Extension Project and the Springvale Colliery Mine Extension Projects (the Projects). This analytical approach is inconsistent with the NSW Government Guidelines published in 2012 for the use of CBA in mining and coal seam gas proposals and other key principles of CBA.

Some examples of the inconsistencies include:

- The analysis excludes the benefits (revenue) and costs to the Proponent.
- Instead, the CBA effectively assumes that most of the proportion of the mine's expenses spent locally (mainly wages) is a net economic benefit to the community. However, this is likely to significantly overstate the true net economic benefit because it implicitly assumes that the opportunity cost of the resources used as inputs into the mine (including labour) are zero.
- Biodiversity offset provisions are inappropriately included as a benefit. The costs of purchasing biodiversity offsets should be incorporated as part of the capital/operating costs of the mine. No evidence is provided to suggest that the benefits are higher than the cost of purchasing the offsets.

¹ Aigis Group, Airly Mine Extension Project, Economic Impact Assessment, August 2014.

- The costs of project impact controls and mitigation are also inappropriately included as a benefit. These costs are presumably designed to prevent environmental damage and should be incorporated as part of the cost base.

Lack of transparency

There are a wide range of calculations that require greater clarity. For example, assumptions regarding future coal prices are not clear, nor the deductions assumed in the royalties calculations. The assumed production profile used to estimate the royalties is also not clear.

As noted earlier, there is no indication of the capital and operating costs. The reasoning behind the choice of some assumptions used to calculate the value of the environmental impacts are not clearly explained. Further, the source of some of the underlying data used to estimate the biophysical impacts from the extension projects are not clear and, in some instances, do not appear to be consistent with that reported in the relevant sections of the Environmental Impact Statement.

Recommendations

- **Based on our review, we believe that the economic assessments undertaken do not meet the requirements of the Guidelines. Further analysis is required by Aigis to ensure consistency with the Guidelines. Greater level of transparency is also required to allow a review of the calculations undertake, including articulating the reasoning behind the choice of any parameter values used to value the environmental impacts.**

Introduction

About the Project

The CIE has been engaged by the NSW Department of Planning and the Environment (the Department) to peer review the economic assessments produced by Aigis Group for Centennial Coal (the Proponent) for three coal mine projects (the Projects):

- ***Springvale Coal Mine Extension Project.*** Springvale Colliery's current development consent expires on 28 September 2015. The Proponent is seeking approval to continue mining beyond this date. Springvale is an underground coal mine producing high quality thermal coal. The application will allow the mine to continue to extract up to 4.5 million tonnes per annum and will extend the life of the mine for an additional 13 years with rehabilitation to be undertaken after this period.
- ***Angus Place Coal Mine Extension Project.*** The existing development consent for the lease boundary will lapse on 18 August 2024. The current approved mine plan is due to expire in March 2016. The Proponent is seeking approval to continue to longwall mining to the east of the current workings and would extend the mine life by up to 25 years. The project would use the existing surface and underground facilities with some additional infrastructure also required. Coal production of up to 4 Mtpa per annum is expected from the mine.
- ***Airly Coal Mine Extension Project.*** The current development consent will lapse on October 2015. The project will allow the underground mine to continue to extract up to 1.8 Mtpa per annum. It will extend the life of mine by 25 years from the date of consent with rehabilitation to be undertaken within this period on cessation of mining.

The Proponent of the Project, Centennial Coal, submitted its Environmental Impact Statement in 2013/14. It received a range of submissions, some of which were critical of the economic analysis undertaken.

Scope of review

The CIE has been engaged by the Department to peer review the economic assessments produced by Aigis for the Projects. The scope of the review includes an assessment of:

- whether assumptions presented are reasonable, appropriate and suitably justified,
- whether the cost benefit analysis aligns with current best practice,
- the adequacy of the methodology, analysis and assessment presented in evaluating the economic costs and benefits of the proposed development (for the Proponent, local, region and State),

- the identification of any areas of deficiency (including inconsistencies, overlaps or “double counting”) and recommendations to improve or resolve these issues in the assessment, and
- consistency of the assessment with any relevant Government guidelines (e.g. NSW Treasury (2007) Guidelines for economic appraisal and/or the NSW Government (2012) Guideline for the use of CBA in mining and coal seam gas proposals).

Cost Benefit Analysis

Features of a CBA

A CBA framework is a widely used tool for deciding *ex-ante* between alternative options (policies or projects). It allows decision makers to consider trade-offs arising from different options in order to assist decisions of whether community as a whole is better off or worse off by adopting an option.

A CBA framework is focussed on the aggregate welfare of the community, rather than the welfare of individual groups. It should take account of the full range of potential benefits and costs of the options, including environmental, health and other social impacts as well as the economic impacts. Where benefits exceed costs, the options are deemed to deliver a net benefit to the community as a whole.

Impacts are often not known with certainty.² In these circumstances the CBA needs to be presented as an expected value taking account of the a range of possible outcomes (each with a known probability of occurrence). In some circumstances, not all impacts can be readily quantified and valued in a robust manner. Decision makers will therefore need to draw on other information to complement the result of the CBA and to assist in deciding on whether society is better off from adopting an option.

The NSW Government's November 2012 Guidelines specifies the key features of a CBA in mining and coal seam gas proposals. These are summarised in Box 2 below.

2 Key features of a CBA³

- Scope — a CBA should include all first round (primary) impacts both direct and indirect but not secondary impacts.
- Estimating costs and benefits — a net public benefit or cost of a project can be calculated through the net benefit of a project less any associated public expenditure and any negative social, health or environmental impacts.
- Discount rate — a discount rate of 7 percent per annum with sensitivity testing at 4 per cent and 10 per cent per annum.
- Timeframe — a term that reflects the time horizon of the impacts of a proposal. Long-term projects should use a 50 year timeframe and a residual value where

² For the purposes of our analysis we use the term risk and uncertainty interchangeably. In theory, risk refers to events where a probability distribution can be developed whereas uncertainty refers to situations where the probability of outcomes cannot be estimated.

³ NSW Government (2012), *Guideline for the use of Cost Benefit Analysis in mining and coal seam gas proposals*, November, p2.

applicable, but this does not preclude a longer time-frame.

- Risk and Uncertainty — a ‘risk neutral’ approach to expected costs and benefits.
- Unquantified factors — decisions based on the quantified expected net benefits in conjunction with information on any impacts that cannot be valued

Defining the scope of the Project

The NSW Government’s Guidelines for Economic Appraisal provides the following guidance for defining the scope of a project:⁴

The scope of the project to be evaluated is also an important issue. Projects or programs will contain a range of elements related to one another and the point at which a discrete project can be identified will require careful judgement.

Taking this into consideration, our review of the definition of the scope of the project was guided by four questions:

- Was the scope of the CBA appropriate?
- How was the project defined and was this reasonable?
- Were the characteristics and elements of the project identified in sufficient detail to enable a robust analysis?
- Were alternative scenarios identified and considered?

Scope of the CBA

The NSW Government Guidelines provide the following guidance for defining the scope of the CBA:⁵

These benefits and costs should be estimated where possible as those that accrue to New South Wales. In the first instance, it will generally be most practical to assess all major costs and benefits to whoever they accrue and then adjust to estimate the proportion of these attributable to residents of the State.

The scope of the CBA should include all first round effects but not secondary impacts.

In terms of the geographic scope of the CBA, Aigis noted in the Angus Place Colliery Extension Project and others that:

The critical focus of the analysis is on the economic impacts of the project for the State and the Lithgow City Council (LCC) Local Government Area (LGA) communities.

In terms of the stakeholder scope of the CBAs, Aigis estimated the costs and benefits of the Projects to the local and state communities *excluding* the impact on the Proponent. That is, company profits, capital investment costs, non-labour operation costs, and any

⁴ NSW Treasury, NSW Government Guidelines for Economic Appraisal, 2007.

⁵ NSW Government, Guidelines for the use of Cost Benefit Analysis in mining and coal seam gas proposals, 2012, p.5.

potential rehabilitation costs were excluded. The implications of this methodology is discussed further below.

- **The scope of the CBA is inconsistent with the NSW Guidelines.**

Project definition

The definition of each project included the extension of the current mine, its operation, as well as a number of on-site and off-site infrastructure projects. In particular, each project scope included but was not limited to:

- the extension and operation of the current mine,
- infrastructure constructed within the Mine Area,
 - including a ventilation facility, dewatering borehole sites, water management structures, and shaft spoil emplacement area.
- other infrastructure projects such as the development of roads to key facilities.

Detail of project characteristics

The characteristics and elements of each project that were included in the articulation of the proposals included the:

- mine's location,
- type of mine,
- duration of the construction and operation phases,
- maximum extraction rate, and
- a range of off-site and on-site infrastructure projects

Alternative scenarios

Two questions are relevant when examining the alternative scenarios considered by Aigis:

- were alternative options taken into account when finalising the definition and scope of the project?
- were feasible alternative options identified and considered in the sensitivity analysis?

In regard to the former, the Proponent reportedly considered a broad range of project options, which were initially assessed from the perspective of ecological sustainability. Those project options deemed to be ecologically sustainable were assessed against a broader range of criteria including:

- economic feasibility,
- ecological impacts management and/or
- social and community impacts.

For each project, one or two alternative project options were reported to have met these criteria and were included in the sensitivity analysis. These projects typically involved alternative orientations of longwall blocks and the rates of extraction.

- **In the absence of an analysis of options, the CBA only provides an indication of the impacts of the Projects. That is, there may be alternative options (including different project staging or different mining practices) that may deliver superior results to society. The results of the CBA needed to be interpreted in this context.**

Quantifying and valuing the changes

Our review of the values attributed to cost and benefit categories identified was guided by four questions:

- Was the baseline adequately established?
- What cost and benefit categories were identified, and were these appropriate?
- What cost and benefit categories quantified and valued and how was this done?
- Were the estimated values benchmarked?

Establishing the baseline

The NSW Government Guidelines provide the following definition of the baseline or 'base case':

The 'base case' is typically a projection of the current land use case including current and committed policy settings. The base case effectively describes a business as usual scenario.

Aigis noted that in the case of Springvale Colliery and Angus Place Colliery, the baseline case would involve the cessation of mining and the closure of the collieries. That is, given that these Projects involve the extension of existing mines, it is argued that the profitability of the whole mine is dependent on receiving approval for the extension projects.

In the case of the Airly Mine, the baseline was reported to involve the continued operation of the mine on a care and maintenance basis. Aigis did not provide any evidence in support of these assumptions or indicate how the land may be used after the closures and what, if any, costs and benefits would be associated with this activity.

The establishment of a clear baseline is required to ensure that only the incremental costs and benefits attributable to the Projects are included in the CBA.

- **The validity of the baseline assumptions is difficult to assess as no evidence was provided by Aigis. We note that the recent closure of the Angus Place Colliery is broadly consistent with the base case, although this appeared to be due to a downturn in international coal markets.⁶ If mining operations ceased as the development consent has expired then, presumably, the cost of rehabilitation**

⁶ See for example, <http://www.lithgowmercury.com.au/story/2656092/closure-of-angus-place-means-devastating-job-losses/>

activities and the environmental gains from this would also need to be incorporated as part of the base case.

Cost and benefit categories identified

Table 3 shows the cost and benefit categories identified and valued by Aigis for each project.⁷ The economic cost categories were reportedly sourced from the Director General's Requirements (DGR) issued by the NSW Department of Planning and Infrastructure for the Project. The DGR, however, typically refer to the Environmental Assessment of the project and are not specific guidelines for the preparation of the CBA.

3 Cost and benefit categories identified by Aigis

Key categories identified by Aigis	Valued?
Economic benefits	
Sustained employment	Yes
Coal royalties	Yes
Other government taxes and charges	Yes
Biodiversity offset provision	Yes
Project impact controls and mitigation provisions	Yes
Economic costs	
Subsidence	Yes
Land resources	Yes
Water resources	Yes
Biodiversity	Yes
Heritage	Yes
Air quality	Yes
Greenhouse gases	Yes
Noise	Yes
Traffic and transport	No
Visual	Yes
Social and economic	No
Rehabilitation	No

Sources: Aigis Group, Angus Place Colliery Extension Project, Economic Impact Assessment, March 2014, Springvale Colliery Mine Extension Project, Economic Impact Assessment, March 2014, Airly Mine Extension Project, Economic Impact Assessment, August 2014.

The NSW Government Guidelines include a list of cost and benefit categories that determine the net public benefit of a major mining or coal seam gas project.⁸ Table 4

⁷ NSW Government, Guidelines for the use of Cost Benefit Analysis in mining and coal seam gas proposals, 2012, p.5.

⁸ NSW Government, Guidelines for the use of Cost Benefit Analysis in mining and coal seam gas proposals, 2012, p.5.

compares this list to the cost and benefit categories identified and valued by Aigis in their analysis for each project.⁹

Overall, Aigis did not identify or value the economic cost categories that would impact on the Proponent or fully estimate the gross mining revenue that would be generated from the project extensions. In this respect, the CBAs are intended to be seen from the point of view of all community stakeholders excluding the mining company. This approach is in contrast to the guidelines outlined by the NSW Government and is a key limitation of the analysis. As discussed below this has also contributed to some conceptual problems in measuring the economic benefits.

4 Summary of the identified costs and benefits

Key elements identified by NSW Government	Identified by Aigis	Valued?
Benefits		
Gross mining/onsite revenue	No	No
Costs		
Exploration costs	No	No
Capital investment costs	No	No
Operating costs	No	No
Rehabilitation costs	No	No
Revenue foregone in base case	No	No
Public expenditure		
Public expenditure relative to base case	No	No
Environmental and social impacts		
Water quality	Yes	Yes
Streams, alluvial aquifers, or alluvial soils	Yes	Yes
Air pollution	Yes	Yes
Noise pollution	Yes	Yes
Visual amenity	Yes	Yes
Traffic impacts	No	No
Carbon emissions	Yes	Yes
Biodiversity	Yes	Yes
Conservation	No	No
Quality of open spaces	No	No
Rural amenity and culture	Yes	No
Aboriginal and historical heritage	Yes	No

Notes: Gross mining revenue net of corporate income was estimated.

Sources: Aigis Group, Angus Place Colliery Extension Project, Economic Impact Assessment, March 2014, Springvale Colliery Mine Extension Project, Economic Impact Assessment, March 2014, Airly Mine Extension Project, Economic Impact Assessment, August 2014.

⁹ Centennial Coal, Angus Place Colliery Extension Project, Economic Assessment, March 2014.

Assessment of methodology for valuing economic impacts

A review of the values attributed to the cost and benefit categories involves assessing the methodology, assumptions, and data sources used to value the costs and benefits.

Table 5 summarises the methodology, assumptions and data sources used in the estimation of the most significant economic cost and benefit categories identified above.

5 Methodologies used to value key benefit categories

Costs and benefits quantified	Methodology	Key assumptions	Sources of data
Sustained employment	<ul style="list-style-type: none"> ▪ Employment projections based on current levels of employment. ▪ Methodology used to determine the number of construction positions required and wage levels of employees was not stated. 	<ul style="list-style-type: none"> ▪ Current employment levels would continue over the life of the extension project. 	<ul style="list-style-type: none"> ▪ The Proponent
Coal royalties	<ul style="list-style-type: none"> ▪ Product of the value of production and assumed royalty rate. 	<ul style="list-style-type: none"> ▪ Royalty rate of 7.2 per cent ▪ Value of production not stated. 	<ul style="list-style-type: none"> ▪ The Proponent
Federal taxes	<ul style="list-style-type: none"> ▪ Product of corporate income and corporate tax rates 	<ul style="list-style-type: none"> ▪ Corporate tax rate of 30.1 per cent ▪ Corporate income not stated. 	<ul style="list-style-type: none"> ▪ The Proponent

Sources: Aigis Group, Angus Place Colliery Extension Project, Economic Impact Assessment, March 2014, Springvale Colliery Mine Extension Project, Economic Impact Assessment, March 2014, Airlly Mine Extension Project, Economic Impact Assessment, August 2014.

As discussed above, a key shortcoming of the methodology for valuing the economic benefits and costs is that the benefits received and costs incurred by the mining company are excluded from the analysis on the grounds that they are highly commercially sensitive. Instead, many of the Proponent's costs are counted as economic benefits to the community.

The Guidelines require that where possible, the CBA should measure those costs and benefits that accrue to NSW. Given that the mines are foreign-owned, it may be reasonable to exclude the mining company's profits from the analysis as these will mostly flow outside the state. However, treating the costs incurred by the mining company — such as worker's wages and other inputs — as economic benefits to the community are likely to significantly overstate the true economic benefits.

While it is true that much of the revenue from mining activities flows to parties within the scope of the CBA, including the wages earned by workers, revenue to input suppliers and taxes paid to the NSW Government and the local council (and a proportion of the taxes paid to the Commonwealth Government). These payments stimulate economic activity. However, the approach used in the CBAs effectively assume that the

opportunity cost of these resources used — including labour — are zero over the life of the mine.

- In relation to labour (which forms the largest part of the estimated economic benefits), it could be argued that in regional areas, where there are few alternative employment opportunities, the opportunity cost of labour may be relatively low. However, it will be significantly higher than zero. As the guidelines point out, the real benefit to the worker is the difference between the wage that workers are paid in mining and their minimum reservation wage (the minimum wage they would accept) for working in the mining sector.¹⁰
- In relation to the biodiversity offset provision and project impact controls and mitigation provisions, these are intended to prevent and/or offset environmental impacts. These are costs to the mining company; it is unclear why these have been included as economic benefits.
- On the other hand, taxes are a transfer from the Proponent to the government and should be included as a benefit to the community.

Another issue was that many of the assumptions underpinning these estimates were difficult to assess due to the fact that they were based on information sourced from the Proponent, or elsewhere, and not presented in the reports. This included assumptions made regarding the value of production, corporate income, and wage rates.

Assessment of approach to valuing environmental and social impacts

Non-market environmental and social impacts are notoriously difficult to value. In general, Aigis has made a reasonable attempt at measuring most of the relevant environmental and social costs. The assumptions underpinning these estimates are summarised in table 6. In general, these estimates are based on academic studies that were not directly related to the Projects. The appropriateness of transferring benefits from other studies and the number of people or households affected by these issues are always questionable.

6 Methodologies used to value cost categories

Costs and benefits quantified	Methodology	Key assumptions	Sources of data
Heritage	<ul style="list-style-type: none"> ■ Calculate the product of the number of heritage sites affected and the cost per site to the local community. 	<ul style="list-style-type: none"> ■ \$7.00 per capita p.a. for each 1000 places protected 	<ul style="list-style-type: none"> ■ Allen Consulting Group (2005) ■ Streever WJ et al (1998)
Water	<ul style="list-style-type: none"> ■ Based on an upper bound estimate of NSW households willingness to pay for wetland conservation 	<ul style="list-style-type: none"> ■ \$154 per household per annum 	<ul style="list-style-type: none"> ■ Streever WJ et al (1998)

¹⁰ NSW Government, *Guideline for the use of Cost Benefit Analysis in mining and coal seam gas proposals*, November 2012, p. 7.

Costs and benefits quantified	Methodology	Key assumptions	Sources of data
Soil	<ul style="list-style-type: none"> Same as above 	<ul style="list-style-type: none"> \$154 per household per annum 	<ul style="list-style-type: none"> Streever WJ et al (1998)
Subsistence	<ul style="list-style-type: none"> Same as above 	<ul style="list-style-type: none"> \$154 per household per annum 	<ul style="list-style-type: none"> Streever WJ et al (1998)
Visual amenity	<ul style="list-style-type: none"> Calculate the product of the number of hectares of vegetation removed and the cost associated with the removal of vegetation. 	<ul style="list-style-type: none"> \$1 331 per hectare per annum 	<ul style="list-style-type: none"> EIA Curtis I.A. (2004)
Greenhouse gas	<ul style="list-style-type: none"> Calculate the product of the quantity of carbon emissions and the cost these emissions. 	<ul style="list-style-type: none"> A constant price of \$AUD 23 per tonne of emissions. 	<ul style="list-style-type: none"> Carbon price at the time of the report.
Air pollution	<ul style="list-style-type: none"> Calculate the product of the number of residents affected and the cost of the air pollution. 	<ul style="list-style-type: none"> Cost assumed to be the upper bound cost assumed for air pollution in Sydney GMR in 2002 	<ul style="list-style-type: none"> Air quality report from EIA NSW Government (2005) "Health Costs of Air Pollution in the Greater Sydney Metropolitan Region".
Noise pollution	<ul style="list-style-type: none"> Calculate the product of the dB(A) exposure of residential properties within proximity to the site and the cost associated with the exposure. 	<ul style="list-style-type: none"> \$202 per Db(A) per households per year. 	<ul style="list-style-type: none"> EIA Day B, Bateman I & Lake I (2010).
Biodiversity	<ul style="list-style-type: none"> Calculate the product of the number of threatened species and the cost to the local community. 	<ul style="list-style-type: none"> \$0.21 per specie per household per annum 	<ul style="list-style-type: none"> Land & Water Australia (2005)

Sources: Aigis Group, Angus Place Colliery Extension Project, Economic Impact Assessment, March 2014, Springvale Colliery Mine Extension Project, Economic Impact Assessment, March 2014, Airly Mine Extension Project, Economic Impact Assessment, August 2014.

In particular, it was not clear that:

- an estimate of the willingness to pay of NSW households for wetland conservation was appropriate to use in valuing the impact of the Projects on subsidence, soil, and water, and
- that the estimated cost of air pollution in Sydney Greater Metropolitan Region in 2002, was an appropriate proxy for the expected cost of pollution levels surrounding the Projects (for example, air pollution in the Sydney Greater Metropolitan Region would affect more people than in less densely populated areas).

Lastly, Aigis values the cost of greenhouse gas emission using a constant price of A\$23 per tonne of carbon dioxide equivalent (CO_{2-e}). This appears to be based on the starting

price used for the previous Commonwealth Government's carbon pricing mechanism. Although the carbon price has now been repealed, the estimated carbon price profile is likely to be a reasonable estimate of the cost of greenhouse gas emissions over time. However, the cost of carbon emissions under the carbon pricing mechanism was expected to increase significantly in real terms over time.

Additional comments on a selection of environmental and social impacts quantified/valued and included in the CBA are provided below.

Assessment of biodiversity

Biodiversity includes all plants, animals, fungi, bacteria and other micro-organisms in the natural environment. It encompasses three components: genetic diversity, species diversity and ecosystem diversity, which comprise composition, structure and function.

According to the NSW Government's Guidelines, valuation techniques such as hedonic pricing and willingness to pay should be used to estimate costs to biodiversity in coal mining projects.

In recognising the impact on biodiversity as a result of continued mining, Aigis group valued the costs to biodiversity sourced from Land & Water Australia's 'Making Economic Valuation Work for Diversity Conservation'. This was estimated as \$0.21 per species and applied as follows:

- Angus Place Colliery: two Endangered Ecological Communities (EECs), two threatened flora and 23 threatened fauna
- Springvale Mine Extension Project: three EECs, three threatened flora and 17 threatened fauna
- Airly Mine Extension Project: two EECs, three threatened flora and 21 threatened fauna

Cross-checking with the EIS showed that there were some discrepancies with the number of species threatened. For example, the EIS for Springvale Colliery showed that in addition to two threatened flora species, seven additional flora species have been identified as potentially threatened. However, only three threatened flora species were assumed as part of the CBA. The source and/or assumptions behind this were not made clear in the report. Further information is required to assess the validity.

Moreover, the source of the valuation technique referred to is a basic review of environmental economic techniques. This report was also based in Victoria and the Aigis Group have not reported on the transferability of results to the Lithgow region.

Additionally, biodiversity offset provision was included under the project benefits. In doing so, the implicit assumption is that the offset program will generate benefits (or greater environmental value) in addition to mitigating the negative impact due to mining activity. The basis for this assumption was not made clear.

There are also some issues in placing a value on biodiversity offset programs. Bull et al. (2013) put forward that there is an implicit assumption that the baseline for biodiversity is fixed at the point of the project, however ecosystems are generally dynamic.

Furthermore, the outcomes of offset schemes may be uncertain and there can also be temporal gaps between impacts from the project and benefits from a rehabilitation plan.¹¹ Therefore, the benefits from biodiversity offset programs may be uncertain.

Assessment of heritage

In valuing the costs associated with impact on heritage, the Aigis Group relied on the study by Allen Consulting Group in 2005 titled 'Valuing the Priceless: The Value of Heritage Protection in Australia'. This study used choice modelling to show that on average, respondents were willing to pay \$5.53 per annum per additional 1000 Heritage places protected. Even though data from the 2005 study by Allen Consulting Group has been adjusted to account for inflation, the size of the population used in calculations by Aigis is from the 2011 Census data. The assumption of constant population in the area may not be realistic.

Furthermore, according to the NSW Government's Guidelines, an example of data source for valuing heritage is the Aboriginal Heritage Information Management System. This data source would have been more pertinent to the Aigis Group's report as it states that 49 Aboriginal heritage sites in Lithgow may be impacted by mining.

It is however unclear why it was assumed that 49 Aboriginal heritage sites may be impacted by the mining activity. The sources and relevant assumptions were not made explicit in the report by Aigis group. Moreover, according to the Cultural Heritage Impact Statement relating to Springvale Colliery, "overall 34 Aboriginal sites have been identified in the Project Application Area or within 50m of its boundary" (2014, p. 2).¹² Therefore the number of Aboriginal heritage sites reported in the Aigis report is inconsistent with the Cultural Heritage Impact Statement.

Assessment of visual amenity

A CBA undertaken by DAE on the Rocky Hill Coal Project acknowledged that exposed spoil heaps and light emitted by mines can detract from the visual amenity of an area. According to Ambrey and Fleming (2011)¹³, there are two main methods of valuing scenic amenity:

- the **revealed preference approach**: this relies on observations about peoples' behaviour in markets that are somewhat related to the environmental good or service under consideration
 - for example, hedonic pricing and the travel cost method
- the **stated preference approach**: this uses surveys to find out how respondents value that good or service

¹¹ Bull, J.W, Suttle, K.B., Gordon, A., Singh, N.J., and Milner-Gulland, E.J. (2013), 'Biodiversity offsets in theory and practice' in *Fauna and Flora International*, pp. 1- 12

¹² RPS Australia East Pty Ltd (2014), 'Cultural Heritage Impact Statement – Springvale Mine Extension Project' prepared for *Springvale Coal Pty Limited*

¹³ Ambrey, C.L. and Fleming, C.M. (2011), 'Valuing scenic amenity using life satisfaction data' in *Griffith Business School Discussion Papers*, no. 2011-03

- for example, contingent valuation and choice modelling

In their assessment of impact on visual amenity, Aigis group referred to a study by Curtis (2004) titled ‘Valuing Ecosystem Goods and Services: A new approach using a surrogate market and the combination of multiple criteria analysis and a Delphi Panel to assign weights to attributes’. However, this report investigated the impact on the wet tropics of Queensland world heritage area. The study also did not look at the impact due to mining activity. Therefore, the transferability of results from this study to the Lithgow region is highly questionable.

Furthermore, calculations of costs to community as a result of the impact on visual amenity was treated inconsistently across the three Aigis reports. Even though the source for all three reports referred to Curtis’ ecosystem valuation approach (2004),

- for the Airly Mine, the estimated value used was \$1 137 per hectare whereas
- for both the Angus Place Mine and Springvale Mine, the estimated value used was \$1 331 per hectare.

The assumptions underpinning the detailed calculations were not made explicit in the Aigis reports. The reference to the estimated obtained from the 2004 study was also not made clear and as a result, these could not be validated.

Assessment of subsidence, soil and water

According to the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development,¹⁴

Subsidence is a localised lowering of the land surface. It occurs when underground voids or cavities collapse, or when soil or geological formations (including coal seams, sandstone and other sedimentary strata) compress due to changes in moisture content and pressure within the ground.

In valuing the costs associated with subsidence, soil and water, the Aigis Group referred to a report by Streever et al. (1998) entitled “Public attitudes and values for wetland conservation in New South Wales, Australia”. After adjusting for inflation, it was estimated that the cost of subsidence, soil and water would be around \$154 per household per annum. This estimate was applied to the number of households in the Lithgow LGA obtained from the Census 2011 data. One limitation here is that population is assumed to have remained constant from 2011 to 2016, which may not be the case.

Furthermore, the report referred to was published in 1998 and there have been other updated environmental studies relating to coal projects and impact on subsidence, soil and water since then. For example, in their guide to non-market valuation, the Productivity Commission refers to a study by Gillespie Economics (2009)¹⁵ which

¹⁴ Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (2014), ‘Fact Sheet: Subsidence from longwall coal mining’ available at <<http://www.iesc.environment.gov.au/publications/subsidence-longwall-coal-mining>>

¹⁵ Gillespie Economics (2009), ‘Bulli Seam Operations: Choice Modelling Study of Environmental and Social Impacts’ prepared for *Illawarra Coal Holdings Pty Ltd*

undertook choice modelling to assess the community's willingness to pay to reduce negative impacts of coal mining. The reasoning behind the Aigis Group choosing to refer to values from the older study (Streever et al. 1998) is unclear.

Moreover, there is a possibility that the willingness to pay value will apply to households outside the Lithgow area as the subsidence impacts will affect a National Park. However, in their analysis, the Aigis Group has only applied the willingness to pay value to households in Lithgow. Consequently, these costs may be understated.

Generating the future stream of benefits and costs and calculating the cost benefit ratio

Our review was guided by two questions:

- Was the timeframe used appropriate?
- Was the methodology used to calculate the cost benefit ratio appropriate?

Was the timeframe used appropriate?

The NSW Government Guidelines provide the following guidance for identifying the timeframe of the analysis:¹⁶

The costs and benefits should be estimated over the timescale of the impacts of a project. Where a project has environmental impacts, the impacts may continue well after the productive life of the project under construction. It is recommended that long-term projects should use a 50-year time-frame and where applicable a residual value for impacts beyond that time period.

In each case, Aigis used the project timeline as the timeframe for the analysis, although the rationale or basis for these assumptions was not provided. It is also not clear whether this timeline applied to all the impacts as well. That is, whether they were discounted over the same period.

Were residual values identified and considered?

A number of the cost and benefit categories valued by Aigis were contained within the project lifetime. The residual values, however, have not been identified and considered.

- **Greater transparency is required on the timeframe used for the CBA analysis and how it was applied to the different impacts. No information was provided on the residual values.**

¹⁶ NSW Government, Guidelines for the use of Cost Benefit Analysis in mining and coal seam gas proposals, 2012, p.8.

Uncertainty and sensitivity analysis

The NSW Government (2012), “Guidelines for the use of Cost Benefit Analysis in mining and coal seam gas proposals” provides the following guidance for conducting sensitivity analysis:¹⁷

The CBA should also provide sensitivity tests that show the outcome of a project may vary with plausible alternative estimates of the main uncertain quantified costs and benefits and for a range of discount rates.

Sensitivity tests show the estimated outcomes may vary with variations in key assumptions. To be useful, these tests should indicate how likely the tested scenarios are. Sensitivity tests are useful if there is a plausible likelihood of the alternative estimates being correct.

A discount rate of 7% should be used and tested at 4% and 10%. All costs and benefits should be discounted by the same rate.

Taking this into consideration, our review of the sensitivity analysis conducted was guided by four questions:

- What are the main uncertain quantified costs and benefits and were they included in the sensitivity analysis?
- Were plausible scenarios used?
- Was the methodology used appropriate, and in particular, were correlations with other relevant variables considered?¹⁸
- Were multiple discount rates applied?

What are the main uncertain quantified costs and benefits?

Table 7 below shows the magnitude of the costs and benefit categories quantified by Aigis for the Projects. The three cost and benefit categories that were estimated to have the largest impact on the overall net present value of the Projects were:

- employment wages,
 - which is the product of gross mining revenue and share of wages
- coal royalties, and
- government taxes.

¹⁷ NSW Government, Guidelines for the use of Cost Benefit Analysis in mining and coal seam gas proposals, 2012, p.8.

¹⁸ For example, in testing the sensitivity of the net present value of the project to changes in coal price forecasts, it may be necessary to also consider how the volume coal production may change under different price scenarios.

7 Magnitude of the incremental costs and benefits quantified

Parameter	Angus Place	Springvale	Airly Mine
	NPV (\$ million)	NPV (\$ million)	NPV (\$ million)
Economic Benefits			
Employment wages	473	648	102
Coal royalties	203	201	120
Government taxes	55	22	86
Mitigation provisions	38	30	35
Economic Costs			
Noise	0.39	1.5	1.5
Subsidence	14.3	16.4	20.1
Soil and land capability	16.4	16.4	20.1
Surface water & groundwater	14.3	16.4	20.1
Air	0.26	0.3	0.3
GHG emissions	10.1	6.4	1.4
Heritage	14.4	16.5	20.1
Biodiversity	0.61	3.5	0.6
Visual amenity	0.42	0.2	0.6

Sources: Aigis Group, Angus Place Colliery Extension Project, Economic Impact Assessment, March 2014, Springvale Colliery Mine Extension Project, Economic Impact Assessment, March 2014, Airly Mine Extension Project, Economic Impact Assessment, August 2014.

In terms of cost and benefit categories, Aigis performed sensitivity analysis on revenue only. Aigis' sensitivity analysis however also included the alternative project scenarios identified above.

Were plausible scenarios used?

In the case of revenue projections, Aigis noted that the most likely source of variation relates to coal prices, which may be comparatively volatile. Sensitivity testing was based on price assumptions derived from market data and price adjustments at ten and twenty per cent higher and lower. The market data referred to and the rationale for the sensitivity ranges was not specified.

Was the methodology used appropriate?

Aigis provided no indication of the methodology used to produce estimates of the net present value of the project under alternative scenarios. As a result, it is not clear whether the sensitivity analysis was performed by:

- 1 simply altering the value of the parameters outlined above in line with the sensitivity ranges, or
- 2 using a more formal approach, possibly with the aid of risk analysis software.

The first approach is appropriate if the parameters being considered are not correlated with other benefit or cost categories. This may not be the case with revenue which could be correlated with a range of environmental impacts such as pollution and noise.

Were multiple discount rates applied?

Consistent with NSW guidelines, sensitivity analysis was performed with discount rates of 4 per cent and 10 per cent. This variation in the discount rate was found to alter the net present value of, for example, the Angus Place Extension Project from \$630 million to \$962 million. Across the three project scenarios considered, net present value calculations varied from \$629 million to \$996 million (Table 8).

8 Sensitivity analysis of Angus Place Extension Project

	Option 1	Option 2 (Preferred)	Option 3
	NPV (\$m)	NPV (\$m)	NPV (\$m)
Base case	698	699	722
Revenue (+20%)	756	757	786
Revenue (-20%)	658	659	676
Discount rate (4%)	961	962	996
Discount rate (10%)	629	630	708

Source: Aigis Group, Economic Assessment, Angus Place Extension Project, March 2014

- **Overall, the sensitivity analysis conducted by Aigis lacked transparency. The analysis included multiple project scenarios, while revenue was the only benefit or cost category that was included in the analysis. In addition, the methodology used to conduct the sensitivity testing and rationale for the sensitivity ranges was not made clear. Discount rates of 4 per cent to 10 per cent were included in the sensitivity analysis in line with NSW Government Guidelines. Varying the discount rate within this range resulted in the net present value for the Angus Place project varying from \$629 million to \$996 million.**

Regional Economic Impacts

As per the NSW Government's *Guidelines for the use of Cost Benefit Analysis in mining and coal seam gas proposals*, the scope of a CBA includes all first round (primary) impacts including both direct and indirect effects. Direct impacts include the costs and benefits of producers whereas indirect impacts include effects on third parties. However, CBAs do not include secondary impacts of a Project, which are the flow-on impacts from the first round impacts. Therefore, to address this, an extended economic impact analysis was undertaken by Aigis to identify and quantify where appropriate, the broader impacts of the three Projects.

The effects of the stimulus provided to regional and broader economies by direct construction and operating activity and the associated impacts were considered by Aigis.

Geographic scope of the analyses

Centennial's operations in the Lithgow and adjacent Mid-Western Regional Council LGAs are significant contributors to these regional economies, and those of contiguous LGAs, such as Bathurst and the Blue Mountains.

The Lithgow LGA was the focus of both Angus Place Colliery Extension Project and the Springvale Colliery Extension Project. For Centennial Airly, the Mid-Western Regional Council LGA was also considered in addition to the Lithgow LGA.

The broader impacts identified

Centennial Coal undertook community consultations in 2012 in relation to a range of projects, including Springvale Colliery and Angus Place Colliery. The issues raised by the community in relation the wider regional developments include:

- general visual impacts, particularly from open cut mining
- intensification of mining activities; and
- the recognition of impacts from sources other than Centennial such as other mining operations and the two power stations.

Based on the issues identified above, Aigis' analyses recognised the social value relating to individual value judgement on impacts is subjective and therefore difficult to accurately quantify. These were acknowledged as an aspect of social impact.

Assumptions, methodology and sources of data used

To evaluate the impact of mining in the region, the analyses referred to Lithgow City Council Economic Development Strategy.

To measure the regional economic impacts of a Project, there are two main techniques that may be used – Input Output (I-O) multiplier analysis or computer general equilibrium (CGE) modelling. Both approaches can provide estimates of increases in economic output, value added and employment in the broader economy flowing from the Project, although there are significant limitations in the application of I-O multipliers.

Input-output multipliers are summary measures used for estimating the total impact on all industries in an economy due to a change in the demand for the output of any one industry. This was the preferred methodology of Aigis. Multipliers for ‘mining and services’ and ‘construction’ were sourced from the NSW Department of Trade, Investment, Regional Infrastructure and Services (Division of Resources and Energy). These are shown in table 9 below.

9 Type 2A multipliers for ‘mining and services’ and ‘construction’

Description	Mining and services multiplier value	Construction multiplier value
Output multiplier	2.136	2.694
Gross Value Added Multiplier	4.099	4.369
Income Multiplier	2.839	2.899
Employment Multiplier	3.977	2.727

Source: Aigis Group, Economic Impact Assessments for Springvale Colliery Mine Extension Project, Angus Place Colliery Extension Project and Airly Mine Extension Project

Aigis stated that the relatively large Gross Value Added multiplier demonstrated the importance of incomes generated by the relevant projects. The GVA comprised of all components of income to labour, plus the gross operating surplus of the corporate entity. This could accrue beyond NSW because of the foreign ownership of Centennial. This was duly noted in the three analyses.

With regards to the construction GVA multiplier, Aigis put forward that there would be wider geographic impacts in terms of economic activity since suppliers and contractors may be more likely to originate beyond the immediate region, given the specialised nature of the infrastructure being constructed. It was however acknowledged that the Centennial Coal practice involved inviting all locally-based tenderers for relevant works, with a view to ensure that opportunities to retain work locally are offered.

Limitations of using multiplier analysis

Input-output multipliers describe average effects, not marginal effects and therefore do not take into account economies of scale, unused capacity or technological change.

There have been several reviews highlighting the gaps and issues when using multiplier analysis. The limitations of using I-O multipliers according to the ABS have been detailed in Box 10 below.

10 Limitations of using I-O multipliers for economic impact assessment

The following limitations of using I-O multipliers were stated by the ABS:

- **Lack of supply-side constraints:** An implicit assumption when using multipliers is that output in one area can be increased, without any impact on the resources available in another areas. This overstates the economic impacts because actual impact is likely to be dependent on the extent to which the economy is operating at or near capacity.
- **Fixed prices:** When using multipliers, prices are assumed to be unaffected by policy and any crowding out effects are not captured.
- **Fixed ratios for intermediate inputs and production:** Impact analysis using multipliers can be seen to be describing average effects, not marginal effects. This is due to the assumption that there is a fixed input structure in each industry and fixed ratios of production.
- **No allowances for purchaser's marginal response to change:** There is an assumption when using multipliers that household consumption of goods and services are in exact proportions to their initial budget shares. This also applies to industrial consumption of intermediate inputs and factors of production.
- **Absence of budget constraints:** When using multipliers that consider consumption induced effects, there is an implicit assumption that household and government consumption is not subject to budget constraints.
- **Not applicable to small regions:** Small region multipliers tend to be smaller than national multipliers since their inter-industry linkages are normally relatively shallow. This is due to their limited capacity to produce an extensive range of goods for inputs and consumption and instead, importing a significant portion of these goods from other regions.

Source: ABS, 'Australian National Accounts: Input-Output Tables, 2009-10', catalogue no. 5209.0.55.001

In their analysis of the regional economic impacts, Aigis acknowledged that there were limitations to the application of I-O multipliers. Furthermore, Aigis stated "the practical effect of these limitations is that the output of multiplier analysis can only be considered as indicative of outcomes that may result from economic stimuli".

Employment numbers

Given the nature of I-O multipliers, employment numbers provide only an indication of the order of magnitude involved. These should be considered a maximum value under the assumption that there are unemployed workers in the region who could fill the roles required. If that is not the case, then additional workers will need to be drawn from other activities. Therefore, net employment effect may be much smaller than indicated.

It is also important to note that 'construction' multipliers and related employment numbers will only accrue to the initial construction period and will not continue to the main operational period of the Project.



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