APPENDIX 17

Cost Benefit Analysis and
Economic Impact Analysis

Deloitte Access Economics

Cost Benefit Analysis and Economic Impact Analysis of the Mount Owen Continued Operations Project

Umwelt (Australia) Pty Limited

October 2014

Deloitte.

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9 October 2014

Dear Tim

Cost Benefit Analysis and Economic Impact Analysis of the revised Mount Owen Continued Operations Project

I am pleased to provide a cost benefit analysis and economic impact analysis of the revised Mount Owen Continued Operations Project. This report analyses, in detail, the costs and benefits of the development of the Mount Owen Continued Operations Project as well as an analysis of whether the project would result in a net benefit for the NSW community.

The analysis has been prepared with a number of guidelines in mind, how these guidelines have been addressed is summarised in Appendix A. To ensure that all critical parts of the various guidelines have been adhered to, the Appendix contains a cross reference of each key aspect of the guidelines to the sections of the report where they are dealt with.

Yours sincerely,

Steve Brown
Director
Deloitte Access Economics Pty Ltd

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Glossary

ABS	Australian Bureau of Statistics
ACHA	Aboriginal Cultural Heritage Assessment
ACHMP	Aboriginal Cultural Heritage Management Plan
AIS	Agricultural Impact Statement
ANZECC	Australian and New Zealand Environment Conservation Council
AUD	Australian dollar
BCR	Benefit Cost Ratio
BNP	Bayswater North Pit
BSAL	Biophysical Strategic Agricultural Land
CBA	Cost Benefit Analysis
CDE	Constant Differences of Elasticities
CGE	Computable General Equilibrium
CHPP	Coal Handling and Preparation Plant
CRESH	Constant Ratio of Elasticities Substitution, Homothetic
DAE	Deloitte Access Economics
DALY	Disability Adjusted Life Year
DEC	Department of Environment and Conservation
DGRs	Director General's Requirements
DP&E	Department of Planning and Environment
ECX EUA	European Climate Exchange European Union Allowance
EEC	Endangered Ecological Community
EIA	Economic Impact Analysis
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
EP&A	Environmental Planning and Assessment Act
EVRI	Environmental Valuation Reference Inventory
FOB	Free on board
FTE	Full Time Equivalent
GDP	Gross Domestic Product
GRP	Gross Regional Product
GSP	Gross State Product
ICE	Intercontinental Exchange
IO	Input Output
IRR	Internal Rate of Return
LGA	Local Government Area
LSC	Land and Soil Capability
MIA	Mining Infrastructure Area

NPV	Net Present Value
NSW	New South Wales
PM	Particulate Matter
RAP	Registered Aboriginal Party
RCT	Ravensworth Coal Terminal
RERR	Ravensworth East Resource Recovery
RGEM	Regional General Equilibrium Model
ROM	Run-of-mine
RUM	Random Utility Maximisation
SIOA	Social Impact & Opportunities Assessment
SLA	Statistical Local Area
SUA	Significant Urban Area
TSP	Total Suspended Particulate Matter
UK	United Kingdom
USD	United States dollar
VCA	Voluntary Conservation Area
VPA	Voluntary Planning Agreement
VSL	Value of Statistical Life
WACC	Weighted Average Cost of Capital
WTP	Willingness to pay

Executive Summary

Deloitte Access Economics has been commissioned by Umwelt Australia to undertake a Cost Benefit Analysis and Economic Impact Analysis of the proposed Mount Owen Continued Operations Project ('the Project').

The findings of this report can be summarised as follows:

- The Project delivers net benefits of around $758 million over its life and generates a benefit cost ratio of around 1.30.
- Royalties generated by this Project, relative to the baseline, are estimated to be worth around $258 million in NPV terms to the NSW Government. Around 92% of these royalties are attributable to the continued operations at the North Pit.
- It is estimated that the Project would generate a net benefit to the Singleton community of around $306 million (in NPV terms) over the life of the Project, assuming that in the absence of the Project, local employees and suppliers would earn the average level of income in Singleton.
- It is considered unlikely that the negative externalities treated qualitatively in this analysis would be of a scale that would exceed the net benefits of the Project.
- Over the life of the Project, the Hunter Region's Gross Regional Product (GRP) is projected to increase by just under $1.3 billion in NPV terms.
- NSW's Gross State Product (GSP) (including the Hunter) increases by around $1.9 billion (NPV terms).
- The economic impact analysis projects a state-wide employment peak in 2020 with over 1,200 additional full time equivalent (FTEs) workers. This employment includes the direct employment, any employment from suppliers and crowding out of any economic activity in other sectors of the economy as a result of the Project. Of this, 1,091 are projected to be employed in the Hunter region.

The Mount Owen Complex is located within the Hunter Coalfields in NSW. The Complex encompasses three open cut mining operations: the Mount Owen, Ravensworth East and Glendell Mines. Through the Mount Owen Continued Operations Project (referred to as 'the Project'), Mount Owen Pty Limited (Mount Owen) is seeking to extend mining operations at the Mount Owen Mine beyond 2018 out to 2030, and consolidate the Mount Owen and Ravensworth East Operations through a single development consent.

This report presents a detailed assessment of the incremental costs and benefits of the Project relative to a baseline, 'business as usual' case, as well as an analysis of whether the project would result in a net benefit for the NSW community. These assessments have been made in reference to the Director General's Requirements (DGRs). It should be noted that the analysis has drawn on information provided by Mount Owen, the findings of the EIS and further information provided by Umwelt.

Overall the Project is expected to generate net benefits and is also expected to generate increased economic activity and employment within the NSW community.

Consideration of the costs and benefits of the Project is primarily done through a cost benefit analysis (CBA). The CBA compares the Project case to a baseline case which involves mining activity at the Mount Owen North Pit out to 2018, and a single year of mining at the Bayswater North Pit (BNP) in 2015, followed by land rehabilitation.

It is noted that should the Project not proceed, additional mining would be undertaken at the Ravensworth Mine, subject to the existing approvals. However, this baseline has been adopted to allow for the measurement of the incremental costs and benefits of the Project, in order to determine the net economic value of the Project, under a consolidated development consent which is being sought by Mount Owen. This is consistent with the other components of the EIS, where the assessment of all Project impacts reflects activity at the North Pit, BNP and RERR Mining Area.

The overall finding of the CBA is that the Project as a whole is likely to deliver net economic benefits. In the central case (which is based on a 7% discount rate, discounted back to the end of 2014), the Project delivers net benefits of around $758 million over its life and generates a benefit cost ratio of around 1.30.

In undertaking the cost benefit analysis we have had regard to the costs and benefits listed in Table i on the following page. These items have been drawn from the DGRs and a number of guidelines for cost benefit analysis published by the NSW Government.

As recommended in CBA guidelines such as NSW Treasury (2007), where it is difficult to place a value on a particular cost or benefit of the Project, a qualitative analysis has been undertaken. We consider that all of the potentially large negative externalities of the Project have been valued in quantitative terms. The remaining negative externalities which have been considered qualitatively, such as visual amenity, are identified in the table below and discussed thoroughly in Section 5.

The results indicate that these non-quantified negative externalities would need to be valued at around $89 million per year (in real terms), between 2016 and 2030 to offset the estimated net benefits of the Project. This is equivalent to an undiscounted value of $1.34 billion over the period. This is considered to be unlikely, given the nature of the evidence regarding these impacts. Furthermore, this annual value would represent more than a sixteen-fold increase in the level of externalities estimated in quantitative terms.

It should also be noted that these CBA results do not explicitly identify benefits to particular groups (such as tax payments to the NSW government) as these are a transfer payment and do not sit within the scope of a CBA. However, the additional royalties generated by this Project, relative to the baseline, are estimated to be worth around $258 million in NPV terms to the NSW Government (this is equivalent to a total of $461 million in additional revenue over the life of the Project).

An estimation of the net benefits to the Singleton community is also of interest. CBA calculations are not easily disaggregated into regional assessments. However, to do this we have assumed that payments to mine suppliers and employees are proportional to the share of employees from different geographic locations. In order to illustrate the range of outcomes that could be achieved in the absence of the Project, it was assumed that these businesses and workers could either earn the same level of income from alternative sources, or the average level of income in Singleton in the baseline case.

Under these assumptions, along with a number of others regarding the share of externalities borne by the community, it is estimated that the Project would generate impacts of a net benefit of up to $306 million (in NPV terms) for the Singleton community over the life of the Project.

Table i: Costs and Benefits – Mount Owen Continued Operations Project

	Costs	Benefits
Production	Other onsite revenue forgone	Gross mining revenue
	Exploration costs	Residual value of capital
	Capital investment costs	
	Operating costs excluding taxes	
	Rehabilitation costs	
	Decommissioning costs	
	Residual value of land forgone	
Externalities	Offsite agricultural revenue*	Net traffic impacts
	Related public expenditure*	Conservation*
	Groundwater quality*	
	Surface water quality*	
	Carbon emissions	
	Air quality impacts – particulate matter	
	Air quality impacts – other pollutants*	
	Noise impacts	
	Visual amenity*	
	Biodiversity – flora and fauna	
	Quality of open space*	
	Rural amenity and culture	
	Aboriginal heritage*	
	Historic heritage*	
	Health*	

* Item has been considered qualitatively

Note: As the Project involves open-cut mining activity, there are no subsidence impacts which need to be valued in this analysis. Nevertheless, this item is discussed qualitatively in Section 5 in accordance with NSW Government (2012)

Regional economic impacts

We have analysed the overall economic impacts of the Project using Computable General Equilibrium (CGE) modelling and find that, over the life of the Project from 2016 to 2030, the Hunter Region's Gross Regional Product (GRP) is projected to increase by nearly $1.3 billion in NPV terms, while NSW's Gross State Product (GSP) (including the Hunter) increases by around $1.9 billion (both of these are in NPV terms).

Table ii: Mount Owen Continued Operations Project – economic impacts, 2016 - 2030

	Total (NPV)
Coal sales ($m)	3,244
Hunter modelling region ($m GRP)	1,288
NSW total GSP ($m)	1,902

The report also provides an estimate of the projected employment impacts of the Project. State-wide employment peaks in 2020 with over 1,200 additional full time equivalent (FTE) workers. Of this, 1,091 are estimated to be employed in the Hunter region and 127 in the rest of the state. These estimates are of total employment including that at the mine and further employment generated in the economy.

More detail on the year-on-year GSP and employment impacts are outlined in Section 6, along with more information on the CGE modelling framework used.

Summary Report

[DN: In executive summary, employment, GRP and net benefit to Singleton are repeated]

Deloitte Access Economics has been commissioned by Umwelt Australia to undertake a Cost Benefit Analysis and Economic Impact Analysis of the proposed Mount Owen Continued Operations Project ('the Project').

The Project aims to continue the mine-life of the current operations at the Mount Owen Mine from 2018 out to 2030 to extract additional coal resources south of the currently approved North Pit mining limit (the North Pit Continuation). In addition, Mount Owen is seeking consolidation of the Mount Owen and Ravensworth East Operations through a single development consent. Accordingly, the Project also involves continued mining operations within the Bayswater North Pit (BNP) beyond 2015 to 2022, sequentially followed by mining at the Ravensworth East Resource Recovery (RERR) from 2022 to 2027.

The Project does not include any changes to operations at the Glendell Mine, which will continue to operate in accordance with its current development consent.

In this report, the impacts of the Project are measured relative to a baseline case, whereby mining activity takes place at the Ravensworth East BNP in 2015, and at the Mount Owen North Pit from 2014 to 2018.

It is noted that should the Project not proceed, further mining would be undertaken at the Ravensworth Mine, subject to the existing approvals. However, this baseline scenario has been adopted to allow for the measurement of the incremental costs and benefits of the Project, in order to determine the net economic value of the Project, under a consolidated development consent. This is consistent with the other components of the EIS, where the assessment of all Project impacts reflects activity at the North Pit, BNP and RERR Mining Area.

The report is broadly split into four parts:

1. Background discussion on the region and the methodology employed in the report
2. Cost Benefit Analysis (CBA)
3. Economic Impact Analysis (EIA)
4. Appendices providing more detail on the methodologies used in the analysis.

Background – the coal mining region

The Mount Owen Complex is located within the Hunter Coalfields in the Upper Hunter Valley of New South Wales (NSW). It is approximately 20 kilometres north-west of Singleton, 24 kilometres south-east of Muswellbrook and to the north of Camberwell village. The complex is located within the Singleton Local Government Area (LGA).

Since 2001, the economy of the Singleton LGA has undergone change, generally as a result of an increase in mine-related activity. The usual resident population in the LGA has increased by about 10% and incomes have risen – from an already high base. Incomes in the Singleton LGA have increased from about $1,300 a week in 2001 to almost $1,750 in

2011; a 32% increase. This can be compared to incomes in the state as a whole which only increased by 12% over the same period.

Table iii: Median household income ($/week)

	2001	2006	2011	2001-2011 Change
Singleton	1,322	1,511	1,748	32.2%
New South Wales	1,140	1,243	1,278	12.1%

Source: ABS, 2011 Census Time Series Profile Cat. 2003.0
Note: All dollar values reflect real figures adjusted using ABS CPI to June 2013 dollars.

Operational activity

Under the Project case, the Mount Owen and Ravensworth East Mines are estimated to produce 77.20 Mt of saleable coal over the period from 2014 to 2030. Under the baseline case, 25.58 Mt of saleable coal will be produced between 2014 and 2018. Under each case, it is anticipated that two distinct coal outputs will be produced: semi-soft coking coal, and thermal coal (with an ash content of around 12.5%). Under the Project case, thermal coal is expected to account for approximately 90% of the additional saleable coal produced.

Cost Benefit Analysis

A cost benefit analysis (CBA) involves obtaining a consolidated estimate of the net economic value of the Project by identifying the incremental costs and benefits of the project relative to the baseline case, and placing a quantitative value on these items wherever possible (NSW Treasury 2007).

The list of costs and benefits considered in this analysis are set out in Table iv below. In recognition of the broad range of impacts of the Project, the costs and benefits shown have been separated into two categories. First, the costs and benefits that affect the financial outcomes of the proponent can be classified as internal effects of production, while the costs and benefits that affect others are considered as externalities.

The approach to valuation has generally been to rely on market prices where available, then to use industry standard values, then to make use of a literature review and finally to draw on original research or deal with the item qualitatively.

As recommended in CBA guidelines such as NSW Treasury (2007), where it is difficult to place a value on a particular cost or benefit of the Project, a qualitative analysis has been undertaken. We consider that all of the potentially large negative externalities of the Project have been valued in quantitative terms. The remaining negative externalities which have been considered qualitatively, such as impacts on visual amenity, are identified in the table below and discussed thoroughly in Section 5.

Table iv: Costs and Benefits – Mount Owen Continued Operations Project

	Costs	Benefits
Production	Other onsite revenue forgone	Gross mining revenue
	Exploration costs	Residual value of capital
	Capital investment costs	
	Operating costs excluding taxes	
	Rehabilitation costs	
	Decommissioning costs	
	Residual value of land forgone	
Externalities	Offsite agricultural revenue*	Net traffic impacts
	Related public expenditure*	Conservation*
	Groundwater quality*	
	Surface water quality*	
	Carbon emissions	
	Air quality impacts – particulate matter	
	Air quality impacts – other pollutants*	
	Noise impacts	
	Visual amenity*	
	Biodiversity – flora and fauna	
	Quality of open space*	
	Rural amenity and culture	
	Aboriginal heritage*	
	Historic heritage*	
	Health*	

* Item has been considered qualitatively

Note: As the Project involves open-cut mining activity, there are no subsidence impacts which need to be valued in this analysis. Nevertheless, this item is discussed qualitatively in Section 5 in accordance with NSW Government (2012)

It should be noted that the analysis has drawn on information provided by Mount Owen, the findings of the EIS and further information provided by Umwelt.

- **Gross mining revenue:** production estimates were combined with price forecasts developed from consensus forecasts provided by Glencore. In the Project case, 77.20 Mt of saleable coal is produced, generating total revenue of $5,579 million in present value terms. In the baseline case, 25.58 Mt of saleable coal is produced, generating total revenue of $2,335 million in present value terms. For a net coal coals of$3,244 milllion
- **Other onsite revenue:** Umwelt has advised that approximately 25 hectares of land within the proposed disturbance area is currently used for grazing. The loss of this revenue in the Project case is considered quantitatively in estimates of the residual value of land, described below.
- **Exploration costs:** an allowance for ongoing exploration under the Project case has been included in ongoing operating cost estimates.
- **Capital investment costs:** under both the baseline and Project case, capital investment of $31.5 million will be undertaken at Ravensworth East in 2015. Under the Project case, additional capital investment of $152.9 million will be incurred during the construction phase of the Project. Mount Owen has proposed to commence

construction within one year of the commencement of mining beyond the currently approved mining. For the purpose of this analysis, construction is assumed to take place in 2016 and 2017. The additional Project case capital costs are valued at $128.30 million in present value terms.

- **Operating costs excluding taxes:** operating costs consist of free on board (FOB) costs, associated with the extraction, processing and delivery of coal, as well as ongoing expenditure on the purchase and maintenance of equipment and machinery necessary for production. FOB costs per tonne were estimated based on an econometric model of open cut mining in Australia. These estimates vary from year to year, according to anticipated changes in the stripping ratio and daily production. Under the baseline case, operating costs are expected to range between $54 and $65 per product tonne, while operating costs are estimated at between $57 and $88 per product tonne under the Project case. Estimates of ongoing equipment and machinery costs were provided by Mount Owen, under the baseline and Project case. These are estimated at $19.99 million and $424.18 million respectively, in undiscounted terms.

  Overall, total operating costs are estimated at $1,426 million and $3,702 million in the baseline and Project case respectively, in present value terms.

- **Rehabilitation costs:** land rehabilitation is required under both the baseline and Project case. The costs associated with this activity are estimated at $4.18 million and $13.38 million respectively, in present value terms.
- **Decommissioning costs:** at the completion of mining activity in each case, decommissioning costs will be incurred. The present value of these costs is estimated at $45 million in the baseline, and $67.44 million in the Project case. Decommissioning costs for Ravensworth East have been included in the Project case, but not the baseline, to present a conservative analysis given that Ravensworth East operations are currently approved regardless of the outcome of the Project.
- **Residual value of capital:** Mount Owen has advised that it will fully utilise the value of all capital assets over the life of the mine in both the baseline and Project case.
- **Residual value of land:** this item captures the value that society places on the land within the proposed disturbance area, from 2014 onwards in the baseline, and at the conclusion of mining activity and land rehabilitation under the Project case. These values reflect the proportions of land used for different purposes, particularly native forest and woodland vegetation, derived native grassland and potential grazing land.

  The social values assigned to areas used for vegetation and grassland were derived from the NSW Government's BioBanking scheme, while grazing land was valued using estimates of gross margins from beef enterprises in NSW, published by the Department of Primary Industries. This analysis assumes that vegetation and grassland in the proposed disturbance area would be valued at 50% of the price of recent BioBanking transactions in the baseline case, and 25% of the price in the Project case. These discounts have been applied to represent differences in the quality of land within the Complex, relative to other sites covered under the Scheme.

  Overall, the residual value of land is estimated at $2.41 million and $0.23 million in the baseline and Project case respectively, in present value terms. These valuations do not capture the residual value of land at Ravensworth East, given that it is previously disturbed and, in practice, would not be realised until the conclusion of operations. Excluding the residual value of this land is a conservative approach that works to lower the net benefits.

- **Related public expenditure:** Mount Owen has advised that, for the purposes of this Project, any public expenditure generated by the Project will be accounted for in a Voluntary Planning Agreement. These transfer payments are not included in the CBA.
- **Offsite agricultural revenue:** the Agricultural Impact Statement notes that the Project will impose a low to moderate risk on the level of productivity of surrounding agricultural systems and enterprises, relative to the baseline. While the potential for effects on the agricultural productivity is acknowledged, there is no clear empirical evidence which enables the impact to be quantified. Furthermore, research by Environment Australia (1998) suggests that it is unlikely that declines in revenue would be substantial. Accordingly, it is considered appropriate to treat these potential impacts qualitatively in this analysis.
- **Groundwater quality:** the Groundwater Assessment indicates that the Project is expected to have a negligible impact on the quantity and quality of groundwater supplies, relative to the baseline. In addition, any potential impacts are unlikely to affect other external users in non-mining industries. Accordingly, no value has been assigned to this item in either the baseline or Project case.
- **Surface water quality:** the Surface Water Assessment indicates that, historically, the quality of surface water supplies have typically remained within relevant criteria. It is anticipated that the Project will have negligible impacts on the surface water quality and quantity with limited cumulative impacts on downstream water users. There is, therefore, expected to be no quantitative difference between the baseline and Project case from an economic perspective. Any impacts on quality will be managed through the Mount Owen Water Management System over the life of the Project.
- **Subsidence:** as the Project involves continued open-cut mining, there are no subsidence effects in either the baseline or Project case.
- **Carbon emissions:** the Greenhouse Gas Assessment has provided estimates for the quantity of emissions expected over the life of the mine in the Project case. These were used to obtain an estimate of the emissions per tonne of run-of-mine (ROM) coal extracted. In turn, this average was used to calculate annual emissions under the baseline and Project case. These emissions have been valued at a constant price of $8.91 per tonne of emissions, derived from the current Intercontinental Exchange European Climate Exchange European Union Allowance (ICE ECX EUA) futures price of €6.17 per tonne, converted into Australian dollars using the exchange rate reported by the Reserve Bank of Australia (MarketWatch, 2014; RBA, 2014). This is the best available estimate of the social cost of carbon following the repeal of the carbon pricing mechanism. Overall, the cost of Scope 1 emissions is valued at $19 million in the baseline and $44.12 million in the Project case, in present value terms.

  Scope 2 and 3 carbon emissions are indirect emissions generated from the Project's consumption of electricity and other intermediary inputs and from the use of the Project's output. These emissions are not directly emitted by the Project. For both Scope 2 and 3 emissions, it is not clear, methodologically, to what extent these emissions should be incorporated in a CBA. For scope 3 emissions it is also not clear what a reasonable baseline case would be and the data requirements of calculating any baseline for scope 3 emissions is extensive. As such, carbon emission costs associated with Scope 2 and 3 emissions have not been included in the CBA. Nevertheless, it is noted that inclusion of Scope 2 emissions would add costs of around $3 million in the baseline and $7 million in the Project case, in present value terms, a level that does not alter the conclusions of this analysis.

- **Air quality impacts – particulate matter:** likely health costs to Singleton associated with PM_{10} emissions were quantified based on cost estimates provided by the Department of Environment and Conservation NSW for the Hunter Valley as a whole (2005).

  These estimates incorporate the cost of a number of key health endpoints associated with PM_{10} emissions, such as chronic and acute bronchitis, respiratory and cardiovascular hospital admissions, asthma attacks, restricted activity days and death. The annual costs per 10 ug/m^3 increase in the concentration of PM_{10} in the Hunter region as reported by the Department, was used to estimate a value for changes in PM_{10} concentration in Singleton, in 2014 prices. This approach suggested a cost of $3.80 million per 1 ug/m^3 increase in the concentration of PM_{10}. This was then multiplied by forecasts of the increase in concentration of PM_{10} at Singleton Heights attributable to mining at Mount Owen and Ravensworth East under the baseline and Project cases, drawing from the Air Quality Assessment. The additional health costs associated with air pollution under the Project case, relative to the baseline case, are estimated to be worth about $13.24 million in present value terms.

  Particulate matter can also result in non-health, quality of life effects. This potential effect was investigated using a hedonic pricing study, Appendix D. No statistically significant effect was identified in the study.

- **Air quality impacts – other pollutants:** the blast fume assessment for the Project indicates that nitrogen dioxide emissions from Mount Owen have the potential to exceed assessment criteria. However, Mount Owen will undertake blasts outside of adverse weather conditions to ensure there are no exceedances. As some health impacts produced by the emissions are correlated with PM_{10}, and would be captured in the estimate of air pollution costs above, the potential for additional health impacts is not quantified as part of this item.

- **Noise impacts:** estimates of the noise exposure of residential properties, for representative years under the Project case were obtained from the Noise Impact Assessment, from 2016 onwards. It was assumed that the baseline case impacts between 2016 and 2018 are consistent with Year 1 of the Project. After applying a 30dB(A) threshold (consistent with the minimum rating background noise level used in the EPA's Industrial Noise Policy), these exposures were valued at $62.38 per dB(A) per household per year (the upper range identified in Navrud, 2002, converted to current Australian dollars). This produced total estimates of the cost of noise pollution of $0.05 million in the baseline, and $0.18 million in the Project case, in present value terms.

- **Visual amenity:** based on the findings of the Visual Impact Assessment, it is anticipated that the current visual impacts from Mount Owen under the baseline will continue at a similar but slightly reduced level over the course of the Project. The slight reduction is due to the fact that with ongoing rehabilitation, the visual impacts should reduce over time. These impacts are acknowledged but not quantified in this analysis.

- **Traffic:** based on the findings of the Traffic Impact Assessment, during the operations phase, the Project is not anticipated to cause adverse impacts on traffic conditions and service levels during the continued mining operations. However, during the construction phase, it is estimated that travel delays during the AM and PM weekday peaks at the New England Highway intersections at Hebden Road and Glennies Creek Road will increase by 89 vehicle hours per year. Meanwhile, the proposed Hebden Road Rail Overpass is expected to reduce travel times by 1,871 vehicle hours per year once completed. For the purpose of this analysis it is assumed that this benefit will be realised from 2018 onwards. Applying travel time values and idle time operating costs estimated by Transport for NSW (2013) implies that the overpass will generate total net benefits of around $0.77 million in present value terms.

It is acknowledged that the proposed replacement of the single lane bridge on Hebden Road over Bowmans Creek should further reduce travel times and improve road safety, but these impacts are not quantified in this analysis due to uncertainties surrounding the extent of both current delays outside the AM peak and the likely change in the risk of accidents. Nevertheless, this benefit is likely to be less than $22,000 in present value terms.

- **Biodiversity (flora and fauna):** a Biodiversity Offset Strategy that is consistent with Commonwealth and State Government policies has been prepared. This means that although the Project is anticipated to disturb land currently inhabited by a number of species of flora and fauna, the strategy is designed to mitigate and offset potentially significant biodiversity impacts. Specifically, three offset areas have been designed, to hold a similar biodiversity value as the areas affected by the Project. Accordingly, no quantitative valuation is placed on the risks to biodiversity.

  However, these offsets do incur management costs. This analysis utilises a rate of $3,318 per hectare of land, as an estimate of the lifetime costs of offset management, consistent with estimates produced by the NSW Office of Environment and Heritage Credit Calculator (2012), updated to 2014 prices. Overall, these costs are estimated at $2.22 million in NPV terms in the Project case. There are no additional risks to biodiversity expected under the baseline.

- **Conservation:** Umwelt has advised that the Project will not impact on any existing Mount Owen Mine conservation areas or biodiversity offset areas. As outlined above, three additional offset areas will be established and maintained in perpetuity under the Project case, relative to the baseline. To avoid double counting against the treatment of these areas under the biodiversity item, no separate costs or benefits have been attributed to the conservation item in this analysis.

- **Quality of open space:** this item considers the impact of the Project on the ability of residents and visitors to utilise areas in the vicinity of the proposed disturbance area. The Social Impact and Opportunities Assessment indicates that the Project is not anticipated to directly impact the Ravensworth State Forest or the Lake Liddell Recreation Area, or the level of public access to those sites, relative to the baseline. As a result, no quantitative values are assigned to this item in both the baseline and Project case as part of the CBA.

- **Rural amenity and culture:** the Social Impact and Opportunities Assessment has also found that the Project is likely to have low impacts on the local population, community and infrastructure services, community sustainability and intergenerational equity and the sense of community and cohesion, in cumulative terms, taking into account the existing mining activities within the region.

  Although the extent to which the sense of community will be affected by the Project alone is uncertain, this analysis utilises an estimate of the willingness to avoid a decline in rural population published by Bennett, van Bueren and Whitten (2004) as a proxy for these costs. Umwelt has advised that a total of three additional privately owned residences, relative to the baseline, are likely to meet the acquisition criteria in relation to the air quality and/or noise impacts of the Project. It is assumed that the rights would be granted from the time of approval. Although acquisition rights do not necessarily result in relocation, it does provide an indication of the number of people that could potentially relocate from the immediate surrounding area as a direct result of the Project. The costs of a decline in rural amenity and culture are estimated at $8.04 million in present value terms. As a number of assumptions were involved in this valuation, this cost should be considered an indicative estimate of the likely order of magnitude of any impacts on the sense of community and cohesion. It is noted that these costs may be offset to some extent by community investments made by Mount Owen over the course of the Project, such as support for Mount Pleasant School.

- **Aboriginal heritage:** the Aboriginal Cultural Heritage Assessment (ACHA) found that the wider region surrounding the Project Area is identified as being of high cultural significance to many Wonnarua people, however the Project Area, and more specifically the Project Disturbance Area, has been assessed by this project as holding lower cultural significance than much of the surrounding region. The scientific value of the sites in the Project Area is limited, mainly due to existing clearance of trees and major soil loss, as well as ongoing mine infrastructure, revegetation and previous archaeological salvage. Thus, the heritage assessment indicates that, under the Project Case, any impacts are unlikely to affect sites of high significance. As part of the Project, Mount Owen will undertake measures to manage any potential impacts on Aboriginal heritage. Given the difficulties associated with quantifying any costs associated with losses of Aboriginal heritage, in the context of this Project, the risks of the Project are acknowledged but only considered qualitatively.
- **Historic heritage:** the Historic Heritage Assessment indicates that only one site with potential heritage local value – an area from the former Ravensworth Village within the proposed Hebden Road upgrade area – will be impacted by the Project. However, this site only has potential local significance and so it is anticipated that the Project will have no impact, direct or indirect, to any listed heritage items. As the existence of any heritage items located in the former Ravensworth Village area is uncertain, and as management measures will be put in place to mitigate these risks, it is not considered that there are any historic heritage costs.
- **Health:** The cost of health impacts are explicitly captured in the valuation of air pollution, and to some extent, implicitly captured in the costs of noise pollution, it is not appropriate to place a separate value on the health costs arising from additional cases of various health outcomes.

Given the values assigned to each cost and benefit in Section 5.2, the next stage of the CBA is to compare the baseline and Project cases and obtain a consolidated estimate of the net economic value of the Project. The overall results of the analysis are summarised in the following table:

Table v: CBA results

Discount rate	Total net benefits ($m)	Benefit Cost Ratio
4%	987.60	1.316
7%	758.05	1.305
10%	588.67	1.293

Source: DAE calculations

As the above analysis relies on a number of input assumptions, it is also prudent to test the sensitivity of the overall results to ranges of these inputs. A summary of the results of this sensitivity analysis are included below.

The important result here is that, with the exception of the 30% reduction in coal prices, the Project is expected to deliver positive net benefits in all cases.

The risks associated with a large reduction in coal prices will be primarily borne by Mount Owen. Some price risk is also borne by the NSW Government from reduced royalties. It should also be noted that this scenario represents an extreme case whereby prices remain at historically low levels throughout the life of the Project (around the 17th percentile of historical coal prices).

Table vi: Sensitivity Analysis – comparison of net benefits

Parameter	Variation in Parameter	Total Net Benefits ($m)		
		4%	7%	10%
Central CBA	N/A	988	758	589
Coal price forecasts	+ 30%	2,222	1,731	1,368
	- 30%	-247	-215	-191
Project capital investment	+ 25%	946	719	552
	- 25%	1,030	797	626
Operating costs per tonne	+ 10%	732	557	428
	- 10%	1,243	959	749
Cost per tonne of carbon emissions	+ 10%	984	756	587
	- 10%	991	761	591

Source: DAE calculations

Another way of interpreting these results is that the non-quantified negative externalities would need to be valued at around $89 million per year (in real terms), between 2016 and 2030 to offset the estimated net benefits of the Project. This is equivalent to an undiscounted value of $1.34 billion over the period. This is considered to be extremely unlikely, given the nature of the evidence regarding these impacts. Furthermore, this annual value would represent more than a sixteen-fold increase in the level of externalities estimated in quantitative terms.

Estimated Regional Net Economic Benefits

Although transfer payments, such as the payment of taxes to State Governments, are not normally included in a CBA, we estimate that the NSW Government will receive around $258 million in additional royalties in present value terms, which is equivalent to an additional $461 million in government revenue over the life of the Project. Around 92% of the present value of additional royalties is attributable to the continued operations at the North Pit.

While this estimate does take into account the allowable deductions for full cycle washing of product coal, it does not include potential further deductions for payment of levies, insurance, bad debts and bank commissions due to the difficulty in estimating the future level of these deductions

An estimation of the net benefits to the Singleton community is also of interest. CBA calculations are not easily disaggregated into regional assessments. However, to do this we have assumed that payments to mine suppliers and employees are proportional to the share of employees from different geographic locations. In order to illustrate the range of outcomes that could be achieved in the absence of the Project, it was assumed that these businesses and workers could either earn the same level of income from alternative sources, or the average level of income in Singleton in the baseline case.

Under these assumptions, along with a number of others regarding the share of externalities borne by the community, it is estimated that the Project could generate a net benefit of up to $306 million (in NPV terms) for the Singleton community over the life of the Project.

Subregional impacts of the project have been discussed in more detail in the Social Impact and Opportunities Assessment, which can be found in Appendix 5 of the EIS.

Economic Impact Analysis

The EIA measures the economic impacts of the Project over the whole of the Project's life-cycle. The assessment covers the capital intensive phase, where about $152.9 million in capital (undiscounted) is proposed to be installed. Mount Owen proposes to commence construction within one year of the commencement of mining beyond currently approved mining. For the purposes of this analysis it is assumed that this will take place between 2016 and 2017.

The assessment also covers the operational phase, where mining activity under the Project case differs from expected activity under the baseline case.

To model the economic impacts we have used our in-house Deloitte Access Economics – Regional General Equilibrium Model (or DAE-RGEM). DAE-RGEM is a Computable General Equilibrium (CGE) model that represents the dynamic relationship between economic agents. More detail on the model can be found in Appendix E.

The model has been customised for this analysis to incorporate three distinct Australian modelling regions, these include:

- Hunter Valley area — containing the localities of Branxton, Broke, Central Coast, Cessnock, Greta, Jerrys Plains, Kurri Kurri, Lake Macquarie, Maitland, Muswellbrook, Newcastle and Singleton;
- New South Wales; and
- The rest of Australia.

Economic impacts – Gross Regional Product

The modelling suggests much of the economic impacts are concentrated in the Hunter region. About $3.2 billion in coal output (NPV – 2016 to 2030) from the continuation is projected to generate just under $1.3 billion in GRP to the Hunter and a total of about $1.9 billion to NSW (NPV), see Table vii.

These projected impacts of the Project are measured against a baseline case scenario where the development does not proceed. The modelling incorporates both the increase to the capital stock and the continuation of coal output. Against the baseline case the continuation maintains higher levels of coal output and mine operations, which provides direct employment and related supplier inputs.

Partially offsetting the direct activity and increased demand in supply chains is the increase in competition of scarce resources, for example labour. This is reflected in the increased wage rate in the Hunter. This competition for resources also crowds out economic activity in other sectors of the region and the state.

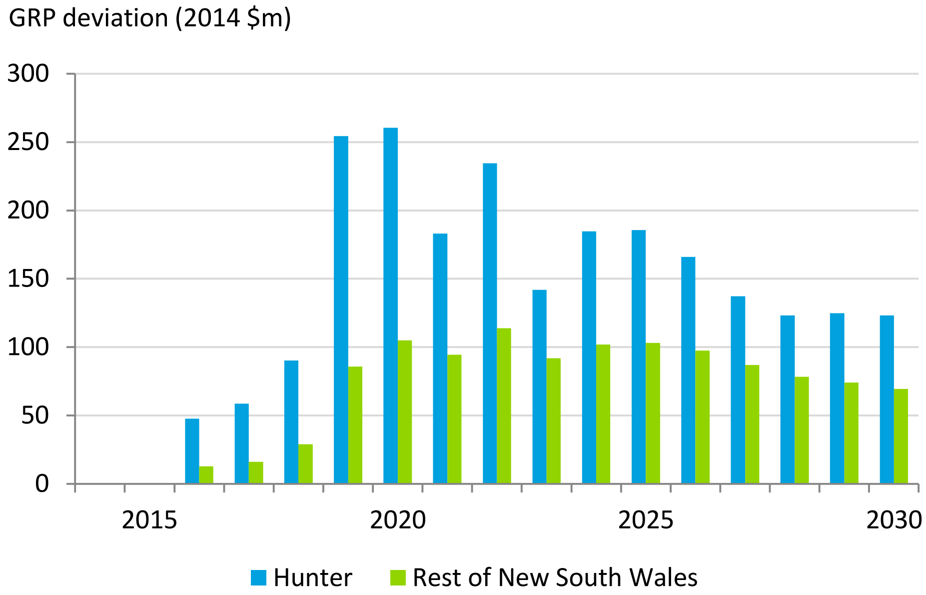
Table vii: GRP and GSP impacts, NPV, 2016 - 2030 (AUD $2014)

Regions	GRP/ GSP (NPV)
Hunter (GRP $m)	1,288
Rest of New South Wales (GRP $m)	613
Total NSW (GSP ($m)	1,902

Source: Deloitte Access Economics; NPV uses 7% discount rate

Economy-wide impacts tend to follow the output of the Project. Chart i outlines the year-on-year GRP impacts to the Hunter region and the rest of NSW. Over the modelling period the returns to the Hunter tend to follow the direct output activity. The GRP impact to the region is highest in 2020 at $260 million (in 2014 prices), to coinciding with the peak in mine output.

Chart i: GRP/GSP impacts by region

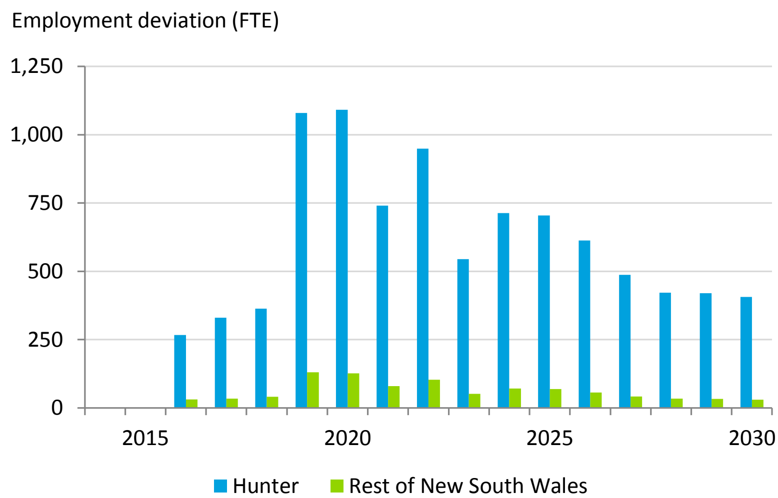


Source: Deloitte Access Economics

Employment – Direct and flow on

Employment impacts of the Project generally follow its ROM activity. Additional employment in the Hunter Region peaks in 2020 at 1,091 FTEs (see Chart ii). This includes employment at the mine and employment generated elsewhere in the economy and any projected crowding out in other sectors of the economy as a result of the Project. Over the remainder of the period to 2030 employment is projected to remain positive for the Hunter. The employment impacts – when compared to the GSP and mining activity – do trend lower over the period reflecting baseline employment productivity.

Chart ii: Employment impacts by region



Source: Deloitte Access Economics

Sensitivity Analysis

The report also outlines three sensitivities given the uncertainty over future coal prices. To understand the potential implications of different coal price trajectories for the continuation of the operations at Mount Owen and Ravensworth East, the economic impact analysis was conducted for three modelling scenarios:

- Central estimate of coal price forecasts
- Lower price scenario (30% lower than the central estimates)
- Higher price scenario (30% higher than the central estimates)

GRP impacts are proportionate to the coal price inputs. In the Hunter region GRP is modelling to decrease from $1,288 million in the Central case to $935 million in the low and increase to $1,647 million in the higher price scenario.

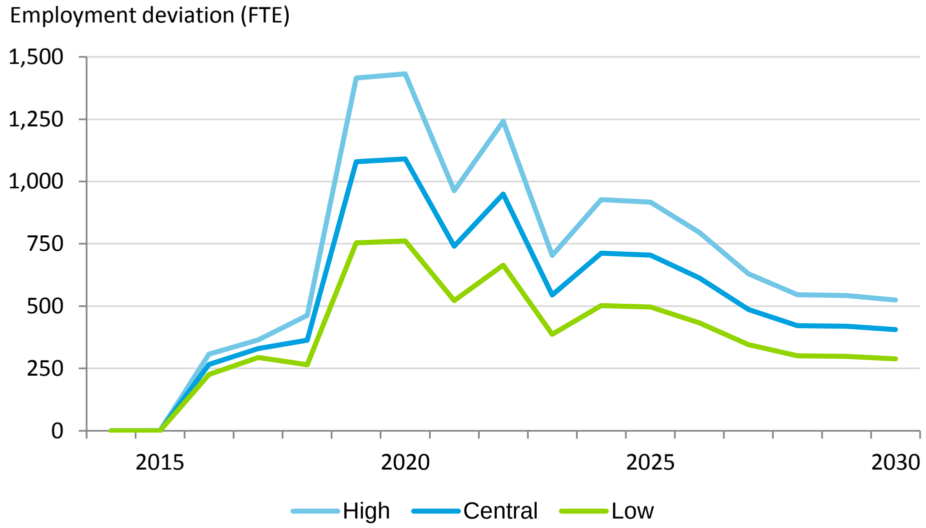
Table viii: GRP impacts, NPV, 2016 - 2030 (AUD $2014)

NPV	Central	Low	High
Hunter	1,288	935	1,647
Rest of New South Wales	613	427	804
Total NSW	1,902	1,362	2,451

Source: Deloitte Access Economics; NPV uses 7% discount rate

Chart iii outlines the total regional employment impacts of the proposed mine development under the three modelling scenarios in the Hunter region. As with the central case outlined above, the total regional employment impacts are relatively small over the construction phase of the modelling and peak in 2020.

Chart iii: Employment impacts, Hunter region



Source: Deloitte Access Economics

Deloitte Access Economics

1 Introduction

The Mount Owen Complex is located within the Hunter Coalfields in the Upper Hunter Valley of New South Wales (NSW), approximately 20 kilometres north-west of Singleton, 24 kilometres south-east of Muswellbrook and to the north of Camberwell village.

Mount Owen Pty Limited (Mount Owen), a subsidiary of Glencore Coal Pty Limited (formerly Xstrata Coal Pty Limited), currently owns the three open cut operations in the Mount Owen Complex. These three operations are: Mount Owen (North Pit), Ravensworth East (West Pit and Bayswater North Pit (BNP)) and Glendell (Barrett Pit). This relationship is shown in Figure 1.1.

The Mount Owen North Pit and associated infrastructure is owned by Mount Owen Pty Ltd and is currently operated under contract by Thiess Pty Limited (Thiess). All operations at Glendell and Ravensworth are managed and operated by Mount Owen.

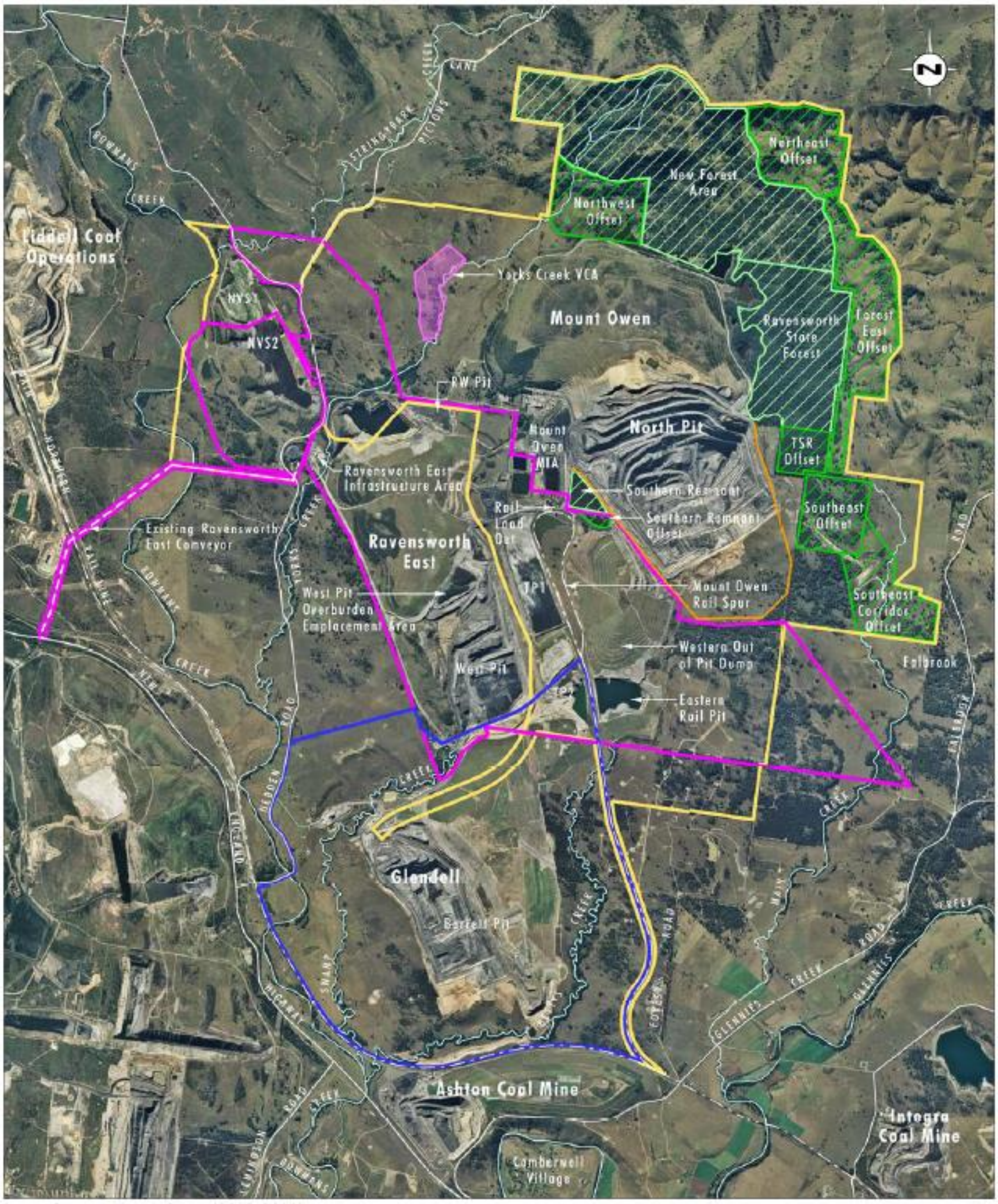
Figure 1.1: Schematic of operations at the Mount Owen Complex

As shown in Figure 1.2, the mining operations at the Mount Owen Complex include the integrated use of the Mount Owen coal handling and preparation plant (CHPP), coal stockpiles and the rail load-out facility.

As part of the Mount Owen Continued Operations Project ('the Project'), Mount Owen proposes to extend mining operations at the Mount Owen Mine beyond 2018 out to 2030 to extract additional coal resources south of the currently approved North Pit mining limit (the North Pit Continuation) and to undertake mining operations within the BNP sequentially followed by mining in the RERR Mining Area.

While the proposed operations at the BNP and RERR are within areas currently approved for mining, Mount Owen is seeking consolidation of the Mount Owen and Ravensworth East Operations through a single development consent. The Project does not include any changes to operations at the Glendell Mine, which will continue to operate in accordance with its current development consent.

Figure 1.2: Current operations at the Mount Owen Complex



Source: Umwelt

In accordance with the EP&A Act, an Environmental Impact Statement (EIS) is required for the Project. The objective of the environmental assessment is to ensure that approval bodies, government authorities (including local councils), the applicant and the broader public have sufficient material to properly consider the potential environmental consequences of a proposal (NSW Government, 2000).

As such, an EIS has been prepared for the Project to accompany a Project Application following Department of Planning and Environment (DP&E) issuing Director-General's Requirements (DGRs) for the Project.

A required component of the EIS is an analysis of economic issues. Specifically, the DGRs include the need for an assessment of the costs and benefits of the development of the Project as well as an analysis of whether the Project would result in a net benefit for the NSW community.

This report therefore undertakes an assessment of the impacts of the Project within a cost benefit analysis (CBA) framework to address the costs and benefits of the proposed continued operations, relative to a baseline, 'business as usual' scenario. This baseline case involves mining activity at the Mount Owen North Pit out to 2018, and a single year of mining at the BNP in 2015, followed by land rehabilitation.

It is noted that should the Project not proceed, additional mining would be undertaken at the Ravensworth Mine, subject to the existing approvals. However, this framework has been adopted to allow for the measurement of the incremental costs and benefits of the Project, in order to determine the net economic value of the Project, under a consolidated development consent for operations at Mount Owen and Ravensworth East.

A Computable General Equilibrium (CGE) model is then used to analyse the impact of this Project on the NSW community as measured by changes in economic activity and employment.

1.2 Report structure

The first four chapters of this report are structured in accordance with the general CBA guidelines. An additional analysis using CGE modelling is provided to outline the anticipated impact of the Project on the regional economy. The CGE analysis can be understood as an extension to the CBA, accordingly, the CGE results may not be directly comparable to the CBA results or other projections outlined in the EIS. This is because it encompasses a broader range of impacts than the initial economic, environmental, or financial analysis.

The structure of this report is as follows:

- Chapter 2 outlines the methodology employed in this report, including how the approach used aligns to the NSW CBA guidelines.
- Chapter 3 provides a background of the Singleton LGA, presenting a brief demographic and employment profile of the region.
- Chapter 4 details the Project and defines the base case and the expected scenario under the Project case.
- Chapter 5 presents the results of the cost benefit analysis, including a disaggregation of all the anticipated impacts included in the analysis.
- Chapter 6 presents the results of an analysis of the impacts of the Project on the regional economy, using CGE modelling.
- Appendix A provides a checklist illustrating how this report has met the requirements of various guidelines.
- Appendix B outlines relevant valuation techniques that are often employed in CBA.
- Appendix C discusses the variety of approaches that may be used to value specific costs and benefits.
- Appendix D provides additional detail on the hedonic pricing modelling used to value the impact of air pollution used in this report.
- Appendix E presents an overview of the CGE model.

2 Methodology

DAE have established a methodology for undertaking this CBA which relies on the range of guidelines and requirements set out by the NSW Department of Urban Affairs and Planning (2002), NSW Treasury (2007) and NSW Government (2012) in undertaking CBAs and applied to this Project in particular. This chapter reviews the guidelines and requirements before discussing how these have been applied to develop the methodology.

2.1 CBA guidelines

CBA is an extremely common and long standing approach and so there are a large number of guidelines available for both reference and compliance purposes. These guidelines cover conceptual issues such as how environmental consequences should be treated as well as practical issues, such as what discount rates should be used in what circumstances. The following documents have been used as the most relevant guidelines for this CBA:

- NSW Treasury (2007), "NSW Government Guidelines for Economic Appraisal";
- NSW Department of Urban Affairs and Planning (2002), "Guideline for economic effects and evaluation in EIA"; and
- NSW Government (2012), "Guideline for the use of Cost Benefit Analysis in mining and coal seam gas proposals"

These three documents move from high level issues around CBA through to how CBA should be applied to an EIA and then also cover the application of CBA to coal mines in particular. A full account of the requirements of these guidelines is given in Appendix A and the requirements are cross referenced to sections of this report.

2.2 Director General's requirements

In addition to the CBA focused guidelines listed above, for this project there are also specific requirements set out in the Director General's Requirements (DGRs). The DGRs for the Project were issued in March 2013 and set out specific issues that the EIS for the Project must cover. As noted in Section 1, this report addresses the requirement for a detailed assessment of the costs and benefits of the development as a whole and whether it would result in a net benefit for the NSW community.

While the remainder of the requirements cover topics beyond the scope of an economic assessment, there are particular areas which are relevant to our methodology. These areas of relevance are summarised and cross referenced in Appendix A.

2.3 Implications of these guidelines

Together, these four documents set the baseline requirements for this economic assessment. While Appendix A contains an item by item reconciliation of how these guidelines have been addressed, it is worth considering their implications qualitatively here. Overall, they require that the CBA should be carried out using a set of standard approaches and also must include consideration of certain topics.

Looking first at the standard approach, the guidelines suggest that the CBA should involve:

- identification of the characteristics of the proposal and any alternatives;
- defining the spatial boundaries of analysis (e.g. local, regional, state, national);
- identification of the environmental impacts of the Project;
- identification of costs and benefits, including:
  - economic resource costs (e.g. capital expenditure);
  - negative externalities;
  - base case benefits given up;
- quantification of costs and benefits, using market prices where available, otherwise using imputed prices or a qualitative assessment;
- consolidation of values by applying a discount rate; and
- applying decision criteria such as a benefit cost ratio.

This standard approach will be applied throughout this report. The definition of the proposal and spatial boundaries of analysis is covered in Section 4. Section 5 then covers the identification, discussion, quantification and consolidation of costs and benefits of the Project.

Moreover, the guidelines suggest that the CBA must contain analysis of a broad range of issues, costs, benefits and distributional matters. Beyond the costs and benefits of the Project itself (such as revenue, capital investment and operating expenditure), the issues broadly fall into two main categories:

- **Externalities:** these externalities cover areas where the Project will create costs or benefits, which cannot be captured in current market transactions, for third parties not involved in the production, sale or purchase of coal. These are mostly relevant in areas where property rights are non-existent or difficult to enforce. Key externalities here include effects on agricultural productivity; bodies of water and water quality; carbon emissions; air quality impacts; noise impacts; visual amenity; traffic; biodiversity and ecosystem conservation; quality of open space; rural amenity and culture; and heritage.
- **Regional and industry flow-on economic effects:** as with the externalities, flow-on effects involve parties who are not directly transacting in the production or consumption of coal, and encompass any market based responses to the presence of the Project. Flow-on effects are indirect impacts due to adjustments in the economy, such as price movements, that depend upon initial market based responses or direct impact which occur first. For example, if the Project increases demand for a certain type of labour this may affect the price of labour in the region which will have flow-on consequences for other local industries. These are not externalities, but are rather seen as the mechanisms by which the economy re-adjusts in response to changed

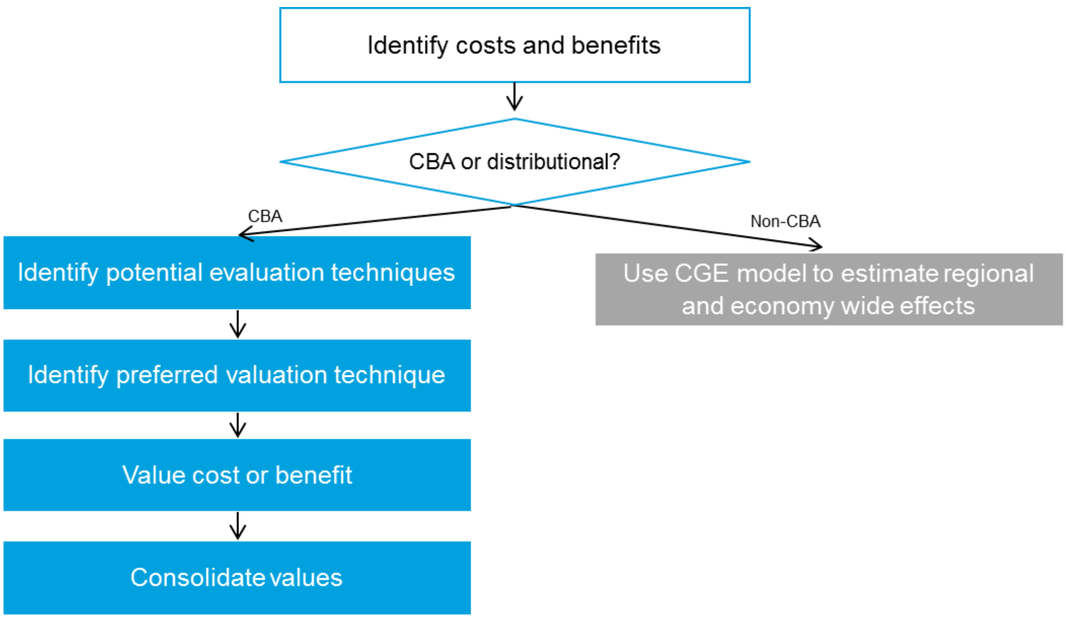
patterns of supply and demand. Key effects here include: increases in mine worker wages; profits of mine suppliers; impacts on the agricultural industry; impacts on labour supply and local tourism effects.

A traditional CBA, which focuses mainly on the Project itself and then incorporates any quantifiable externalities, may not be able to provide sufficient analysis of the diversity of this range of issues. For example, a CBA, by its nature, does not take into account the general equilibrium flow-on effects described above as these are essentially benefits to some parts of the economy which are offset by costs elsewhere. The following section sets out our approach for ensuring that all the requirements are covered within this economic analysis.

2.4 Our Methodology

Taking the above guidelines together creates a complex set of requirements which encompass topics that are handled well by a traditional CBA as well as other issues which do not fit neatly into a CBA framework. To address this we have developed a methodology which first analyses items amenable to CBA modelling within a CBA framework and then applies CGE modelling to look at further issues, such as a circumstance where wages may increase in response to increased demand for labour or distributional effects, whereby the impact on wages differs across subregions or industries of the local economy.

Figure 2.1: Outline of methodology



The methodology has been designed to clearly separate the issues identified in the guidelines and requirements based on how they can be analysed from an economic point of view. For example, the issues covered under externalities are amenable to modelling within a CBA framework. These will therefore pass through the stages of having evaluation techniques identified, selecting one particular technique, valuing the externality and adding it into the consolidated value of the CBA (such as a NPV or cost benefit ratio).

This approach can be contrasted with an issue such as impacts on local labour supply. This issue is not amenable to a CBA framework, as it involves transfers of costs and benefits between groups within the economy which cancel each other out. As a result, issues like this will pass down the other arm of the methodology. The CGE modelling is used to determine the economy wide effects of the Project and provides a clear picture of benefits for NSW, especially the Hunter economy.

CGE modelling can be seen as an addition and extension of the CBA but with a particular focus. That is, the CBA focuses on the Project and its immediate external effects. The CGE model is then used to trace these immediate effects through the economy more broadly. For example, increased capital expenditure may lead to increased demand for steel and fuel as inputs. This, in turn, can increase demand for labour in iron mines and oil refineries. This chain of events will create complex interactions between supply and demand in each market which will ultimately be resolved by changes in prices and outputs across the economy. The CGE model provides a way to trace this chain of events through to its final resolution. It should be noted that the CGE model is, fundamentally, built on the national accounting system and so focuses on outputs that are traded in markets and contribute to GDP – it does not capture environmental and other externality costs that are captured as part of the CBA.

It should also be noted that CGE modelling is a substitute for Input-Output (IO) modelling. Both approaches can provide estimates of increases in economic output, value added and employment in the broader economy flowing from the Project. CGE modelling uses a more complex set of techniques and involves different assumptions about the state of the economy. One central difference between the two approaches is that IO modelling generally assumes that there is a large pool of resources available in the economy to meet increases in demand. In contrast, CGE modelling generally assumes that the economy and sectors within the economy are competing for the use of resources. This means that increases in demand from the Project may result in effects such as increased prices in other markets and crowding out effects (rather than just increased output).

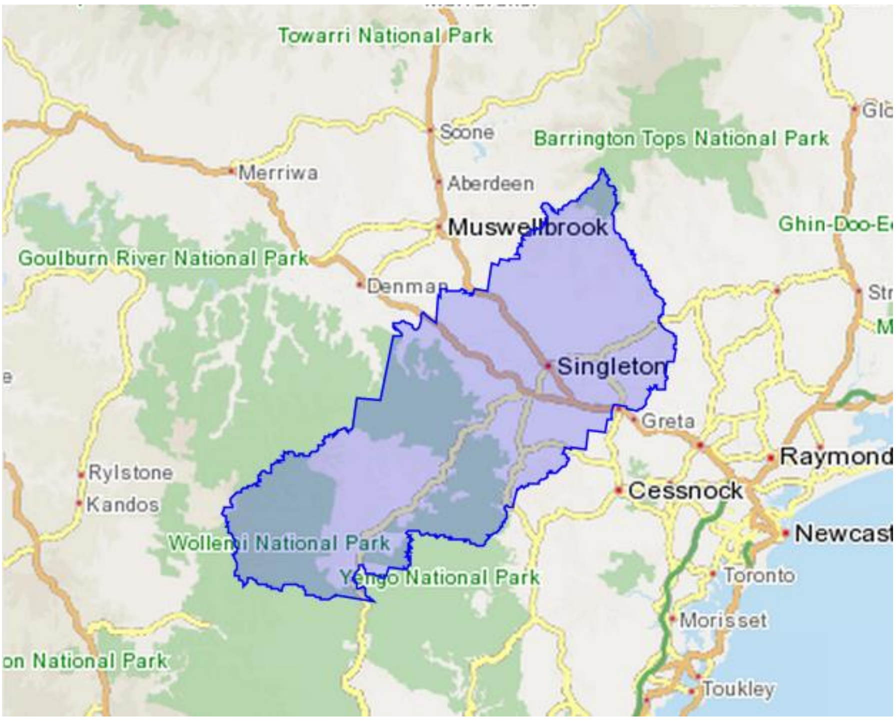
3 Background on Project Area location

This chapter provides an overview of the economic and demographic characteristics of the location of the Project. The Singleton Local Government Area (LGA) is used as the unit of analysis in this chapter as it provides an appropriate scale on which to give a picture of local social and economic conditions. Later chapters of the report include detailed analysis on the broader Hunter region.

Singleton LGA is located in the Hunter region of New South Wales, approximately 200 km northwest of Sydney and 80km inland from Newcastle. The LGA consists of a number of townships and villages, including Singleton, Broke, Camberwell and Jerrys Plains, as well as numerous surrounding smaller localities.

The LGA is bounded by the LGAs of Muswellbrook to the west, Upper Hunter Shire to the north, Dungog, Maitland and Cessnock to the east and Lithgow and Hawkesbury to the south.

Figure 3.1: Singleton LGA



Source: ABS (2013)

3.1 People

At the time of the 2011 Census, the population of Singleton LGA was 22,694 which amounts to a 10.7% increase in population from 2001. This is higher than the population increase state wide which was 9.2%. The population is evenly split across sexes, with 51% of the population being male. The average age across the LGA is approximately 35 years, which is slightly lower than the New South Wales average of 38 years.

Table 3.1: Population characteristics of Singleton

	2001	2006	2011	2001-2011 change
Population (usual residence)	20,509	21,939	22,694	10.7%
Population (enumeration)	20,384	22,071	23,019	12.9%
Mean household size	2.8	2.8	2.7	-3.70%
Median age	33	34	35	6.1%
Total occupied private dwellings	6,983	7,640	8,163	16.9%
Median mortgage repayment ($/month)	1345	1675	2073	54.1%
Median rent ($/week)	179	215	269	50.3%
Median household income ($/week) - Singleton	1322	1511	1748	32.2%
Median household income ($/week) - NSW	1140	1243	1278	12.1%

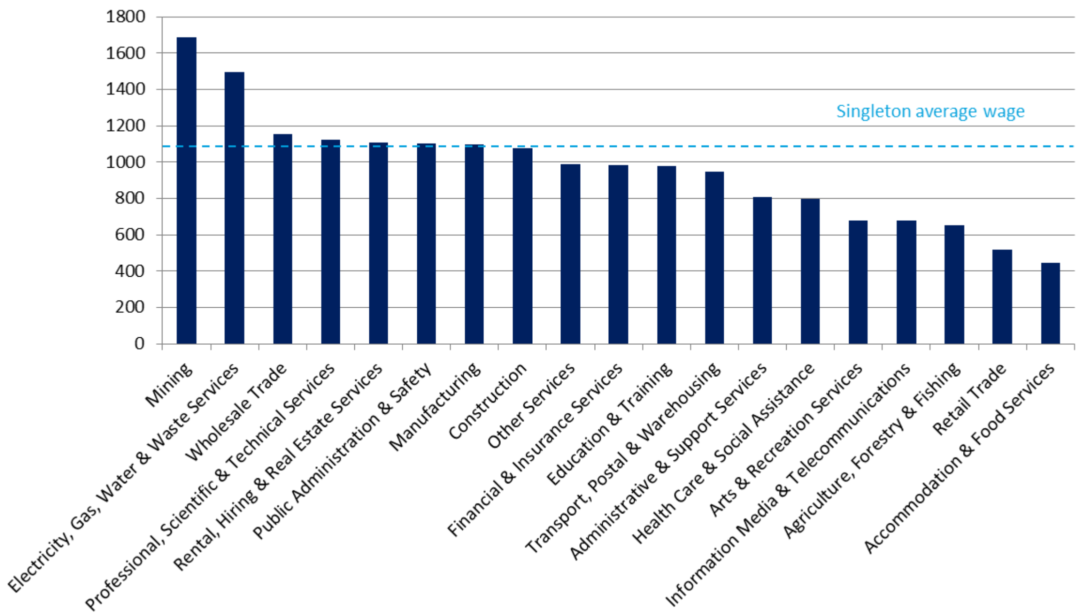
Source: ABS, 2011 Census Time Series Profile Cat. 2003.0
Note: All dollar values reflect real figures adjusted using ABS CPI to June 2013 dollars.

The number of occupied private dwellings in the Singleton LGA has increased by 16.9% over the ten years from 2001 to 2011, an average annual growth rate of 1.6%. Approximately 1,200 additional dwellings were established in Singleton LGA over the period from 2001 to 2011. This trend is a reflection of both the population growth in the region and the decline in average household size observed between 2001 and 2011.

In the 2012-13 financial year, there were 162 new residential dwellings approved in Singleton LGA, including 86 new houses. The value of residential building approvals over the financial year was $24.3 million and the value of total building approvals was $66.7 million (ABS Building Approvals, 2013).

The 2011 census, still the most reliable piece of information on household income, indicates that the median weekly household income in Singleton in 2011 was $1,748, considerably higher than the NSW median of $1,278. Given anecdotal reports, it may be that this gap has since narrowed. A breakdown of the average wage by industry is provided in Chart 3.2 below. As illustrated, mining is the highest paying industry in the Singleton LGA.

Chart 3.1: Singleton average weekly personal income by industry – 2011



Source: ABS (2012a)

3.2 Education

The average educational attainment in Singleton is lower than the NSW average, as evidenced by Table 3.2 below. For example, in the 2011 Census, only 12.4% of the population indicated they held a tertiary level qualification, compared with 22.8% of the NSW population.

Table 3.2: Highest level of education attained

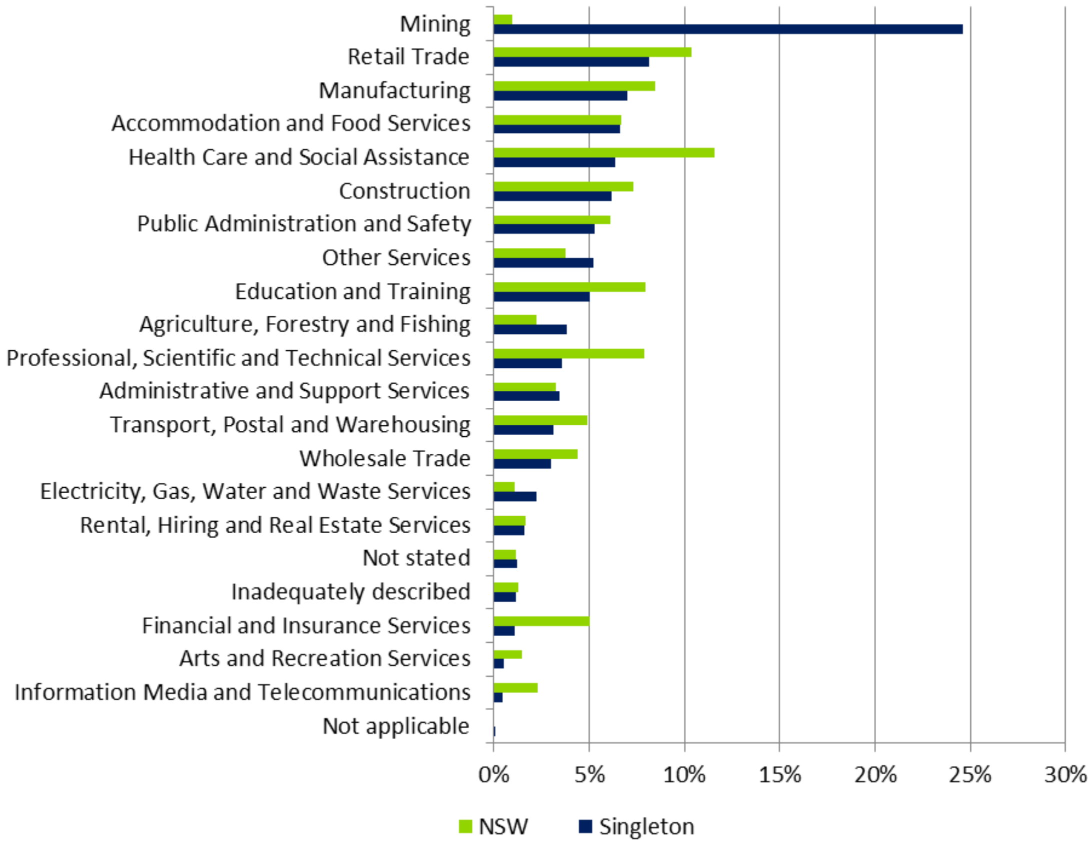
Highest level of education	Singleton	NSW
Tertiary level		
Postgraduate degree level	0.9%	3.5%
Graduate diploma and graduate certificate level	0.6%	1.2%
Bachelor degree level	5.9%	11.4%
Advanced diploma and diploma level	5.0%	6.7%
Certificate level		
Year 12 or equivalent	24.8%	38.4%
Year 11 or equivalent	6.7%	4.8%
Year 10 or equivalent	28.7%	19.5%
Year 9 or equivalent	7.8%	5.9%
Year 8 or equivalent	4.2%	4.5%
Did not go to school	0.3%	0.8%
Highest year of school not stated	5.3%	6.9%

Source: ABS, 2011 Census (2012a)

3.3 Industries of employment

Mining is the major industry of employment in the Singleton LGA, employing 24.6% of the employed population. This is much higher than in NSW, where just 1.0% of the employed population work in the mining sector. The retail and manufacturing industries are the next highest employers, at 8.2% and 7.0% respectively.

Chart 3.2: Industry of employment in Singleton LGA and New South Wales



Source: ABS (2012a)

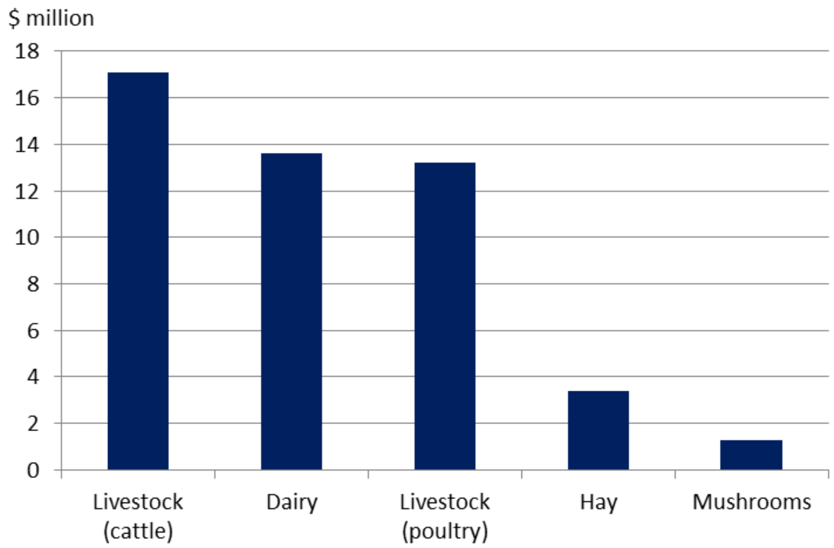
3.3.2 Mining

As at the 2011 Census, the mining industry employed 2,808 people in the Singleton LGA. The vast majority of these jobs are in Coal Mining (89.4%), with the next highest sub-industry employment in Exploration (5.8%). Given anecdotal reports, it may be that this figure has since declined. The major mines and operations in the local area are Mount Owen, Integra, Liddell, Ashton and Ravensworth Operations, as well as a number of other mines.

3.3.3 Agriculture

In the year ended June 2011, the Singleton LGA produced agricultural produce of a gross value of $50.9 million from 454 businesses. The major contributing commodities were livestock, dairy and hay, as illustrated in Chart 3.3 below.

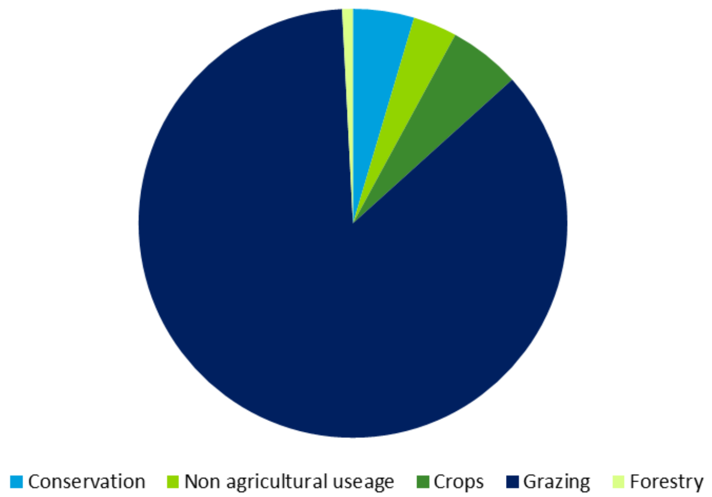
Chart 3.3: Gross value of primary agricultural commodities – Singleton 2010-11



Source: ABS, Agricultural Commodities, 2010-11, Cat. 7121.0

91% (135,545 ha) of land in the Singleton LGA is used for agricultural purposes, as evidenced in Chart 3.4 below. The vast majority of this agricultural land is dedicated to grazing (94% of agricultural land).

Chart 3.4: Use of agricultural land in Singleton and Singleton region SLAs – 2011



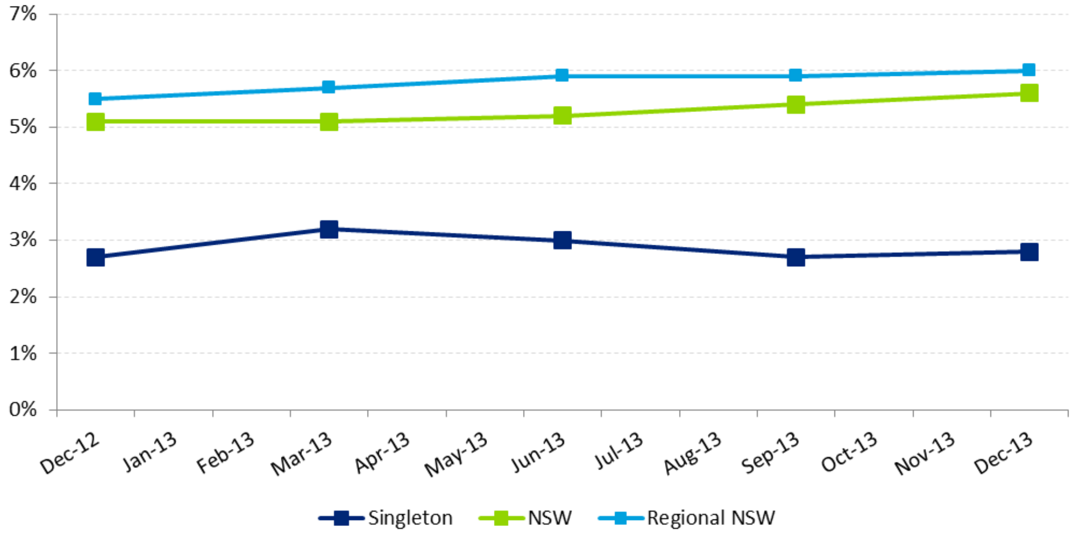
Source: ABS, Agricultural Commodities, 2010-11, Cat. 7121.0 (Note that this is has different boundaries to the Singleton LGA shown in Figure 3.1 due to ABS region definitions. Land is also only that covered by the Agricultural Resource Management Survey and so will not include non-agricultural uses such as state forests.)

3.4 Unemployment

According to Department of Employment small area labour markets data, the unemployment rate for the quarter preceding December 2013 in Singleton was 2.8%, relatively similar to the unemployment rate of 2.7% in the previous year. However, the unemployment rate in Singleton is still substantially lower than the NSW rate (5.2% in June 2013). Chart 3.5 below illustrates a general trend towards rising unemployment across regional NSW over the past nine months, which is reflected to a greater extreme in Singleton LGA[1].

Given anecdotal reports, it is likely that there have been changes in the unemployment rate in Singleton since December 2013, however, this is the most recent data available at the local level.

Chart 3.5: Unemployment rate in Singleton and NSW



Source: Department of Employment 2014, Small Area Labour Markets Data

[1] The Department of Employment unemployment estimate is constructed by apportioning the ABS' Upper Hunter Region employment statistics based on the size of the labour market in the Singleton region. This methodology has the potential to overestimate the Singleton unemployment rate due to movements in other small area labour markets. As a point of comparison, the 2011 Census indicated that the unemployment rate of usual Singleton residents was 3.4%. At the same time, the state-wide unemployment rate, as indicated by the Census, was 5.9%. This is broadly in line with the trends displayed through the Department of Employment estimates, and suggests that while a margin for error applies, the rates displayed in Chart 3.5 is a plausible account of the unemployment pattern in Singleton over the past year.

4 The Mount Owen Continued Operations Project

As described above, the purpose of a CBA is to provide a structured approach to assessing whether or not the Project is likely to result in overall benefits to the economy. To carry out this economic assessment, the costs and benefits associated with the Project are compared to those under a baseline, 'business as usual' case. This comparison allows for an incremental analysis, to reach a clear conclusion on the net benefits of the Project. Accordingly, for the purposes of the CBA, it is important to clearly define the baseline case and the Project case.

As described in Section 1, the Mount Owen Complex consists of three open-cut mining operations, at the Mount Owen, Ravensworth East and Glendell Mines. This analysis focuses on the mining activities at the North Pit at Mount Owen, and the BNP and RERR Mining Area at Ravensworth East. Through the Project, Mount Owen is seeking to combine the development consents for the Mount Owen and Ravensworth East operations.

In both cases, the Glendell Mine will continue in accordance with its development consent. It is anticipated that operations will conclude at Glendell in 2021.

The baseline case and Project case are defined in turn below.

4.1 Baseline case

The North Pit has an approved production rate of 10 million tonnes per annum (Mtpa) of run of mine (ROM) coal, and blended with Ravensworth East (4 Mtpa) and Glendell (4.5 Mtpa) ROM coal, feed the Mount Owen CHPP and associated infrastructure which has a total approved processing capacity of 17 Mtpa of ROM coal. Processed coal, both semi soft and thermal coals, are transported via the Main Northern Rail Line to Port Waratah in Newcastle for export, or by rail or conveyor for domestic use.

Mount Owen expect, subject to market conditions, that mining will be completed within the currently approved area of the North Pit by 2018. Accordingly, the baseline case assumes that 24.32 Mt of product coal will be extracted from the North Pit at Mount Owen between 2014 and 2018. This extraction profile is within the extraction limit of 10 Mt ROM coal per annum.

In addition, the baseline case includes a single year of mining operations at the BNP in 2015. This is expected to produce 1.26 Mt of (predominantly thermal) product coal. These operations are also within the annual extraction limit of 4 Mt ROM coal.

It is noted that should the Project not receive approval, mining operations at the BNP will continue according to existing approvals. However, in order to estimate the incremental costs and benefits of the Project under a single development consent, the assumption that mining will conclude at Ravensworth East after 2015 has been adopted for the baseline case.

On this basis, employment for North Pit operations under the baseline is estimated at 579 FTEs from 2014 to 2017, with a reduction in 2018 to 323 employees in transition from mining operations to rehabilitation. These estimates assume that the mine will be in operation 24 hours per day, seven days per week. In addition, employment for BNP operations in 2015 is estimated at 239 FTEs.

From 2019, the cessation of mining activities at the North Pit will require rehabilitation activities in the mine area. The current consent stipulates that rehabilitated land will be primarily used for native vegetation conservation to redevelop forest and woodland, with some other areas used for grazing. The exact allocation process and proportion of future land use is still to be confirmed and agreed by stakeholders.

In accordance with existing approvals, rehabilitated land at Ravensworth East will be allocated to approximately 70% low level agriculture and 30% rehabilitated forest. The current consent for the Ravensworth Mine lapses in 2021.

Further details on activities approved under the baseline case, relative to the Project case, are summarised in Section 4.3.

4.2 Project case

Mount Owen is seeking development consent for the Mount Owen Continued Operations Project (the Project), to extract additional mineable coal tonnes through continued open cut mining methods. This involves:

- continuation of mining activity at the Mount Owen North Pit beyond 2018 to 2030, extracting an additional 74 Mt of ROM coal;
- continuation of mining activity at the BNP, Ravensworth East, beyond 2015 to 2022, extracting an additional 12 Mt of ROM coal; and
- sequential mining in the RERR Mining Area from 2022 to 2027, extracting an additional 6 Mt of ROM coal.

To improve operational efficiencies, should the Project be approved, Mount Owen will surrender the existing consent for Ravensworth East operations, to take up a single consolidated development consent covering continued Mount Owen operations and the operations at Ravensworth East. As such, the EIS studies, including this economic assessment, measure the impacts of the continued operations at the North Pit, BNP and RERR Mining Area.

As illustrated in Figure 4.1, the operations under the Project case will be accommodated by a continuation of the North Pit by an additional 381 hectares. In the remainder of the report, this area is described as the North Pit Continuation Area. There is no additional disturbance from the Ravensworth East mining pits, as they are located in areas that have been previously disturbed.

The Project would seek to maintain the current approved extraction rates of 10 Mtpa of ROM coal and 4 Mtpa for the North Pit and Ravensworth East operations respectively. The extraction of additional mineable coal tonnes would continue the North Pit life to approximately 2030 (an additional 12 years) extending the substantial employment and economic benefits provided to the existing workforce and suppliers.

In addition, the Project case involves a number of infrastructure upgrades, including:

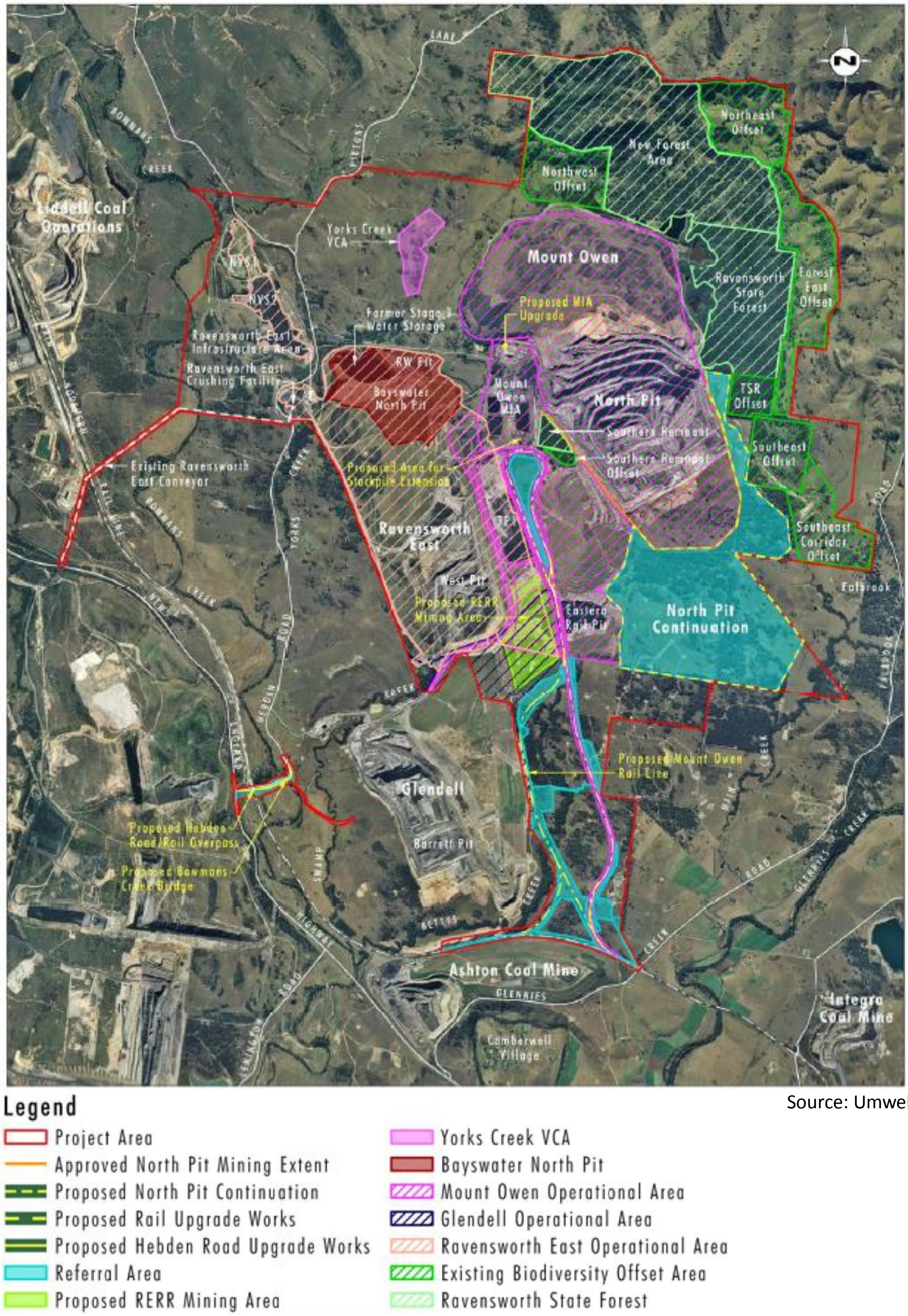
- expansion of the existing product stockpile to manage additional product types;
- upgrade and extension of the Mount Owen mine infrastructure area (within existing operational areas);
- provision of an additional rail line and northern-turn out, to the west of the existing Mount Owen rail spur, with use of the existing rail spur as a park-up area for Glencore trains that are not in service;
- construction of a rail overpass, and removal of the existing level crossing on Hebden Road to improve traffic flow and reduce traffic hazards; and
- construction of a new bridge on Hebden Road to allow for two-way traffic movements over Bowmans Creek.

The rail and road infrastructure upgrades noted here are planned to affect an additional 104 hectares of land. Together with the North Pit Continuation Area, the Proposed Disturbance Area is 485 hectares in total. Mount Owen proposes to commence construction within one year of the commencement of mining beyond the currently approved mining. For the purpose of this analysis, it is assumed that this construction phase will begin in 2016.

In addition, the Project is seeking approval to allow for tailings from Glencore's neighbouring mines to be emplaced within the Mount Owen tailings emplacement areas.

Under the Project case, it is anticipated that annual operational employment levels will remain the same as the baseline in 2014 and 2015. Upon commencement of the Project, it is estimated that employment at Mount Owen will range between 510 and 660 FTEs from 2016 to 2027, with around 473, 361 and 249 FTEs anticipated for 2028, 2029 and 2030 respectively. At Ravensworth East, employment will range from 214 to around 260 FTEs between 2016 and 2027. These will be augmented with a peak construction phase employment of approximately 330 FTEs in 2016.

Figure 4.1: Proposed operations within the Project Area



Source: Umwelt

4.3 Summary

Table 4.1 below summarises the key elements of the baseline case and Project case.

Table 4.1: Comparison of Baseline and Project case

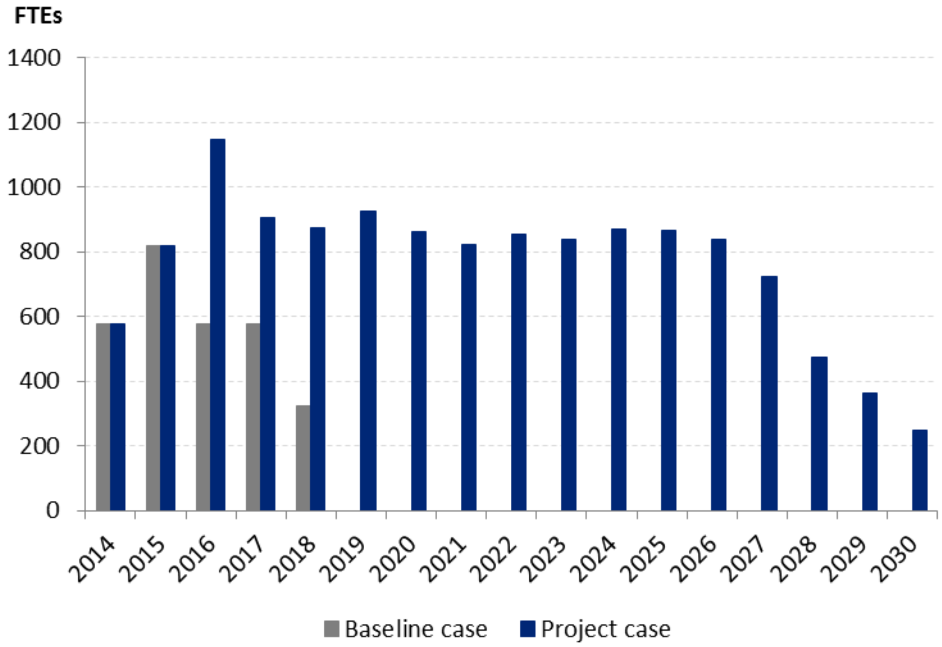
Key Features	Proposed Operations
Mine Life	Consent will be sought for 21 years (from date of Project Approval) to provide for mining at the North Pit until approximately 2030 and contingency for other activities such as rehabilitation and capping of tailings emplacement areas. Proposed mining operations at BNP from 2016 to 2022, and at the RERR Mining Area from 2022 to 2027.
Limits on Extraction	No change in approved extraction rates. • North Pit – up to 10 Mtpa ROM. • Ravensworth East – up to 4 Mtpa ROM.
Mine Extent	• Continuation of the North Pit footprint to the south of current approved North Pit mining limit. • Mining depths to approximately 300 m. • Total additional mineable coal tonnes of approximately 74 Mt ROM for North Pit Continuation, 12 Mt ROM at BNP and 6 Mt ROM in RERR Mining Area.
Operating Hours	No change proposed. 24 hours per day, 7 days per week.
Workforce Numbers	• No significant change to workforce numbers is required. Current workforce required to operate North Pit and CHPP fluctuates and peaks at about 660 and the Ravensworth East development consent allows for a workforce of up to 260 to operate Ravensworth East operations. • Ravensworth East workforce of 260 will continue until 2027, an additional eight years of employment. • Addition of approximately 330 personnel for construction phase for proposed infrastructure works (approximately 18 months).
Mining Methods	No change to mining methods proposed.
Existing Mine Infrastructure	Continued utilisation of all existing mining infrastructure, including the existing crushing plant for the crushing of overburden.

Key Features	Proposed Operations
Construction Activities	• Infrastructure upgrades including: ○ provision for a northern rail line turn-out and additional Mount Owen rail line; ○ product stockpile extension; ○ MIA extensions and improvements; ○ Hebden Road overpass over Main Northern Rail Line; and ○ New Hebden Road bridge crossing over Bowmans Creek. • CHPP improvements (including operational efficiencies) to increase processing capacity and tailings management.
Tailings Emplacement	• Continued use of the Ravensworth East voids for tailings emplacement and co-disposal of coarse reject and overburden within the North Pit Continuation, the West Pit and the RERR Mining Area as mining progresses. • Tailings cells may be constructed and filled within the North Pit Continuation area as required to allow time for consolidation and drying of tailings in the West Pit and the RERR Mining Area. • Minor changes to allow for handling of additional tailings.
Coal Transportation	• No change to current export coal transportation with the exception of the use of the proposed additional rail line. • Use of existing rail line for train park up. • Transportation of up to 2 Mtpa ROM coal and crushed gravel on an as required basis via the existing overland conveyor to Liddell Coal Operations and the RCT in addition to maintaining the current approval to transport ROM coal to Bayswater and Liddell power stations.

Source: Mount Owen; Umwelt

The employment levels expected under each case are also illustrated in Chart 4.1 below. It should be noted that the total expected employment levels for the Project case includes additional construction phase employment, reaching an estimated peak of 330 FTEs in 2016.

Chart 4.1: Employment levels



Source: Mount Owen

4.4 Project options and scope of CBA

In addition to clearly defining the baseline case and the Project case, completion of the CBA also requires a consideration of other project options and the geographic scope of the analysis.

In terms of considering other Project options, the following three alternatives were considered, but were not considered feasible and therefore were not identified as the preferred case. Accordingly, these options were not incorporated in the CBA.

- **Underground Mining (including highwall mining):** economic extraction through underground mining is not possible due to steep seam dips and complex geology;
- **Eastern Extension of Mining Area:** not considered to avoid damage to the Biodiversity Offset areas committed to by Mount Owen in the 2004 approval; and,
- **Western Extension of Mining Area:** not considered to maintain the integrity of the remnant State forest area (committed to by Mount Owen in 2004) and because of economic constraints associated with mining through the existing Western Out-of-pit Dump and the adjacent Eastern Rail Pit tailings emplacement area.

The second issue that must be clarified is the geographic scope of the CBA. This is important as it draws a line for which benefits and costs are included in the analysis and which are excluded. For example, if the scope of the CBA is defined as the State of NSW, rates payable to Singleton Council, and royalties payable to the NSW Government should not be included in the analysis. As the cost to Mount Owen is offset by the benefits to the government, these transfer payments cancel out.

As the CBA is being developed for compliance with NSW Government processes, the scope of the CBA will generally be the State of NSW. However, the fact that the guidelines and requirements discussed in Section 2 do not fit neatly into a traditional CBA framework means that the analysis will sometimes require consideration of effects for particular groups within the scope. Whenever this is the case we will attempt to clearly identify which parties are being analysed and where they are likely to be located.

5 Cost benefit analysis

This section presents the first stage of our methodology, consisting of a CBA of the Project. This involves identifying the incremental costs and benefits of the Project relative to the baseline case and quantifying these items wherever possible to obtain a consolidated estimate of the net economic value of the Project.

Overall, we find that the Project leads to a total net benefit of approximately $758 million (in 2014 NPV terms) and provides a benefit cost ratio (BCR) of 1.30. The steps involved in this analysis are described in this section.

5.1 Identifying costs and benefits

The economic, environmental and social costs and benefits considered in this analysis are set out in Table 5.1 below.

Table 5.1: Direct Costs and Benefits – Mount Owen Continued Operations Project

	Costs	Benefits
Production	Other onsite revenue forgone	Gross mining revenue
	Exploration costs	Residual value of capital
	Capital investment costs	
	Operating costs excluding taxes	
	Rehabilitation costs	
	Decommissioning costs	
	Residual value of land forgone	
Externalities	Offsite agricultural revenue*	Net traffic impacts
	Related public expenditure*	Conservation*
	Groundwater quality*	
	Surface water quality*	
	Carbon emissions	
	Air quality impacts – particulate matter	
	Air quality impacts – other pollutants*	
	Noise impacts	
	Visual amenity*	
	Biodiversity – flora and fauna	
	Quality of open space*	
	Rural amenity and culture	
	Aboriginal heritage*	
	Historic heritage*	
	Health*	

* Item has been considered qualitatively

Note: As the Project involves open-cut mining activity, there are no subsidence impacts which need to be valued in this analysis. Nevertheless, this item is discussed qualitatively in Section 5.2 in accordance with NSW Government (2012)

In recognition of the broad range of impacts of the Project, the costs and benefits shown have been separated into two categories. First, the costs and benefits that directly affect the financial outcomes of the proponent can be classified as internal effects of production. The externalities category incorporates the broader implications of the Project for third party stakeholders, such as residents and external businesses from the local community, the Hunter and Central Coast regions, and beyond.

Section 5.2 describes the techniques used to value each of these items and provides the justification behind the classification of each as a cost or benefit.

As recommended in CBA guidelines such as NSW Treasury (2007), where it is difficult to place a value on a particular cost or benefit of the Project, a qualitative analysis has been undertaken. The items considered qualitatively are marked in the table above and are discussed thoroughly in the sections below. In some cases these items have been considered qualitatively because there is expected to be no significant difference in outcomes under the baseline and Project case (such as related public expenditure, groundwater quality and surface water quality) or because there is no reliable method available to value them in these particular circumstances (such as Aboriginal heritage).

5.2 Valuing costs and benefits

This section details the approach taken to provide a value for each of the costs and benefits identified in 5.1. For the costs and benefits that fall within the production category, a market value can usually be assigned using the financial information provided by Mount Owen. In contrast, it is generally more difficult to attach a monetary value to the non-priced externalities.

The approach to valuation taken in this analysis is described below. Further discussion on the advantages and disadvantages associated with the different valuation techniques mentioned can be found in Appendix B.

Firstly, in cases where there is a market price available, this price is used. Alternatively, if a standard industry approach is available, then this value is used. For example, transport costs are outlined in publications from Transport for NSW (2013). When neither of these options are available, there are then two alternative possible approaches. The first is to undertake a literature review and apply benefit transfer techniques to the local context if required. This can be done using databases of non-market values such as ‘Envalue’, which was maintained by the NSW Department of Environment and Climate Change up until 2004, or its more recently updated international equivalent, the Environmental Valuation Reference Inventory (EVRI) developed by Environment Canada. These databases can be augmented by a direct review of the relevant literature for non-market valuation. Current literature on non-market valuation involves a number of specialised methodologies (e.g. the travel cost method, contingent valuation or choice modelling), which all require extensive surveys, or alternatively empirical analysis such as hedonic pricing, which uses existing market data from an affected sector (e.g. residential property market).

In the event where there is insufficient literature available, a final alternative is to undertake original research into non-market values. In this case a hedonic pricing study has been undertaken and is summarised in Appendix D.

The discussion throughout the chapter draws on the findings in Appendix C, which reviews the unit value evidence for each item considered in this report.

5.2.1 Gross mining revenue

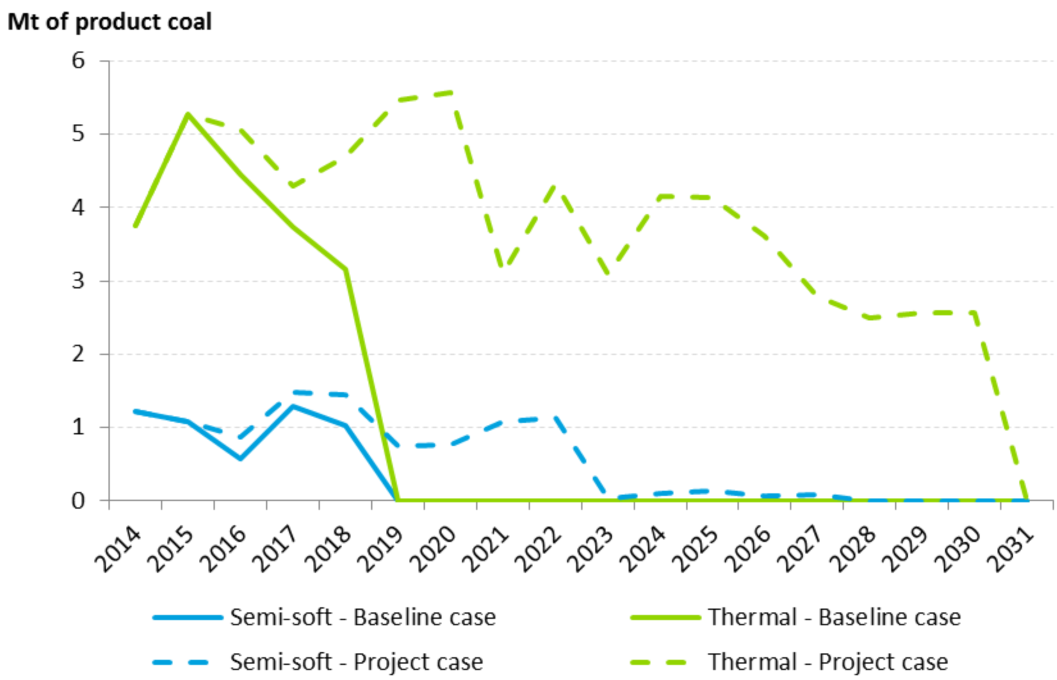
Gross revenue from mining activity at Mount Owen is calculated using forecasts of annual production quantities and annual prices for each coal product.

This analysis utilises production quantity forecasts of semi-soft coking coal and thermal coal provided by Mount Owen, for each year of operation under the baseline and Project case. These quantities incorporate the mining activity at both Mount Owen and Ravensworth East, over the period from 2014 to 2030.

As illustrated in Chart 5.1 below, under the baseline case, a total of 25.58 Mt of saleable coal will be produced between 2014 and 2018. This is predominantly derived from mining at the Mount Owen North Pit, but also includes 1.26 Mt of saleable coal produced at Ravensworth East's BNP in 2015.

Should the Project receive approval, production will continue as per the baseline case in 2014 and 2015. From 2016 to 2018, the annual production profile at the Mount Owen North Pit will be slightly varied compared to the baseline, to accommodate continued operations from 2019 out to 2030. At Ravensworth East, mining at the BNP will continue over the period from 2016 to 2022, followed by mining in the RERR Mining Area from 2022 to 2027.

Chart 5.1: Production profile – Mount Owen Complex*, 2014 – 2031



Source: Mount Owen

*Mining at the North Pit (Mount Owen) and Bayswater North Pit & RERR Mining Area (Ravensworth East)

Overall, a total of 77.20 Mt of saleable coal will be produced between 2014 and 2030 under the Project case, an additional 51.62 Mt of product coal compared to the baseline.

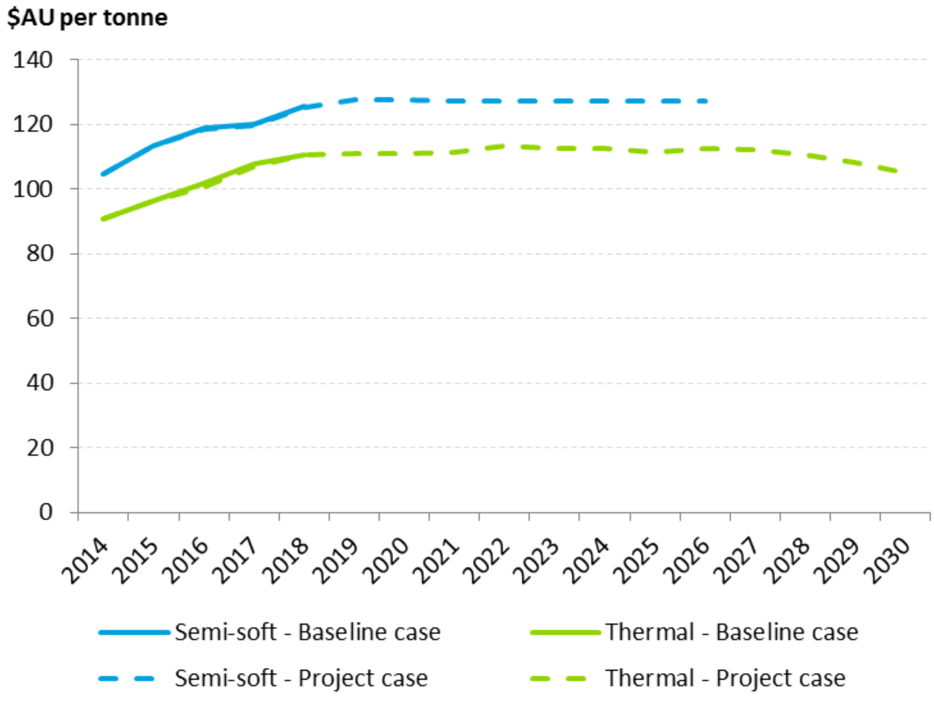
As Chart 5.1 shows, the proportional split between semi-soft coking coal and thermal coal is expected to vary from year to year in both cases. Nevertheless, approximately 90% of the 51.62 Mt of additional saleable coal under the Project case is expected to be thermal. Under the Project case, production of semi-soft coking coal is expected to cease in 2027.

The prices used in this analysis were derived from consensus forecasts for thermal and semi soft coking coal provided by Mount Owen, as at June 2014. These benchmark prices were converted from US dollars to Australian dollars using a consensus forecast of the exchange rate, starting at 0.92 USD$/AUD$, declining gradually to around 0.83 USD$/AUD$ by 2020, and constant thereafter. The prices used in the analysis were then obtained by adjusting the benchmarks for coal quality, using time series data on the estimated calorific value of each saleable coal product for each year under the baseline and Project cases, provided by Mount Owen.

As mining activities are not expected to differ between cases in 2014 and 2015, the same coal price values have been applied in each case for those two years. Over time, as the Project will access new areas, providing coal of higher quality and greater market value, coal prices are expected to vary from year to year.

The resulting coal price forecasts are illustrated in Chart 5.2 below.

Chart 5.2: Coal price forecasts – Mount Owen Complex*, 2014 - 2030



Source: Consensus Economics

*Mining at the North Pit (Mount Owen) and Bayswater North Pit & RERR Mining Area (Ravensworth East)

Applying these values and assumptions gives a central present value estimate of $2,335 million for gross mining revenue in the baseline, and $5,579 million in the Project case. In undiscounted terms, gross mining revenue is estimated at $2,658 million in the baseline and $8,462 million in the Project case.

5.2.2 Other onsite revenue (e.g. agriculture)

It is also necessary to incorporate the impact of the continued operations under the Project case on any additional revenue streams within the Project Area as part of the CBA. Given that the Project will not impact mining activity at the Glendell Mine, this item focuses on the use of surrounding landholdings for agricultural activities such as grazing.

In the context of this analysis, the area of focus here is the proposed disturbance area associated with continued operations at Mount Owen, given that the BNP and RERR Mining Area at Ravensworth East are located on land which has previously been disturbed.

Assessments have indicated that the majority of the proposed disturbance area is 'unused grazing land' with soil suitable for low to moderate intensity grazing, either LSC Class 4 or greater. As noted in the Agricultural Impact Statement, currently, approximately 25 hectares of the proposed North Pit Continuation Area is used for this activity.

However, as the revenue from grazing is included in the baseline estimate of the residual value of land (see Section 5.2.9), revenue foregone under the Project case has not been separately quantified under this item to avoid double counting.

5.2.3 Exploration costs

Exploration expenditure consists of any costs associated with preparatory activities before extraction commences. Where these costs are yet to be incurred, it is appropriate to include them in a CBA.

For the Project, Mount Owen has advised that any exploration costs associated with either the baseline or Project case have been incorporated in the ongoing operating costs estimates. For instance, under the Project case, an allowance of $400,000 has been made for ongoing exploration between 2016 and 2025. Accordingly, no separate values have been assigned to this item in either case.

5.2.4 Capital investment costs

In this analysis, capital investment costs encompass all expenditures on infrastructure associated with the existing and proposed operations.

Mount Owen has advised that under both the baseline and the Project cases, $31.5 million in capital investment is expected at Ravensworth East in 2015.

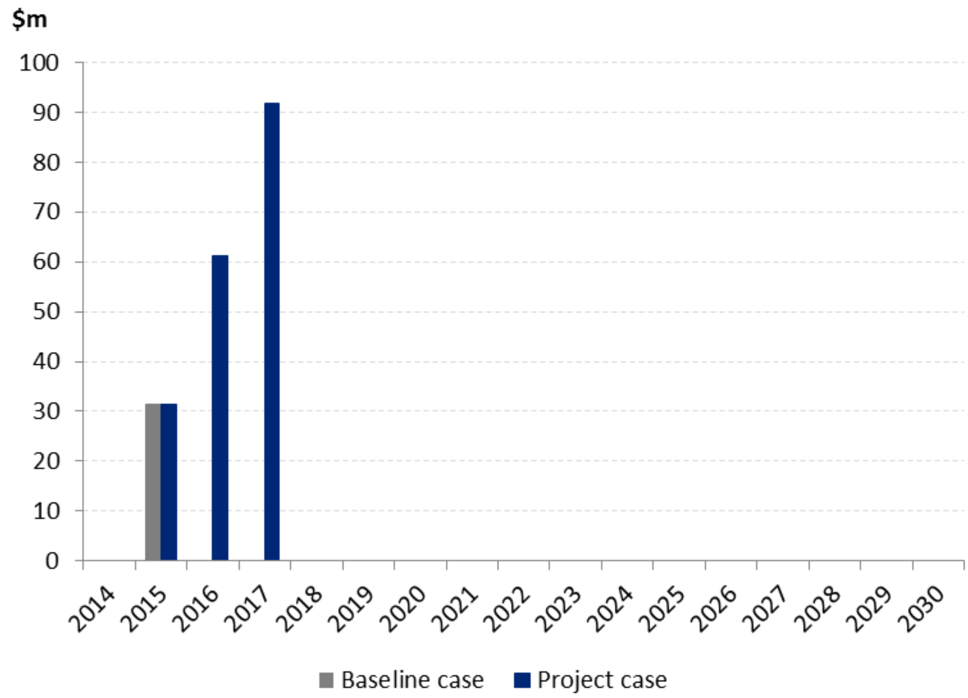
However, should the Project receive approval, additional capital investment of approximately $152.9 million is proposed to be incurred, with the construction phase proposed to commence within one year of the commencement of mining beyond currently approved activity. For the purpose of this analysis it is assumed that this will take place in 2016 and 2017. This includes expenditure on proposed mine industrial area works, stockpile pad extension works, the Hebden Road Rail Overpass, upgrade of the Hebden Road bridge over Bowmans Creek, rail upgrades and water management works.

Combined with investment of $31.5 million at Ravensworth East anticipated in 2015 under both cases, total Project case capital investment is estimated at $184.4 million.

The anticipated timing of this investment in each case is illustrated in Chart 5.3 below.

In present value terms, capital investment is therefore estimated at $29.44 million under the baseline, and $157.74 million in the Project case. Overall, the additional capital investment of $128.30 million, in present value terms, is attributed as a cost of the Project.

Chart 5.3: Capital investment, 2014 - 2030



Source: Mount Owen

5.2.5 Operating costs excluding taxes

Operating costs encompass the expenditure incurred as a direct result of extracting ROM coal, processing it into saleable product and delivering it to a port before loading, known as free on board (FOB) costs, as well as ongoing expenditure on the purchase and maintenance of equipment and machinery necessary for production.

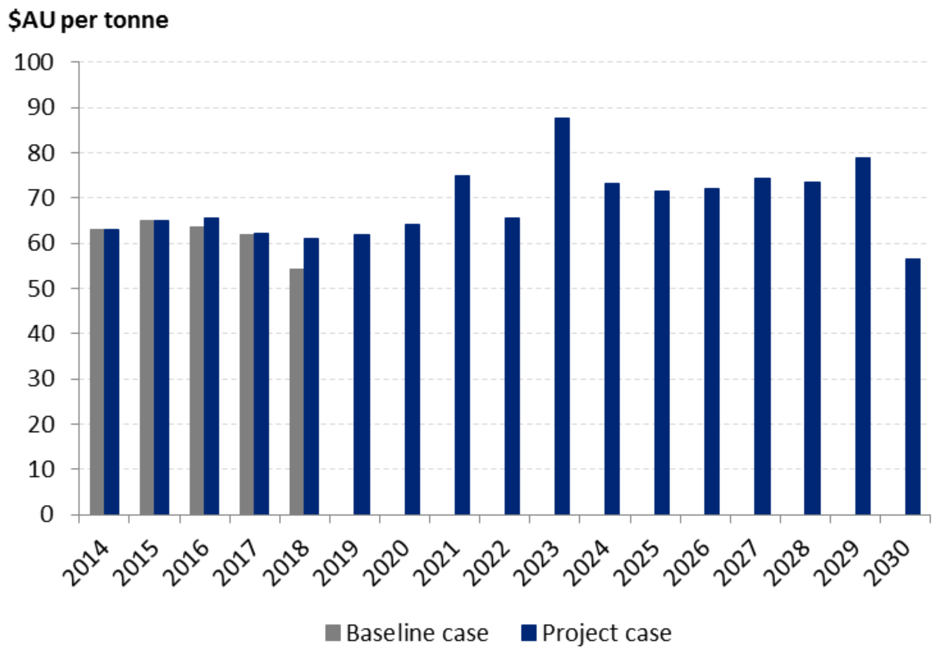
For this analysis, FOB costs have been estimated based on econometric modelling undertaken by Shafiee, Nehring and Topal, using data on open cut coal mines in Australia (2009). The authors define per tonne operating costs as a function of deposit average thickness, the stripping ratio, capital cost and the daily production rate.

Mount Owen has provided estimates for these parameters in the baseline and Project cases, which are expected to vary over the course of production. The inputs provided imply that under the baseline case, operating costs will vary between $54 and $65 per product tonne, from 2014 to 2018.

Under the Project case, FOB costs in 2014 and 2015 are assumed to be the same as under the baseline ($63 and $65 per product tonne respectively), as production is not anticipated to vary between cases for those two years. Between 2016 and 2030, operating costs under the Project are likely to range between $57 and $88 per product tonne, as illustrated in Chart 5.4 below.

The variation is due to changes in the stripping ratio and the average daily production rate from year to year. These costs also incorporate transportation costs of $11.50 per tonne of product coal, based on information provided by Mount Owen.

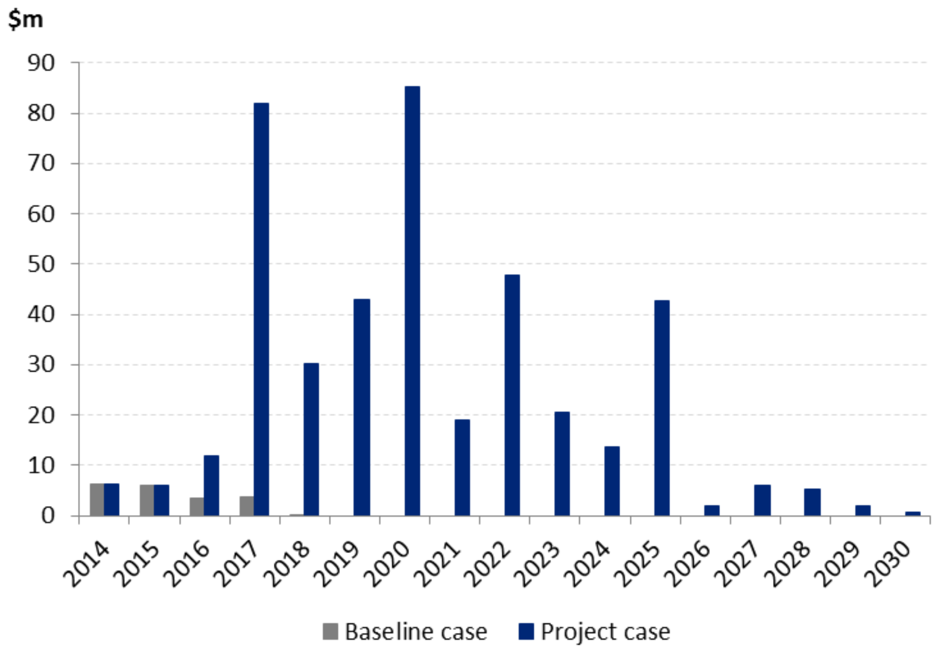
Chart 5.4: FOB costs per tonne, 2014 - 2030



Source: DAE estimates - Shafiee, Nehring and Topal (2009), Mount Owen

Estimates of ongoing expenditure on mobile equipment including sustaining capital and exploration were provided by Mount Owen. This is treated as operational expenditure for the purpose of this analysis. The anticipated profile of this expenditure under the baseline and Project case is presented in Chart 5.5 below.

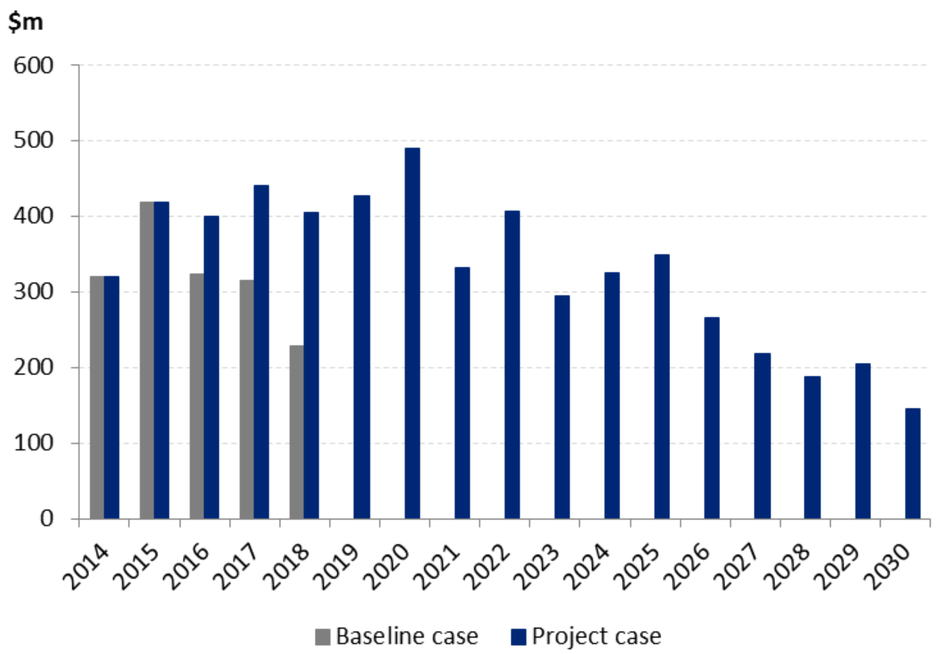
Chart 5.5: Ongoing expenditure on equipment, 2014 - 2030



Source: Mount Owen

Overall, total operating costs under the baseline case are estimated at just over $1.6 billion ($1.43 billion in present value terms using a 7% discount rate). Under the Project case, operating costs are estimated at $5.6 billion, equivalent to $3.7 billion in present value terms. The time series of these total cost estimates are presented in Chart 5.6 below.

Chart 5.6: Total operating costs, 2014 - 2030



Source: DAE estimates; Mount Owen

It is noted that these aggregates do not incorporate the cost of royalties and other taxes. This is because taxes are a transfer of funds, with the expense incurred by the company offset by a gain for government. As such, it is not appropriate to include them in a cost benefit analysis.

5.2.6 Rehabilitation costs

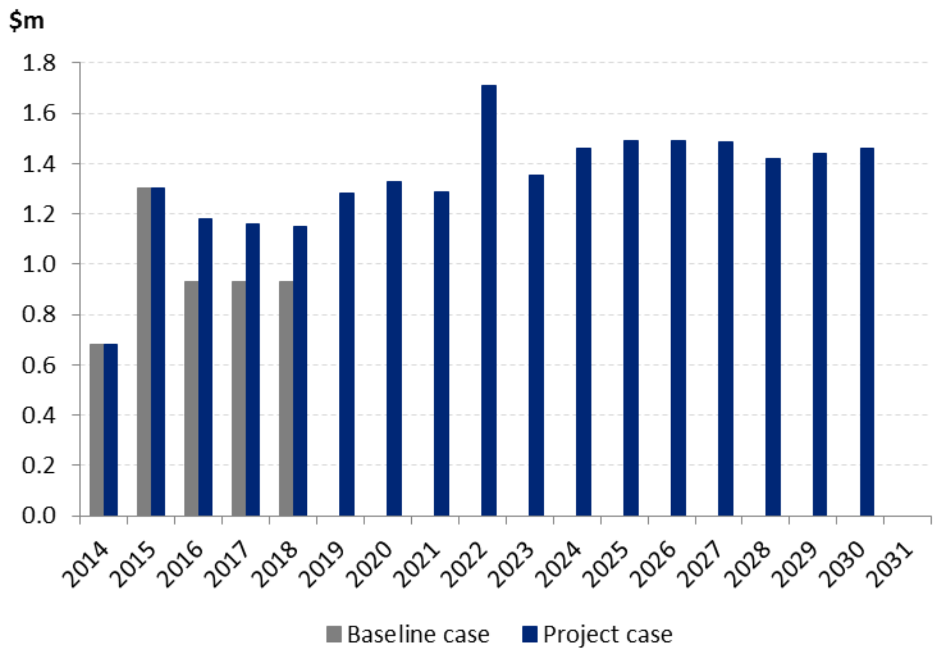
Land rehabilitation works are required in both the baseline and Project case. As the timing and magnitude of this expenditure differs between the two scenarios, these costs have been included in the analysis.

Mount Owen has advised that rehabilitation costs for the baseline case will amount to $4.5 million at the North Pit, with works taking place between 2014 and 2018, along with a further cost of $0.3 million in 2015 at BNP (estimated at $0.15 per tonne of ROM coal). In total, this is equivalent to $4.2 million in present value terms.

Should the Project receive approval, land rehabilitation will continue to be undertaken progressively between 2016 and 2030, generating a total cost of $22.7 million, encompassing both the North Pit and Ravensworth East mining areas. This is valued at $13.4 million present value terms using a 7% discount rate.

The timing of this expenditure, under the baseline and Project case is presented in Chart 5.7 below. Overall, the additional costs of $9.2 million (in present value terms) are attributed as a cost of the Project.

Chart 5.7: Rehabilitation costs, 2014 – 2031



Source: Mount Owen

5.2.7 Decommissioning costs

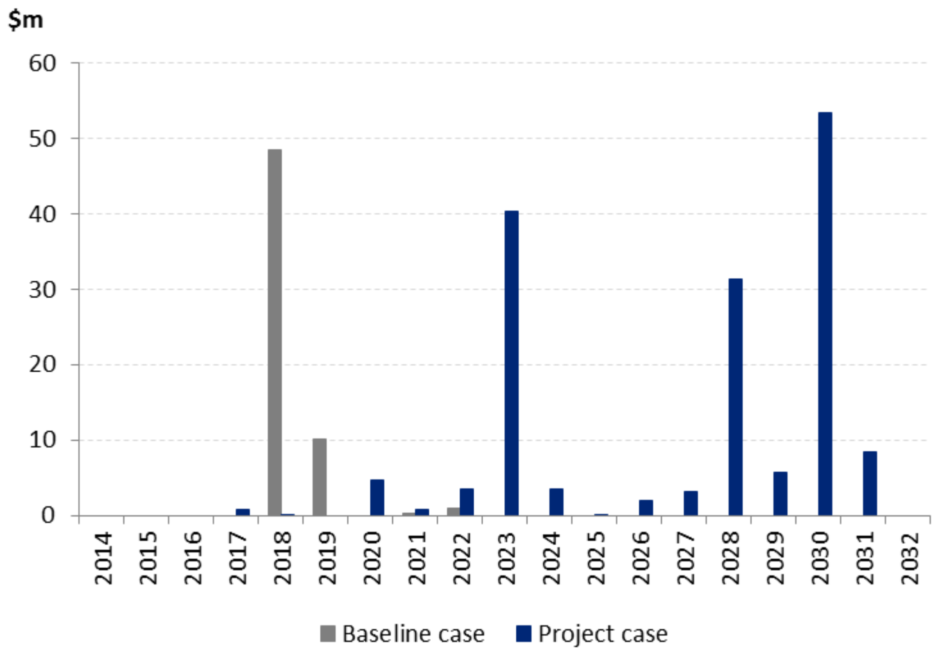
Decommissioning costs comprise costs associated with retrenchments at the conclusion of mining operations and the removal of old assets or infrastructure – in general, the costs involved in the closure of the mine within the Project Area.

Mount Owen has provided data on the anticipated timing and magnitude of these costs under the baseline and the Project case. This is presented in Chart 5.8 on the following page.

As indicated, Mount Owen expects to incur almost $60 million in decommissioning costs between 2018 and 2022 under the baseline case, with the majority of expenditure taking place in 2018. These costs relate specifically to the closure of the North Pit. No decommissioning costs have been included for Ravensworth East in the baseline case to present a conservative analysis of the incremental costs of the Project with a combined development consent. Therefore, baseline decommissioning costs are valued at $45 million in present value terms.

Under the Project case, total closure costs are estimated at $158 million. This comprises of around $73.4 million for closure of operations at the North Pit and $84.5 million for decommissioning at Ravensworth East. It is expected that these costs will be incurred over the period from 2017 to 2031. This is equivalent to $67.4 million in present value terms, using a 7% discount rate.

Chart 5.8: Decommissioning costs, 2014 - 2032



Source: Mount Owen

5.2.8 Residual value of capital

Upon completion of mining, companies often generate additional revenue from the sale of remaining capital goods.

In the context of this Project, Mount Owen has advised that the assets will be fully depreciated over the life of the mine under both the baseline and Project cases. Accordingly, no residual asset values have been incorporated in the CBA.

5.2.9 Residual value of land

Similarly, it is necessary to assign a value to the land within the proposed disturbance area, at the completion of mining activity. This value primarily depends on the ability of the land to support future activities of economic or social value. If the land is not suitable for further uses, such as agriculture or rehabilitation, then it is unlikely that there would be any substantial demand or willingness to pay for it. In this case, the value of the land will be zero.

In the context of this analysis, Umwelt has advised that the proposed disturbance area currently consists of native woodland vegetation, derived native grassland and some land suitable for cattle grazing. Under the baseline, it is assumed that the area of land which could be potentially used for cattle grazing over the period of analysis is limited to the 25 hectares which are currently used for grazing. It is anticipated that the land will continue to be used for these purposes from 2014 onwards.

Should the Project receive approval, these land uses will be precluded as a result of the continuation of the North Pit, and the proposed infrastructure works. While some land will remain as a void, or be impacted by infrastructure such as roads, other areas will be rehabilitated over the life of the mine. Approximately 77 hectares of land will be suitable for grazing post mining. It is expected that this rehabilitation process will be completed by the end of 2034, once the closure phase of the Project is finalised.

Table 5.2 presents details of the anticipated breakdown of the proposed disturbance area in 2014 in the baseline, and at the start of 2035 in the Project case.

Table 5.2: Comparison of land use in the proposed disturbance area

Land use	Baseline case – 2014	Project case - 2035
Native woodland and forest vegetation	223.7 hectares	221 hectares
Derived native grassland	223.1 hectares	35 hectares
Potential cattle grazing	25 hectares	77 hectares

Source: Umwelt

This information can be utilised to ascertain the value of the proposed disturbance area under each case. While the land uses can be valued in perpetuity from 2014 onwards in the baseline case, this analysis conservatively assumes that, under the Project case, the economic and social value of the area will not be realised until 2035. The justification for this assumption is that the social value of areas of vegetation and grassland is likely to be minimal until mining activity has ceased and the closure phase is complete.

As set out in Appendix B, valuations should rely on market prices where available. Accordingly, the social value of areas used for native woodland and forest vegetation, and derived native grassland, has been estimated using data from the NSW Office of Environment and Heritage's BioBanking scheme. Specifically, the BioBanking public register provides information on biodiversity credit transactions and agreements. The value of ecosystem credits is determined by a range of factors including the type of vegetation on the land. Details from the register can be used as an estimate for the social value of conservation land.

Umwelt has advised that the existing 223.7 hectares of native woodland and forest vegetation consists of a number of vegetation communities, over 50% is covered by the Central Hunter Ironbark – Spotted Gum – Grey Forest Endangered Ecological Community. In addition, under the Project case, this is the prominent vegetation community for rehabilitation. Table 5.3 lists the BioBanking transaction records relating to the 'Grey Ironbark – Spotted Gum – Grey Box open forest on the hills of the Hunter Valley, Sydney Basin' vegetation category (type HU556).

Table 5.3: BioBanking ecosystem credit data for vegetation type HU556

Transaction date	Number of credits	Price per credit	Vegetation area (ha)	Estimated value per hectare*
30 January 2013	620	$1,260	103.41	$7,554.39
13 June 2013	606	$1,462	82.56	$10,731.25

Source: NSW Office of Environment and Heritage
* DAE calculation

The difference in the estimated value per hectare for each transaction reflects the way in which a number of factors influence BioBanking credit prices. The higher estimate was chosen as a price reference in this analysis as it is drawn from the most recent transaction. After updating to 2014 prices an estimate of $10,954 per hectare was obtained. Next, to account for the fact that areas assigned to native woodland vegetation in each case would be of lesser quality than the site valued through the BioBanking transaction, this social value has been discounted by 50% in the baseline case, and 75% in the Project case.

A similar research process was undertaken to ascertain an estimate of the social value of derived native grasslands within the proposed disturbance area. For the purpose of this valuation, Umwelt advised that, in general, the vegetation on the land could be described as 'Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter. However, no BioBanking transactions have involved credits for this vegetation type.

Accordingly, this analysis uses an estimate of $9,820 per hectare as a reference price, derived from a transaction on 13 June 2013 relating to the 'Spotted Gum – Broad leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin' vegetation category (type HU629), updated to 2014 prices. Although this description does not exactly reflect the composition of grasslands in the disturbance area, it is likely that the value of the vegetation would be similar.

To account for any reduction in quality of the vegetation due to rehabilitation, this value was also discounted by 50% in the baseline case and 75% in the Project case.

As land suitable for grazing generates income streams, it is appropriate to value potential cattle grazing land in terms of the net present value of expected future revenues. For this purpose, this analysis utilises a value of $220.75 per hectare, being the average gross margin for growing out early weaned calves and steers over a 12 month period, as reported by the NSW Department of Primary Industries (2012), inflated to 2014 prices.

Applying these values to the areas of land in the baseline in 2014, and to the Project case areas in 2034 (as per Table 5.2 and Table 5.4), produced an estimate of the residual value of land of $2.41 million and $0.23 million in present value terms, for each case respectively. The residual value of land foregone under the Project case, of $2.18 million in present value terms, is included as a cost in the CBA.

Table 5.4: Final residual value of land estimates – proposed disturbance area

Land use	Baseline case $/ha	Project case $/ha	Baseline case (NPV $m)	Project case (NPV $m)
Native woodland and forest vegetation	$5,477*	$2,739*	$1.23	$0.15
Derived native grassland	$4,910*	$2,455*	$1.03	$0.02
Potential cattle grazing	$221 p.a.	$224 p.a.	$0.08	$0.06
Total			**$2.41**	**$0.23**

Source: DAE estimates
* Lifetime value
Note: NPVs are calculated using a 7% discount rate

It is noted that these estimates do not include the residual value of land at Ravensworth East, following the conclusion of mining activity. This is justified on the basis that:

- the operations at Bayswater North and the RERR are to be undertaken on previously disturbed land;
- the Bayswater North operations will continue regardless of whether the Project receives approval; and
- with no immediate value under the baseline, it is not appropriate to assign a benefit to the value of land at the conclusion of Ravensworth East operations under the Project case.

5.2.10 Related public expenditure

In some cases, a project may generate additional costs for government. Where this is the case, these external costs should be included in a CBA.

Mount Owen has advised that the baseline case is not expected to generate any additional public expenditure by any level of government. In the Project case, it is assumed that public expenditure at a LGA level, potentially generated by the continued operations would be covered by Mount Owen through the Voluntary Planning Agreement (VPA) with Singleton Council.

This agreement will allocate resources for costs in relation to changes in community infrastructure in the region. As such, public expenditure under this agreement will not be additional to the budgeted costs for the council.

Thus, the Project will not generate additional public expenditure. As payments under the VPA are transfer payments between Singleton Council and Mount Owen, they have not been included in the CBA.

5.2.11 Offsite agricultural revenue

Mining activity can potentially affect the productivity of agriculture in surrounding areas, ultimately reducing the revenue earned by these activities. Where appropriate, it is important to account for these impacts in a CBA. The method of valuing the impacts of mining on agricultural revenue is described in Appendix C.

Currently, some of the Glencore-owned areas surrounding the Mount Owen Mine are utilised for grazing. The main agricultural uses of the adjacent land not owned by Glencore include cattle grazing and fodder crops on irrigated floodplain and terrace landforms along Glennies Creek.

Potential impacts on the productivity of surrounding agricultural areas (specifically, within 10km radius from the Project Area) have been considered in the Agricultural Impact Statement (AIS) (Appendix 12 of the EIS). As described in the AIS, a detailed analysis of soil capability has confirmed that there are no biophysical strategic agricultural land (BSAL) areas[2] within the proposed disturbance area.

However, the AIS has identified that there is a low to moderate risk of reduced productivity of surrounding agricultural systems and enterprises as a result of the Project. These risks are to be managed through Mount Owen's water quality, air quality and land management controls.

While the potential impact on agricultural productivity is acknowledged, there is no clear empirical evidence which enables the relationship between noise or dust and agricultural productivity to be quantified. As described in Appendix C, the nature of these relationships varies with local geology.

Furthermore, research by Environment Australia has found that mine dust deposition rates and impacts "tend to decrease rapidly away from the source", while "in the majority of situations dust produced by mining operations is chemically inert" (1998:2).

Accordingly, it is considered appropriate to treat these potential impacts qualitatively in this analysis. Umwelt has advised that should any agricultural properties be acquired, the agricultural uses of the land are likely to continue, which suggests that any decline in revenue as a direct result of the Project would be minimal.

[2] This category of land incorporates areas with "the best quality landforms, soil and water resources which are naturally capable of sustaining high levels of productivity and require minimal management practices to maintain this high quality" (NSW Department of Primary Industries, 2012).

5.2.12 Groundwater quality

Mining activity can potentially impact the quality and quantity of groundwater supplies, with implications for other users that are not adequately captured in market transactions. As a result, it is necessary to assign a value to the costs borne by third parties as part of a CBA.

In the context of this Project, there are two main hydro geological features located directly within or surrounding the Project Area: the alluvial aquifers along the creek lines and the deeper hard rock aquifers containing the coal measures. The first feature is characterised by shallow and highly porous aquifers with rapid transmission of groundwater, while the second exhibit slower groundwater movement. Water yields from both alluvial and hard rock aquifers in the Project Area are not considered to be high.

An assessment study of the potential groundwater impacts of the Project on these hydrogeological features (measured over a 20km distance around the Project Area) was prepared by Jacobs in accordance with the DGRs and relevant water planning policies and guidelines. The findings from the assessment are summarised in the EIS and indicate that any groundwater impacts associated with the operations of the Project are negligible. This is summarised in the table below.

Table 5.5: Summary of groundwater impact predictions

Potential environmental impact	Assessment predictions
Leakage of groundwater from shallow alluvial aquifers of Bowmans and Glennies creeks and associated tributaries	Negligible Impact
Changes to baseflows in surface drainage systems	Negligible Impact
Impacts on water supply bores and wells	Negligible Impact
Change in water quality	Negligible Impact
Groundwater dependent ecosystems	Negligible Impact

Source: Umwelt/Jacobs

According to the assessment, existing coal mining operations in the area has led to the depressurisation of the hard rock aquifer affecting the local hydrogeological regime. However, the nearest privately owned bore is located over 4 kilometres from the Project Area, while all other 47 registered bores located within 4 kilometres of the Project Area are owned by Glencore operations or other mining companies. Therefore, any of the potential impacts outlined above are unlikely to affect other external users in non-mining industries or private landholders.

Based on Jacobs' hydrogeological modelling, the incremental impacts on groundwater flows and quality associated with the Project are assessed to be negligible, relative to the baseline case. Any groundwater extractions will be subject to existing water licences, and it is not anticipated that any further licenses will need to be purchased by Mount Owen. Accordingly, no value has been assigned to this item in either the baseline or Project case in the CBA.

5.2.13 Surface water quality

Changes in the quality of surface water should also be valued as part of a CBA where those changes are caused by a project and generate substantive impacts on third parties and the surrounding environment. The impacts of the Project on surface water are assessed in Appendix 9 of the EIS.

The main water resources surrounding Mount Owen are the Bowmans Creek catchment (consisting of Stringybark Creek, Yorks Creek, Swamp Creek and Bettys Creek) and the Glennies Creek catchment (Main Creek). The Surface Water Assessment notes that historic water quality within these catchments have complied with the threshold levels set in the ANZECC Guidelines 2000. These threshold levels have been set to 'provide certainty that there will be no significant impact on water resource values if the guidelines are achieved'. As such, no costs associated with reduced surface water quality have been considered under the baseline case.

The Surface Water Assessment describes the likely impact of the Project in relation to surface water volumes, quality and the cumulative impact on downstream water users. The main findings are that:

- The Project will result in changes to the catchment areas for Yorks Creek, Swamp Creek, Bettys Creek and Main Creek, relative to the areas anticipated under current approvals – however the change in flows are less than the seasonal and annual variations in flow volumes observed when comparing dry and wet years. As such, it is predicted that the Project will have a limited impact on waterway stability, scour potential, ecosystems and downstream users.
- The reduction in total contributions to the downstream Bowmans Creek and Glennies Creek catchments are negligible (less than 0.6%).
- Water quality impacts will be managed through the Mount Owen Water Management System over the life of the Project (including erosion and sediment control measures and water quality monitoring), such that the Project is considered to have negligible impacts to water quality on downstream watercourses.
- Private landowners along Main Creek will experience reduced flood peaks and flood durations as a result of the Project. Overall, the Project is considered to have negligible impacts on downstream water users.

These findings indicate that the impact of the Project on surface water quality is anticipated to be negligible, relative to the baseline case. The implications of the Project on surface water supplies are acknowledged, but not considered quantitatively in the CBA.

5.2.14 Subsidence

In instances where mining activity is likely to lead to subsidence, the implications of this effect should be included in a CBA.

In the context of this analysis, Umwelt has advised that no subsidence effects are anticipated under the baseline or Project case, as a result of existing or continued open cut mining activity at Mount Owen. Accordingly, no costs have been included for this item in the CBA.

5.2.15 Carbon emissions

The continuation of mining activities will generate additional carbon emissions than in the baseline case, in which operations will cease by 2018. It is important to incorporate the costs of these additional emissions in the CBA. This requires estimates of the quantity of emissions in each scenario, along with an appropriate unit value of the social cost of an emission.

This analysis focuses on the valuation of 'Scope 1' emissions only. These incorporate all direct emissions from sources owned or controlled by Mount Owen, such as emissions from the combustion of diesel and release of fugitive emissions during the mining process.

The other categories of emissions which encompass indirect emissions generated from use of electricity at the mine (Scope 2) or from the use of the coal produced (Scope 3) are not valued in this analysis. This is because it is not methodologically clear how the costs of these emissions should be treated within a CBA.

Scope 2 emissions are more appropriately attributed as Scope 1 emissions associated with specific power sources, and should be captured in the EIS and CBAs for those developments, rather than the developments where the electricity is used. In addition, given the nature of the electricity network, if these were to be included they would need to consider the emissions from the marginal electricity generator in the National Electricity Market, rather than the producer of the actual electricity used by the Project. It is not evident that this marginal producer would necessarily be located with NSW, and hence may be outside the scope of this CBA.

Scope 3 emissions managed by third parties were not assessed as:

- it is methodologically unclear to what extent they should be included in a CBA;
- there is great difficulty in establishing a realistic baseline case for emissions; and
- there is a lack of data on emissions throughout the mining value chain.

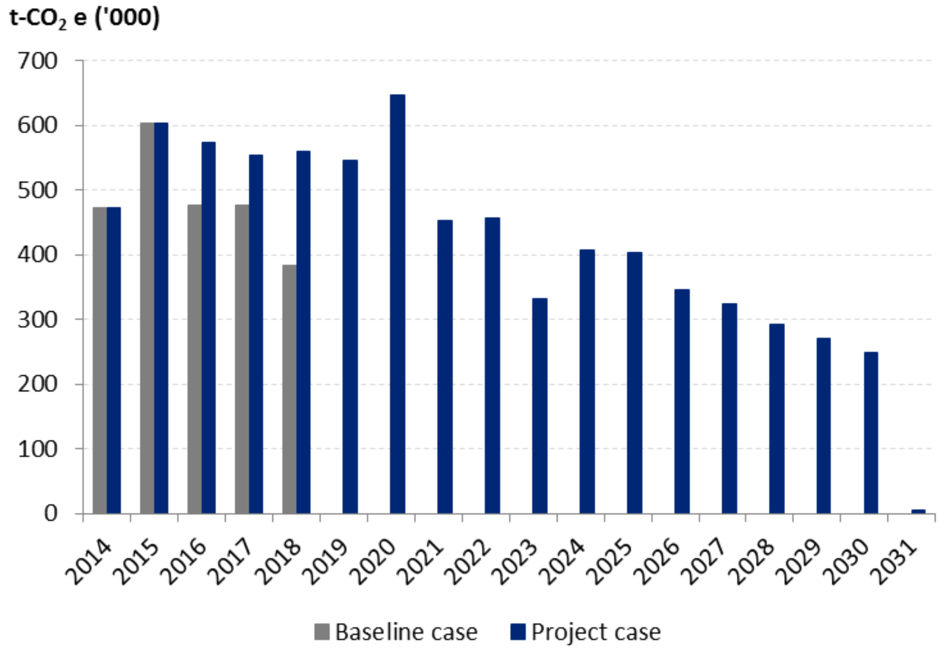
An estimate of the total level of Scope 1 emissions associated with the construction, operation and closure stages of the Project were obtained from the Greenhouse Gas and Energy Assessment undertaken by Umwelt (Appendix 15 of the EIS). Specifically, it is expected that the Project will generate:

- approximately 5,084,389 t CO_2-e of additional Scope 1 emissions during the continued operations from 2016 to 2030; and
- approximately 5,567 t CO2-e of additional Scope 1 emissions in 2031, during the closure phase of the Project.

Given that the Project is expected to involve extraction of an additional 92 Mt of ROM coal from 2016 to 2030, the average emissions per tonne of ROM during mining operations was estimated at 0.06 t CO_2-e. This was then applied to the annual ROM estimates under the baseline and Project case, to obtain estimates of annual emissions per year, under both cases from 2014 to 2030.

Together with the estimate of closure phase emissions under the Project case, this produced an estimate of 2.41 million tonnes CO_2-e of Scope 1 emissions under the baseline over the period from 2014 to 2018, and 7.50 million tonnes CO_2-e in the Project case from 2014 to 2031. These series are illustrated in Chart 5.9 below.

Chart 5.9: Predicted carbon emissions, 2014 - 2031



Source: Mount Owen; Umwelt

As described in Appendix C, it is appropriate to value carbon pollution using the observable market prices of carbon permits. Following the repeal of Australia's carbon pricing mechanism, this study utilises the December 2014 futures price for carbon emissions in the European Union as the best available estimate of the social cost of carbon.

Specifically, a constant price of $8.91 per tonne of emissions was derived from the current Intercontinental Exchange European Climate Exchange European Union Allowance (ICE ECX EUA) futures price of €6.17 per tonne, converted into Australian dollars using the exchange rate of €0.6926/AUD reported by the Reserve Bank of Australia[3] (MarketWatch, 2014; RBA, 2014).

Overall, the cost of carbon emissions is valued at $19 million under the baseline case, and $44.12 million in the Project case, in present value terms.

While these estimates do not include the cost of Scope 2 emissions for the reasons provided earlier in this section, it is noted that their inclusion would not change the results of this analysis, given the substantially smaller quantity of Scope 2 emissions relative to Scope 1 emissions (around 810,223 tonnes over the life of the Project). Undertaking a similar valuation process as described above, the costs of Scope 2 emissions are estimated at around $3 million in the baseline, and $7 million in the Project case, in present value terms.

[3] Closing price and exchange rate as at 22 July 2014

5.2.16 Air quality impacts – particulate matter

The air pollution produced by mining activity and its impact on the built and natural environment, and the health in the surrounding area, is a key issue within the assessment of any mining project. Given that the health impacts of reduced air quality are generally considered to be most significant, the quantification of health costs is the focus of this analysis.

Particulate matter (PM) is often classified into one of the following three size ranges:

- TSP – total suspended particulate matter, which refers to all suspended air particles, with an aerodynamic diameter typically up to 30-50 micrometers;
- PM_{10} – coarse particulate matter, which includes all particles with an equivalent aerodynamic diameter of less than 10 micrometers; and
- $PM_{2.5}$ – all particles with an equivalent aerodynamic diameter of less than 2.5 micrometers, often referred to as fine particles.

As described in Appendix C, there are a number of important methodological issues to be considered when valuing the health impacts associated with these pollutants. Firstly, these pollutants are strongly correlated, making it very difficult to attribute health costs to the emissions of each individual pollutant without the risk of double-counting. The usual approach in valuation is to focus on one pollutant and indirectly capture part of the costs associated with other correlated pollutants.

The other key issue in valuation is the measure of the quantity of emissions. The literature discussed in Appendix C uses a number of measures, including the number of days pollution exceeds health guidelines, tonnes of emissions, and also annual average concentration levels.

The NSW Environment Protection Authority (EPA) has commissioned the most recent work undertaken on the valuation of health externalities caused by air pollution in the Australian context (PAEHolmes, 2013). This paper provides unit damage cost estimates per tonne of $PM_{2.5}$ emissions for specific locations, based on the ABS Significant Urban Area structure. However, it is not considered to be appropriate to apply these results in the context of this analysis, due to difficulties in ascertaining the quantity of $PM_{2.5}$ emissions, in tonnes, that will disperse to the main population centre of Singleton. This has been confirmed by Pacific Environment Limited (previously PAEHolmes), who prepared the Air Quality Assessment for the Project.

Accordingly, this analysis relies on cost estimates provided in an earlier report published by the Department of Environment and Conservation NSW (2005). These relate to changes in the concentration levels of PM_{10} emissions in the Hunter region. By focusing on PM_{10} concentrations, this approach indirectly captures some of the externalities associated with $PM_{2.5}$ emissions.

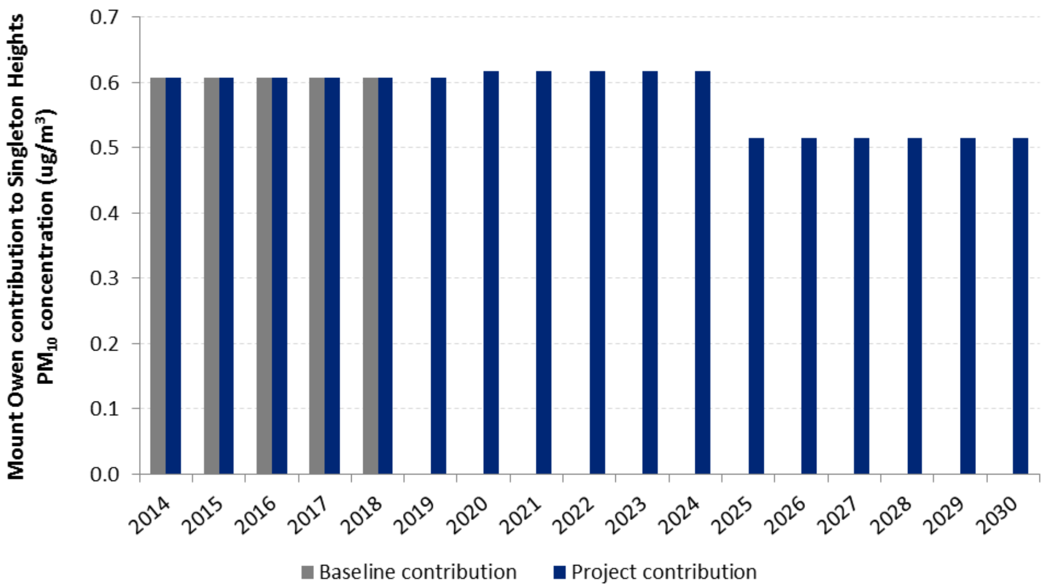
This study estimated that the annual health costs per 10 ug/m^3 increase in the concentration of PM_{10} in the Hunter region range between $174 million - $1.36 billion, in 2003 prices (DEC NSW, 2005).

Taking the average of this range, the share attributable to the Singleton population (3.7% of the Hunter region) and updating to 2014 prices, an adjusted cost estimate of $767 million per 1 ug/m^3 increase in PM_{10} concentration was obtained.

The next step of the valuation process is to apply this cost estimate to the PM_{10} concentration in Singleton attributable to Mount Owen, in the baseline and Project cases.

The Air Quality Assessment (Appendix 6 of the EIS) estimates that the Project will increase the concentration of PM_{10} at Singleton Heights, the closest residential area in Singleton to the mine, by around 0.61 ug/m^3 in Year 1, 0.62 ug/m^3 in Year 5, and 0.51 ug/m^3 in Year 10. These increases have been attributed over the life of the Project as illustrated in Chart 5.10. It is assumed that the contribution from baseline case production from 2014 to 2018 is consistent with predicted contribution in Year 1 of the Project.

Chart 5.10: Mount Owen contribution to PM_{10} concentration at Singleton Heights (ug/m^3)



Source: DAE estimates, inputs from Air Quality Assessment

Overall, after multiplying the cost estimate noted above with the increases in PM_{10} concentration in each case, the health externalities attributable to the mine are valued at around $10.1 million in the baseline, and $23.4 million under the Project case, in present value terms. This implies that the total additional health costs associated with air pollution from the Project in Singleton are worth about $13.2 million.

This should be interpreted as a conservative estimate, given that the methodology for valuing air quality impacts of mining activity, particularly as it relates to $PM_{2.5}$ and dust in the Hunter region, continues to be developed and improved. It is noted that although air dispersion may impact health in other regions beyond Singleton, it would be difficult to attribute the overall impact of the Project from other PM_{10} sources, including mining activities or transport.

In considering the air quality impacts of the Project, it is also useful to note the results of the Air Quality Assessment.

In addition to health costs, particulate matter can also result in non-health, quality of life effects. This potential effect was investigated using a hedonic pricing study, Appendix D. No statistically significant effect was identified in the study.

5.2.17 Air quality impacts – other pollutants

Mining activity is also associated with emission of other air pollutants, such as nitrogen dioxide, sulphur dioxide and carbon monoxide. Common sources of these pollutants include blasting fumes, diesel powered equipment and vehicle exhausts.

A study of blast fume emissions using air quality dispersion modelling by Pacific Environment Limited indicates that potential nitrogen dioxide (NO_2) concentrations by 2025 are predicted to exceed the 1-hour NO_2 standard of 246 micrograms/m^3 over 3 to 12 hours per year, using a sample of four nearby private and mine-owned residences. The analysis is based on a worst-case scenario for blasts of Category 3 (never observed) in 2025 as the reference year, as particulate ground-level concentrations are expected to be the highest in this year. The analysis indicates that a maximum of 12 hours of NO_2 exceedances can be expected from 2,944 blasting hours per year estimated for the Project. Note that these results should not be fully attributed to the Project, as some monitoring units for pollutants interacting in Singleton include background concentrations that are affected by other mining operations.

Management measures to minimise the potential for the formation of NO_x emissions will include continuing to limit blasting activity during adverse weather conditions, which generally increases the likelihood of exceeding air-quality standards.

As some health impacts produced by nitrogen oxides (NO_x) and sulphur oxides are partly correlated with particulate matter, it is reasonable to expect that some of the impacts described above would be captured by the air pollution externalities calculated in Section 5.2.16.

While nitrogen oxides also interact with volatile organic compounds (emitted mostly from chemical processing) increasing ozone formation and leading to additional health impacts, these effects are expected to be minimal as chemical industries are not located within the surrounding mining region. Other air pollutants and sulphur oxides may affect the natural and built environment, however there are limited economic estimates for the Hunter region that would be applicable to quantify these additional impacts.

For these reasons, the potential costs of additional nitrogen dioxide, sulphur dioxide and carbon monoxide are acknowledged, but not considered quantitatively in this analysis.

5.2.18 Noise impacts

The community consultation undertaken as part of the Project has identified that the impact of noise pollution from continued mining operations is a key issue of concern to members of the local community. It is necessary to place a value on the noise impacts expected to be borne by local residents as part of the CBA.

The first step of the valuation process is to compare the levels of noise associated with mining activity under the Project case, compared to the baseline where the Project does not receive approval. This analysis utilises 10^{th} percentile operational noise level predictions provided by Umwelt from the Noise Impact Assessment (Appendix 7 of the EIS). These noise levels are measured in A-weighted decibels (dB(A)) for 112 residential properties in the vicinity of the Mount Owen Mine, for day, evening and night periods. Estimates are presented for three representative years in the Project case (2016, 2020 and 2025).

Accordingly, this analysis values the cost of noise impacts from 2016 onwards. While the exclusion of costs for 2014 and 2015 underestimates the total costs of noise impacts under each case, this approach does not affect the estimate of additional noise impacts costs attributable to the Project, as activity, and hence noise levels, are not expected to vary as a result of the Project in these two years.

As expected, the data indicates that the noise levels experienced by a property are likely to vary between the day, evening and night periods. In order to assign a conservative value to the level of noise experienced as a result of mining activity, this analysis utilises the maximum predicted noise level experienced by each property, as an estimate for the general noise level experienced over the course of that year.

Next, for each property, the noise level which could be directly attributed to mining at Mount Owen was estimated by applying a 30 dB threshold, to account for the level of background noise which is likely to be experienced by residents in any case.

This background noise level is the minimum rating background noise level used in the EPA's Industrial Noise Policy, and has been confirmed by background noise monitoring to apply to the majority of the area surrounding the Project.

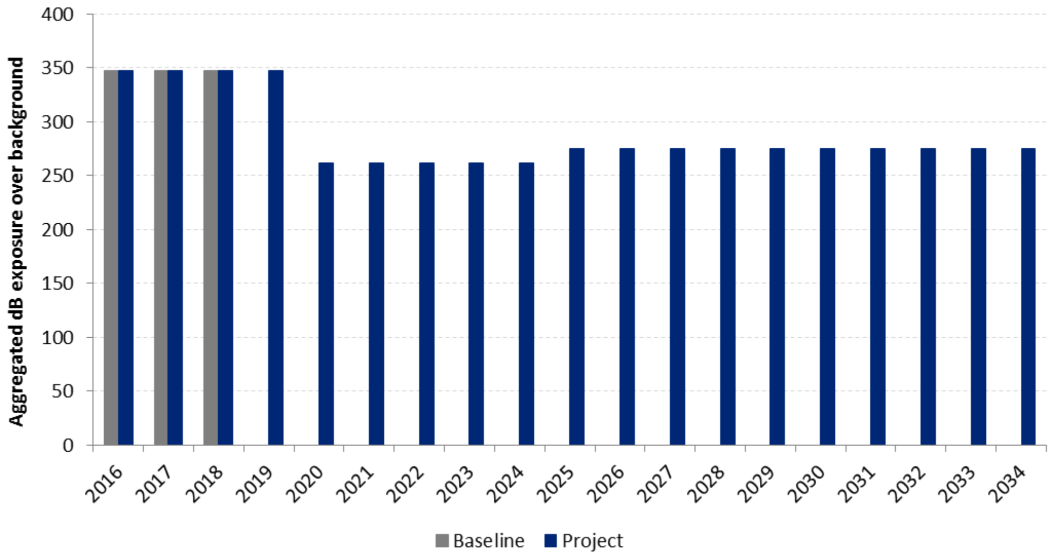
Under the Project case, the total additional dB(A) exposure of the 112 residential properties for 2016, 2020 and 2025 was calculated by adding together these estimated property level noise exposures, attributable to Mount Owen mining operations for each year.

A Project case time series of noise impacts was then developed by assuming no change in the level of exposure between the representative years. For example, it was assumed that the noise impacts in 2016 would remain constant out to 2019. In addition, noise impacts in the Project case were extended out to 2034 to account for noise impacts during the closure phase. It is assumed that the noise exposure from baseline case production between 2016 to 2018 is consistent with predicted Project case exposure in 2016.

These estimates are presented in Chart 5.11 below.

It should be noted that these aggregated values do not have a meaningful interpretation, as decibels are measured on a logarithmic, rather than a linear scale. Instead, the aggregates provide indicative estimates of the additional noise impacts that could be associated with the Project, relative to the baseline.

Chart 5.11: Aggregated household dB exposure estimates (over background noise)



Source: DAE estimates, inputs from Noise Impact Assessment

Having identified the 'quantity' of noise pollution likely to be experienced in the baseline and Project case, it is then necessary to apply a monetary value, representing the cost of an additional decibel of noise borne by a household.

While it would be most appropriate to utilise a monetary value derived specifically for the context of the areas surrounding Mount Owen, the hedonic pricing study described in Appendix D found no statistically significant evidence to suggest that mining operations in the Mount Owen region have had a negative impact on surrounding property prices.

As such, the value utilised in this analysis relies on a value identified in the literature review presented in Appendix C.

Specifically, this study applies a value of $62.38 per dB per household per year, based on the upper limit of the range recommended by Navrud (2002), converted to 2014 dollars. The recommendation was made to the European Commission DG Environment based on the results of a comprehensive literature review. This value was chosen due to its broad evidence base, and the inconclusive hedonic pricing findings for the Mount Owen region making it inappropriate to transfer an estimate from an out-of-context hedonic pricing study. The chosen value should be considered as indicative of the scale of noise related externality costs, not a precise valuation, particularly as it relates to traffic noise rather than the noise impacts of mining.

Applying this value to the aggregated dB exposure estimates yields a noise pollution cost of $0.05 million in present value terms in the baseline, and a cost of $0.18 million in the Project case.

Noise impacts will be managed through:

- equipment location and scheduling;
- modification of operations during adverse meteorological conditions, if required;
- continuous and attended noise monitoring; and
- reviews of noise monitoring data and adaptive management.

In addition, specific mitigation measures will be implemented for properties located within the Management Zone, as determined by the Noise Impact Assessment. This includes a commitment to regular monitoring and management of noise impacts, residence specific management for some properties, and potential acquisition of three additional residential properties.

5.2.19 Visual amenity

It is recognised that mining activity has the potential to detract from the visual amenity of a community. The visual effects of converting an existing landscape to an area featuring emplacement areas, machinery, vehicles and artificial light are therefore important considerations for a CBA.

The affected area is currently surrounded by a mix of rural land and mining landscapes from Mount Owen along with other mines in the Ravensworth area (e.g. Integra and Ashton Coal Mines). Mount Owen's mining activities can be currently observed from the New England Highway, Main Northern Rail Line, and a number of surrounding properties. The visual amenity at night is currently affected by a night time glow from the mining operations in the region. To address this issue, Mount Owen has introduced directional lighting and management controls for mobile lighting.

Likely visual impacts of the Project have been assessed through a series of radial analyses, panoramic photographs and visual montages.

The radial analyses concluded that the Project will not be visible from residences located in the Camberwell Village and north and east areas, but could affect the visual amenity of a small number of residences in the Middle Falbrook area. Specifically, three private residences and two public viewing locations were identified as having the highest potential for visual impacts.

These properties (in the Middle Falbrook area) and public roads were subject to a more detailed visual impact analysis. The impact analysis found that, out of the five locations listed above, only one private residence location and two public viewing locations (namely, the Middle Falbrook Road and Glennies Creek Road Intersection; and the Hebden Road and New England Highway Intersection) will have views affected by existing and proposed operations under the Project. Therefore, the current visual impacts from Mount Owen under the baseline are expected to continue at a similar level in the Project.

Umwelt expects that with ongoing rehabilitation as part of the Project, the visual impacts of current mining operations will be reduced over time.

Mount Owen has incorporated measures to minimise the visual impacts of the Project, including:

- progressive rehabilitation across all areas will reduce visible soil exposure;
- management of mobile lighting will reduce the impacts of lighting at night; and,
- all fixed lighting to follow *Australian Standard AS4282 (INT) 1995 – Control of Obtrusive Effects of Outdoor Lighting*.

For these reasons, no quantitative values have been assigned to this item in the analysis.

5.2.20 Traffic

The effect of the Project on traffic constitutes another element for consideration in the CBA. In this analysis, there are a number of key impacts which should be accounted for. They are:

- the impact of additional vehicle journeys associated with construction and continued mining operations on the service level of local roads;
- the impact of the proposed two lane bridge on Hebden Road over Bowmans Creek on travel times and road safety; and
- the impact of the proposed Hebden Road overpass over the Main Northern Rail Line on travel times.

The Mount Owen Complex is located east of the New England Highway, between Singleton and Muswellbrook. Mount Owen Mine Access Road runs off Hebden Road, which connects with the New England Highway in two places. The first intersection is located immediately north of Lake Liddell, while the southern intersection is at Ravensworth. The majority of vehicles use this southern intersection point to access the Mount Owen Complex. Hebden Road is also used to access public properties, other industrial operations (such as quarries), and the northern side of Lake Liddell.

Operational phase impacts on service levels of local roads

According to the Traffic Impact Assessment (Appendix 16 of the EIS), average daily traffic volumes on Hebden Road and Glennies Creek Road are moderate to low, (i.e. less than 1,400 vehicles per day). This is equivalent to a level of service (LoS) 'B' or better for rural roads, defined by Austroads.

Similarly, the Assessment found that the New England Highway intersections at Hebden Road and Glennies Creek Road are currently both operating with ample spare capacity, minimal delays and virtually no queues in peak times, with an 'A' LoS.

The Assessment found that as the Project does not involve a change to operational staffing levels or shift times, there will be no adverse impacts on these existing acceptable traffic conditions and service levels during the continued mining operations. It is noted that while there is likely to be further improvements in traffic conditions beyond 2018 under the baseline case, any relatively longer travel times experienced under the Project case are likely to be negligible.

Construction phase impacts on service levels of local roads

That said, it is also important to assess the impact of additional vehicles associated with the construction phase of the Project, proposed to begin within 12 months of the commencement of mining beyond the currently approved mining. For the purpose of this analysis, it is assumed that this construction phase will begin in 2016.

The Traffic Impact Assessment reports the outcome of modelling of the impact of these vehicles on the Hebden Road and Glennies Creek Road intersections with the New England Highway. As described in Appendix 16 of the EIS, over the 18 month construction period, average delays will increase by between 0.2 and 4.1 seconds during the AM and PM peaks on weekdays. This will temporarily increase the travel times experienced by other users of the intersections during those times.

Based on estimates of the AM and PM peak two way traffic volumes at these two intersections from the Traffic Impact Assessment (presented in Table 5.6 and Table 5.7), these delays are anticipated at 85 and 4 vehicle hours per year at the Hebden Road and Glennies Creek Road intersections respectively.

Table 5.6: Hebden Road – New England Highway Intersection traffic data

	Weekday AM Peak (6 - 7am)	Weekday PM Peak (6 - 7pm)
Two Way Traffic Volume	189	104
Proportion of medium / heavy vehicles	16%	22%
Average delay – baseline case	2.1 seconds	2.7 seconds
Average delay – Project case construction phase	6.2 seconds	6.5 seconds
Additional delay during construction phase	4.1 seconds	3.8 seconds

Source: Traffic Impact Assessment (Appendix 16 of EIS)

Table 5.7: Glennies Creek Road – New England Highway Intersection traffic data

	Weekday AM Peak (6 - 7am)	Weekday PM Peak (6 - 7pm)
Two Way Traffic Volume	84	51
Proportion of medium / heavy vehicles	0%	2%
Average delay – baseline case	1.2 seconds	0.9 seconds
Average delay – Project case construction phase	1.4 seconds	1.7 seconds
Additional delay during construction phase	0.2 seconds	0.8 seconds

Source: Traffic Impact Assessment (Appendix 16 of EIS)

As described in Appendix C, vehicle hours can be valued using a standard industry cost approach. This analysis utilises the following rural travel time values published by Transport for NSW (2013), updated to 2014 prices:

- $23.88 per vehicle hour for private cars;
- $33.08 per vehicle hour for light commercial vehicles; and
- $35.88 per vehicle hour for heavy commercial vehicles.

This analysis applies the private car value to the delay borne by light vehicles. An average travel time value of $33.80/hour for medium and heavy vehicles was derived using the average proportions of medium and heavy vehicles utilising rural roads, estimated by Transport for NSW (2013).

In addition, it is necessary to account for vehicle operating costs incurred while each vehicle is waiting for the level crossing to reopen. This analysis applies Transport for NSW's value of $9.44 per vehicle hour, (updated to 2014 prices) to all vehicle types (2013).

The resulting estimates of additional travel time costs per year at each intersection, under the Project case are presented in Table 5.8 below. Assuming that the construction phase begins in 2016, aggregating these costs for an 18 month period implies that the present value of additional travel time costs during the construction phase amount to $3,723 in present value terms, using a 7% discount rate. This has been included as a cost in the Project case. It is noted that while this cost does not include any impacts outside the weekday peak hours, the magnitude of the peak hour costs suggests that this has no material impact on the conclusions of this analysis.

Table 5.8: Additional travel time costs during construction phase

Intersection	AM Peak Cost of Delay / Year	PM Peak Cost of Delay / Year
Hebden Road	$1,956	$1,014
Glennies Creek Road	$40	$99

Source: DAE estimates

Impact of proposed dual lane bridge over Bowmans Creek

The existing single land bridge on Hebden Road over Bowmans Creek is located approximately 400m east of the existing Main Northern Rail Line level crossing. The Traffic Impact Assessment estimates that during the AM peak, southbound traffic is delayed by approximately 18.5 seconds on average, with queues reaching 28 metres 5% of the time. This is equivalent to LoS 'B'.

It is noted that the replacement of the existing bridge with a dual lane bridge will reduce travel times along Hebden Road further with preliminary estimates indicating that these are unlikely to exceed $22,000 in present value terms, using a 7% discount rate. This estimate has not been included in the analysis as it relies on the assumption that the average delay at the bridge under the baseline case is constant at the AM peak delay of 18.5 seconds, regardless of the time of day, and thus is likely to be overestimated.

It is also acknowledged that the new, wider bridge may improve road safety and reduce the incidence of vehicle accidents. To that extent, additional benefits would accrue under the Project case. However, due to uncertainty regarding the likely prevalence of incidents on the bridge under the baseline and Project case, this benefit is considered qualitatively.

Impact of proposed Hebden Road overpass

The most significant impact of the Project on traffic and travel times is expected to be the construction of an overpass on Hebden Road over the Main Northern Rail Line. Currently, there is a rail level crossing where the line intersects Hebden Road. The Traffic Impact Assessment notes that approximately 100 trains utilise the crossing per day, with an average crossing closure time of 110 seconds per train. Based on this information, it is estimated that 12.7% of vehicles that travel across the railway line must stop while a train passes through.

Based on the average daily traffic volume of 1,318 vehicle journeys, this implies that the level crossing causes a total delay of 2,011 vehicle hours per year. It is estimated that 22.6% of this delay is borne by medium or heavy vehicles, consistent with the data available in the Traffic Impact Assessment.

Using the travel time values from Transport for NSW described above, it is estimated that the current level crossing imposes costs of $66,550 per year. This is valued in perpetuity from 2014 under the baseline case, producing a total cost of around $1.02 million in present value terms. Under the Project case, the construction of the rail overpass is expected to eliminate these costs from 2018 onwards. As such, the travel time costs in the project case are much lower at $0.25 million in present value terms.

Conclusion

Overall, the Project is expected to deliver net traffic benefits of around $0.77 million, in present value terms, taking into account the impact of construction phase traffic and the proposed Hebden Road Rail Overpass.

5.2.21 Biodiversity (flora and fauna)

It is also necessary to compare the risks to biodiversity in both the baseline and Project case as part of a CBA.

Umwelt has advised that the Project will impact 223.7 hectares of native woodland forest vegetation, along with 223.1 hectares of native grassland. These areas include the following vegetation communities:

- Derived native grassland (223.1 ha);
- Central Hunter Ironbark – Spotted Gum – Grey Box Forest endangered ecological community (EEC) (131.9 ha);
- Central Hunter Bulloack Forest Regeneration (54 ha);
- Planted Ironbark – Spotted Gum – Grey Box Forest EEC (27.4 ha);
- Central Hunter Swamp Oak Forest (5.8 ha);
- Central Hunter Grey Box – Ironbark Woodland EEC (4.4 ha);
- Kunzea Closed Shrubland (4.7 ha); and
- Hunter Valley River Oak Forest (0.2 ha).

The EECs noted above are state listed. There are no federally listed EECs located within the project disturbance area.

A number of threatened species of flora and fauna have been identified in the disturbance area and broader Project Area. The Ecological Assessment (Appendix 11 of the EIS) found that, in particular, the vegetation community in the Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC (noted above), along with the following species have the potential to be significantly impacted by the Project:

- spotted-tailed quoll (*Dasyurus maculatus*);
- squirrel glider (*Petaurus norfolcensis*);
- masked owl (*Tyto novaehollandiae*);
- brown treecreeper (*Climacteris picumnus victoriae*);
- speckled warbler (*Chthonicola saggitata*);
- grey-crowned babbler (*Pomatostomus temporalis temporalis*);
- varied sittella (*Daphoenositta chrysoptera*);
- hooded robin (*Melanodryas cucullata cucullata*);
- diamond firetail (*Stagonopleura guttata*);
- brush-tailed phascogale (*Phascogale tapoatafa tapoatafa*);
- yellow-bellied sheathtail-bat (*Saccolaimus flaviventris*);
- east coast freetail-bat (*Mormopterus norfolkensis*);
- southern myotis (*Myotis macropus*); and
- greater broad-nosed bat (*Scoteanax rueppellii*).

In order to mitigate against any potential biodiversity impacts, Umwelt has prepared a Biodiversity Offset Strategy, with the objective to "maintain or improve ecological features within the Project Area and to compensate for unavoidable impacts on the ecological values of the proposed disturbance area". The strategy involves the creation of three offset areas, as listed in Table 5.9. It is anticipated that these offsets will be maintained in perpetuity from 2016 onwards.

Table 5.9: Proposed offset areas

Offset site	Area (ha)
Cross Creek Offset Site	367
Esparanga Offset Site	303
Stringybark Creek Habitat Corridor	97.5

The offset strategy is designed to mitigate against any loss in biodiversity which may occur as a result of the Project, relative to the baseline. Based on the information provided, the risks to biodiversity generated by the Project are considered qualitatively in this analysis.

However, there are costs associated with the management of these offset areas. This analysis utilises a rate of $3,318 per hectare of land as an estimate of the lifetime costs of offset management, consistent with the NSW Office of Environment and Heritage Credit Calculator (2012), updated to 2014 prices.

Given that these costs are likely to be incurred from 2016, total offset management costs under the project case are estimated at $2.22 million in present value terms, using a 7% discount rate.

5.2.22 Conservation

It is also important to recognise the extent to which the Project will affect conservation areas surrounding the mine.

The continuation of the North Pit, continued mining on previously disturbed land at Ravensworth East, and other infrastructure works will not impact on the Mount Owen Mine Voluntary Conservation Area or any existing Biodiversity Offset Areas.

In contrast, three Biodiversity Offset Areas will be established as part of the Project, in addition to those that currently exist under the baseline.

As discussed above, the costs associated with managing these areas have been included in the CBA under the biodiversity item, while the social value of these areas offsets the negative biodiversity impacts of the Project. Therefore, to avoid double-counting, no quantitative values have been assigned to the conservation item in the baseline or Project case.

5.2.23 Quality of open space

As described in Appendix C, valuation of impacts on the quality of open space incorporates two main elements – the visual amenity associated with the space, and the types of activities that are undertaken in the space. To avoid double-counting, this item is focused on the second component, since the visual amenity impacts of the Project have been discussed in Section 5.2.19 above.

In the context of this Project, the Social Impact and Opportunities Assessment (SIOA) (Appendix 5 of the EIS) indicates that the Project Area is not utilised for recreational activities. Nearby sites used for recreation include the Lake Liddell Recreation Area, located to the west of the Project Area, and potentially the Ravensworth State Forest in the future, although the latter is currently part of Mount Owen's mining leases and is therefore unlikely to be used for recreation activities in the short to medium term. The Project will not directly impact either site, or the level of public access to those sites, relative to the baseline case.

It is noted that access to the Lake Liddell Recreation Area from Hebden Road from the south would likely be affected during the 18 month construction period, however any associated costs would be more than offset by the reduced travel times as a result of the Hebden Road Rail Overpass and dual lane bridge over Bowmans Creek from 2018 onwards. Furthermore, it is noted that the Lake Liddell Recreation Area is also accessible on Hebden Road from the north, providing an alternate route during the construction period.

Based on this evidence, it is considered that the Project is unlikely to cause a material change in the ability of local residents or visitors to use the open spaces surrounding the Project Area for other activities. Accordingly, no quantitative values have been assigned to this item in the baseline or Project case.

5.2.24 Rural amenity and culture

The impact of a proposal on rural amenity and culture should also be considered where the project is likely to affect the composition of the community.

The SIOA (Appendix 5 of the EIS) includes an assessment of the social risks of the Project, within the Upper Hunter region. The aspects considered relevant to rural amenity and culture include:

- impacts of population change;
- impacts on community and infrastructure services;
- sense of community and cohesion; and
- community sustainability and intergenerational equity.

As described in the SIOA, the mitigated technical risk for each of these areas was rated as low, in cumulative terms, taking into account the existing mining activities within the region.

Given the prominence of the mining industry in the Hunter Valley it is difficult to attribute a cost of this impact to the Project specifically. However, one potential approach is to quantify the costs associated with an additional family relocating out of the local area. While it is difficult to determine the number of people who would choose to relocate as a direct result of the Project, the number of additional residential properties which meet acquisition criteria due to Project impacts can be used as a proxy measure.

This is a proxy measure only, as, in the first instance, it is uncertain whether property owners would choose to trigger those rights and relocate. Secondly, Mount Owen has indicated that should it acquire the property, it would attempt to lease it out for residential purposes, as it has done with a number of other residences.

Those points noted, in the context of this study, Umwelt has indicated that a total of three additional, privately owned residential properties are predicted to meet acquisition criteria in relation to air quality and/or noise impacts of the Project.

The next step is to apply a monetary value. Appendix C describes some studies which have attempted to estimate the value of maintaining rural communities. This analysis utilises the results of a choice modelling study undertaken by Bennett, van Bueren and Whitten (2004). As this study was undertaken for a different policy context than that considered in this analysis (the effects of increased environmental protection on rural populations, rather than continued mining activity), it provides an indicative value of the impact of the Project on rural amenity and culture.

As described in Appendix C, the study undertook a number of surveys to illustrate the variation in willingness to pay estimates for different policy contexts. Using a general survey at the national level, it was found that Australian households were willing to pay an average of $0.09 per year, over a twenty year period, to prevent 10 people leaving rural communities across the country. A separate, region-specific survey of households in Rockhampton found that they were willing to pay $2.24 per year over twenty years, for every ten people leaving the Fitzroy Basin region.

The difference in these estimates is likely to reflect a combination of both higher costs borne by the Rockhampton community, compared to the national average; and the impact of more specific questions used in the regional survey, compared to the general questions used in the national survey. As such, it is inappropriate to aggregate the values from the regional survey beyond a regional population.

In the context of this analysis, the results of the study present two options for valuation of the impact of the Project on rural amenity and culture. In the first instance, it is plausible to aggregate the national estimate for all households in Australia. Alternatively, the regional value can be aggregated for all households in the Hunter Valley / Newcastle area. This analysis uses the results of the former approach, as it generates a more conservative estimate of costs.

The first step in this valuation process is to convert the value of $0.09 per year over twenty years, into a one-off payment. Using a perpetuity formula and a discount rate of 7%, this was converted into a cost of $0.95 per household, measured in 2004 prices.

Inflating this value to 2014 prices produced a value of $1.25 per household, for every ten people leaving a rural community. This was then converted into a cost per person leaving the community of $0.12 per household.

Based on the number of residential properties likely to meet acquisition criteria (three) and the average household size in the Singleton LGA, based on 2011 Census data (2.7), it was estimated that, on average, 8.1 people might relocate from the immediate surrounding area as a result of the Project. Using the household cost of $0.12 per person relocating, this implies a total cost of $1.01 per household in Australia. Applying this value to the number of households in Australia as at the 2011 Census (9.1 million) produces a national cost estimate of $9.2 million. It is assumed that the acquisition rights for each property would be granted from Project approval. Given the uncertainty around approval timelines, acquisition is assumed to take place in 2016 for the purpose of this analysis. Accordingly, this cost was then discounted back to $8 million in present value terms, using a 7% discount rate.

It is evident that this valuation involves a number of assumptions. Accordingly, this final estimate should be interpreted as an indicative value of the rural amenity and culture impacts of the Project, particularly for the following reasons:

- The context of the survey undertaken by Bennett, van Bueren and Whitten is quite different from the context of this study – trade off for a reduction in rural populations was the implementation of environmental protection strategies. In the context of mining activity, it is likely that the costs associated with a decline in rural communities would be higher.
- This analysis assumes that the number of households in Australia in 2016 is the same as the number of households reported in the 2011 Census. This also has the effect of underestimating the social costs.
- It is also uncertain whether it is appropriate to apply the values obtained from the survey so far into the future. Assuming that the survey was undertaken in 2004, the twenty year time period for which the reported values apply to ends in 2024. Future generations might experience costs that are smaller or larger than those reported in this analysis.

- As noted above, it is possible that the Project would not directly cause any families in the local community to relocate, which would not otherwise do so under the baseline case.
- Also, these costs may be offset to some extent by community investments made by Mount Owen over the course of the Project, such as support for Mount Pleasant School.

5.2.25 Aboriginal heritage

Aboriginal heritage sites are associated with substantial historical, cultural and scientific value. Where a proposal is anticipated to damage these sites, it is critical that these impacts be considered in a CBA to adequately account for the costs of the Project.

The Mount Owen Mine, along with the proposed North Pit Continuation Area are located in the centre of the traditional country of the Wonnarua people, which is also part of the Wanaruah Local Aboriginal Land Council.

To assess any potential effects of the Project on these areas, Mount Owen undertook an Aboriginal Cultural Heritage Assessment (ACHA) in consultation with relevant Registered Aboriginal Parties (RAPs).

The cultural heritage assessment has shown that the wider regional cultural landscape surrounding the Project Area does hold high cultural and historical significance to Wonnarua people. The landscape within the Project Area however is highly disturbed and fragmented, resulting in much of the past archaeological record already having been lost by agriculture and coal mining. The cultural heritage assessment found that the archaeological sites and the remnant cultural landscape within the Project Area have undergone considerable modification since European settlement and are therefore of lower cultural significance than the surrounding region. Thus, there are no adverse impacts affecting the areas of higher regional significance sites under the baseline or the Project case. The basis for the assessment and its findings are described in more detail below.

The significance of cultural heritage values was assessed through the meaning of all aesthetic, historical, scientific, social and spiritual values that a place or object embeds. In addition, outstanding features, such as rarity, representativeness and conditions, integrity and authenticity, are used to indicate the place or object's degree of cultural significance. Based on this analysis, the following cultural heritage values of medium or high significance have been found in the region:

- **Prominent visual landmark (aesthetic value)**: two prominent landmarks, Bowmans Creek and the remnants of Bettys Creek, have been identified in the region – *high* regional significance, *low* Project Area significance.
- **Relationship with key events or themes in history (historic value):** The wider region is significant for the very early documented interactions between white settlers and Aboriginal peoples, and is the canvas for stories of contact, conflict, death, and dispossession. It is also the backdrop for a narrative of survival, cultural adaption and the on-going interaction of Wonnarua people with the non-Aboriginal community – *high* regional significance, *medium* Project Area significance.

- **Area showing creative or technical achievement (historic value):** within the Project Area, the archaeological sites are typical of assemblages and artefact types in this region, and there is no other physical evidence of creative or technical achievement within the Project Area– *high* regional significance, *low* Project Area significance.
- **Patterns in the development of history (historic value):** the Project Area once formed part of the Ravensworth Estate, which has long and deep historical associations with many Wonnarua people. The association with early settlers features in recounted stories of frontier conflict, dispossession, but also of survival, adaption and the persistence of Wonnarua people – *high* regional significance, *medium* Project Area significance.
- **Project area important as a local marker or symbol (social value**): there does not appear to be any unique cultural markers or symbols within the Project Area, however, the landscape in its entirety was part of a totemic and culturally rich landscape to Wonnarua people. There are places within the wider region that are generally of greater significance – *high* regional significance, *low* Project Area significance.
- **Contribution to the spiritual identity or belief system of a cultural group (spiritual value)**: the Project area is a component of the identity and belief systems of many of the Wonnarua people – medium regional significance, medium Project Area significance.
- **Contribution to investigation, to provide more understanding about people or places, which is not currently available (scientific value):** there is limited research potential for the archaeological sites identified within the Project Area and it is unlikely that further research would provide significant new or important information. There is some potential for research into Traditional Ecological Knowledge in the Project Area and surrounds – *medium* regional significance, *low* Project Area significance.

In terms of the scientific value from archaeological sites, the disturbance area of the Project contains 34 Aboriginal archaeological sites. However, the scientific significance of these sites is low due to clearance of trees and major soil loss, as well as existing mine infrastructure, revegetation and previous archaeological salvage. The concentration of mining has initiated many archaeological salvage programs that have effectively removed well over half of these archaeological site types from the surrounding region. Another eight sites that were identified outside of the disturbance area will not be affected by the Project.

Having established the presence of items of heritage value, the next issue is whether a monetary value can be reasonably placed on those items. To quantify the values people place on heritage sites, stated preference techniques are the predominant method used to eliciting willingness-to-pay estimates through surveys. However, as described in Appendix C, very little research has been undertaken in the Australian context.

A review of available studies in EVRI identified two sources, both of which relied on choice modelling. The first, Rolfe and Windle (2003), assessed the value of protecting an additional 1% of Aboriginal Heritage sites in Central Queensland and found that local Aboriginal communities placed a positive value on protecting Aboriginal heritage but that the general population did not. The other study is based on a choice modelling survey of NSW households undertaken by Gillespie (2009). This study found a value of $29.71 per household per significant Aboriginal site removed.

As described in Appendix B, there are a number of issues which should be noted in using and interpreting the results of contingent valuation or choice modelling surveys:

- By measuring willingness to pay for the conservation of Aboriginal sites, the survey identifies non-use benefits that may not be revealed through actual choices to visit heritage sites. This figure indicates the total value to people in the state of knowing that a site hasn't been destroyed and isn't dependent on the use or access to that site.
- The extent to which it is appropriate to apply the values derived from a small survey to the broader population is uncertain.
- The nature of the questions asked will determine the relevance of the site being valued across respondents, e.g. a Sydney resident may place a different value on the removal of an Aboriginal heritage site than a Singleton resident. The valuation on the importance of heritage may also vary between sites.

As such, it is difficult to obtain an accurate valuation for Aboriginal heritage sites relevant to this Project. Therefore, the impact of the Project on Aboriginal heritage is acknowledged qualitatively only in this analysis. There are a number of management measures that will be undertaken to preserve heritage values in the Project Area as outlined in the ACHA (refer to Appendix 13a of the EIS).

5.2.26 Historic heritage

Similarly, it is also important to consider the impacts of a proposal on European heritage sites, relative to the baseline. To do so, this analysis relies on the findings of the Historic Heritage Assessment for the Project (Appendix 14 of the EIS). The Assessment identifies the likely impact of the Project on nine listed heritage items and eleven unlisted areas with potential heritage value.

It was found that the Project would have no direct or indirect impact on any of the listed heritage items, as they are all located outside the Project Area, and are not expected to experience significant ground vibration levels. That said, given the proximity of one listed item, the former Ravensworth Public School, to the proposed Hebden Road Rail Overpass, Mount Owen has proposed to survey the surface of the land on the north side of Hebden Road (within the proposed disturbance area) for items that might be associated with the site, and to develop protection or mitigation plans in consultation with the Heritage Division of the Office of Environment and Heritage if potential items are found. For these reasons, no costs to listed heritage sites have been included in the CBA.

With respect to the identified potential heritage items, nine of the eleven items have been identified within the Project Area, with three of those within the proposed disturbance area. Each item has been assessed as having no significance with no research potential, apart from the Ravensworth Village, which is located within the disturbance area. However, it is acknowledged that the former Hebden Public School site and John Winter Memorial site are considered to be of local significance, primarily in terms of their potential associative and social significance.

Specific proposed management measures with respect to these sites of potential significance are described below.

Ravensworth Village: an area approximately 180 x 100 metres located to the south of Hebden Road will be disturbed as a result of the proposed Hebden Road Rail Overpass. Although part of this area has been previously disturbed, it has the potential for a locally significant archaeological resource. Management measures include:

- documentation of an archaeological work method statement, to be endorsed by the Heritage Branch of the Office of Environment and Heritage;
- an on-site archaeological investigation of the proposed disturbance area, prior to the construction of the overpass, including a machine stripping of the grass cover and recording and hand excavation of any identified archaeological remains; and
- machine excavation of a series of test trenches to identify the potential for surviving archaeological remains surviving.

Former Hebden Public School site: this is located within the north-west corner of the Project Area, approximately 880 metres north-west of the proposed Bayswater North Pit. A structural analysis of the site identified that the predicted maximum ground vibration at the site as a result of blasting at the proposed BNP is 6.3 mm/s well below the limit of 16-19 mm/s. As such, there are not expected to be any impacts (either direct or indirect as a result of vibration from blasting).

John Winter memorial site: the memorial and potential grave site are within the north-west corner of the Project Area, approximately 880 metres north-west of the proposed Bayswater North Pit. Vibration limits at the site have been identified as 250 mm/s. The predicted maximum ground vibration at the site as a result of blasting at the proposed BNP is 6.4 mm/s. As such, there are not expected to be any impacts (either direct or indirect as a result of vibration from blasting).

Overall, it is considered appropriate not to place any quantitative value on the impact of the Project on historic heritage, given that there are no known heritage sites which will be affected. That said, the potential for heritage items to be located at the former Ravensworth Village site is acknowledged. As the extent to which heritage items are located at in this area remains uncertain, and that management measures will be put in place to mitigate these risks, it is not considered necessary to quantify these potential losses.

That said, based on the value of heritage sites estimated by the Allen Consulting Group (2005), as described in Appendix C, the costs to NSW as a result of the impact on the area of land within the former Ravensworth Village are likely to be less than $0.69 million in present value terms, using a 7% discount rate. However, this valuation implicitly assumes that the area to be disturbed is a known heritage site, and ignores the interpretation issues identified by the Productivity Commission in its Inquiry into Conservation of Australia's Historic Heritage Places (2006). As such, the impact of the Project on areas of potential local heritage significance is considered qualitatively in this analysis.

5.2.27 Health

The final element which should be considered in a CBA is the impact of mining activity on the health of local residents and employees of the mine.

It is noted that health impacts are also often captured within the results of hedonic pricing studies. However, as described in Appendix D, an analysis of property prices in Singleton, along with the surrounding localities of Ravensworth, Camberwell and Glennies Creek produced inconclusive evidence of additional costs associated with residing in close proximity to a mine. As a result, health impacts would need to be measured and valued in terms of Quality Adjusted Life Years.

However, it is not appropriate to consider this item separately in this analysis, given that health impacts are explicitly captured in the valuation of air pollution, and to some extent, implicitly captured in the costs of noise pollution.

5.3 Overall CBA results

Given the values assigned to each cost and benefit in Section 5.2, the next stage of the CBA is to compare the baseline and Project cases and obtain a consolidated estimate of the net economic benefit of the Project. This assessment is directly related to the DGRs which include a detailed assessment of the costs and benefits of the development as a whole.

Table 5.11 on the following page presents the incremental benefits and costs associated with each item considered in the previous section, measured in NPV terms using a 7% discount rate. A 7% discount rate is the standard discount rate recommended by the NSW Government (2007).

The additional gross mining revenue expected as a result of the open cut mining continuation is the main incremental benefit of the Project in relation to the baseline case.

On the other hand, some of the key incremental costs of the Project are the additional operating costs and capital investment borne by Mount Owen, along with the negative externalities associated with carbon emissions and particulate matter.

These outcomes lead to a total net benefit of approximately $758 million and a benefit cost ratio (BCR) of 1.30.

Table 5.10 illustrates the variation in these results using alternative discount rates of 4% and 10%.

Table 5.10: CBA results

Discount rate	Total net benefits ($m)	Benefit Cost Ratio
7%	758.05	1.305

Source: DAE calculations, discounting back to end of 2014

It is important to note that the calculation of benefit cost ratios (BCRs) are sensitive to a number of assumptions.

For example, the preferred BCR outlined in the NSW Government Guidelines for Economic Appraisal (NSW Treasury, 2007) is calculated using initial capital costs in the denominator of the ratio, with ongoing costs subtracted from incremental benefits in the numerator. The purpose of this measure is to ensure that the return to scarce capital is maximised. However, when applied to this Project, this calculation method produces significantly higher results than a standard ratio which divides all incremental benefits by all incremental costs. As such, the BCRs reported above are the more conservative estimates of the benefits delivered by the Project.

In any case, as the DGRs for the Project seek "a detailed assessment of the costs and benefits of the development as a whole, and whether it would result in a net benefit for the NSW community", the total net benefit figures presented in this report are considered to be the most appropriate measure for Project evaluation, rather than the BCRs.

Table 5.11: Incremental benefits and costs

No.	Item	Baseline NPV ($m)	Proposal NPV ($m)	Incremental benefit ($m)	Incremental cost ($m)
1	Gross mining revenue	2,335.02	5,579.06	3,244.04	-
2	Other onsite revenue	-	-	-	-
3	Exploration costs	-	-	-	-
4	Capital investment costs	29.44	157.74	-	128.30
5	Operating costs excluding taxes	1,426.21	3,702.12	-	2,275.90
6	Rehabilitation costs	4.18	13.38	-	9.20
7	Decommissioning costs	45.01	67.44	-	22.43
8	Residual value of capital	0.00	0.00	0.00	-
9	Residual value of land	2.41	0.23	-	2.18
10	Offsite agricultural revenue*	-	-	-	-
11	Related public expenditure*	-	-	-	-
12	Groundwater quality*	-	-	-	-
13	Surface water quality*	-	-	-	-
14	Carbon emissions	19.00	44.12	-	25.12
15	Air quality impacts – particulate matter	10.12	23.35	-	13.24
16	Air quality impacts – other pollutants*	-	-	-	-
17	Noise impacts	0.05	0.18	-	0.12
18	Visual amenity*	-	-	-	-
19	Traffic costs	1.02	0.25	0.77	-
20	Biodiversity	0.00	2.22	-	2.22
21	Conservation*	-	-	-	-
22	Quality of open space*	-	-	-	-
23	Rural amenity and culture	0.00	8.04	-	8.04
24	Aboriginal heritage*	-	-	-	-
25	European heritage*	-	-	-	-
26	Health*	-	-	-	-
				3,244.81	2,486.76

Source: DAE calculations – note numbers may not add due to rounding

NPV measured in real 2014 dollar terms, as at the end of 2014, using a 7% discount rate

* Considered qualitatively

5.4 Sensitivity analysis

The CBA results presented above are subject to the assumptions and valuations applied to each cost and benefit, as outlined in Section 5.2. Accordingly, it is necessary to test the sensitivity of the estimate of net economic benefit and the benefit cost ratio by also considering upper and lower bound discount rates, and varying the size of a number of parameters of interest. This provides an insight into the range of possible outcomes that could be expected from the project, given a number of different scenarios.

The sensitivity analysis results reported in this section utilise a lower bound discount rate of 4%, and an upper bound discount rate of 10%. As noted in Appendix A, these are the values recommended in the NSW Government Guidelines for Economic Appraisal published by the NSW Treasury (2007). It is noted that this lower bound rate of 4% is recognised in the literature as a reasonable discount rate to use when there is an interest in incorporating intergenerational concerns (Arrow et al 2012).

Table 5.10 illustrates the variation in the results of the CBA using these alternative discount rates.

Table 5.12: Central CBA results

Discount rate	Total net benefits ($m)	Benefit Cost Ratio
4%	987.60	1.316
7%	758.05	1.305
10%	588.67	1.293

Source: DAE calculations, discounting back to end of 2014

As shown, the BCR remains greater than 1 for all three discount rates, indicating that the costs of the Project, including the quantifiable externality costs, are more than offset by the expected benefits.

The estimate of net economic benefits range from around $590 million to almost $1 billion, a respective 22% decrease and 30% increase on the central estimate produced using the standard discount rate of 7%.

The second necessary component of a sensitivity analysis is to also vary the estimates for different inputs. The importance of testing scenarios is also recognised in the NSW Government Guidelines for Economic Appraisal (NSW Treasury, 2007).

The variations undertaken as part of this analysis include:

- increasing coal price forecasts by 30%;
- decreasing coal price forecasts by 30%;
- increasing Project capital investment by 25%;
- decreasing Project capital investment by 25%;
- increasing the estimate of operating costs per tonne by 10%;
- decreasing the estimate of operating costs per tonne by 10%;

- increasing the cost per tonne of carbon emissions by 10%; and
- decreasing the cost per tonne of carbon emissions by 10%.

The sensitivity ranges for the coal price were arrived at through an analysis of data. For the 30% range, around 66% of the range of historical coal prices are covered, with the lower sensitivity placed at the 17th percentile of historical coal prices, and the upper sensitivity around the 83rd percentile. Furthermore, it is noted that around 90% of year on year changes in the average annual coal price at the Port of Newcastle have been under 30%.

A comparison of the total net benefits of the Project obtained in each of these scenarios, using a 4%, 7% and 10% discount rate is presented in Table 5.13 below.

Table 5.13: Sensitivity Analysis – comparison of net benefits

Parameter	Variation in Parameter	Total Net Benefits ($m)		
		4%	7%	10%
Central CBA	N/A	988	758	589
Coal price forecasts	+ 30%	2,222	1,731	1,368
	- 30%	-247	-215	-191
Project capital investment	+ 25%	946	719	552
	- 25%	1,030	797	626
Operating costs per tonne	+ 10%	732	557	428
	- 10%	1,243	959	749
Cost per tonne of carbon emissions	+ 10%	984	756	587
	- 10%	991	761	591

Source: DAE calculations, discounting back to end of 2014

These results indicate that the benefits of the Project are likely to exceed the costs, including any negative externalities imposed on broader society, in all scenarios apart from the case where there is a 30% reduction in coal prices. It should be noted that this scenario represents an extreme case whereby prices remain at historically low levels throughout the life of the Project (around the 17th percentile of historical coal prices).

The impact of this reduction in coal prices on the Project financials is assessed in Section 5.4.2 below.

5.4.2 Sensitivity of project financials

It is important to note the sensitivity of the Project financials to the assumptions used above, in order to gain an idea of the risks which are borne by Mount Owen. For this analysis, we have assumed that the only benefit to the proponent is through coal revenues and that their only costs are capital investment, operating costs, rehabilitation costs and decommissioning costs.

A consequence of these assumptions is that the Project financials are only sensitive to certain types of scenarios. Specifically, Project financials are only exposed to risks associated with changes in the operating expenditure, capital investment and coal price, but are not exposed to variations in the social cost of carbon.

Table 5.14 shows sensitivities of the Project financials under the sensitivities discussed. It should be noted that the benefit cost ratios for the central CBA listed in this table differ from those in Table 5.12, as they do not incorporate any externalities of the Project.

Table 5.14: Comparison of net benefits of project financials under multiple scenarios

Parameter	Variation in Parameter	Net Benefits of Project Financials ($m)		
		4%	7%	10%
Central CBA		1,046	808	632
Coal price forecasts	+ 30%	2,280	1,781	1,411
	- 30%	-188	-165	-148
Project capital investment	+ 25%	1,004	769	595
	- 25%	1,088	848	669
Operating costs per tonne	+ 10%	791	607	471
	- 10%	1,302	1,009	792

Source: DAE calculations, discounting back to end of 2014

Notably, the net benefits of the Project financials are positive under most potential scenarios, with the exception of the scenario involving a 30% reduction in coal prices. This illustrates that the Project may become unviable in the event that coal prices are significantly lower than expected. As noted above, this is an extreme case which assumes prices will remain at around the 17th percentile of historical coal prices over the life of the Project.

5.5 Subregional Impacts

While a CBA provides a clear picture of the overall benefits and costs of the Project, it is not well suited to show that the costs and benefits are not evenly distributed between the different stakeholders. For example, some of the costs of the negative externalities are borne by the local community, while the benefits of increased taxation accrue to the NSW and Australian Governments. These regional benefits are considered in the following sections.

One important regional benefit is the generation of taxation revenue for the NSW Government. Although tax payments are normally treated as a transfer payment within a CBA model, we estimate that the project would generate around $442 million (in NPV terms) in royalties for the NSW Government, compared to $185 million in the baseline (an increase of $258 million). In undiscounted terms, this is equivalent to an additional $461 million in government revenue over the life of the Project. Around 92% of the present value of additional royalties is attributable to the continued operations at the North Pit.

This estimate of royalties incorporates allowable deductions of $3.50 per tonne of product coal that is subjected to full cycle washing. However, the potential for further deductions related to payment of levies, insurance and other items such as bad debts and bank commissions have not been accounted for in this estimate, due to the variability in such payments and the difficulty to forecast them accurately over time.

Further, these deductions are unlikely to have a large effect on the estimated royalties as they are removed from gross revenue before calculating royalties payable not removed from royalties payable (that is, only 8.2% of deductions are removed from royalty payments).

An estimation of the net benefits to the Singleton community is also of interest. Although CBA calculations are not easily disaggregated into regional assessments, an estimate of the net benefits likely to be received by the Singleton community was produced based on the following assumptions:

- the community's share of the net benefits from capital investment were estimated using data provided by Mount Owen in relation to the location of suppliers during the construction phase of the Project, and a Frontier Economics estimate of the weighted average cost of capital in mining, which is borne by Mount Owen;
- the community's share of the net benefits from operating costs were estimated using data provided by Mount Owen in relation to the location of suppliers and employees during the operation phase of the Project. In order to illustrate the range of outcomes that could be achieved in the absence of the Project, it was assumed that these businesses and workers could either earn the same level of income from alternative sources, or the average level of income in Singleton in the baseline case. As illustrated in Chart 3.1, the average level of income in Singleton is approximately 64% of income from mining. Industries which provide this average level of income include public administration and safety, manufacturing and construction;
- the community was attributed all the benefits of reduced travel time as a result of the Hebden Road Rail Overpass;
- the community's share of the national costs of carbon pollution was estimated using the Singleton LGA's share of the national population;
- the community was attributed all of the health costs associated with additional particulate matter emissions;
- the community was attributed all of the costs associated with additional noise pollution; and
- the community's share of the national costs of lost rural amenity and culture was estimated using the Singleton LGA's share of national private residences using 2011 Census data.

These assumptions imply that, over the life of the Project, the Singleton community will receive a net benefit of up to $306 million, in NPV terms, under the assumption that, in the absence of the Project, local employees and suppliers would earn the average level of income in Singleton.

6 Impact on regional economy

This chapter examines the economic impact of continuing the operations of the Mount Owen open cut mine to 2030 on the local economy in the Hunter region and the New South Wales economy. The approach uses CGE modelling to estimate how the Project's capital investment, operational expenses and revenues are distributed across the broader economy over time.

Over the period 2016 – 2030 the Project is projected to impact the Hunter region economy by $1.3 billion from $3.2 billion in coal sales (in NPV terms). The total Gross State Product (GSP) impact to NSW is projected at around $1.9 billion over the same period. The Project is also projected to impact employment in both the Hunter region and the State, with economy-wide employment peaking in the early stages of the operational phase, in 2020 of 1,091 FTEs in the region and about 127 FTEs in the rest of NSW for a total of about 1,200. These results capture the direct and indirect impacts of the development, and any crowding out of activity. More detail on the impacts to the Hunter region and NSW are outlined below.

6.1 Analytical methodology

This study adopts a bottom up framework to determine the likely size, timing and location of the additional activity generated by extending the life of the Mount Owen mine in the Hunter region under the Project. For this, we have relied on comprehensive project data provided by Mount Owen on the capital expenditure and the operational activity at the coal mine. This commercial information includes forward development and expenditures, production volumes and workforce requirements over the construction and operation phases of the Project.

The economy-wide impacts of the Project have been projected using the Deloitte Access Economics Regional General Equilibrium Model (DAE-RGEM). The model projects macroeconomic aggregates such as GDP, employment and wages for the Project scenario against a baseline case for each of the modelling years from 2016 to 2030. More technical detail regarding CGE modelling can be found Appendix E.

The model has been disaggregated and customised to match the attributes of the Hunter Valley area regional economy. To disaggregate the Hunter modelling region from the rest of NSW, information was used from the most recent 2011 Census on the workforce population.

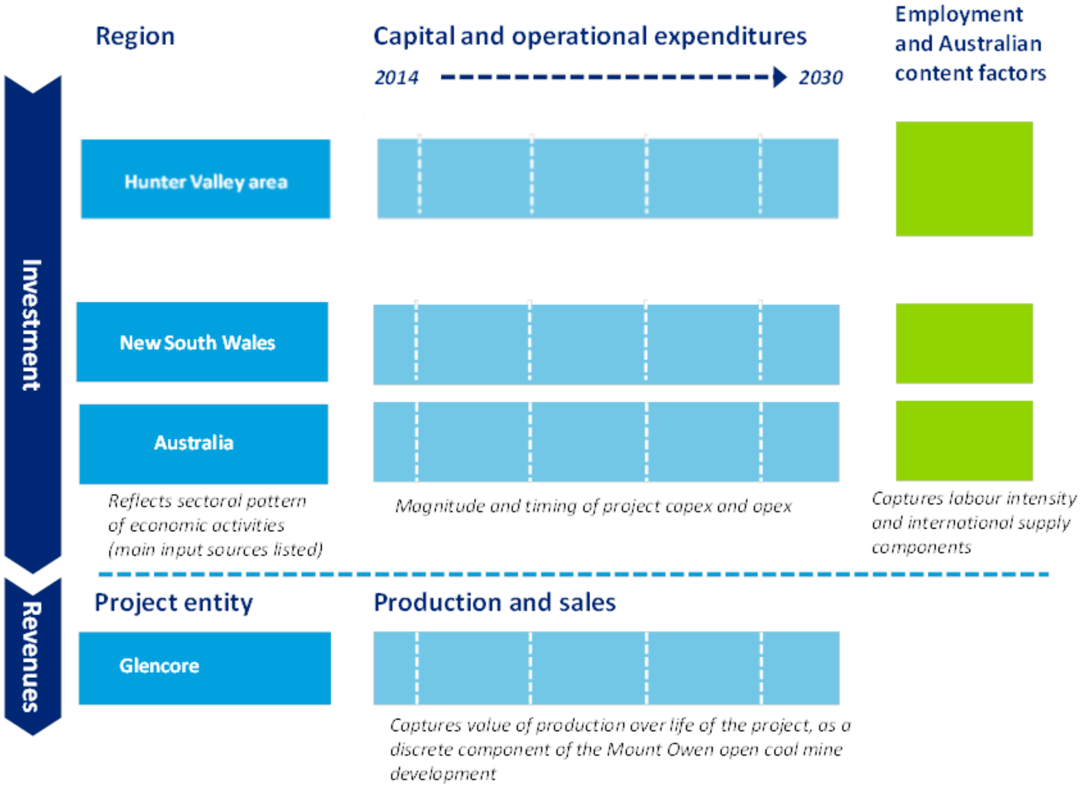
For the purpose of the modelling, the 'Hunter Valley area' includes the Hunter Valley geographical region and part of the Central Coast, as they both cover the main localities supplying labour or intermediate inputs to the Mount Owen Mine.

Modelling has been undertaken for the period 2016 to 2030 for the following economic regions:

- **Hunter Valley area** — contains the localities of Branxton, Broke, Central Coast, Cessnock, Greta, Jerrys Plains, Kurri Kurri, Lake Macquarie, Maitland, Muswellbrook, Newcastle and Singleton
- **New South Wales** — includes impacts across the Hunter Valley area and rest of the State
- **The Rest of Australia**

The results from the economic impact analysis are presented as percentage and absolute deviations in output, employment and wage from a baseline case that the Mount Owen Mine ceases operations by 2018 in each of the economic regions. The broad approach to the economic impact analysis is shown in Figure 6.1.

Figure 6.1: Modelling framework



Based on the capital and operational expenditures, the modelling gauges the wider economic impacts of the continuation of operations of the Mount Owen Mine at two levels:

- **Direct impacts** — the economic gains associated with 'core' commercial operations, namely the additional coal extraction and processing, and revenues generated by sale of coal exports from the Mount Owen Mine.
- **Indirect, induced and crowding out impacts** — the economic gains in related upstream or downstream industries where the benefits associated with increased resource activity are typically the highest. As outlined above the CGE modelling also captures any crowding out of activity in other sectors of the economy as a result of the Project.

Because of these two distinct elements, the results presented in this Chapter may not necessarily be comparable to the output value and employment projections from the continuation of the Mount Owen Mine outlined in other areas of this Economic Impact Analysis, which take a narrower financial view.

6.2 Modelling scenarios

The analysis captures the peak of Project construction and the majority of production, including ramp up in the new mining area and stabilisation of resource extraction. The sale of semi-soft coking coal and thermal coal has been considered to assess the output of the Project.

One of the realities of an extended analytical horizon is that projections contain an element of uncertainty. Forecasting economic growth, advances in technology, external political dimensions and other dynamic factors, which are likely to impact on commodity prices and the investment climate over the long-term, is a complex task. In this Project the most significant source of uncertainty affecting the project is export coal prices.

To understand the potential implications of different coal price trajectories for the continuation of the operations in the Mount Owen Mine, the economic impact analysis will be conducted for three modelling scenarios:

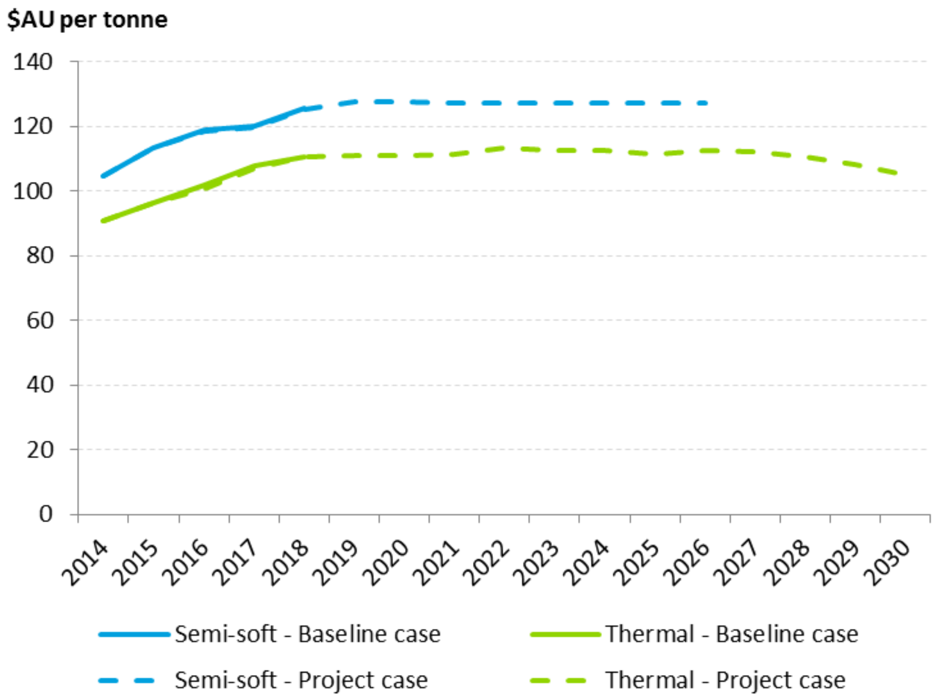
- Central estimate of coal price forecasts
- Lower price scenario (30% lower below central estimates)
- Higher price scenario (30% higher above the central estimates)

All scenarios are based on the same assumptions around the continuation of operations of the Mount Owen Mine for which approval is being sought. The first scenario provides a central case for the continuation of operations with central estimates of export prices, while the others incorporate low and high price sensitivities into the analysis. The results for the central scenario are outlined in Section 6.4 where discussion on the sensitivities is outlined in Section 6.5.

Coal price – revenue per tonne

For each of these scenarios, two series of independent price forecasts are required: coking coal prices (used as reference for trading semi-soft coal) and thermal coal, as set out in Chart 6.1. In the cost-benefit analysis and CGE modelling the prices in have been adjusted to reflect variations in expected quality of coal mined in the Project relative to the reference quality. Baseline and Project case prices are provided below.

Chart 6.1: Coal price forecasts and projections, 2014 to 2030



Source: Consensus Economics

Coal price projections are informed by the Consensus Economics long-term forecast for coking coal and thermal coal. Relevant coal prices, as measured in Australian Dollars, are generally expected to rise from 2014 over the projection period (to 2018 – post 2018 we have assumed coal prices remain at this level). While prices are expected to increase they are expected to remain significantly lower than 2011 prices.[4]

To gauge the economic impacts of varying levels of coal production, each scenario is compared against a baseline, or counterfactual.

[4] Bureau of Resources and Energy Economics *Resources and Energy Quarterly* September 2013 report indicates that 2011 was a peak year for Semi-soft and High-quality coking coal prices (as measured in US$/t over the historical period to 1998 (see Figure 4 on page 54). Over the same period Thermal coal peaked in 2008 and 2011 and declined over the period to 2013.

The baseline case sets out a story of how the economy would have evolved over time in the absence of the Project. Other planned and approved developments in proximity to the modelling area (and indeed across Australia) that are unrelated to the Project have been considered to form part of the baseline. In this respect, each scenario represents the incremental gains to the economy above and beyond what would have occurred without further capital and infrastructure investments from the continuation of operations in the Mount Owen Mine.

6.3 Phases of continuation

Driving the economic impacts of continuation of operation of the Mount Owen coal mine are two distinct phases of the development: the construction and operational periods. These phases underpin the pattern of economic activity and the types of demands placed on neighbouring regions as follows.

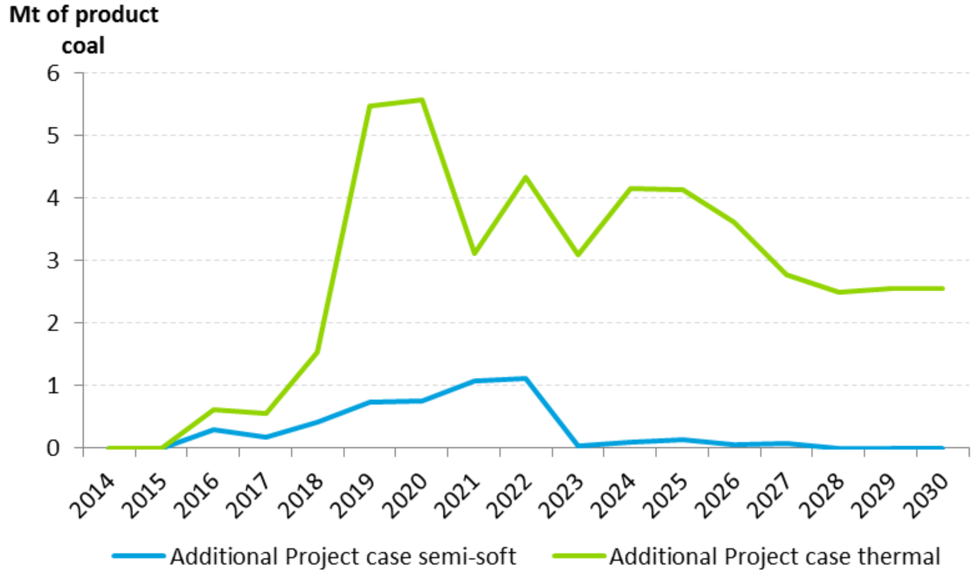
- **Construction phase** —involves the initial period where capital works are undertaken to allow the continuation of existing operations at the Mount Owen mine. This includes the creation and continuation of production capacity supported by additional infrastructure (e.g. coal processing plant, roads and services, dams and water management, power infrastructure). Total Project capital of $152.9 (undiscounted) million.
- **Operation phase** —involves the operational costs incurred over the life of resource production from the continuation of the Project. In this phase, additional capacity is brought online and coal production commences at scale (e.g. processing operation, maintenance costs, water management systems, mobile fleet purchases etc).

Operational phase

The continuation of operations at Mount Owen through the Project, over 2016-2030, is estimated to produce a total ROM of 91.7 million tonnes with a total of 51.6 Mt of saleable coal.

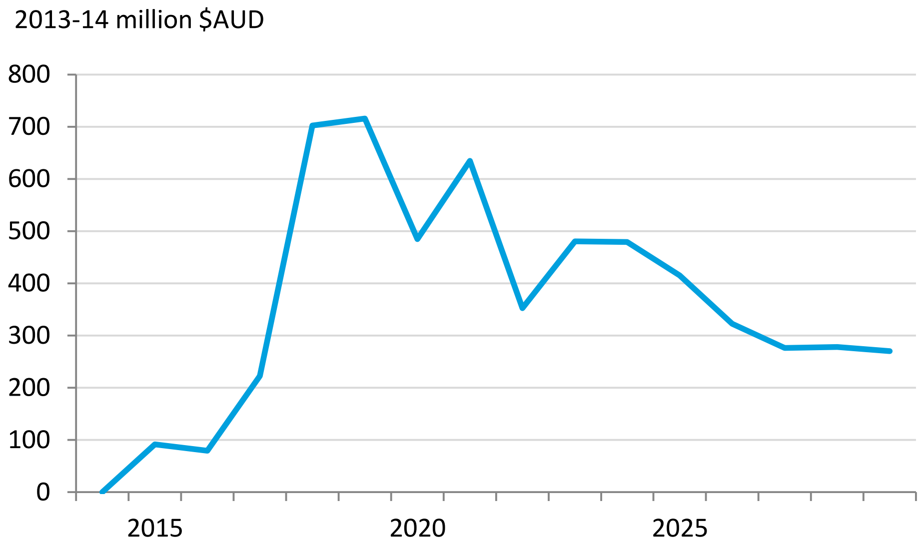
Relative to the baseline operations, the Project is projected to significantly increase output of semi-soft coking coal over the period 2016-2022 when compared to the baseline case, with production of semi-soft ceasing in 2027, see Chart 6.2. Thermal coal production is also higher in all periods, peaking at 5.6 Mt of product coal in 2020.

Chart 6.2: Forecast additional Project production per annum



Final sale prices have been adjusted to account for the variations in calorific value across coal products to calculate final revenue estimates provided in Chart 6.3. Sales are projected to peak in 2020 at just over $715 million.

Chart 6.3: Additional Mount Owen coal mine revenue, 2014–2030



Source: Deloitte Access Economics

6.4 Economic impacts – Central case

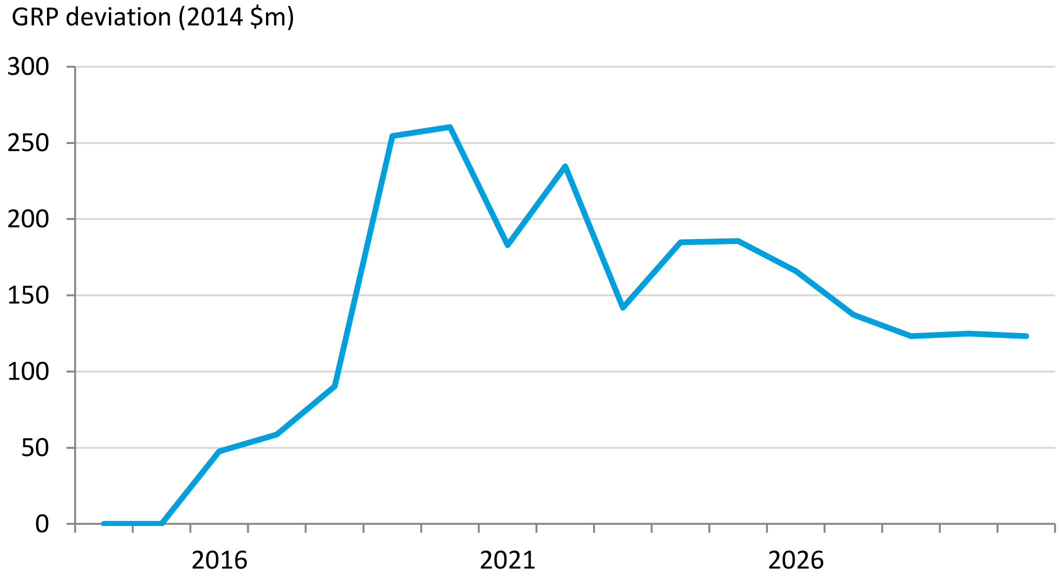
The following discussion provides the economic impacts of the Project over the modelling period 2016 to 2030. As outlined above, the period 2016 – 2017 is the capital expenditure phase that includes some change in operational profile with the full continuation of operations starting in 2018 and extending through to 2030. This section outlines the projected impacts to the regional Hunter economy and the NSW state-wide impacts.

Economic impacts – GRP

The Project is projected to have a significant positive economic impact on the Hunter Valley area.

Chart 6.4 depicts the additional economic output generated in the Hunter region in real 2014 terms as a result of the Project. During the capital expenditure phase, Hunter-region GRP is projected to increase by $48 and $59 million. The timing of this expenditure is assumed to take place in 2016 and 2017 respectively, noting that construction is proposed to commence within one year of the commencement of mining beyond the currently approved activity. From 2018, when production ramps, the Hunter-region GRP is projected to increase significantly over the baseline, with the economic impact of the Project peaking at $260 million in 2020.

Chart 6.4: GRP impacts in the Hunter region, Scenario 1



Note: All values are in real 2014 terms
Source: Deloitte Access Economics

In NPV terms, over the modelling period total Hunter-region GRP is projected to increase by just below $1.3 billion from coal sales of over $3 billion, see Table 6.1. Economic benefits of the development also accrue to the rest of NSW by $613 million for a total state-wide impact of just over $1.9 billion.

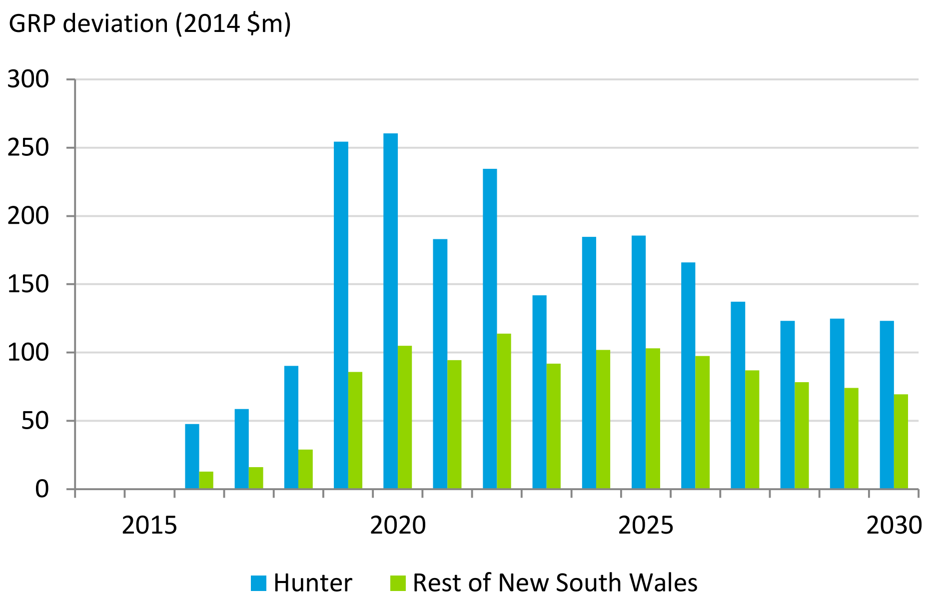
Table 6.1: Regional economic impacts, 2016 – 2030, (NPV)

	NPV	2016	2020	2024	2028	2030
Coal sales	3,244	91	716	480	276	270
GRP/ GSP/ GDP						
Hunter-region	1,288	48	260	185	123	123
Rest of NSW	613	13	105	102	78	69
Total NSW	1,902	60	366	287	202	192
Deviation from the reference case (%)						
Hunter-region		0.12	0.61	0.39	0.24	0.23
Rest of NSW		0.003	0.02	0.02	0.01	0.01

Note: All values are in real 2014 terms. The NPV discount rate is 7 per cent.
Source: Deloitte Access Economics

The relatively large increase in the rest of NSW may be an indication of a relatively high proportion of intermediate inputs being used at the mine being supplied from other regions in NSW including Sydney. In addition it is likely that much of the supplier inputs of the induced household consumption are also supplied from the large economic base of Sydney located close to the modelling region, the results are outlined in Chart 6.5.

Chart 6.5: GRP impacts by region, Scenario 1



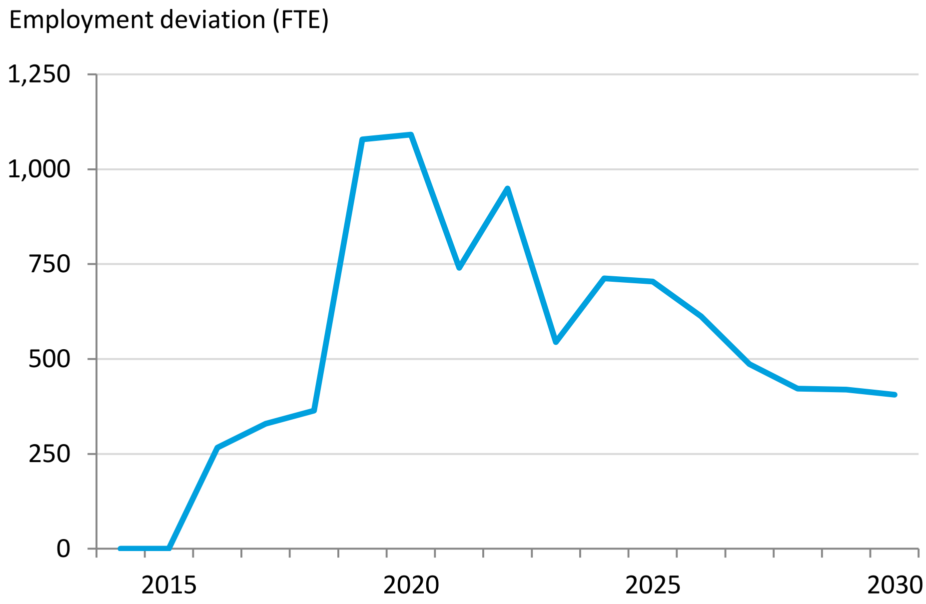
Note: All values are in real 2014 terms
Source: Deloitte Access Economics

Employment

Chart 6.6 depicts the additional total regional employment generated by the Project in the Hunter-region. The employment includes those employed directly at the mine-site, contractors and Project suppliers and any crowding out in other sectors of the economy.

Total projected regional employment peaks early in the continuation phase (2020) at around 1,091 FTE workers. Over the remainder of the period to 2030 employment is projected to remain positive for the Hunter. The employment impacts, when compared to the GSP and mining activity, do trend lower over the period reflecting baseline employment productivity.

Chart 6.6: Employment impacts in the Hunter region, Scenario 1



Source: Deloitte Access Economics

The economy-wide employment in NSW is projected to peak in 2020, at about 1,218 FTE workers. By 2024 state-wide FTE employment in NSW is projected to increase by almost 784 over the baseline case, see Table 6.2.

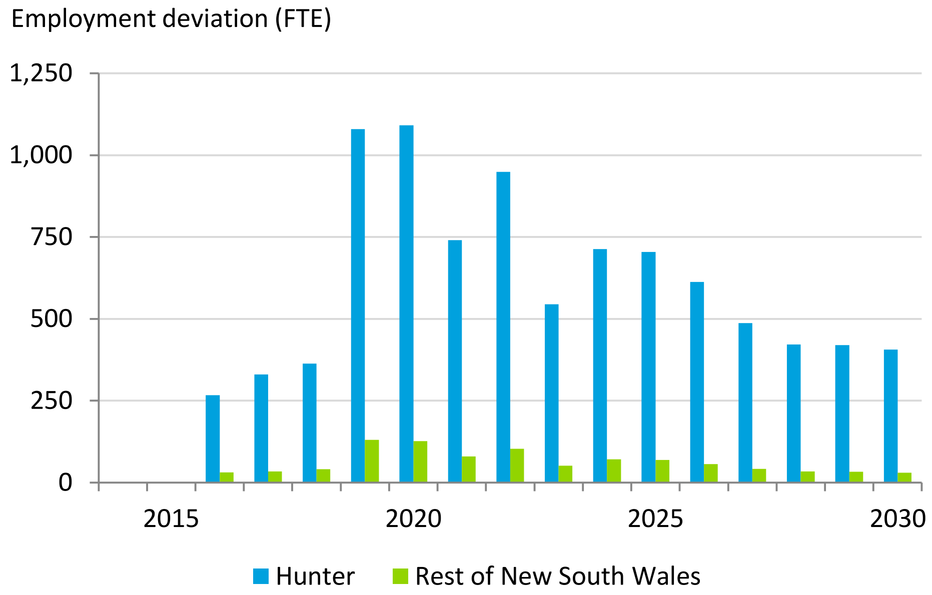
Table 6.2: Regional employment impacts, 2016 – 2030

	2016	2020	2024	2028	2030
Employment (FTE)					
Hunter-region	266	1,091	713	422	406
Rest of NSW	31	127	71	33	30
Total NSW	297	1,218	784	455	435
Deviations from the baseline					
Hunter-region	0.08	0.31	0.19	0.11	0.10
Rest of NSW	0.001	0.004	0.002	0.001	0.001

Source: Deloitte Access Economics

By the end of the modelling period state-wide total employment is projected to reduce to just over 435 FTE workers as Project production activity falls away, as outlined in Chart 6.7.

Chart 6.7: Total Regional Employment impacts by region, Scenario 1



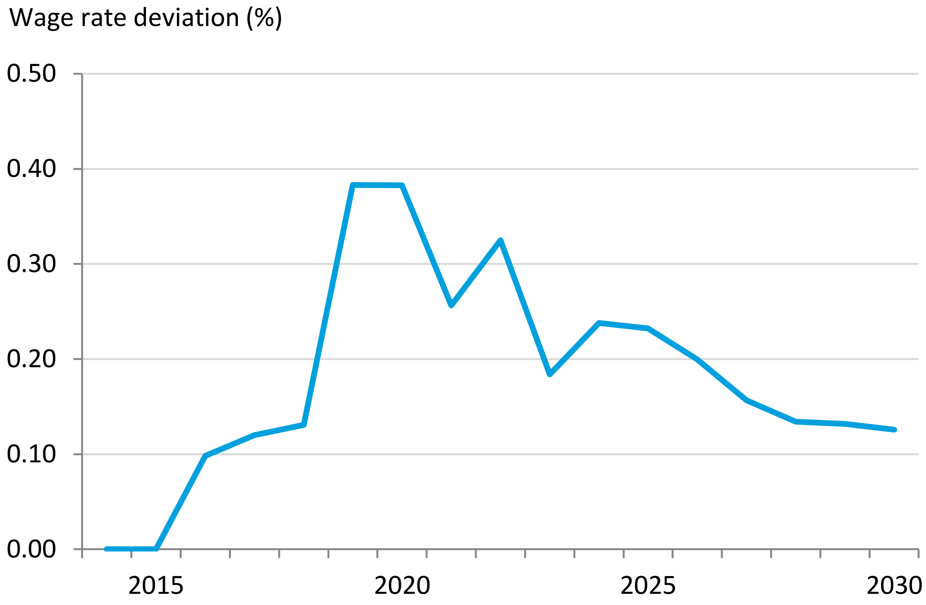
Source: Deloitte Access Economics

Alongside the growth in employment generated by the continuation, is an increase in real wages, which peak at around 0. 38% in 2020 (see Chart 6.8).

These projected impacts of the Project are measured against a baseline case scenario where the development does not proceed. The modelling incorporates both the increase to the capital stock and the continuation of coal output. Against the baseline case, the continuation maintains higher levels of coal output and mine operations, which provides direct employment and related supplier inputs.

Partially offsetting the direct activity and increased demand in supply chains is the increase in competition of scarce resources, for example labour. This is reflected in the increased wage rate in the Hunter (as outlined in Chart 6.8). This competition for resources also crowds out economic activity in other sectors of the region and the State.

Chart 6.8: Hunter-region wages impact



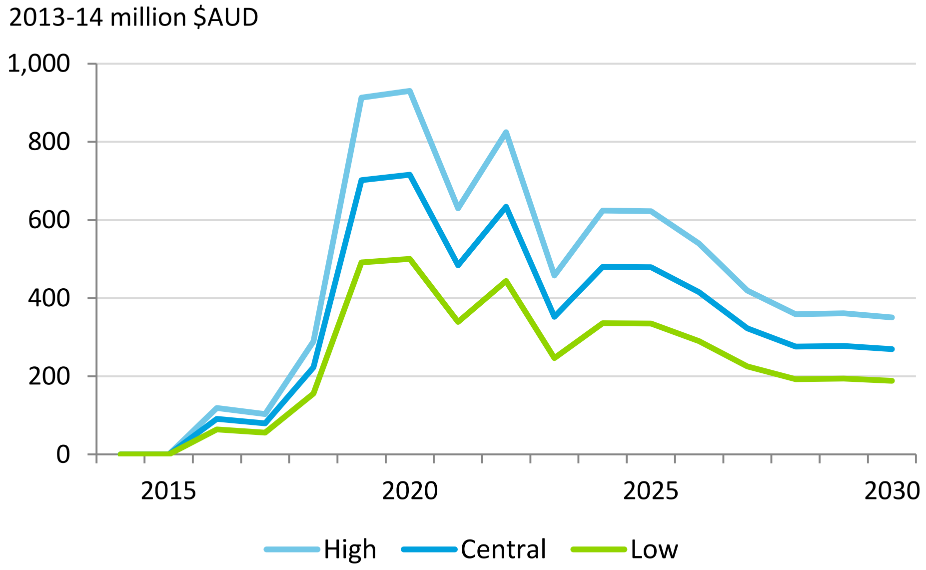
Source: Deloitte Access Economics

6.5 Sensitivities

The following section outlines the economic impacts under three modelling scenarios. As outlined above, the scenarios are based on a 30% increase and decrease of the coal price over the modelling period 2016 to 2030.

Final sale prices are adjusted to account for the variations in calorific value across coal products to calculate final revenue estimates provided in Chart 6.9. The chart outlines the revenue under the three modelling scenarios.

Chart 6.9: Additional Mount Owen coal mine revenue under different coal prices



Source: Consensus and Deloitte Access Economics

Table 6.3 outlines the GRP impact of the three modelling scenarios. As expected the projected GRP impacts are proportionate to the coal price inputs.

In the Hunter region, GRP estimates decrease from about $1,288 million in the central case to about $935 million in the low and increase to almost $1,647 million in the higher price scenario.

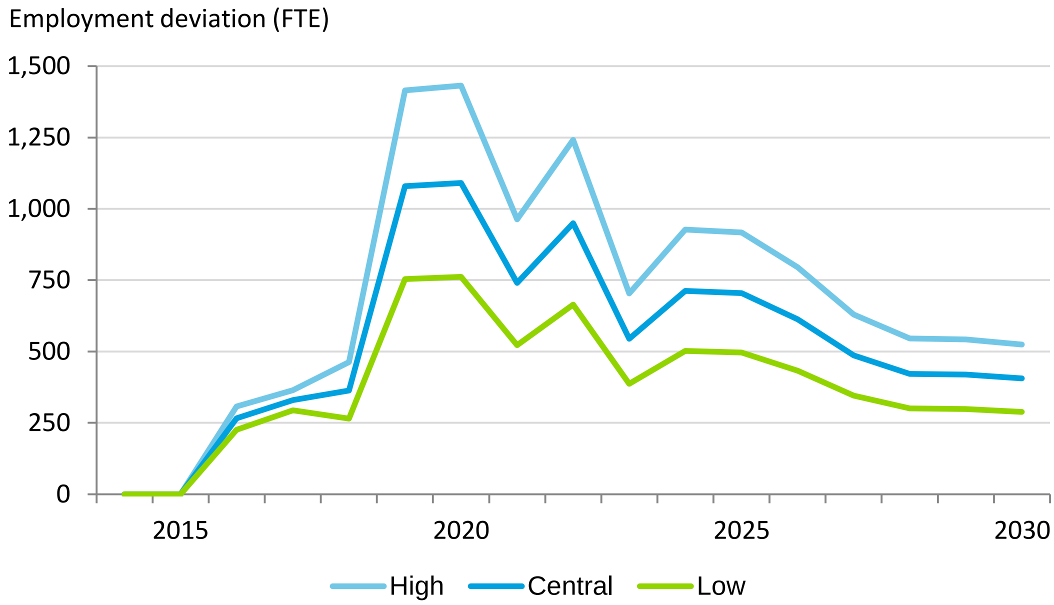
Table 6.3: GRP impacts, NPV, 2014 - 2030 (AUD $2014)

NPV	Central	Low	High
Hunter	1,288	935	1,647
Rest of New South Wales	613	427	804
Total NSW	1,902	1,362	2,451

Note: All values are in real 2014 terms. The NPV discount rate is 7 per cent.
Source: Deloitte Access Economics

Chart 6.10 outlines the total regional employment impacts of the proposed mine continuation under the three modelling scenarios in the Hunter Region. As with the central case outlined above, the total regional employment impacts are relatively small over the construction phase of the modelling and peak in 2020.

Chart 6.10: Employment impacts, Hunter region, 2014 – 2030



Source: Deloitte Access Economics

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Appendix A: Checklist against guidelines

NSW Treasury (2007) NSW Government Guidelines for Economic Appraisal

Table A.1: Key issues mentioned in NSW Treasury (2007)

Draft Guidelines	Addressed	Reference
Identify Options		
"Do nothing" option	Yes	4.1
Option development	Yes	4.2
Identify Benefits		
Avoided Costs	Yes	5.1
Savings	Yes	5.1
Revenues	Yes	5.1
Benefits to consumers not reflected in revenue flows	Yes	5.1
Benefits to the broader community	Yes	5.1
Identify Costs		
Identify all relevant cost items	Yes	5.1
Stream of costs should cover full project period	Yes	5.1
Identify Qualitative Factors		
Identify costs and benefits that cannot be quantified	Yes	5.1
Other impacts include environmental considerations, industrial relations, social or regional impact, safety, public relations, resource availability	Yes	5.1
Assess Net Benefits		
Assessment of benefits in real terms	Yes	5
Discount at 7% rate, with 4% and 10% for sensitivity testing	Yes	5.3
Net Present Value	Yes	5.3
Net Present Value per $ of capital outlay	NA	
Benefit-Cost Ratio (BCR)	Yes	5.3
Internal Rate of Return (IRR)	NA	
Sensitivity Testing		
Projected outcomes under alternative scenarios	Yes	5.4
Emphasis given on pessimistic alternatives	Yes	5.4
Ecologically Sustainable Development		
Inter-generational equity principle	Yes	5.4
Identification of Environmental Impacts	Yes	5.1
Valuation of Environmental impacts	Yes	5.2
Sensitivity and Threshold Analyses	Yes	5.4
Use of ENVALUE	Yes	Appendix C

Note: NAs in this table reflect summary measures that were not assessed as being necessary to reach conclusions.

NSW Department of Urban Affairs and Planning (2002) Guideline for economic effects and evaluation in EIA

Table A.2: Key issues mentioned in NSW Department of Urban Affairs and Planning (2002)

Draft Guidelines	Addressed	Reference
Conduct Preliminary Assessment		
Review main elements of proposed projects, alternatives and surrounding environment	Yes	4
Review information on environmental impacts of proposal	Yes	5
Determine spatial and temporal boundaries for analysis	Yes	4
Specify relevant community and major groups affected	Yes	5
Specify the kinds of economic values affected	Yes	5.1
Obtain preliminary estimates of likely magnitude of benefits and costs	NA	
Assessment of scale of economic effects relative to regional or local economy	Yes	6
Determine whether an economic impact assessment is required	Yes	6
Scoping the economic study		
Consider environmental impacts and economic values predicted in preliminary analysis	Yes	5
Consider time, skills and budget for analysis	NA	
Determine values to be quantified in benefit-cost analysis, sources of information and methodology	Yes	5
Determine extent and approach to community consultation	NA	
Identify level and extent of other economic assessments	NA	
Derive economic values and conduct efficiency analysis		
Specification of baseline scenario	Yes	4
Valuation of direct benefits and costs of proposal and alternatives	Yes	5
Valuation of environmental effects	Yes	5
Set up benefit-cost assessment framework	Yes	5
Summarise all economic values	Yes	5
Calculate NPV and other criteria specified by State Treasury	Yes	5.3
Conduct incidence analysis identifying distribution of costs and benefits	Yes	5.5
If required, conduct economic impact analysis to assess economy wide-effect		
Specify economic boundaries for assessment	Yes	6
Specify linkages between project and economy	Yes	6
Apply relevant economic impact assessment model	Yes	6
Estimate results, including changes in output, employment and income for sectors of the economy	Yes	6
Incorporate any results into BCA	NA	
Apply ESD principles		
Ensure predicted changes in natural resources and environment have been comprehensively valued	Yes	5
Assess risk, uncertainty and irreversible environmental impacts	Yes	5
Address intra- and inter- generational equity issues	Yes	5.4, 5.5
Conduct integrated assessment of options		
Summarise results on economic efficiency	Yes	5.3
Summarise results on intra- and inter-generational equity	Yes	5.4, 5.5
Document and report main findings	Yes	Report as a whole

Note: NAs in this table reflect tasks completed elsewhere in the EIS

NSW Government (2012), "Guideline for the use of Cost Benefit Analysis in mining and coal seam gas proposals"

Table A.3: Key issues mentioned in the Guideline

Draft Guidelines	Addressed	Reference
Key features		
Scope: all first round impacts	Yes	5.1
Net public benefit or cost	Yes	5.3
Discount rate of 7% with sensitivity analysis	Yes	5.4
Appropriate timeframe	Yes	5
Risk Neutral approach	Yes	5
Discussion of unquantified factors	Yes	5
Stages of analysis		
Identify the Base Case	Yes	4.1
Define Project and Develop Options	Yes	4.2
Estimate the Impacts of the Project	Yes	5
Estimate the monetary value of these impacts	Yes	5
Estimate the Overall Net Value of the project	Yes	5.3
Test for Uncertainty and Risk	Yes	5.4
Prepare Report Including CBA Results and Qualitative Impacts	Yes	Whole of report
Distribution effects	Yes	5.5
CBA at the regional or catchment level	Yes	5.5
Costs and benefits		
Revenues from mining or CSG per annum	Yes	5.2.1
Any other revenues from the land use during or after mining	Yes	5.2.2, 5.2.9
Capital expenses	Yes	5.2.4
Exploration expenses	Yes	5.2.3
Infrastructure contributions	Yes	5.2.10, 5.2.20
Operating expenses per annum	Yes	5.2.5
Remedial costs post mining	Yes	5.2.6, 5.2.7
Value of rural output forgone	Yes	5.2.11
Value of residential amenity forgone	Yes	5.2.19, 5.2.23, 5.2.24, Appendix D
Cost of changes in infrastructure	Yes	5.2.10
Air quality	Yes	5.2.16, 5.2.17
Health	Yes	5.2.27
Groundwater	Yes	5.2.12
Noise	Yes	5.2.18
Biodiversity	Yes	5.2.21
Heritage	Yes	5.2.25, 5.2.26
Other economic impacts		
Increased wages for workers	Yes	6
Increased profits for suppliers to the mining sector	Yes	6
Changes in incomes in tourism or other local businesses	Yes	6

Director General's requirements

Table A.4: Key issues mentioned in the DGRs

DGR Key Issues	Addressed	Reference
Social and economic	Yes	Whole of report

Source: NSW Government (2013), *State Significant Development – Director General's Requirements Mount Owen Continued Operations Project (SSD – 5850)*

Appendix B: Valuation techniques

This appendix provides a general overview of the range of possible approaches to valuing items in a cost benefit analysis. This appendix is intended to provide background on approaches and techniques that could be used in the CBA itself. The approaches outlined below encompass a range of techniques including the use of:

- project financials;
- market prices;
- foregone revenue;
- hedonic pricing;
- stated preference;
- travel time costs;
- defensive expenditure; and
- value of statistical life.

These techniques cover direct approaches where either financial or market information is available as well as indirect approaches where values have to be discerned from behaviour. The application of these techniques to particular costs and benefits is discussed in Appendix C.

Project financials

Project financials or other information provided by the project proponent can be used to value many of the expected inputs and outputs associated with the proposal. Minimal analysis is required to derive this data, as the values are usually stated explicitly and provided by the project proponent. This approach is particularly useful when attempting to estimate values like the expected size of the work force, scale of operations or output produced.

However it is important to note and critique the validity of assumptions used to generate the projected values provided as the proponent has an interest in the implications of the data.

It should be noted that project financial data is sometimes chosen to serve as a "best estimate", and is therefore prospective in nature. Thus, in undertaking any critique of the information, it may be more valid to compare projected financials to other prospective data sources such as futures prices, rather than historical data.

Observable market prices

Market prices – the price of goods actually traded on the market – represent the revealed value of an object as determined by those who buy and sell it. For commoditised items (e.g. a tonne of coal), this price can be readily observed in the spot market. An idea of future price movements can also be gained through futures markets. For goods that are less commoditised (e.g. housing or land), market prices are derived by looking for comparable goods traded on the market and estimating a market price for a good.

Market prices are thus best used for commodities that are regularly traded, or have comparable goods that are regularly traded.

Market prices are seen as the most reliable way to estimate the value of an item as, in the presence of a relatively efficient market, prices are empirically based, do not require the use of any theoretical assumptions, are normally free from extreme influence by any one individual or organisation and involve actual cash transactions rather than statements of preference or policy.

An important property of market prices is that they are affected by future expectations. This means that prices can be affected by announcements or the perceived likelihood of future events happening. When calculating the impact of a project on market prices, it may be important to correct for the fact that prices may have already reacted to announcements regarding the project, and thus partially account for the expected future impact. A further implication of the forward looking nature of prices is that, if a project is likely to dramatically affect the cost of a good (e.g. wages in a local economy), it may not be appropriate to use pre-project prices to estimate the cost of such a good.

A constraint of market prices is that they necessarily reflect *effective* demand, that is to say, a person must be both willing and *able* to purchase a product for the market to reflect their valuation. Thus, if people's purchasing decisions are constrained then their valuation may not be reflected in market prices. For example, if people in an area experiencing pollution are unable to access credit to move away, the cost of pollution to such people may not be reflected in the market price of housing.

Having noted these considerations and limitations, it is still the case that a valuation on market prices is the most preferable way to value items within a CBA.

Forgone revenue or increased costs

Foregone revenue or increased cost are attempts to make a comparison between a proposal and a counterfactual, by observing the revenue that would have been earned by a particular entity (or entities) as a result of the proposal, or the increased costs faced as a result of the proposal. Both techniques require modelling scenarios with and without the proposal. Furthermore, they require explicit mention of the means by which the proposal could affect the party involved. As examples, a project could distort prices of inputs (price effects), create secondary consequences (externalities) or even compete directly with local entities (direct competition).

It should be noted that measures such as foregone revenue and increased costs are not, necessarily, themselves measures of overall costs. Foregone revenue and increased costs can sometimes represent transfers of wealth between different segments in a community (such as a transfer from employees to employees) and may thus overstate the impact of a project on the overall community. In this case, an advantage consideration of foregone revenue or increased costs allows for an assessment of the distributional impact of a project.

Hedonic pricing

Hedonic pricing is a method of using observable market prices to value intangible goods or particular properties of goods. To do this, hedonic pricing tries to compare the price of goods that are similar in every respect except for the property being compared. An example would be an attempt to value the cost of discomfort from noise pollution, by comparing the market price of houses which are substantially similar except for the presence of noise pollution.

Hedonic pricing relies on observable market prices, and is thus considered revealed preference data (as opposed to stated preference data). It is therefore a more empirical approach as it relies on data from market transactions rather than just statements about preferences.

A critical drawback of hedonic pricing is that any attempt to value properties or goods in this way is dependent on the theoretical model used to determine the value of an object. As it is often difficult to find two items that are identical in all respects except for a given property, comparisons are made using a theoretical model that attempts to describe the way in which different properties are combined to produce a particular value. The most common method of doing so would involve assuming that the costs of different properties are independent and additive. For example, when valuing a house, one might assume that the decline in value from noise pollution and the decline in value from air pollution are independent of the other properties of the house and that the decline in value from having both noise pollution and air pollution together is the sum of the decline in value of noise pollution and air pollution.

Stated preference, willingness to pay, choice modelling and similar

As opposed to revealed preference approaches which are based on prices, such as hedonic pricing, this methodology determines the maximum value assigned by an individual, that is, their willingness to pay, using a structured survey. Stated preference approaches are particularly useful for the valuation of externalities – costs or benefits which are not incorporated in market transactions, such as the environmental, cultural and social impacts of economic activity.

Stated preference valuations are undertaken using one of two techniques – contingent valuation, or choice modelling (Fujiwara & Campbell, 2011). The main difference between the two is that contingent valuation surveys generally relate to the overall valuation of a non-market good, while choice modelling surveys aim to ascertain valuations of certain characteristics of that good. When multiple attributes are considered in choice modelling, an overall valuation can also be obtained (Fujiwara & Campbell, 2011). Both contingent valuation and choice modelling surveys can take a number of different forms. These vary according to the manner in which respondents are asked to indicate their preferences.

In the case of choice modelling, each survey question asks respondents to rank, rate or choose between multiple hypothetical scenarios, including a status-quo option. These scenarios vary according to the state of different attributes, generally including non-market impacts, such as the extent of the effect on flora, fauna or water quality, and an associated level of cost to be borne by the individual which limit the effects to this level. Depending on the complexity of the scenario, a large number of questions may be required.

Statistical methods are then applied to quantify the trade-offs between each characteristic, establishing estimates of willingness to pay and implicit prices for marginal changes in each attribute. Specifically, discrete choice models such as multinomial, nested or mother logit models are utilised in this analysis process.

While stated preference methods can provide useful insights on the valuations of non-market impacts, they are associated with a number of important practical considerations. In particular:

- the process of developing an appropriate questionnaire involves substantial costs;
- the scenarios posed in question sets should be realistic and reflect local circumstances; and
- an adequate sample size of data must be collected to provide statistically significant results.

Even if these methodological challenges are overcome, the computation of model parameters and the resulting willingness to pay estimates is another complex process, which requires an understanding of underlying assumptions and the issues relating to aggregation of results for the entire population.

Further details regarding these matters are outlined in the summary guide prepared by the UK Department for Transport, Local Government and the Regions (DTLR) (2002) and the accompanying manual (Bateman et al, 2002).

Travel time costs

The travel time cost method is a surrogate market technique useful for valuing physical sites which are not subject to price mechanisms, such as recreational facilities (Parsons, 2003). The methodology is based on the assumption that the costs an individual incurs in travelling to a site provide an insight into the value they assign to that facility and the activities which they participate in at the location (Planning NSW, 2002). The aim is to use this information to derive a demand curve for the recreational benefits of a site.

Travel time cost valuation methods usually take the form of a single site or multiple site model (Parsons, 2003). Where there are minimal substitutes for a facility and the focus of valuation is to determine society's willingness to pay to access the site, a single site model will usually suffice. Multiple site models are particularly useful for capturing the effects of variation in site attributes on valuations, such as the effect of changes in environmental quality on willingness to pay. In this regard, multiple site models may be appropriate for valuing the environmental impact of mining activity. As the name suggests, multiple site models can also take substitution effects into account, providing simultaneous estimates of access values at a number of locations.

According to Parsons (2003), the process of estimating one of the most common multiple site models, the random utility maximisation (RUM) model, can be broken down into 11 steps. These are listed and briefly described in the table below.

Table B.1: Brief outline of modelling travel time costs with a random utility maximisation model

Step	Action	Brief description
1	Identify the impacts to be valued	• Identify the site characteristics of interest • Consider whether these can be measured objectively
2	Define the population of users to be analysed	• Identification of all current users and potential users of sites, with and without characteristic changes
3	Define the choice set	• Determining which sites an individual will be assumed to consider when making a visitation choice
4	Develop a sampling strategy	• Identifying the method for sampling and data collection
5	Specify the model	• Identifying variables for site characteristics and individual characteristics which influence their likelihood to make a trip
6	Gather site characteristic data	• Using data from primary/secondary sources • May involve results of an auxiliary regression, using observable features as inputs
7	Decide on the treatment of multiple purpose trips	• Choose to either identify and drop multiple purpose trips, or include dummy variables in site characteristics which account for other opportunities nearby
8	Design and implement the survey	• Obtain information from respondents on their frequency of trips over a defined time period, details of their last trip, and demographics
9	Measure trip cost	• Involves computation of distances travelled and travel time for every site in each individual's choice set
10	Estimate model	• Undertake a regression to estimate the parameters of the theoretical model
11	Calculate access and/or quality change values	• Ascertain access valuations, or valuations of changes in the attributes of site/s

Source: Parsons (2003)

It is evident that, like the stated preference approach, development of a travel time cost model involves many practical considerations and substantial costs. In particular, it can be difficult to obtain precise estimates of the value of travel time (Planning NSW, 2012) although estimates of travel time costs can be obtained from Austroads (2010).

Defensive expenditure

Another methodology useful for the valuation of externalities, such as environmental impacts, is the defensive expenditure approach (Planning NSW, 2012). This revealed preference technique utilises data on the expenditures that people make in order to protect themselves from some risk or impact (Whitehead et al, 2007). The extent of these defensive expenditures on market goods can be used as proxy values of associated non-market, environmental goods. For example, investments in double glazed windows can be used as an estimate of the value of reduced exposure to road traffic noise (Fujiwara & Campbell, 2011).

The defensive expenditure method provides a partial, or lower bound estimate of the valuation of environmental impacts (OECD, 2006). This is due to the fact that the expenditures may not be directly related to the impacts (Planning NSW, 2002).

Rather, the accurateness of the valuation produced by this method is dependent on an interaction between environmental quality and the effectiveness of the defensive expenditure (Sotelsek, 1998). It is therefore generally assumed that that the costs incurred in protection reflect a minimum valuation of the environmental benefits (Planning NSW, 2002). Meanwhile, recognition of broader benefits associated with defensive expenditure is critical to the accuracy of this methodology. Under these circumstances, it can be difficult to isolate a valuation that is specific to the environmental benefit of interest (Planning NSW, 2012).

Value of statistical life, DALY, wage differential and similar

The health impacts of economic activity can be valued according to human capital or willingness to pay approaches, although the latter is most common and is considered most appropriate (Jalaludin et al, 2009 & OBPR, 2008). There are also a number of health-specific valuation concepts useful for placing values on the cost of mortality and morbidity. These include the value of statistical life, and the disability-adjusted life year.

The value of statistical life (VSL) represents an “estimate of the financial value society places on reducing the average number of deaths by one” (OBPR, 2008). As noted by the World Bank (2003), the measure is not intended to reflect the fundamental value of human life. Although the VSL is a well established economic concept, there is a great deal of variability in estimates. According to the OBPR (2008), the most appropriate measurement technique for VSL is willingness to pay – that is “estimating how much society is willing to pay to reduce the risk of death”. Using this framework, it was estimated that the VSL in an Australian context is approximately $3.5 million (OBPR, 2008).

An alternative health metric is the disability-adjusted life year (DALY). This is a measure of the burden of disease, incorporating the effects of mortality and morbidity, with a single DALY representing “one lost year of healthy life” (WHO, 2013). The inclusion of the mortality component in the DALY calculation implies that if used in a CBA, it should substitute, rather than complement VSL measures to avoid double-counting (BTRE, 2005). However, it appears that a number of practical issues constrain this transition, including a lack of data on DALY monetary valuations (Jalaludin et al, 2009).

Hedonic pricing analysis of wage differentials is another technique which has been applied to obtain valuations of health impacts. These models analyse wage differentials with the aim of ascertaining a value for risk exposure. Specifically, wages are modelled as a function of individual characteristics and job characteristics, to derive an estimate of the compensation paid for risk of fatal and nonfatal injury (World Bank, 2003). However, the accuracy of this technique relies on a number of theoretical assumptions relating to employee mobility and access to information which may not hold in practice (Jalaludin et al, 2009).

The final method used for valuing health impacts is the human capital approach (Planning NSW, 2002). This technique estimates the economic output foregone as a result of reduced productivity caused by “absenteeism, temporary or permanent disability and premature mortality” (Jalaludin et al, 2009). While this methodology is often used to value the health impacts of environmental degradation, such as pollution, the estimates are not alternative measures of the VSL (Planning NSW, 2002). However, lost earnings due to premature mortality could be considered as a minimum estimate of VSL (World Bank, 2003).

Appendix C: Approaches to valuing specific costs and benefits

This appendix provides a general outline of the available approaches to valuing the various costs and benefits identified in the guidelines for CBA published by the NSW Government, and summarises the evidence produced by quantitative valuations. It is intended as a guide to the approach taken in the CBA and to provide views on alternative data sources.

Industry impacts

Gross mining revenue

Gross mining revenue would be provided by the project proponent or evident in the project financials. This mining revenue would be based on the value of output, a factor of both the volume of output and the relevant coal price. Relevant coal prices can be estimated using the spot price of coal or through the price of coal futures. The volume of output is usually estimated by the project proponent themselves. It is important to note that the volume of output is selected to match the marginal cost of production with the current market price of coal.

Coal prices

Coal prices are observable market prices –Australian thermal coal was valued at $78.42 per metric ton in July 2014, measured in Australian dollars (Index Mundi 2014). The current price of coal is observable on the spot market. The future price of coal is observable in the futures market, although that may not be necessary as efficient commodities markets should result in current prices of coal taking into account future expectations.

Mine related costs

Mining exploration costs are also data which the project proponent would have on hand. Expenditure on mining capital investment and operating costs would be detailed on project financials. Rehabilitation expenses, such as landform reconstruction, revegetation would also be accounted for as project costs on financial statements.

Forgone agricultural revenue

Foregone agricultural revenue can be estimated based on financial information on agricultural land use prior to mine development. Open cut coal mining competes directly with agricultural land use as it removes land with agricultural potential to reach coal underneath. Furthermore, both open cut coal mining and underground coal mining can impact on the local water system and thus affect agriculture across a given water system.

The effect of a mining activity on agriculture can be assessed by first considering the productivity of the agricultural land in regions of interest. The first stage in this analysis was to find the agricultural productivity of the regions of interest. The results of this analysis are set out in the table below.

Table C.1: Average agricultural productivity by SLA

Area	Productivity of vegetables, fruit, nuts, grapes, berries ($2013/ha)	Productivity of dairy livestock ($2013/ha)
Cessnock	4,556.86	1,121.80
Muswellbrook	7,977.41	1,462.07
Singleton	57,561.72	1,429.15
Upper Hunter Shire	12,863.93	1,474.90

Source: ABS Catalogue 7125.0, DAE calculations

This land productivity data can then be combined with information on the area of land that is likely to be affected by mining activity to provide a decrease in agricultural activity that can be attributed to increased mining activity.

We believe that this process of estimating the effect on agricultural production from coal mining is likely to be generous. Previous analysis undertaken by DAE suggests that mining operations often take place in areas of grazing, cropping and forestry which will have significantly lower productivity than average.

Where land is used for grazing activity, revenue foregone can also be valued using the estimates of gross margins for NSW beef enterprises, published by the NSW Department of Primary Industries (2012). As shown in Table C.2, the Department reports gross margins per hectare for a range of beef enterprises, including of pasture costs.

Table C.2: Summary of gross margins for NSW beef enterprises, December 2012

Enterprise	Gross margin per hectare ($2012)
Inland weaners	75.54
North Coastal Weaners 1	46.95
North Coastal Weaners 2	126.57
Specialist local trade	131.38
Local trade / feeders (creep fed)	147.84
Yearling production (southern/central NSW)	164.62
Young cattle 15-20 months	112.61
Young cattle heavy feeder steers	100.75
Growing out early weaned calves 160-340kg in 12 months	207.11
Growing out steers 240-420kg in 12 months	196.69
Growing out steers 240-460kg in 12 months	229.19
EU cattle	174.22
Japanese ox (grassfed)	109.72

Source: NSW Department of Primary Industries (2012)

As there is no empirical evidence on the relationship between agricultural productivity and the noise or dust impacts of mining activity, it is difficult to quantify the extent of these negative externalities. In addition, impacts are generally:

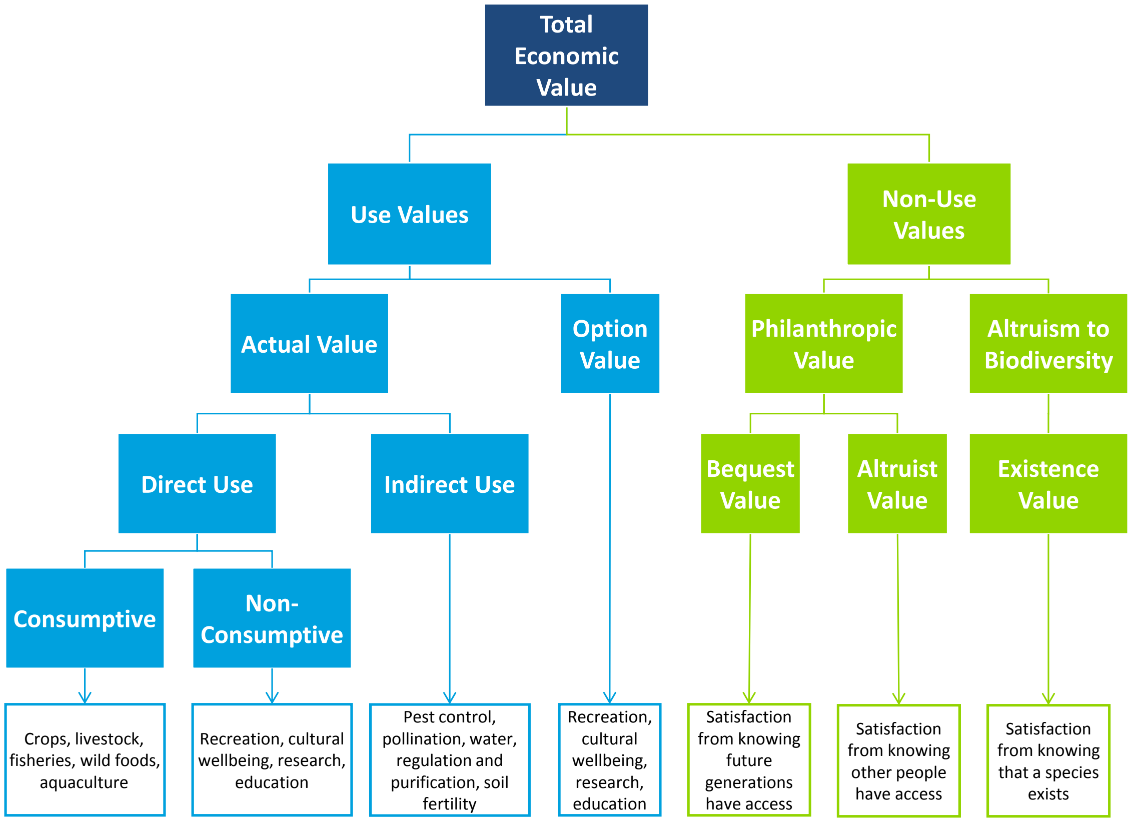
- highly dependent on the local geology;
- often manifests as a risk, rather than an event; and
- not clearly established in scientific literature.

Therefore, any estimates of declines in agricultural productivity should be seen as indicative, included to ensure that the issue is taken into account, without being interpreted as a precise quantification of the effects of mining on agriculture.

Externalities

A convenient method of accounting for the Total Economic Value of a natural environment is to disaggregate values into use values and non-use values. Chart C.1 represents in a diagram the breakdown of values used in this cost-benefit analysis.

Chart C.1: Breakdown of Total Economic Value



Source: Adapted from Kumar (2010)

Use values are values a person places on the benefits to themselves that are derived from the current or potential future use of a natural environment.

Direct value refers to benefits derived directly from the natural environment. For example, a use value of a river would include the value of irrigation water provided by the river.

Indirect use values refer to values that accrue as a side effect of the natural environment continuing to exist, such as the preservation of soil fertility on agricultural land that is next to a natural environment.

Option value refers to possible future use values that have yet to materialise. An example of this would be the possible future value that derives from research on the natural environment.

Non-use values are values a person places on a natural environment, other than those that benefit themselves.

Altruist value is the value that people place on knowing that other people who currently exist are able to access a natural environment. Bequest value is similar except that it relates to future generations being able to access a natural environment. Lastly, existence value is the value that people place on merely knowing that a natural environment is preserved, wholly apart from the fact that anyone derives other benefits from it.

When measuring externalities, it is often not possible to measure each component of the Total Economic Value separately. It is thus important to note which values are being measured and to note that different valuation methodologies may measure overlapping components of the total economic value.

Changes in related public expenditure

Changes in related public expenditure would be information specific to each project and would be provided by the project proponent. For example, public expenditure on water or sewerage may change, where a region is transformed from residential to mining. Further, public investment in transport or road infrastructure may change, with the possibility of increased spending on roads to facilitate movement of coal to ports in key mining areas.

This may also manifest as a potential benefit, as some mining projects may include upgrades or construction of new infrastructure. This infrastructure may be usable by the general public either during or after the operation of the mine.

Other externalities – use values

Water quality

The impact of mining on water quality varies according to the form of mining activity (open cut or underground), the proximity of the mine to water sources and the geological composition of aquifer systems. These factors influence the way in which fracturing of hard rock, mine runoff and dust pollution can lead to a reduction in the overall quality of ground and surface water.

This section reviews the literature on the use values of water quality, given its importance for households and industry. The valuation of groundwater and surface water are considered separately.

Quality of groundwater

Groundwater refers to water that has accumulated within soil or cracks or pores in rocks, known as aquifers (Geoscience Australia, 2013a).

Mining activity has been associated with the in-flow of saline groundwater, degradation of alluvial aquifers and an overall reduction in the quantity of groundwater supplies (Department of Planning, 2005; R.W. Corkery & Co, 2009; Smith, 2009). It is important to assess the implications of these effects for other groundwater users.

Groundwater is a critical source of drinking water in various locations across Australia, particularly in Western Australia (Geoscience Australia, 2013). The primary methods utilised to assess the value of drinking water quality are the contingent valuation and defensive expenditure approaches. As described by Koteen, Alexander and Loomis (2002:9), it is difficult to estimate household demand for water quality, 'as households cannot directly purchase water of varying quality'. Nevertheless, it is important to consider the benefits that individuals gain from the awareness that the water they receive is of high quality.

Table C.3 summarises the literature on the values that households assign to the quality of drinking water. It is noted that very little research has been undertaken in Australia, with the available evidence fairly dated. The appropriateness of these findings is contingent on relevance of the measures listed, which in turn depends on the nature of any anticipated change in water quality caused by mining activity.

There is also little evidence in an Australian context of the value of groundwater for agriculture, irrigation and other industrial uses, at different quality levels. Instead, the literature has focused on valuation of the costs that would be incurred by these commercial users of groundwater, in the instance that the groundwater supply was completely depleted (Marsden Jacob Associates, 2012). This is known as the deprival value approach, with values representing the cost of a worst case scenario where total degradation of water quality takes place.

Nevertheless, it may be possible to estimate the value of water in its existing state by observing prices in the water markets. In addition, it is important to note that the impact of a reduction in water quality on the agricultural industry is likely to be captured by estimates of foregone agricultural revenue.

In locations where groundwater sites also provide recreational opportunities, it is also necessary to value the impact of changes in water quality on the value of recreational trips. However, no studies have been undertaken in Australia which estimate these costs directly. Instead, the literature is concentrated around the recreational value of surface water.

However, a crude benefit transfer has been used to estimate the impact of reducing extractions of groundwater from the Great Artesian Basin (Rolfe, 2010). This study used an average of the estimated value of tourist trips to the Flinders Ranges, the Fairbairn Dam in QLD, and two locations along the Murray River as an estimate of recreation benefits of the basin (2010). This benefit transfer also relied on additional assumptions regarding visitor numbers, average trip length and, most importantly the impact of reduced water extraction on daily recreational benefits.

Due to the uncertainty behind the accuracy of this final assumption, the relevance of this estimate to the current context is uncertain. A contingent valuation study would be required to identify the benefits of groundwater in different quality states for recreational purposes.

In some parts of Australia groundwater is also used for other residential purposes, such as watering gardens, as well as other public purposes such as the maintenance of parks. Given that these purposes might also be captured in the value of open space or visual amenity, they are not considered in this section.

Table C.3: Drinking water quality values

Study & Context	Methodology	Measure	Value	Units
Edwards (1988) US - 1986	Contingent valuation	WTP to prevent uncertain nitrate contamination	$1,128 per household per annum	$ US (1986 dollars)
Abdalla, Roach & Ep (1992) US - 1988	Defensive expenditure	Preventive expenditure to protect against the effects of trichloroethylene contamination	$0.40 per household per week	$US (1988 dollars)
Schultz & Lindsay (1990) US - 1988	Contingent valuation	WTP to protect against nitrate contamination	Mean - $129 per household per annum Median - $40 per household per annum	$US (1988 dollars)
Jordan & Elnagheeb (1993) US - 1991	Contingent valuation	WTP for improved public water quality	Mean - $10.07 per household per month Median - $5.49 per household per month	$US (1990 dollars)
Carlos (1991) Australia - 1991	Contingent valuation	WTP for control and prevention of salinity and turbidity in the Yass district household water supply	Mean - $42.21 per person per annum Median - $40 per person per annum	$A (1991 dollars)
Dwyer (1991) Australia - 1991	Contingent valuation	WTP to indefinitely preserve water quality in Sydney	$54 - $67 per household	$A (1991 dollars)

Source: Envalue (2004)

Quality of surface water

Rivers, lakes, wetlands and other forms of surface water can also be affected by mining activity. The quality of water can be reduced as a result of runoff or dust pollution. It may also be affected as an indirect result of mining impacts on groundwater, although the interaction between groundwater and surface water varies according to topography, geology and climate (Geoscience Australia, 2013b).

The majority of Australia's water supply is derived from surface water. Therefore, changes to the quality of surface water will impact households and industry. Valuation of the impact of changes to surface water quality is subject to the same issues discussed above. However, there is substantially more evidence on the value of water quality specific to recreation at surface water sites. Within the Australian literature, stated preference approaches such as contingent valuation and choice modelling are the predominant methodologies employed. Table C.4 summarises the estimates obtained in some relatively recent Australian studies.

Table C.4: Recreational water quality values ($A)

Study	Methodology	Measure	Value
van Bueren & Bennett (2000)	Choice modelling	Average $ per household per annum for every 10km of waterway restored for fishing or swimming	National context: $0.08 Great Southern Region: $1.56 – Albany $0.91 – Perth Fitzroy Basin Region: $2.02 – Rockhampton $0.79 – Brisbane
Robinson et al (2002)*	Benefit transfer	$ per household per annum for a 'moderate improvement' in the health of the Bremer River in Queensland from the existing level	$36
Morrison & Bennett (2004)	Choice modelling	$ per household in form of one-off levy to increase water quality of the whole river to a fishable level	Within-catchment: $51.33 – Bega River $46.63 – Clarence River $45.26 – Georges River $48.94 – Gwydir River $54.16 – Murrumbidgee River Outside-catchment: $29.93 – Gwydir River $28.75 – Murrumbidgee River
Morrison & Bennett (2004)	Choice modelling	$ per household in form of one-off levy to increase water quality of the whole river to a swimmable level	Within-catchment: $100.98 – Bega River $72.77 – Clarence River $73.88 – Georges River $104.07 – Gwydir River $75.24 – Murrumbidgee River Outside-catchment: $59.98 – Gwydir River $86.46 – Murrumbidgee River
Bennett et al (2008)	Choice modelling	$ per household for a 1% increase in the length of river suitable for primary contact recreation	Within-catchment: $0 – Gellibrand River $2.12 – Goulburn River $0 – Moorabool River Outside-catchment (Melbourne): $1.64 – Goulburn River $0 – Moorabool River

* in Rolfe et al, 2005

When transferring these values to a new context, it is important to consider the similarity of waterway characteristics, population characteristics, the scale of the change in quality and whether the focus is on quality improvements or maintenance of existing standards (van Bueren & Bennett, 2004).

It is likely that in most instances these factors will not align exactly. In those cases, the use of benefit transfer values should be seen as indicative, included to ensure that the impact of changes in water quality is taken into account, rather than as a precise estimate.

Air pollution

Particulate matter

The main methods of valuing the costs of air pollution are hedonic pricing, stated preference techniques or through use of a direct costing approach.

Hedonic pricing is usually measured by examining the price differential associated with distance to a project, in order to determine the cost associated with the externalities generated. It is particularly useful, as it is a form of revealed preference, and is very difficult to manipulate. However, hedonic pricing, if undertaken without a direct measure of air pollution (for example, measures of particulate matter in the air), cannot disaggregate the price difference caused by a project into its components such as air pollution, noise pollution, loss of visual amenity and convenience. Furthermore, hedonic pricing relies on the fact that individuals are aware of and can appropriately value the cost of air pollution to their utility (Abelson 2007). Therefore, hedonic pricing serves as a way to measure the aggregate impact of a variety of measures, a point that should be noted to avoid double counting costs or benefits.

Contingent valuation studies involve asking individuals regarding their willingness to pay to reduce the impact of air pollution. Similarly to hedonic pricing, this valuation methodology assumes that individuals are sufficiently aware of and can appropriately value the impact of air pollution to their utility. The life-satisfaction approach was used by Ambrey et al (2012) to estimate the cost of air pollution from particulate matter in South East Queensland. This study yields an implicit willingness to pay of $6,000 per household for a one day decrease in the number of days pollution exceeds health guidelines in their local area.

An alternative method of measuring the impact of air pollution is to measure its medical impact on health and life expectancy of the population exposed to it. One method of valuing health and life is use of Quality Adjusted Life Years (QALY). The effects of air pollution can thus be measured in the number of QALYs lost as a result of the pollution (Coyle et al. 2003). This value can then be combined with an appropriate monetary value placed on life as determined elsewhere. A current estimate that is useful to apply is $151,000 as the value of a statistical life year (OBPR 2008). Thus the number of QALYs lost can be multiplied by a per life year value to produce a total cost associated with additional air pollution. The difficulty with this approach is that it is not straightforward to ascertain the number of QALYs likely to be lost as a result of a specific project, relative to the baseline scenario.

Using a two stage approach, combining exposure-response estimates relating Coarse Particulate Matter and health endpoints from epidemiological studies, and estimates of the costs of those health endpoints, the Department of Environment and Conservation NSW (2005) calculated the health costs of air pollution in the Greater Sydney Metropolitan Region. The health endpoints considered in the study include mortality, chronic bronchitis in adults, respiratory hospital admissions, cardiovascular hospital admissions, acute bronchitis in children, asthma attacks for both adults and children, and the cost of lost productivity due to restricted activity days for adults.

The values reported by the Department allow for the health costs of air pollution of a project to be calculated in terms of total emissions levels (costs per tonne of PM10 emitted) or in terms of changes in annual average concentration levels (costs per 10 μg/m^3 increase in the PM10 concentrations).

The benefit of this study is that it produces estimates for three different subregions of the Greater Sydney Metropolitan Region, as listed in the tables below. The costs allow for comparisons between a macro, 'regional level' approach (using the values in Table C.5 and Table C.6) and a micro, 'property level' approach (using the values in Table C.7).

Table C.5: Annual health costs of air pollution across selected regions, per tonne of PM10 - with 7.5 μg/m^3 threshold ($ 2003)

	Lower bound	Midpoint	Upper bound
Sydney	$28,000	$132,000	$235,000
Hunter	$8,000	$35,000	$63,000
Illawarra	$6,000	$26,000	$46,000

Source: Department of Environment and Heritage NSW (2005) – Table 6.3.1

Table C.6: Annual health costs of air pollution across selected regions, per tonne of PM10 – no threshold ($ 2003)

	Lower bound	Midpoint	Upper bound
Sydney	$45,000	$236,000	$427,000
Hunter	$13,000	$63,000	$112,000
Illawarra	$10,000	$47,000	$85,000

Source: Department of Environment and Heritage NSW (2005) – Table 6.4.1

Table C.7: Annual health costs of air pollution across selected regions, per 10 μg/m^3 increase in PM10 annual average concentrations – with 7.5 μg/m^3 threshold ($m 2003)

	Lower bound	Average	Upper bound
Sydney	$547.0	$2,598.5	$4,650.0
Hunter	$174.0	$767.0	$1,360.0
Illawarra	$69.9	$310.0	$550.0
Total	$791.0	$3670.5	$6,550.0

Source: Department of Environment and Heritage NSW (2005) – Table A.1

An important issue related to the valuation of health impacts of air pollution is whether or not to assume a threshold. The use of a threshold (as in Table C.5 and Table C.7) assumes that there are no health impacts below the threshold concentration. This has the effect of producing lower total cost estimates.

Given that the World Health Organisation has determined that there is no safe level of exposure to PM10, it is considered that the use of 'no threshold' cost estimates, such as those in Table C.6 is most appropriate, and sufficiently conservative for a CBA.

More recently, PAEHolmes published unit damage cost estimates per tonne of PM2.5 emissions in a report for the NSW Environment Protection Authority (EPA) (PAEHolmes, 2013). These estimates were developed for specific locations using the ABS Significant Urban Area structure for urban centres with more than 10,000 people. This analysis was undertaken to provide health cost estimates that take into account population-weighted exposure, for use in economic appraisals.

Cost estimates produced by this study are reported for a sample of Significant Urban Areas (SUAs) in NSW, in Table C.8 below. However, the full report by PAEHolmes also includes unit damage costs in other states. It is considered that these are the best available estimates of the cost of particulate matter for cost-benefit analysis in NSW.

Table C.8: Unit damage costs by SUA (rounded to two significant figures) - NSW

SUA code	SUA name	Population density (people/km2)	Damage cost / tonne of PM2.5 ($AU 2011)
1030	Sydney	991	$280,000
1035	Wollongong	470	$130,000
1023	Newcastle – Maitland	391	$110,000
1010	Cessnock	294	$82,000
1028	Singleton	127	$36,000
1021	Muswellbrook	45	$13,000
1000	Not in any Significant Urban Area (NSW)	1.3	$360

Source: PAEHolmes (2013)

Beyond total suspended particles, PM10 and PM2.5, a core component of the particulate emission of any coal mining project is dust. It is created by the disturbance of particles which occurs throughout the mining process by activities such as blasting, handling and transporting. However, mine dust rarely presents a serious threat to the wider environment. In the majority of situations the dust produced is chemically inert and deposition rates tend to decrease rapidly away from the source (Environment Australia, 1998). Buffer zones have evolved to become common practice in an effort to mitigate the effect of dust, noise and vibration on surrounding agricultural lands.

Carbon pollution

The cost of carbon emissions can be estimated in a variety of ways. It is important to note that the cost of carbon is usually measured as the marginal social cost of emitting one metric ton of carbon (or one metric ton of carbon dioxide).

The main methods of pricing carbon emissions are based on modelling, observed market prices and defensive expenditure.

The predominant method of valuation relies on the use of Integrated Assessment Models (IAMs). These model the climate, the global economy and feedbacks between those two so as to determine the damage associated with carbon emissions.

The US Environmental Protection Agency estimated the social cost of carbon as US$21 (24.86 AUD) per tonne of carbon dioxide, rising over time to US$26 per tonne in 2020 and US$33 per tonne in 2030 (prices are measured in 2007 dollars) (USG 2010). There is quite a large variation in the estimated cost of carbon emissions, with estimates depending heavily on the discount rate used (Tol 2008).

Table C.9: Estimates for Social Cost of Carbon

Study	Price terms	Cost of 1 ton of carbon dioxide (local currency)	Cost of 1 ton of carbon dioxide (AUD)
US EPA	2007	US$21	$24.86
UK Department of Energy and Climate Change	2011	£15.30	$23.04
Nordhaus	2011	US$12	$15.66
Wahba et al.	2006	US$5-$49	$6.60 - $64.70

Source: Nordhaus (2011), US EPA (2010), UK DECC (2011), Wahba et al. (2006), ATO (2014)

The cost of carbon pollution in the environment can also be valued at market prices. While Australia no longer enforces a carbon pricing mechanism, there are market systems in place overseas, including the European Union. At present, carbon emissions are priced at around €6 per metric tonne of emissions (MarketWatch 2014).

It should be noted that valuing the social cost of carbon at a value higher than the market price for a carbon permit may open a cost-benefit analysis to manipulation. As the act of purchasing a carbon permit generates a net social benefit equal to the difference between the model price and market price for carbon, it is possible for a proposal that would otherwise fail a cost-benefit analysis to purchase carbon permits until it passes this analysis.

Noise pollution

Noise pollution can be measured in a variety of ways. It is important to note however, that most studies of noise pollution have looked at noise from a particular source (e.g. road traffic, rail). As annoyance varies depending on the type of noise produced, noise valuation studies usually vary by source.

A primary means of valuing noise pollution is to use hedonic pricing methods to compare house prices based on proximity to a source of noise (e.g. highway, airport). While this methodology is useful for assessing the marginal willingness-to-pay (WTP) associated with noise costs, there is no expectation that the marginal WTP will be stable across contexts. Thus, while hedonic pricing is very useful where applicable, it may not be appropriate to generalise the cost derived from hedonic pricing studies to a broader context. A US meta-analysis estimates a 0.50% to 0.60% decrease in house price per dB of noise (Nelson 2004).

This similarly matches estimates from Scotland of 0.20% per dB increase in noise level (Bateman et al. 2001).

As an alternative, contingent valuation methods can be used to assess the cost of noise pollution. The values derived for contingent valuation studies however, vary quite greatly with estimates for road traffic noise varying between $3.82 and $189.05 per decibel per household per year. The Final Report to the European Commission DG Environment recommended valuing road traffic noise at $3.82 to $61.11 per dB per household per year (Navrud 2002).

Traffic

The costs and benefits associated with nearby traffic can be broken down into several categories. Traffic produces several negative externalities, including noise pollution, air pollution and traffic congestion. Proximity to traffic however can also generate benefits due to the time and travel benefits associated with proximity to a mode of transport.

Valuations of the costs and benefits associated with traffic should also note that the costs and benefits do vary depending on mode of transport (Navrud 2002) and time of day (Carlsson et al. 2004). Traffic can also be measured in intensity, either by frequency of occurrence or through a measure of the traffic density on a route (Ossokina and Verweij 2011).

Valuing the net cost (or benefit) of traffic can thus be done using hedonic pricing by measuring property prices and proximity to particular modes of traffic, for example, railway lines, highways or airports (Ossokina and Verweij 2011). However, hedonic pricing based on proximity to a transport line is problematic as it does not necessarily disaggregate the costs and benefits into noise pollution, air pollution, congestion and convenience. Without actual measurement of noise or air pollution levels, hedonic pricing studies tend to measure the net cost or benefit associated with living close to a mode of transport. This is something to be noted, to avoid double counting costs and benefits, and may not be a problem if a study is only interested in the net effect of traffic.

An alternative method of valuation that is capable of disaggregating the effects of traffic on an area is through contingent valuation methodologies. Contingent valuation permits the measurement of variations in discrete components of the effects of traffic and can thus measure particularised values for each component independently. Furthermore, contingent valuation studies allow for the measurement of effects caused by infrastructure changes that have yet to occur.

Transport for NSW also provides a guide set of values for rural freight externalities on a 1000 tonne-km basis. It should be noted that this measure of externalities overlaps in part with the other environmental impacts. Furthermore, the “Upstream and Downstream Cost” listed is meant to include the cost to infrastructure associated with transport.

Table C.10: Rural Freight Externalities in $ per 1000 tonne-kilometre travelled

Externality Type	Light vehicle	Heavy Vehicle
Air pollution	0	0.24
Greenhouse Gas Emission	56.49	5.38
Noise	0	0.41
Water Pollution	0.27	1.45
Nature and Landscape	0.21	4.04
Urban Separation	0	0
Upstream and Downstream Costs	188.29	21.53

Source: Transport for NSW (2013)

Lastly, it is important to value the cost associated with delays or additional congestion arising out of the project. The value of $23.39/vehicle-hour is estimated as the value of travel time for occupants (Transport for NSW 2013).

Health

A consideration in the impact of coal mining on an area is the impact of coal mining on the health of those living near a coal mine. This cost is primarily borne by the residents that live near the mine. Most of this externality is likely to be picked up by measurements of other externalities, such as air pollution or through methods of valuation that aggregate across externalities such as hedonic pricing.

A recent study by Hendryx and Ahern (2008) identifies significant increases in a range of diseases due to coal production. According to Hendryx and Ahern (2008), living near a coal mine raises the incidence of Cardio-Pulmonary disease, diabetes, kidney disease, cancer and arthritis/osteoporosis. A summary of their finding can be found in Table C.11. However, this valuation is based on data from West Virginia and does not appear to be easily translatable into the NSW context, particularly due to potential differences in the regulatory regimes between the two locations. Even if the health effects listed above could be translated into the Australian context, it is not clear how to convert the disease burden listed here into a comparable measure such as QALYs so that they can then be included in the cost benefit analysis.

Table C.11: Health Status and Rates of Disease Among Young Adults (N=16,493) by County Coal-Production Levels: West Virginia, 2001

	0 tons	≤3.9 million tons	≥4.0 million tons	P	Bonferroni P
Health Status, Mean Score	2.62	2.68	2.85	<0.001	0.002
Any cardiopulmonary disease, %	13.5	13.8	15.9	<0.001	0.007
Lung disease, %					
Any lung disease	4.2	4.6	5.7	<0.001	0.007
Chronic obstructive pulmonary disease	1.6	1.5	2.1	0.05	0.85
Asthma	2.6	2.6	3.1	0.27	0.999
Black lung	0.3	0.7	0.8	<0.001	0.003
Heart disease or stroke, %					
Any heart disease	10.4	10.6	12.3	0.004	0.068
Hypertension	5.6	5.5	7.6	<0.001	0.002
Congestive heart failure	0.9	0.7	0.6	0.17	0.999
Arteriosclerosis	0.3	0.4	0.3	0.57	0.999
Cardiovascular disease	1.3	1.2	1.4	0.9	0.999
Stroke	0.5	0.4	0.6	0.41	0.999
Angina or coronary disease	5.4	5.6	5.4	0.87	0.999
Diabetes, %	6.2	5.7	7.0	0.043	0.73
Kidney disease, %	0.4	0.4	1.0	<0.001	0.002
Cancer, %	2.3	1.8	2.2	0.26	0.999
Arthritis or osteoporosis, %	5.5	5.4	6.4	0.069	0.999

Source: Hendryx and Ahern (2008)

Visual amenity

The term 'visual amenity' is not clearly defined in the literature. This review applies Brodbeck's definition of scenic quality, being 'the degree to which the visual aesthetics of a landscape are valued from a human point of view' (2005). It is acknowledged that spoil heaps and light emitted by mines can detract from the visual amenity of an area. In order to avoid overlap with the benefits of open space, discussed below, the valuation of visual amenity impacts could be restricted to those of properties that will have a direct view of the mining area.

The process of valuing visual amenity requires consideration of a number of factors including the visual characteristics of the site, the surrounding environment, the scale of the project and the current beneficiaries of the visual amenity aspects of the site. Hedonic pricing and stated preference techniques are the most common methods of quantifying visual amenity (Ambrey & Fleming, 2011).

In instances where local residents are the primary beneficiaries of visual amenity, hedonic pricing is the preferred method of valuing visual amenity (UHERO, 2013). Controlling for other influential factors, such as number of bedrooms, backyard size and proximity to schools and parks, this methodology can infer a value for the impact of the presence or quality of a view on property prices.

Hedonic pricing techniques are commonly used to estimate the value of amenity. Within Australia, this method has been used to value the amenity of river views, ocean views, national parks and urban wetlands (Ambrey & Fleming, 2011). Since the values obtained directly reflect the visual characteristics of specific sites, they cannot be applied to the cost benefit analysis of mining Projects. Instead, the process of analysis would have to be replicated in the mining context.

Hedonic pricing studies that have considered the impact of mining activity on property prices in Australia have tended to place a focus on valuing the impact of pollution. For example, Neelawala, Wilson & Athukorala (2012) assessed the impact of mining and smelting-related lead pollution on residential house prices. This highlights the difficulties associated with isolating the visual element of amenity from other aspects such as the level of noise or dust pollution.

Alternatively, stated preference surveys can be used to obtain estimates of the value of visual amenity. This methodology is most relevant when the view of the site is primarily enjoyed by visitors to an area (UHERO, 2013). While it might be possible to pose questions in a manner which will help provide a direct estimate of the value of the visual aspect of amenity, it should be noted that there may remain a difficulty in distinguishing the value of visual amenity from the value of biodiversity or conservation, in the case of natural environments. In addition, care should be taken to ensure against double-counting, given the visual amenity benefits of open space, discussed below.

Overall, the difficulties associated with obtaining quantitative estimates of the value of amenity are acknowledged by the NSW Government. It is noted in the 2012 Guidelines that these impacts may have to be considered qualitatively in a CBA. In that case, the likely size of impacts on visual amenity should be discussed relative to the overall net public benefit of the project.

Quality of open space

Where a proposed mining expansion is intended to impede on open space, it is necessary to account for the loss of benefits derived by individuals who use that space. The two main ways in which individuals benefit from open space are through the visual amenity of the space and the activities that take place in the area (McConnell & Walls, 2005).

The main methods used to value the quality of open space are hedonic pricing and stated preference techniques. After reviewing the literature on the topic, McConnell and Walls note that there is substantial variation in the estimated value of open space as a result of differences in location, the type of space, the services provided by the space and the methodology utilised by the study (2005).

It is recommended that values for the quality of open space be ascertained by considering the value of the activities that take place in potential areas of impact. In some cases, this value will be captured in measurements of foregone agricultural revenue, or the value of recreational activities that take place at water sites.

Rural amenity and culture

The expansion of a mine may also have negative social impacts through the reduction of rural amenity and culture. The noise, light and dust pollution generated by mining activity can alter the overall rural amenity of the surrounding area by establishing an industrial ambience. Where this change causes people to leave the area, the remaining residents may experience a loss of their sense of community.

Stated preference techniques are the main method used to value rural amenity and culture.

Bennett, van Bueren and Whitten (2004) present the results of two choice modelling studies investigating household willingness to pay to maintain rural communities, within the context of environmental protection strategies.

The first study considered the value of retaining farm populations in the Murrumbidgee River Floodplain, given different wetland protection strategies. Survey respondents from Wagga Wagga, Griffith, Canberra and Adelaide were told that implementation of these strategies might cause farmers to leave the floodplain region. The responses indicated that, on average, households were willing to pay a one-off sum of $5.73 to prevent a farmer from leaving. The 95% confidence interval for this estimate was $4.21-$7.35. It was found that this valuation did not vary significantly according to the different locations.

The second study undertook three different surveys. The first was framed to ascertain values at a national level, while the two others referred to case studies of the Great Southern region in WA and the Fitzroy Basin region in QLD. The national survey was distributed to households from samples of Albany, Rockhampton and the general population. The Great Southern survey was distributed to another sample of households in Albany, while the Fitzroy Basin survey was issued to a sample of households in Rockhampton.

Estimates of household willingness to pay to prevent rural populations from declining were ascertained from the responses in each survey-sample combination.

These values were measured in terms of an annual payment to be made over a 20 year period, in order to prevent 10 people from leaving a rural community. The results are summarised in Table C.12 below.

Table C.12: WTP to maintain rural communities

Survey	Sample	Annual household cost of 10 people leaving rural communities
National	National	$0.09
	Albany	$0.11
	Rockhampton	$0.06
Great Southern	Albany	$0.56
Fitzroy Basin	Rockhampton	$2.24

Source: Bennett, van Bueren & Whitten (2004)

It is evident that the benefit of maintaining rural communities varies according to the context of the analysis, with regional-based surveys generating higher willingness to pay values. This is likely to be reflective of framing or scoping effects (Bennett, van Bueren & Whitten, 2004). In addition, it is plausible that these values underestimate the value of rural culture in the context of mining, given that individuals might be more accepting of costs to the community as a result of environmental protection requirements than they are for mining expansions.

A choice modelling survey was also undertaken by Ivanova et al (2007) to assess the social effects of coal mining in the Bowen Basin in Queensland. The authors found that while residents of Blackwater were not largely concerned by changes in the size of the population, a 1% increase in the 'proportion of jobs held by people who don't live in the town' was equivalent to a reduction in welfare of $41.88 per household.

The importance of rural amenity and culture in the Hunter region was identified in a choice modelling survey undertaken by Gillespie and Bennett (2012). A sample of households in NSW drawn from a panel were distributed an online questionnaire about how they valued different impacts of the Warkworth Mine. From the 2,354 responses, the authors identified that, on average, a household was willing to pay $33.32 to prevent one rural family from being displaced from the community. The 95% confidence estimate for this estimate was $29.31-$37.72. This is likely to be the most relevant estimate for the value of rural amenity and culture in the context of mining activity.

Heritage – Aboriginal

The use values of heritage sites derive primarily from the value associated with visiting such sites. However, the value associated with such visitation often cannot be measured through a market price and thus relies on stated preference data. As a consequence, it is difficult in practice to separate the use and non-use values associated with a heritage site. Furthermore, the value of a particular heritage site will vary depending on the demographics of the community surveyed.

For example, in a study measuring the value of protecting an additional 1% of Aboriginal Heritage sites in Central Queensland the willingness to pay of various communities was determined as per Table C.13.

Table C.13: Willingness to Pay for protection of Aboriginal Heritage Sites

Community	Rocky Indigenous Community	Rockhampton General Community	Brisbane General Community
Willingness to pay for protection of further 1% of Aboriginal Heritage sites (2003 Dollars)	3.22	-2.08	-1.78

Source: Rolfe and Windle (2003)

It is important to note that the Indigenous community and the general population appear to value Aboriginal heritage sites very differently. Thus the assessment of the value of Aboriginal heritage sites necessarily presents issues of equity that involve balancing the interests of different groups in the community.

Previous studies of heritage valuations in the coal mining context have produced an estimate of $29.71 per household to avoid a highly significant Aboriginal site being destroyed, a value that was aggregated up to produce a community value of $33,558,730 to avoid such a site being destroyed (Gillespie Economics 2009).

Heritage – Historic

A national choice modelling study to value the Old Parliament House in Canberra for example, estimated the marginal willingness to pay for various alternative use-scenarios for Old Parliament House. The values were then multiplied up to produce an estimate of the aggregate willingness to pay across Australia for the scenarios presented which ranged from $561,258.21 to $65,790,289.29 in total (Choi et al 2010).

There is also an extensive literature valuing heritage sites that are residential buildings, commercial buildings and tourist places (Allens 2005). Results from choice modelling studies indicate that the average willingness to pay for the protection of additional places from loss is estimated to be $5.53 per person each year for every 1000 places protected (Allens 2005). This is equivalent to an annual willingness to pay of $0.007 per person per site protected, in 2013 dollars.

As mentioned in Appendix B, there are uncertainties involved with aggregating these individual valuations beyond the choice modelling survey sample. Table C.14 illustrates the variation in valuations according to three different levels of aggregation.

Table C.14: Variations in the value of protecting one local heritage site ($2014)

Aggregation level	Annual value of protecting one site ($m)	NPV of protecting one site in perpetuity ($m)
All residents in the Hunter and Central Coast region	0.01	0.09
All residents in NSW	0.05	0.67
All residents in Australia	0.15	2.14

It should be noted that the Productivity Commission's Inquiry into the Conservation of Australia's Historic Heritage Places (2006:145) found that these values are of little relevance for individual sites, due to the difficulty in interpreting these values and applying them in different contexts.

Other externalities – non-use values

Ecosystems (Water, Biodiversity, Conservation)

The non-use valuation of ecological systems requires the use of stated-preference valuations, the most common of which would be contingent valuation studies. It should be noted that while such studies may not produce consistent measures of values (Dutton et al. 2010), they are a useful way to measure non-use values of an ecological site. It should be noted that non-use valuations of ecological systems often do not disaggregate value into the components of an ecosystem. Thus the valuation of a water system, ecological habitat and the biodiversity supported by it will usually be lumped together in such a valuation.

Furthermore, to ensure that the items being valued can be understood by the general population, abstract properties of ecosystems such as clean water or an absence of pollutants are usually translated into more meaningful indicators such as number of species saved (MacDonald et al. 2011).

By virtue of the contingent valuation methodology, it may not always be possible to separate non-use values from the declared valuations in a survey. People may implicitly value an ecological site due to a future use (e.g. visiting it in the future). Although surveys may attempt to disaggregate a declared value based on motivation (Subade 2005), not all of them do so. This is important to note to avoid double counting when summing values.

It is also important to note that the per person valuation of an ecological system is heavily dependent on the community being surveyed. Communities geographically closer to an ecosystem tend to value that ecosystem more highly (Kumar 2010). It is therefore important to discount per person values from surveys taken of communities close to a particular ecosystem when attempting to generalise the value of an ecosystem (Bennett et al 2007).

Lastly, an alternative means of valuing biodiversity is through the NSW Office of Environment and Heritage's BioBanking scheme. The valuations within that scheme rely on a fixed formula, as detailed in the Biobanking Assessment Methodology. (Department of Environment and Climate Change NSW 2008). A review of the BioBanking scheme found that credits were sold at a value between $2500 and $9500 per credit (Office of Environment and Heritage 2012). Assuming that the Office of Environment and Heritage has represented the preferences of the community in the Assessment Methodology, any damage to species or ecosystems can be offset through the program.

Heritage

Heritage sites often have significant non-use values. Locations or buildings of significant cultural value are often seen as worth preserving in and of themselves.

The fact that heritage sites often have value to particular cultures creates distributional concerns when valuing such a site. Thus a naïve valuation would value a heritage site that appeals to a more populous or dominant culture as more valuable than that of a minority culture. Furthermore, as valuation is sometimes affected by personal wealth effects, the wealth of a particular community can also influence the valuation of a heritage site. It should be noted that this is somewhat mitigated by the fact that people often do place value on the preservation of minority cultural heritage sites, regardless of their background (Rolfe and Windle 2003). As a result of this it is important to consider equity issues, or the distribution of heritage values, when considering the valuation of heritage sites.

Additionally, heritage sites are often considered unique and thus irreplaceable. It is thus often not possible to offset the damage to a heritage site through expenditures elsewhere.

The predominant method of valuing non-use value in heritage sites is through contingent valuation methods that examine alternatives involving the preservation of heritage locations or a number of heritage locations. As a result of the unique nature of most heritage sites, it is unlikely to create an estimate for the value of heritage generally.

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Appendix D: Hedonic pricing study

As noted throughout Appendix C, many externalities are best valued using a hedonic pricing study. Hedonic price modelling is a standard revealed preference method used to assess the impacts of pollution or other externalities, such as noise, on the value of residential properties. The strength of a hedonic pricing study is that it may be able to capture location specific values for externalities. For example, it can be difficult to translate the results of a literature review to the details of a specific geographic location for externalities such as noise, light, vibration, particulate matter and outdoor recreation value. A hedonic pricing study can help as it may be able to value these externalities by identifying their cumulative effect of local prices.

This appendix sets out the results of a hedonic pricing study undertaken by Deloitte Access Economics. The hedonic pricing study attempted to quantify negative externalities created by coal mines in the Upper Hunter by analysing house sale prices in the region. The analysis was undertaken using a standard linear regression model to estimate the impact of proximity to coal mines on house prices while holding other variables constant.

The hedonic pricing study is premised on the idea that externalities of coal mining directly affect the utility that home owners get from their property. This is then translated into a reduction in the price that buyers are willing to pay for a property in the area. In this way, coal mining could lead to a decline in the value of properties and this would be positively correlated with proximity to the mine itself.

Data

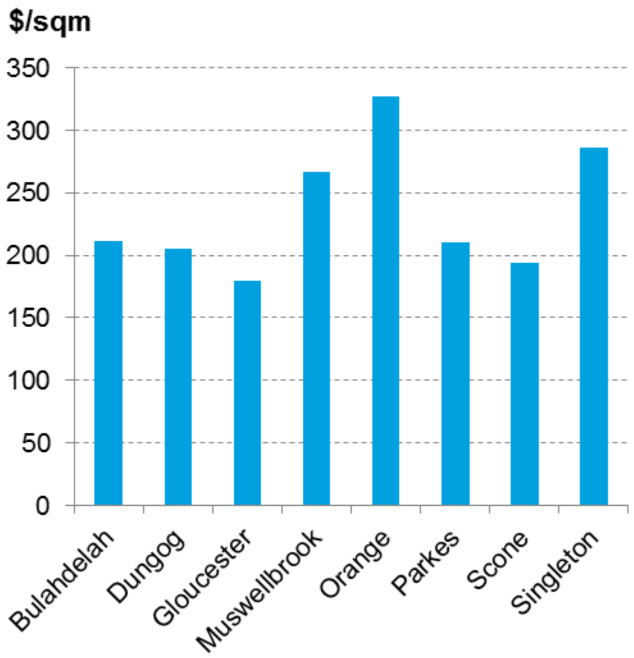
DAE gathered an extensive set of sales data for residential properties sold over the period from 2000 to 2012 from the website onthehouse.com.au. Data was gathered for the following locations in regional NSW:

- Bulahdelah
- Dungog
- Gloucester
- Muswellbrook
- Orange
- Parkes
- Scone
- Singleton

These locations were selected to provide a range of areas within NSW covering the Upper Hunter (with varying levels of coal mining activity), the lower Hunter and other regional centres. The data covered includes sale prices, number of beds, number of bathrooms, garage spaces, land size and property type.

The initial set of around 42,000 observations were reduced down to 5035 observations which contained full information on all variables and did not display data discrepancies (such as very high or low prices per unit area). That is, we selected roughly the 12% of the full data set, being the most complete observations, to ensure that it was reliable.

Chart D.1: Average house sale ($ per sqm from 2000-2012)



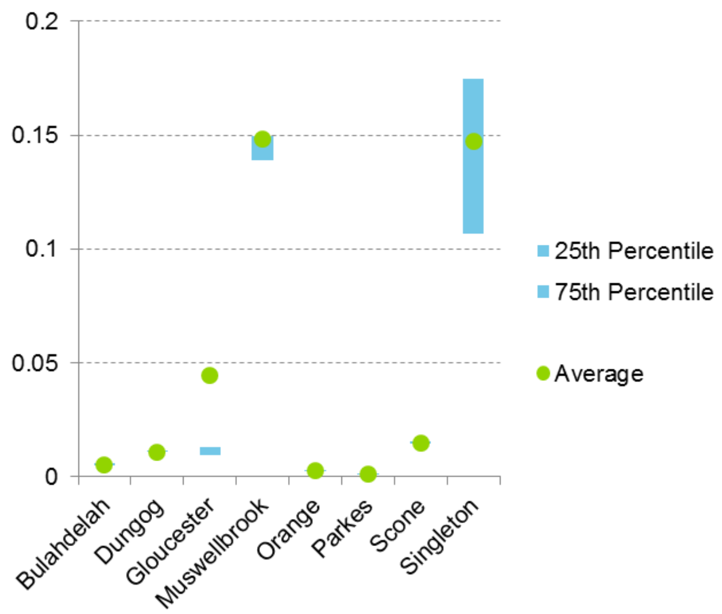
An additional variable was added if the property was located within 4km of Ravensworth, Camberwell or Glennies Creek in the Hunter area. This was in recognition of the fact that these townships may experience particular mining externalities.

This house price data was then combined with data on the location of coal mines in NSW. This data was sourced from the Australian Mines Atlas. This allowed for computation of the distance from each house to each mine in NSW and an assessment of the overall impact of mining on each property. The main variable used to measure the impact of mining was a constructed variable referred to as ‘mine gravity’:

$$mine.gravity_i = \sum_n \frac{1}{(distance\ from\ property\ i\ to\ mine\ n)^2}$$

Where *i* is a list of all properties and *n* is a list of all mines. Mine gravity provides a cumulative measure of overall exposure to mining – properties that are closer to mining activity have higher estimated mine gravity than those that are further away. The relationship is also linear so that, for example, properties that are twice as far away from a mine experience far less than half the mine gravity. This can be seen in the summary of mine gravity for each of the regions within the dataset:

Chart D.2: Average and range of observed mine gravity estimates



The information available from these two data sets was then used to estimate a series of linear regression models to analyse the potential effects of mining activity on house sales prices.

Variables used in modelling

The variables used in the modelling included

- The dependent variable was the natural log of house sale price (converted to real 2013 dollars)
- Independent variables were
    - Number of bedrooms
    - Number of bathrooms
    - Number of car spaces
    - Land size (natural log)
    - Year of sale
    - Indicator variables indicating region
        - Mount Owen (Ravensworth, Camberwell or Glennies Creek)
        - Dungog
        - Gloucester
        - Muswellbrook
        - Orange
        - Parkes
        - Scone
        - Singleton
    - Interaction terms between mine gravity and region

Results

The model provided the following results:

Table D.2: Regression model results

Variable	Estimated value	Standard Error
Beds	0.1282***	(0.0068)
Bathrooms	0.1711***	(0.0092)
Carspaces	0.0360***	(0.0043)
ln(land size)	-0.9317***	(0.0063)
Mount Owen, Broke	0.0122	(0.7118)
Dungog	-0.4333	(0.3674)
Gloucester	-0.9535***	(0.2663)
Muswellbrook	-0.6727*	(0.2718)
Orange	0.3655	(0.3607)
Parkes	-0.6721	(0.3827)
Scone	-1.3633***	(0.3118)
Singleton	-0.7157**	(0.2660)
Year of sale	0.0694***	(0.0012)
Mine gravity*Bulahdelah	-170.3030***	(50.9254)
Mine gravity*Mount Owen	-0.6477	(0.8384)
Mine gravity*Dungog	-35.3637	(23.3318)
Mine gravity*Gloucester	0.7168	(2.1654)
Mine gravity*Muswellbrook	-1.2485**	(0.4395)
Mine gravity*Orange	-464.2871***	(100.8129)
Mine gravity*Parkes	-335.8675	(278.2408)
Mine gravity*Scone	36.8905**	(11.2786)
Mine gravity*Singleton	0.0291	(0.2303)
Constant	-127.2922***	(2.3817)

Note: =* p<0.05 ** p<0.01 *** p<0.001

Source: DAE analysis

The linear regression model explained about 85% of the variation in the housing (R-squared). Heteroscedasticity in the error terms was identified, probably due to the large difference in prices between smaller and larger properties. To control for this, robust standard errors were used but, due to the large sample size, this did not greatly change the significance levels.

Key findings from the analysis are:

- Property prices per sqm have increased by an average of around 4% each year, over the last decade. Prices per sqm in 2013 were about 92.9% greater than prices paid in 2000.
- Impact of house features:
  - an additional bedroom increases prices by about 13%;
  - an additional bathroom increases property prices by 17%;
  - an additional car space leads to a price increase of 4%;
- Prices per sqm decrease at a faster rate in larger properties as compared with smaller properties. The analysis indicates that 1% increase in land sizes lead to an equivalent 0.9% decrease in prices per sqm.

Turning to the effect of mining on property values, a key aspect of this form of the model is that it separately identified the effect that being located in a particular region has on housing prices compared to the effect that being close to a mine has. The effect of mining is also differentiated for each region. This is important as mining activity in a region may work to increase house prices generally (due to demand effects) but may have negative consequences for those located particularly close to the mine itself.

The estimated effects of the mining externalities themselves are shown in bold in Table D.2. A negative sign here indicates that a negative externality has been identified. Statistically significant negative externalities have been identified in Bulahdelah, Muswellbrook, Orange and Scone.

In the region surrounding Mount Owen, a statistically significant result has not been achieved. This suggests that either mining activity is not reducing property prices in the area or there is simply not enough data to definitively answer the question of whether there is any effect.

The conclusion of the hedonic pricing study is, therefore, that there is currently no statistically significant evidence to suggest that mining operations have had negative consequences on housing prices in the Singleton area comprising close localities in the Mount Owen area. This suggests that the best approach to valuing externalities in the area is likely to be through literature reviews, stated preference techniques and reliance on information provided by the project proponent.

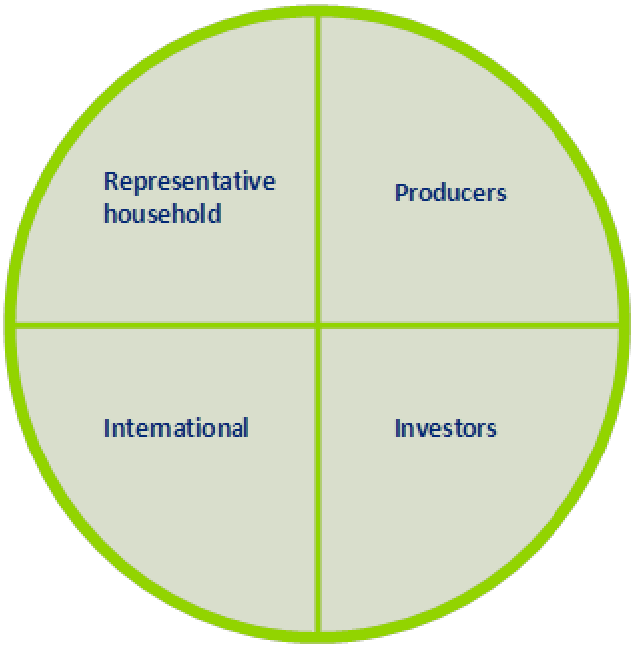
Appendix E: CGE modelling

The Deloitte Access Economics – Regional General Equilibrium Model (DAE-RGEM) is a large scale, dynamic, multi-region, multi-commodity computable general equilibrium model of the world economy. The model allows policy analysis in a single, robust, integrated economic framework. This model projects changes in macroeconomic aggregates such as GDP, employment, export volumes, investment and private consumption. At the sectoral level, detailed results such as output, exports, imports and employment are also produced.

The model is based upon a set of key underlying relationships between the various components of the model, each which represent a different group of agents in the economy. These relationships are solved simultaneously, and so there is no logical start or end point for describing how the model actually works.

Figure E.1 shows the key components of the model for an individual region. The components include a representative household, producers, investors and international (or linkages with the other regions in the model, including other Australian States and foreign regions). Below is a description of each component of the model and key linkages between components. Additional technical detail is also provided.

Figure E.1: Key components of DAE-RGEM



DAE-RGEM is based on a substantial body of accepted microeconomic theory. Key assumptions underpinning the model are:

- The model contains a 'regional consumer' that receives all income from factor payments (labour, capital, land and natural resources), taxes and net foreign income from borrowing (lending).
- Income is allocated across household consumption, government consumption and savings so as to maximise a Cobb-Douglas (C-D) utility function.
- Household consumption for composite goods is determined by minimising expenditure via a CDE (Constant Differences of Elasticities) expenditure function. For most regions, households can source consumption goods only from domestic and imported sources. In the Australian regions, households can also source goods from interstate. In all cases, the choice of commodities by source is determined by a CRESH (Constant Ratios of Elasticities Substitution, Homothetic) utility function.
- Government consumption for composite goods, and goods from different sources (domestic, imported and interstate), is determined by maximising utility via a C-D utility function.
- All savings generated in each region are used to purchase bonds whose price movements reflect movements in the price of creating capital.
- Producers supply goods by combining aggregate intermediate inputs and primary factors in fixed proportions (the Leontief assumption). Composite intermediate inputs are also combined in fixed proportions, whereas individual primary factors are combined using a CES production function.
- Producers are cost minimisers, and in doing so, choose between domestic, imported and interstate intermediate inputs via a CRESH production function.
- The model contains a more detailed treatment of the electricity sector that is based on the 'technology bundle' approach for general equilibrium modelling developed by ABARE (1996).
- The supply of labour is positively influenced by movements in the real wage rate governed by an elasticity of supply.
- Investment takes place in a global market and allows for different regions to have different rates of return that reflect different risk profiles and policy impediments to investment. A global investor ranks countries as investment destinations based on two factors: global investment and rates of return in a given region compared with global rates of return. Once the aggregate investment has been determined for Australia, aggregate investment in each Australian sub-region is determined by an Australian investor based on: Australian investment and rates of return in a given sub-region compared with the national rate of return.
- Once aggregate investment is determined in each region, the regional investor constructs capital goods by combining composite investment goods in fixed proportions, and minimises costs by choosing between domestic, imported and interstate sources for these goods via a CRESH production function.
- Prices are determined via market-clearing conditions that require sectoral output (supply) to equal the amount sold (demand) to final users (households and government), intermediate users (firms and investors), foreigners (international exports), and other Australian regions (interstate exports).

- For internationally-traded goods (imports and exports), the Armington assumption is applied whereby the same goods produced in different countries are treated as imperfect substitutes. But, in relative terms, imported goods from different regions are treated as closer substitutes than domestically-produced goods and imported composites. Goods traded interstate within the Australian regions are assumed to be closer substitutes again.
- The model is able to account for greenhouse gas emissions from fossil fuel combustion. Taxes can be applied to emissions, which are converted to good-specific sales taxes that impact on demand. Emission quotas can be set by region and these can be traded.

The representative household

Each region in the model has a so-called representative household that receives and spends all income. The representative household allocates income across three different expenditure areas: private household consumption; government consumption; and savings.

Going clockwise around Figure E.1, the representative household interacts with producers in two ways. First, in allocating expenditure across household and government consumption, this sustains demand for production. Second, the representative household owns and receives all income from factor payments (labour, capital, land and natural resources) as well as net taxes. Factors of production are used by producers as inputs into production along with intermediate inputs. The level of production, as well as supply of factors, determines the amount of income generated in each region.

The representative household's relationship with investors is through the supply of investable funds – savings. The relationship between the representative household and the international sector is twofold. First, importers compete with domestic producers in consumption markets. Second, other regions in the model can lend (borrow) money from each other.

Some detail

- The representative household allocates income across three different expenditure areas – private household consumption; government consumption; and savings – to maximise a Cobb-Douglas utility function.
- Private household consumption on composite goods is determined by minimising a CDE (Constant Differences of Elasticities) expenditure function. Private household consumption on composite goods from different sources is determined by a CRESH (Constant Ratios of Elasticities Substitution, Homothetic) utility function.
- Government consumption on composite goods, and composite goods from different sources, is determined by maximising a Cobb-Douglas utility function.
- All savings generated in each region are used to purchase bonds whose price movements reflect movements in the price of generating capital.

Producers

Apart from selling goods and services to households and government, producers sell products to each other (intermediate usage) and to investors. Intermediate usage is where one producer supplies inputs to another's production. For example, coal producers supply inputs to the electricity sector.

Capital is an input into production. Investors react to the conditions facing producers in a region to determine the amount of investment. Generally, increases in production are accompanied by increased investment. In addition, the production of machinery, construction of buildings and the like that forms the basis of a region's capital stock, is undertaken by producers. In other words, investment demand adds to household and government expenditure from the representative household, to determine the demand for goods and services in a region.

Producers interact with international markets in two main ways. First, they compete with producers in overseas regions for export markets, as well as in their own region. Second, they use inputs from overseas in their production.

Some detail

- Sectoral output equals the amount demanded by consumers (households and government) and intermediate users (firms and investors) as well as exports.
- Intermediate inputs are assumed to be combined in fixed proportions at the composite level. As mentioned above, the exception to this is the electricity sector that is able to substitute different technologies (brown coal, black coal, oil, gas, hydropower and other renewables) using the 'technology bundle' approach developed by ABARE (1996).
- To minimise costs, producers substitute between domestic and imported intermediate inputs is governed by the Armington assumption as well as between primary factors of production (through a CES aggregator). Substitution between skilled and unskilled labour is also allowed (again via a CES function).
- The supply of labour is positively influenced by movements in the wage rate governed by an elasticity of supply (is assumed to be 0.2). This implies that changes influencing the demand for labour, positively or negatively, will impact both the level of employment and the wage rate. This is a typical labour market specification for a dynamic model such as DAE-RGEM. There are other labour market 'settings' that can be used. First, the labour market could take on long-run characteristics with aggregate employment being fixed and any changes to labour demand changes being absorbed through movements in the wage rate. Second, the labour market could take on short-run characteristics with fixed wages and flexible employment levels.

Investors

Investment takes place in a global market and allows for different regions to have different rates of return that reflect different risk profiles and policy impediments to investment. The global investor ranks countries as investment destination based on two factors: current economic growth and rates of return in a given region compared with global rates of return.

Some detail

- Once aggregate investment is determined in each region, the regional investor constructs capital goods by combining composite investment goods in fixed proportions, and minimises costs by choosing between domestic, imported and interstate sources for these goods via a CRESH production function.

International

Each of the components outlined above operate, simultaneously, in each region of the model. That is, for any simulation the model forecasts changes to trade and investment flows within, and between, regions subject to optimising behaviour by producers, consumers and investors. Of course, this implies some global conditions must be met such as global exports and global imports are the same and that global debt repayments equals global debt receipts each year.

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