# LIDDELL COAL OPERATIONS

APPENDIX A

## Economic Assessment, Liddell Coal Operations Proposed Modification (Gillespie Economics 2013)

APPENDICES

# Liddell Coal Operations

# Proposed Modification

# Economic Assessment

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## EXECUTIVE SUMMARY

Gillespie Economics was commissioned by GSS Environmental, on behalf of Liddell Coal Operations (LCO) Pty Ltd to complete an economic assessment of a proposed modification to LCO's existing development consent DA 305-11-01. This assessment is to form part of an Environmental Assessment (EA) being prepared to support an application under section 75W of the *Environmental Planning and Assessment Act 1979* (EPA Act) to allow for the extension of open cut mining operations beyond the currently approved mining footprint so as to maximise coal recovery. The Modification primarily involves the extraction of an additional 38 million tonnes of run-of-mine (ROM) coal and extension of the operation of the mine from 2019 to 2025.

From an economic perspective there are two important aspects of the Modification that can be considered:

- the economic efficiency of the Modification (i.e. consideration of economic costs and benefits of the Modification using benefit cost analysis (BCA)); and
- the economic impacts of the Modification (i.e. the economic activity that the Modification would provide to the local, regional and NSW economy).

A BCA of the Modification indicated that it would have net production benefits to Australia of $316M. Provided the residual environmental, social and cultural impacts of the Modification that accrue to Australia are considered to be valued at less than $316M, the Modification can be considered to provide an improvement in economic efficiency and hence is justified on economic grounds.

Instead of leaving the environmental, cultural and social impacts unquantified an attempt was made to quantify them. The main quantifiable environmental impacts of the Modification that have not already been incorporated into the estimate of net production benefits, relate to greenhouse gas emissions, surface water impacts and groundwater impacts. These impacts to Australia are estimated at less than $1M, considerably less than the estimated net production benefits of the Modification. There may also be some non-market benefits of employment provided by the Modification which are estimated to be in the order of $46M. Overall, the Modification is estimated to have net benefits to Australia of between $315M and $362M and hence is desirable and justified from an economic efficiency perspective.

While the main environmental, cultural and social impacts have been quantified and included in the Modification BCA, any other residual environmental, cultural or social impacts that remain unquantified would need to be valued at greater than between $315M and $362M for the Modification to be questionable from an Australian economic efficiency perspective.

While the BCA is primarily concerned with the aggregate costs and benefits of the Modification to Australia, the costs and benefits may be distributed among a number of different stakeholder groups at the local, state, National and global level. The total net production benefit will be distributed amongst a range of stakeholders including:

- The Commonwealth Government in the form of any Company tax payable ($182M present value) which is subsequently used to fund provision of government infrastructure and services across Australia and NSW, including the local and regional area;
- The NSW Government via royalties ($134M present value) which are subsequently used to fund provision of government infrastructure and services across the State, including the regional area;
- LCO shareholders in the form of after tax (and after voluntary contributions) profits; and
- The local community in the form of any voluntary contributions to community infrastructure and services.

The environmental, cultural and social impacts of the Modification may potentially accrue to a number of different stakeholder groups at the local, State, National and global level.

Any residual noise costs will occur at a local level. Surface water and groundwater use will impact at the local level but has been paid for through the acquisition of water entitlements. Greenhouse gas costs will occur at the national and global level and will be internalised through payment of the Commonwealth Government's carbon tax. The potential bearers of these costs are therefore compensated via the payment to the Commonwealth Government. The clearing of native vegetation will potentially impact households at the local, State and National level who hold values for the impacted flora and fauna. However, compensation will be made in the form of a biodiversity offset package. Other potential environmental impacts would largely occur at the local level and were found to be insignificant from an aggregate economic efficiency perspective. Any non-market benefits associated with employment provided by the Modification would largely accrue at the local or State level[1].

The residual non-market costs that have been quantified and accrue to NSW are estimated at less than $1M. This is considerably less than the net production benefits that directly accrue to NSW through royalties ($134M). Consequently, as well as resulting in net social benefits to Australia the Modification would result in net social benefits to NSW.

An economic impact analysis, using input-output analysis, estimated that the Modification would make up to the following direct and indirect average annual contribution to the regional economy[2] for approximately 7 years, with lessor impacts when the incremental production associated with the Modification is ramping up and ramping down:

- $458M in annual direct and indirect regional output or business turnover;
- $283M in annual direct and indirect regional value added;
- $37M in annual direct and indirect household income; and
- 469 direct and indirect jobs.

The Modification is estimated to make up to the following direct and indirect average annual contribution to the NSW economy for 7 years, with lessor impacts when the incremental production associated with the Modification is ramping up and ramping down:

- $657M in annual direct and indirect regional output or business turnover;
- $374M in annual direct and indirect regional value added;
- $113M in annual direct and indirect household income; and
- 1,128 direct and indirect jobs.

The Modification will delay cessation of mining by approximately 7 years. Cessation of the mining will lead to a reduction in economic activity in the region and NSW. The significance of these cessation impacts would depend on:

- The degree to which any displaced workers and their families remain within the region, even if they remain unemployed. This is because continued expenditure by these people in the regional economy (even at reduced levels) contributes to final demand.

[1] It should be noted that the study from which the employment values were transferred, surveyed NSW households only.
[2] Comprising the Local Government Areas of Muswellbrook, Singleton and Upper Hunter Shire.

- The economic structure and trends in the regional economy at the time. For example, if Modification cessation takes place in a declining economy the impacts might be felt more greatly than if it takes place in a growing diversified economy.
- Whether other mining developments or other opportunities in the region arise that allow employment of displaced workers.

# 1 INTRODUCTION

Liddell Coal Operations (LCO) is an established open-cut mining operation located at Ravensworth, approximately 25 kilometres north-west of Singleton in the Upper Hunter Valley of New South Wales. LCO is operated and managed by Liddell Coal Operations Pty Limited, a wholly owned subsidiary of Glencore Coal Pty Limited (Glencore), on behalf of a joint venture between Glencore (67.5%) and Mitsui Matsushima Australia (32.5%).

Mining at LCO has been in continuous operation since the 1950s, during which time mining operations have been subject to a number of development consents. In 2001, a development application (DA) was lodged with Planning NSW (now the Department of Planning and Infrastructure (DP&I)) to continue operations within the colliery holding. Development Consent DA 305-11-01 was granted by the Minister for Planning on 20 November 2002 for 21 years of continued mining operations at LCO. This DA remains the current development consent for LCO, and has since been modified on four separate occasions.

LCO is now seeking a further modification under section 75W of the *Environmental Planning and Assessment Act* (EPA Act), 1979 to allow for the extension of open cut mining operations beyond the currently approved mining footprint so as maximise coal recovery. The proposed expansion of mining is within both the existing development consent DA 305-11-01 boundary and mining lease ML 1597.

An Environmental Assessment (EA) of the Modification is required in accordance with provisions of Section 75W of the NSW EPA Act. An economic assessment is required as part of the EA.

The scope of work completed by Gillespie Economics for this assessment included addressing the Director-General's Requirements (DGRs) for the Environmental Assessment relating to economics, issued on 15 February 2012. These indicate that an economic assessment is required as part of the EA including:

- a detailed assessment of the costs and benefits of the project as a whole, and whether it would result in a net benefit for the NSW community; and
- an assessment of the potential impacts of the project on the local and regional community.

In this respect, consideration was given to the relevant aspects of the Department of Planning and Infrastructure's (DP&I) (James and Gillespie, 2002) *Draft Guideline for Economic Effects and Evaluation in EIA*) and the NSW Government (2012) *Draft Guideline for the use of Cost Benefit Analysis in mining and coal seam gas proposals*.

From an economic perspective there are two important aspects of the Modification that can be considered:

- The economic efficiency of the Modification (i.e. consideration of the economic costs and benefits of the Modification); and
- The economic activity impacts of the Modification (i.e. the economic activity that the Modification will provide to the local, regional or NSW economy).

The DP&I's draft guideline (James and Gillespie, 2002) identifies economic efficiency as the key consideration of economic analysis. Benefit Cost Analysis (BCA) is the method used to consider the economic efficiency of proposals. The draft guideline (James and Gillespie, 2002) identifies BCA as essential to undertaking a proper economic evaluation of proposed developments that are likely to have significant environmental impacts. The NSW Government (2012) draft *Guidelines for the use of Cost Benefit Analysis in mining and coal seam gas proposals* also identifies BCA as the appropriate method for evaluating mining proposals. This latter guideline does not provide guidance on other forms of economic assessment.

The NSW DP&I's draft *Guideline for Economic Effects and Evaluation in EIA* considers that regional economic impact assessment may provide additional information as an adjunct to the economic efficiency analysis. Economic stimulus to the region can be estimated using input-output modelling of the regional economy (regional economic impact assessment).

It is important not to confuse the results of the economic impact assessment, which focuses on indicators of economic activity i.e. direct and indirect output (expenditure/revenue), value-added, income and employment, in a specific region, with the results of BCA which is concerned with the net benefits from the modification.

This study relates to the preparation of each of the following types of analyses:

- A BCA of the Modification (Section 2); and
- An economic impact assessment of the Modification (Section 3).

# 2 BENEFIT COST ANALYSIS

## 2.1 INTRODUCTION

### Introduction

BCA has its theoretical underpinnings in neoclassical welfare economics. Applications in NSW are guided by these theoretical foundations as well as the NSW Treasury (2007). BCA applications within the NSW environmental assessment framework are further guided by the NSW DP&I *Draft Guidelines for Economic Effects and Evaluation in EIA* (James and Gillespie 2002) and the NSW Government (2012) *Draft Guidelines for the use of Cost Benefit Analysis in mining and coal seam gas proposals*.

BCA is concerned with a single objective of the EP&A Act and governments i.e. economic efficiency. It provides a comparison of the present value of aggregate benefits to society, as a result of a project, policy or program, with the present value of the aggregate costs. These costs and benefits are defined and valued based on the microeconomic underpinnings of BCA. In particular, it is the values held by individuals in the society that are relevant, including both financial and non-financial values. Provided the present value of aggregate benefits to society exceed the present value of aggregate costs (i.e. a net present value of greater than zero), a project is considered to improve the well-being of society and hence is desirable from an economic efficiency perspective.

While BCA can provide qualitative and quantitative information on how economic efficiency costs and benefits are distributed, welfare economics and BCA are explicitly neutral on intra and intergenerational distribution of costs and benefits. There is no welfare criterion in economics for determining what constitutes a fair and equitable distribution of costs and benefits. Judgements about equity are considered subjective and are therefore left to decision-makers.

Similarly, BCA does not address other objectives of the EP&A Act and governments. Decision-makers therefore need to consider the economic efficiency implications of a project, as indicated by BCA, alongside the performance of a project in meeting other conflicting goals and objectives of the EP&A Act and government.

### Definition of Society

BCA includes the consideration of costs and benefits to all members of society i.e. consumers, producers and the broader society as represented by the government.

As a tool of investment appraisal for the public sector, BCA can potentially be applied across different definitions of society such as a local area, state, nation or the world. However, most applications of BCA are performed at the national level. This national focus extends the analysis beyond that which is strictly relevant to a NSW government planning authority. However, the interconnected nature of the Australian economy and society creates significant spillovers between States. These include transfers between States associated with the tax system and the movement of resources over state boundaries.

Nevertheless, “where major impacts spill over national borders, then BCA should be undertaken from the global as well as the national perspective” (Boardman et al 2001). For mining projects, impacts that spill over national borders include greenhouse gas costs and benefits to foreign owners.

BCA at a sub-national perspective is not recommended as it results in a range of costs and benefits from a project being excluded, making BCA a less valuable tool for decision-makers (Boardman et al 2001).

BCAs of mining projects are therefore often undertaken from a global perspective i.e. including all the costs and benefits of a project, no matter who they accrue to, and then truncated to assess whether there are net benefits to Australia. A consideration of the distribution of costs and benefits can then be undertaken to identify the benefits and costs that accrue to NSW and other regions. However, a

project is considered to improve the well-being of society if it results in net benefits to the nation, even if it results in net costs to the local area.

**Definition of the Project Scope**

The definition of the project for which approval is being sought has important implications for the identification of the costs and benefits of a project. Even when a BCA is undertaken from a global perspective, and includes costs and benefits of a project that accrue outside the national border, only the costs and benefits associated with the defined project are relevant. For mining projects, typically only the costs and benefits from mining the coal and delivering it to Port or domestic users, are relevant.

Coal is an intermediate good i.e. it is an input to other production processes such as production of electricity and steel making. However, these other production processes themselves require approval and, in BCA, would be assessed as separate projects.

**Net Production Benefits**

BCA of mining proposals invariably involves a trade-off between:

- the net production benefits of a project; and
- the environmental, social and cultural impacts (most of which are costs of mining but some of which may be benefits).

Net production benefits can be estimated based on market data on the projected financial[3] value of coal less the capital and operating costs of projects, including opportunity costs of capital and land already in the ownership of mining companies. This is normally commercial in confidence data provided by the proponent. Production costs and benefits over time are discounted to a present value.

**Environmental, Social and Cultural Impacts**

The consideration of non-market impacts in BCA relies on the assessment of other experts contributing information on the biophysical impacts. The environmental impact assessment process results in detailed (non-monetary) consideration of the environmental, social and cultural impacts of a project and the proposed means of mitigating the impacts.

At its simplest level, BCA may summarise the consequences of the environmental, social and cultural impacts of a project (based on the assessments in the EA), for people's well-being. These qualitatively described impacts can then be considered alongside the quantified net production benefits, providing important information to the decision-maker about the economic efficiency trade-offs involved with a project.

At the next level of analysis, attempts may be made to value some of the environmental, social and cultural impacts. These environmental, social and cultural impacts generally fall into three categories, those which:

- "can be readily identified, measured in physical terms and valued in monetary terms;
- can be identified and measured in physical terms but cannot easily be valued in money terms; and
- are known to exist but cannot be precisely identified, measured or valued" (NSW Treasury 2007).

[3] In limited cases the financial value may not reflect the economic value and therefore it is necessary to determine a shadow price for the coal.

Impacts in the first and second category can potentially be valued in monetary terms using benefit transfer or, subject to available resources, primary non-market valuation methods. Benefit transfer involves using information on the physical magnitude of impacts and applying per unit value estimates obtained from non-market valuation studies undertaken in other contexts.

Primary non-market valuation methods include choice modelling and the contingent valuation method where a sample of the community is surveyed to ascertain their willingness to pay to avoid a unit change in the level of a biophysical attribute. Other methods include the property valuation approach where changes in environmental quality may result in changes in property value.

In attempting to value the impacts of a project on the well-being of people there is also the practical principle of materiality. Only those impacts which are likely to have a material bearing on the decision need to be considered in BCA (NSW Government, 2012).

Where benefits and costs cannot be quantified these items should be included in the analysis in a qualitative manner (NSW Treasury 2007).

**Consideration of Net Social Benefits**

The consideration of the net social benefits of a project combines the value estimate of net production benefits and the qualitative and quantitative estimates of the environmental, social and cultural impacts.

In combining these considerations it should be noted that the estimates of net production benefits of a project generally includes accounting for costs aimed at mitigating, offsetting or compensating for the main environmental, social and cultural impacts. This includes the costs of purchasing properties adversely affected by noise and dust, providing mitigation measures for properties moderately impacted by noise and dust, the costs of providing ecological offsets and the cost of purchasing groundwater and surface water entitlements in the water market etc. Including these costs effectively internalises the non-monetary environmental, social and cultural costs. To avoid double counting of impacts, only residual impacts, after mitigation, offset and compensation, require additional consideration.

Even when no quantitative valuation is undertaken of the environmental, social and cultural impacts of a project, the threshold value approach can be utilised to inform the decision-maker of the economic efficiency trade-offs. The estimated net production benefits of a project provides the threshold value that the non-quantified environmental, social and cultural impacts of a project (based on the assessments in the EA), after mitigation, offset and compensation by the proponent, would need to exceed for them to outweigh the net production benefits.

Where the main environmental, social and cultural impacts of a project are valued in monetary terms, stronger conclusions can be drawn about the economic efficiency of a project i.e. the well-being of society.

Any other residual environmental, cultural or social costs that remain unquantified in the analysis[4] can also be considered using the threshold value approach. The costs of these unquantified environmental, cultural and social impacts would need to be valued by society at greater than the quantified net social benefit of a project to make it questionable from an economic efficiency perspective.

[4] Including potential impacts that were unknown at the time of the preparation of the EIS or arise during the EIA process due to differences in technical opinions.

**Steps in BCA of the Modification**

BCA of the proposed Modification involves the following key steps:

- identification of the base case (the "without" Modification case, defined as the currently approved operations over time);
- definition of the "with" Modification case;
- identification and valuation of the incremental benefits and costs associated with the Modification relative to the base case;
- consolidation of value estimates using discounting to account for temporal differences;
- application of decision criteria;
- sensitivity testing; and
- consideration of non-quantified benefits and costs..

What follows is a BCA of the modification based on financial, technical and environmental advice provided by LCO and its' specialist consultants.

## 2.2 IDENTIFICATION OF THE BASE CASE AND THE MODIFICATION

Identification of the "base case" or "without" Modification scenario is required in order to facilitate the identification and estimation of the incremental economic benefits and costs of the Modification.

Under the base case, LCO would continue its current operation in accordance with development consent DA 305-11-01. This approval allows mining operations until 31 December 2023, producing up to 8 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal. Product coal, both thermal and semi-soft coal, is delivered to export markets via the Hunter Valley Rail Loop, Main Northern Railway Line and Newcastle Port. However, under current production rates mining would be completed in 2019.

In contrast, the key components of the Modification include the following:

- Expansion of the open cut mining footprint;
- Extension to the operation of the mine from 2019 to 2025;
- Recovery of an additional approximate 38 million tonnes of coal;
- Additional tailings emplacement area in the South Pit void;
- Continued coal processing at the LCO CHPP at the approved rate of up to 8 Mtpa;
- Minor additional infrastructure, including but not limited to, a conveyor, powerlines, water management infrastructure and haul roads.

BCA is primarily concerned with the evaluation of a Modification relative to the counterfactual of no Modification. Where there are a number of alternatives to a Modification then these can also be evaluated using BCA. However, alternatives need to be feasible to the proponent and to this end a number of alternatives to the Modification were considered by LCO in the development of the Modification description. Section 9 in the Main Volume of the EA provides more detail on the consideration of Modification alternatives.

The Modification assessed in the EA and evaluated in the BCA is considered by LCO to be the most feasible alternative for minimising environmental and social impacts whilst maximising resource recovery and operational efficiency. It is therefore this alternative that is proposed by LCO and was subject to detailed economic analysis.

## 2.3 IDENTIFICATION OF BENEFITS AND COSTS

Relative to the base case or "without" Modification scenario, the Modification may have the potential incremental economic benefits and costs shown in Table 2.1. The main potential economic benefit is the producer surplus (net production benefits) generated by the Modification and any non-market employment benefits it provides, while the main potential economic costs relate to any environmental, social and cultural costs.

**Table 2.1 – Potential Incremental Economic Benefits and Costs of the Modification**

| Category | Costs | Benefits |
|---|---|---|
| Net production benefits | Opportunity costs of capital<br>Opportunity cost of land<br>Development costs including acquisition costs for impacted properties and offsets<br>Operating costs of mine including mitigation measures<br>Rehabilitation and decommissioning costs at end of the Modification life | Avoided decommissioning and rehabilitation costs at end of current approval<br>Value of coal production<br>Residual value of capital and land at end of Modification life |
| Potential environmental, social and cultural impacts | Greenhouse gas impacts<br>Agricultural production<br>Noise impacts<br>Blasting impacts<br>Air quality impacts<br>Surface water impacts<br>Groundwater impacts<br>Ecology impacts<br>Road transport impacts<br>Aboriginal heritage impacts<br>Non-Aboriginal heritage impacts<br>Visual impacts | Any non-market benefits of employment |

It should be noted that the potential environmental, social and cultural costs, listed in Table 2.1, are only economic costs to the extent that they affect individual and community well-being through direct use of resources by individuals or non-use. If the potential impacts do not occur or are mitigated to the extent where community wellbeing is insignificantly affected (ie those bearing the costs are fully compensated), then no environmental, social or cultural economic costs should be included in the Modification BCA.

## 2.4 QUANTIFICATION/VALUATION OF BENEFITS AND COSTS

Consistent with NSW Treasury (2007) guidelines, NSW DP&I draft guidelines (James and Gillespie 2002) and NSW Government (2012) draft guidelines, the analysis has been undertaken in real values with discounting at 7 percent (%) and sensitivity testing at 4% and 10%. The analysis period is 13 years. Any costs or benefits that continue after this period are included in the final year of the analysis as present values. Where competitive market prices are available, they have generally been used as an indicator of economic values. Environmental, cultural and social impacts have been initially been left unquantified and interpreted using the threshold value method[5]. An attempt has also been made to estimate the main environmental, cultural and social impacts using market data and benefit transfer[6]. Where some impacts remain unquantified these have been interpreted using the threshold value method.

### 2.4.1 *Production Costs and Benefits*[7]

***Production Costs***

*Opportunity Cost of Land and Capital*

There is an opportunity cost associated with using land that is already in LCO ownership for the Modification instead of its next best use. An indication of the opportunity cost of this land can be gained from its market value, estimated at $17M.

No capital equipment that is already owned by LCO will be brought forward into the Modification and hence there are no opportunity costs of capital apart from that which is reflected in the prices paid for machinery purchased for the Modification and thus reflected in the development costs of the Modification.

*Development Cost of the Modification*

Development costs of the Modification are associated with the purchase of mining equipment, updating of the surface water management system, construction of new dewatering bores, construction of an explosive reload facility and other associated infrastructure. These costs include labour costs during the development of the Modification, which reflect the value of labour resources in their next best use.

These incremental development costs over the life of the Modification are estimated at $64 M. These capital costs include an allowance for acquisition of land for ecological offsets. Capital costs are included in the economic analysis in the years that that they are expected to occur.

*Annual Operating Costs of the Modification*

The operating costs of the Modification include those associated with mine operation (including topsoil and overburden stripping, ROM coal mining and haulage and rehabilitation), plant and infrastructure operations (including CHPP operation), coal delivery (rail freight and Port handling and loading) and general costs (including overheads and administration, marketing and the research levy). These costs include labour costs, which reflect the value of labour resources in their next best use.

While royalties are a cost to LCO, they are part of the overall net production benefit of the mining activity that is redistributed by government. Royalties are therefore not included in the calculation of

[5] The threshold value method uses the value of quantified net production benefits as the amount that unquantified environmental, social and cultural costs would need to exceed to make a project questionable from an economic efficiency perspective.
[6] Benefit transfer refers to borrowing economic values that have been determined for other study sites.
[7] All values reported in this section are undiscounted Australian dollars unless otherwise specified.

the resource costs of operating the Modification. Nevertheless, it should be noted that the Modification would generate total royalties in the order of $245M ($134M present value).

Depreciation has also been omitted from the estimation of operating costs since depreciation is an accounting means of allocating the cost of a capital asset over the years of its estimated useful life. The economic capital costs are included in the years in which they occur.

*Rehabilitation and Decommissioning Costs*

Annual rehabilitation costs are included in the operating costs for the Modification reported above. A provision for final site decommissioning and rehabilitation works of $45M has also been included in the analysis.

***Production Benefits***

*Value of Coal*

Total ROM coal production is estimated at up to 38 Mt with peak production at 8 Mtpa ROM. Product coal is a mix of both semi soft coal and thermal coal.

Both demand for and supply of thermal coal influences current and projected prices.

Projected revenue for the sale of semi soft coal and thermal coal was provided by LCO and included in the BCA. There is uncertainty around future coal prices (valued in USD) as well as the AUD/USD exchange rate and hence assumed coal prices have been subjected to sensitivity testing (see Section 2.6).

*Avoided Rehabilitation and Decommissioning Costs*

Extension of the mine life will result in avoidance of $40M of site decommissioning and rehabilitation costs in 2020. This is an economic benefit of the Modification.

*Residual Value at End of the Evaluation Period*

At the end of the Modification, capital equipment and land may have some residual value that could be realised by sale or alternative use. This residual value is estimated at $17M for capital equipment and $17M for land.

### 2.4.2 *Environmental, Social and Cultural Costs and Benefits*

***Greenhouse Gases***

The Modification combined with the existing approval is predicted to generate in the order of 4.4 Mt of direct carbon dioxide equivalent ($CO_2$-e) emissions associated with mining (Scope 1 emissions) over the lifetime of the Modification (PAE Holmes 2013). Approximately 0.2 Mt of indirect (Scope 2) $CO_2$-e emissions associated with on-site electricity consumption and 0.6 Mt of indirect (Scope 3) $CO_2$-e emissions associated with the transport of product coal to Newcastle and on-site diesel and electricity use would also be generated over the lifetime of the Modification[8]. The economic analysis is only concerned with the incremental greenhouse gas emissions that would arise from the Modification. These have been estimated on the basis of the ROM production of the Modification and included in the BCA as an environmental cost of the Modification.

[8] Scope 3 omissions associated with the burning of coal are beyond the scope of a BCA of a mining project.

To place an economic value on $CO_2$-e emissions, a shadow price of $CO_2$-e is required that reflects its global social costs. The global social cost of $CO_2$-e is the present value of additional economic damages now and in the future caused by an additional tonne of $CO_2$-e emissions. There is great uncertainty around the global social cost of $CO_2$-e with a wide range of estimated damage costs reported in the literature. An alternative method to trying to estimate the global damage costs of $CO_2$-e is to examine the price of $CO_2$-e credits/taxes. Again, however, there is a wide range of prices. For this analysis, a shadow price of AUD$23/t $CO_2$-e rising at 2.5 per cent per year in real terms for three years and then remaining constant, was used. Sensitivity testing assuming a shadow price from AUD$8/t $CO_2$-e to AUD$40/t $CO_2$-e was also undertaken (refer to Attachment 1).

This represents the global social cost of carbon i.e. the cost of carbon emissions to the population of the whole world. In the absence of any studies that have focused on the social damage cost of carbon emissions to Australians, some means of apportioning global damage costs borne by Australians is required. For the purpose of the economic assessment this has been undertaken using Australia's share of global GDP (around 1%). An alternative approach would be Australia's share of world population which is considerably less than 1%.

***Agricultural Production***

The present value of foregone agricultural production is reflected in land prices. The value of any foregone agricultural production, as a result of the Modification, has therefore been incorporated in the BCA through inclusion of the full value of land required for the Modification (both the opportunity cost of land already in LCO ownership and the capital cost of land that will be acquired).

***Operational Noise***

Mining

Noise modelling under neutral atmospheric conditions identifies that noise levels would be significantly less than the Project Specific Noise Criteria (PSNC) at all identified receptor locations. However, noise modelling under enhanced meteorological conditions indicates that two private receivers would experience minor (1-2 db) exceedances of the PSNC during the evening and night period and that one receivers would experience minor (1-2 dB) exceedances of the PSNC during night periods.

The impact of the Modification noise on nearby properties can potentially be valued using the property value method, where the change in property value as a result of the noise impacts are estimated. However, given the minor potential exceedances would only occur under enhanced meteorological conditions, the impact on private receivers is likely to be negligible. No economic cost is therefore included in the BCA.

In addition, the Liddell Recreation Area (owned by Macquarie Generation) is predicted to experience moderate exceedances of the PSNC during the day and evening and moderate to significant exceedances at night. This could potentially have some impacts on the owners and users of this area. However, this impact remains unquantified in this analysis.

Road and Rail Noise

Employees and contractors primarily utilise the New England Highway and usage as a result of the Modification will be a fraction of the overall usage of the New England Highway. Incremental noise impacts as a result of continuation of current usage levels for a 5-year period and some additional construction workforce is therefore predicted to be negligible. Consequently, no economic effects have been included in the BCA.

The modification would result in a continuation of existing rail movements for a period of up to 5 years. Compared to early cessation of existing rail movements, continuation of rail movements for this time

period is predicted to have negligible impact on receivers along the rail corridor. Consequently, no economic costs have been included in the BCA for rail noise impacts.

***Blasting***

Blasting at the Modification has the potential to cause structural damage or human discomfort at properties surrounding the Modification. The blasting assessment found that historical blasting has exceeded the upper limit criterion four times in the last five years at two properties, with the frequency trend declining.

Exeedance of blasting criteria can potentially be valued using the property value method, where the change in property value as a result of the blasting impacts, are estimated. The existence of exceedances suggests there may be some potential property value impacts. However, the infrequency of the impacts i.e. less than once a year, suggest that these would be insignificant.

Consequently, no economic costs have been included in the BCA for blasting impacts.

***Air Quality***

Air quality modelling indicates that there will be no exceedances of the annual average PM10, TSP or dust deposition criteria as a result of the Modification for LCO alone, or cumulatively. One property is predicted to be impacted by the cumulative 24-hour average PM10 criteria with the existing activities in the area, rather than the Modification, being the main contributors. The property affected would be impacted on only one day per year and impacts would become less as the mine progresses to the southeast. Consequently, the impact can be considered to be minor.

Predictions of 24-hour and annual average PM2.5 concentrations of the proposed Modification show that the levels predicted are well below the relative advisory standards for both 24-hour and annual averaging periods. Predicted annual average PM2.5 concentrations are all below 1 µg/m3, and in most cases the levels are below the level which could be detected by monitoring.

Consequently, no air quality impacts are included in the BCA.

***Surface Water***

The Modification will require LCO to continue to hold 277 ML/ year of surface water licences that it already owns for an additional five years. Some of these licences may also be required to be held for a longer periods, pending stabilisation of the final landform. Conservatively, these water licences are assumed to continue to be held by LCO in perpetuity. The opportunity cost of holding these licences has been included in the BCA by applying an assumed market value of water of $2,000/ML.

In addition, the Modification is predicted to result in an increase in leakage from the Bowmans Creek alluvial aquifer, peaking at approximately 270 ML/year at the end of mining in the Entrance Pit. LCO currently holds access licence allocations of 142 ML/year for this water source. It is anticipated that LCO will be required to purchase additional licences of approximately 128 ML/yr to account for this increase, and the cost of this has been included in the BCA.

***Groundwater***

The Modification will require LCO to continue to hold groundwater licences that it already owns. The majority of these groundwater licences relate to saline water from deep hard rock aquifers and so have negligible economic value. However, 5 ML relates to water that could otherwise be used for irrigation purposes. There is an opportunity cost of continuing to hold this licence for mining purposes. This opportunity cost has been included in the BCA by applying and assumed market value of $2,000/ML.

The predicted zone of depressurisation due to the Modification will not result in any reduction in the water level in any nearby privately owned bores. Consequently, no additional economic effects are included in the BCA.

***Ecology***

The Modification Disturbance Boundary will result in the clearing of 188 ha native vegetation including 56 ha of Endangered Ecological Communities (EEC).

A Biodiversity Offset Package (BOP) is proposed that includes the protection and enhancement of native vegetation and threatened species habitat, to develop a positive long-term outcome for the threatened species and key ecological features affected by the Project.

Land opportunity costs and operational expenditure associated with the biodiversity offset areas have been included in the development and operating costs of the Modification.

The impacted vegetation, and associated fauna, is likely to have non-use values to the community that would be lost as a result of the Modification. These values could potentially be estimated using non-market valuation methods. Similarly, the provision of offsets is also likely to have non-use values to the community that would be gained as a result of the Modification. Provided the values held by the community for the offsets are equal or greater than values that would be lost then no additional economic costs warrant inclusion in the BCA. In this respect, it is noted that the BOP is required to improve or at least maintain biodiversity values.

***Road Transport***

The Modification will involve some increase in traffic movements associated with:

- a maximum 12 week construction period;
- extension of the length of the currently approved haulage route by 1.5km to the Ravensworth CHPP; and
- extension of the life of the LCO operations which will necessitate staff vehicle movements for a number of years beyond the mine life of the current approval.

Parsons Brinkerhoff (2013) concludes that the traffic impacts associated with the construction period would be negligible, particularly as some of the construction activities will be undertaken by the current workforce.

Extension of the currently approved haul road will result in limited conflicting movements at the Ravensworth CHPP access points for vehicles turning right in/left out of the site (Parsons Brinkerhoff 2012).

No intersection upgrades are required as a consequence of the Modification and impacts from an extension of the life of the LCO are considered to be minimal (Parsons Brinkerhoff 2012).

Consequently, no costs are included in the BCA.

***Aboriginal Heritage***

Aboriginal archaeology assessment identified 25 sites that will be impacted by the Modification including six sites that have been the subject of a previous section 90 application to destroy. Consequently, the number of Aboriginal sites that will be impacted by the Modification (either partially or completely) is 19. Five of these sites have been identified as being of moderate scientific significance with the rest of the sites having low scientific significance.

Any impacts on Aboriginal heritage sites may impact the well-being of the Aboriginal community. However, monetisation of these impacts is problematic and so these impacts are best left to consideration as part of the preparation of the Aboriginal Heritage Impact Assessment.

Impacts on highly significant Aboriginal heritage sites have also been shown to affect the well-being of the broader community (Gillespie Economic 2009a, 2009b, 2010). However, no highly scientific significant Aboriginal heritage sites are predicted to be directly or indirectly impacted by the Project. Consequently, no economic implications associated with Aboriginal heritage have been included in the BCA.

***Non-Aboriginal Heritage***

One item of historical significance, the Chain of Ponds Inn, is located within approximately 65 m of the limit of open cut mining associated with the South Pit Extension. This item is listed on the Register of the National Estate and the State Heritage Register and has been identified as having both State and local heritage significance.

As part of the Environmental Assessment Process, a Blast Impact Strategy has been developed to ensure that the potential for impacts on the building as a result of blasting are minimised. The costs of these mitigation works are included in the capital and operating costs of the Modification above. The Heritage Assessment concluded that none of the proposed works would have an impact on the aesthetics, current function or historical significance of the Inn and its associated structures. Consequently, no other economic costs have been included in the BCA.

***Visual Impacts***

The visual assessment predicted that the impact of the Modification would be minimal due to topography, existing vegetation and because the mine would be progressing in a south easterly direction away from the nearest residences, which are located to the north east/north west of LCO. Consequently, no economic costs have been included in the BCA.

***Non-market Value of Employment***

Historically employment benefits of projects that are enjoyed by people other than those who are employed, have tended to be omitted from BCA on the implicit assumption that labour resources used in a proposal would otherwise be employed elsewhere and that there are no costs associated with transferring from one job to another. Where this is not the case and labour resources would otherwise be unemployed for some period of time, Boardman et al (2001) identifies that these labour resources should be valued in a BCA at their opportunity cost (e.g. wages less social security payments and income tax) rather than the wage rate. Adopting this approach would have the effect of increasing the net production benefits of the proposal. In addition, there may be social costs of unemployment that require the estimation of employees' willingness to pay to avoid the trauma created by unemployment (Streeting and Hamilton, 1991). These values have not been included in the Modification BCA and so the net social benefits of the Modification may be underestimated.

Although employees' willingness to pay to avoid the trauma created by unemployment are omitted from the Modification BCA, it has also been recognised that the broader community may hold non-market values (Portney, 1994) for social outcomes such as employment (Johnson and Desvouges, 1997).

In a study of the Metropolitan Colliery in the NSW Southern Coalfields, Gillespie Economics (2008) estimated the value the community would hold for the 320 jobs provided over 23 years at $756M (present value). In a similar study of the Bulli Seam Operations, Gillespie Economics (2009a) estimated the value the community would hold for the 1,170 jobs provided over 30 years at $870M

(present value). In a study of for the Warkworth Mine extension, Gillespie Economics (2009b) estimated the value the community would hold for 951 jobs from 2022 to 2031 at $286M (present value).

The Modification will directly employ up to 360 people for approximately 7 years. Using benefit transfer from the more conservative Bulli Seam Operation study and applying the employment value to the estimated incremental direct employment of the Modification[9] gives an estimated $46M for the non-market employment benefits of the Modification. This value has been included in the BCA. In the context of a fully employed economy and a different project context to the source study[10] there may be some contention about the inclusion of this value. Consequently, the results are reported with and without these values.

## 2.5 CONSOLIDATION OF VALUE ESTIMATES

### 2.5.1 Aggregate Costs and Benefits

The present value of costs and benefits, using a 7% discount rate, is provided in Table 2.2. The main decision criterion for assessing the economic desirability of a project to society is its net present value (NPV). NPV is the present value of benefits less the present value of costs. A positive NPV indicates that it would be desirable from an economic perspective for society to allocate resources to the project, because the community as a whole would obtain net benefits from the project.

The Modification is estimated to have total net production benefits of $742M. Assuming 100% foreign ownership, $316M of these net production benefits would accrue to Australia. The estimated net production benefits that accrue to Australia can be used as a threshold value or reference value against which the relative value of the residual environmental impacts of the Modification, after mitigation, may be assessed. This threshold value is the opportunity cost to society of not proceeding with the Modification. The threshold value indicates the price that the community must value any residual environmental impacts of the Modification (be willing to pay) to justify in economic efficiency terms the no development option.

For the Modification to be questionable from an economic efficiency perspective, all incremental residual environmental impacts from the Modification, that impact Australia[11], would need to be valued by the community at greater than the estimate of the Australian net production benefits i.e. greater than $316M. This is equivalent to each household in the Singleton, Muswellbrook and Upper Hunter local government areas (LGAs) valuing residual environmental impacts at $15,600. The equivalent figure for NSW and Australian households is $120 and $38, respectively.

Instead of leaving the analysis as a threshold value exercise, an attempt has been made to qualitatively consider and where possible quantify the main environmental, cultural and social impacts. From Section 2.4 it is evident that the main potential impacts of the Modification are internalised into the production costs of the Modification through mitigation measures and compensation costs. Other costs not already included in the production costs of the Modification include those associated with opportunity cost of water and greenhouse gas costs, although from Table 2.2 it is evident that these impacts to Australia are small, considerably less than the estimated net production benefits of the Modification to Australia. There may also be non-market benefits from the employment provided by the Modification.

Overall, the Modification is estimated to have net social benefits to Australia of between $315M and $362M, and hence is desirable and justified from an economic efficiency perspective.

[9] This is consistent with the non-market valuation studies which focused on direct employment.
[10] The source study was concerned with a continuation of an existing underground mine rather than a new open cut mine.
[11] Consistent with the approach to considering net production benefits, environmental impacts that occur outside Australia would be excluded from the analysis. This is mainly relevant to the consideration of greenhouse gas impacts.

While the major environmental, cultural and social impacts have been quantified and included in the Modification BCA, any other residual environmental, cultural or social impacts that remain unquantified would need to be valued at greater than between $315M and $362M for the Modification to be questionable from an Australian economic efficiency perspective.

**Table 2.2**
**Benefit Cost Analysis Results of the Modification (Present Values @7% discount rate)**

| | Costs | | Benefits | |
|---|---|---|---|---|
| | **Description** | **Value ($M)** | **Description** | **Value ($M)** |
| **Production** | Opportunity cost of capital | $0 | Avoided decommissioning and rehabilitation costs in 2020 | $23 |
| | Opportunity cost of land | $10 | Value of coal | $1,633 |
| | Development costs | $46 | Residual value of capital | $7 |
| | Operating costs | $853 | Residual value of land | $7 |
| | Decommissioning and rehabilitation costs | $19 | | |
| | ***Sub-total*** | ***$928*** | ***Sub-total*** | ***$1,670*** |
| | **Net Production Benefits** | | | **$742 ($316)** |
| **Environmental, cultural and social impacts** | Greenhouse gas impacts | $38($0.4) | Non-market values of employment | $46 |
| | Agricultural impacts | Included in opportunity cost of land and capital costs (land acquisitions) | | |
| | Noise impacts | Insignificant* for private receptors.<br><br>Impact on Liddell Recreation Area unquantified. | | |
| | Blasting | Insignificant* | | |
| | Air quality impacts | Insignificant* | | |
| | Surface water | $0.6 | | |
| | Groundwater | $0.01 | | |
| | Ecology | Some loss of values but offset. Cost of biodiversity offset included in capital costs and operating costs | | |
| | Road transport impacts | Insignificant* | | |
| | Aboriginal heritage | Insignificant* | | |
| | Non-Aboriginal heritage impacts | Insignificant* | | |
| | Visual impacts | Insignificant* | | |
| | ***Non-market impacts sub-total*** | ***$39 ($1)*** | | ***$46*** |
| **NET SOCIAL BENEFITS – including employment benefits** | | | | **$750 ($362)** |
| **NET SOCIAL BENEFITS – excluding employment benefits** | | | | **$703 ($315)** |

*from an aggregate economic efficiency perspective
Note: totals may have minor discrepancies due to rounding.
When impacts accrue globally, the numbers in brackets relates to the level of impact estimated to accrue to Australia

### 2.5.2 Distribution of Costs and Benefits

***Introduction***

As identified in Section 2.1, BCA is only concerned with the single objective of economic efficiency. BCA and welfare economics provide no guidance on what is a fair, equitable or preferable distribution of costs and benefits. Nevertheless, BCA can provide qualitative and quantitative information for the decision-maker on how economic efficiency costs and benefits are distributed (Table 2.3).

***Intra Generational***

The net production benefit of the Modification is distributed amongst a range of stakeholders including:

- The Commonwealth Government in the form of any Company tax payable ($182M present value) which is subsequently used to fund provision of government infrastructure and services across Australia and NSW, including the local and regional area;
- The NSW Government via royalties ($134M present value) which are subsequently used to fund provision of government infrastructure and services across the State, including the regional area;
- LCO shareholders in the form of after tax (and after voluntary contributions) profits; and
- The local community in the form of any voluntary contributions to community infrastructure and services.

The environmental, cultural and social impacts of the Modification may potentially accrue to a number of different stakeholder groups at the local, State, National and global level.

Any residual noise costs will occur at a local level. Surface water and groundwater use will impact at the local level but has been paid for through the acquisition of water entitlements. Greenhouse gas costs will occur at the national and global level and will be internalised through payment of the Commonwealth Government's carbon tax. The potential bearers of these costs are therefore compensated via the payment to the Commonwealth Government. The clearing of native vegetation will potentially impact households at the local, State and National level who hold values for the impacted flora and fauna. However, compensation will be made in the form of a biodiversity and rehabilitation offsets package. Other potential environmental impacts would largely occur at the local level and were found to be insignificant from an aggregate economic efficiency perspective. Any non-market benefits associated with employment provided by the Modification would largely accrue at the local or State level[12].

[12] It should be noted that the study from which the employment values were transferred, surveyed NSW households only.

**Table 2.3 - Distribution of Benefits and Costs (Present Values at 7% Discount Rate)**

| Value ($M) | | Distribution | | | |
|---|---|---|---|---|---|
| | | Local | State | National | Global |
| **Net Production Benefits** | | | | | |
| Net production benefits to proponent | $426 | ✓ | ✓ | ✓ | ✓ |
| Net production benefits to Commonwealth Government – Company tax | $182 | ✓ | ✓ | ✓ | - |
| Net production benefits to NSW Government – Royalties | $134 | ✓ | ✓ | - | - |
| Net production benefits to local and regional community in the form of voluntary contributions | Unquantified | ✓ | - | - | - |
| ***Total*** | ***$742*** | | | | |
| **Non-market Costs and Benefits** | | | | | |
| ***Benefits*** | | | | | |
| Non-market benefit of employment | $46 | ✓ | ✓ | - | - |
| ***Total*** | ***$46*** | | | | |
| | | | | | |
| ***Costs*** | | | | | |
| Greenhouse gas emissions rest of the world[1] | $38 | - | - | - | ✓ |
| Greenhouse gas emissions Australia[2] | $0.4 | ✓ | ✓ | ✓ | |
| Agricultural impacts | Included in opportunity cost of land and capital costs (land acquisitions) | ✓ | - | - | - |
| Noise impacts | Insignificant* for private receptors.<br><br>Impact on Liddell Recreation Area unquantified. | ✓ | - | - | - |
| Blasting | Insignificant* | ✓ | - | - | - |
| Air quality impacts | Insignificant* | ✓ | - | - | - |
| Surface water | $0.6 | ✓ | - | - | - |
| Groundwater | $0.01 | ✓ | - | - | - |
| Ecology | Some loss of values but offset. Cost of biodiversity offset included in capital costs and operating costs | ✓ | ✓ | ✓ | - |
| Road transport impacts | Insignificant* | ✓ | - | - | - |
| Aboriginal heritage | Insignificant* | ✓ | ✓ | ✓ | - |
| Non-Aboriginal heritage impacts | Insignificant* | ✓ | ✓ | ✓ | - |
| Visual impacts | Insignificant* | ✓ | - | - | - |
| ***Total*** | ***$39*** | | | | |
| **Net Social Benefits** | **$750** | | | | |

*From an aggregate economic efficiency perspective

Note: Totals may have minor discrepancies due to rounding.

The residual non-market costs that have been quantified and accrue to NSW are estimated at less than $1M. This is considerably less than the net production benefits that directly accrue to NSW through royalties ($134M). NSW will obtain additional benefits through voluntary contributions to the local and regional community and infrastructure and services provided with a share of Commonwealth Government Company tax. There are also additional benefits to NSW from the potential non-market employment benefits ($46M). Consequently, as well as resulting in net social benefits to Australia the Modification would result in net social benefits to NSW.

***Intergenerational***

Some of the environmental, social and cultural impacts of the Modification may be felt by future generations. This is particularly the case for non-market environmental impacts. However, as identified above BCA is not concerned with distributional issues. The consideration of intergenerational equity issues is therefore outside the scope of BCA.

However, it should be noted that the costs and benefits in BCA are defined and valued based on the microeconomic underpinnings of BCA. They are based on the values held by individuals in the society i.e. current generations. There is no way to measure the value that future generations hold for impacts of current day projects as they are not here to express it.

Nevertheless, as identified by Boardman et al (2001) this is not considered a serious problem for BCA because:

- few policies involve impacts that only appear in the far future. Consequently, the willingness to pay of people alive today can be used to predict how future generations will value them;
- most people alive today care about the well-being of their children, grandchildren , and great grandchildren, whether or not they have yet been born. They are therefore likely to include the interests of these generations to some extent in their own valuations of impacts. Because people cannot predict with certainty the place that their future offspring will hold in society, they are likely to take a very broad view of future impacts; and
- discounting used in BCA also reduces the influence of costs and benefits that occur a long way into the future.

Furthermore, increased wealth (e.g. royalties and taxes) generated by projects that have a net benefit to the community can be used to improve the services (e.g. health, school and community services) and environment (e.g. protected areas) that are passed on to future generations.

## 2.6 SENSITIVITY ANALYSIS

This NPV presented in Table 2.2 is based on a range of assumptions around which there is some level of uncertainty. Uncertainty in a BCA can be dealt with through changing the values of critical variables in the analysis (James and Gillespie, 2002) to determine the effect on the NPV.

In this analysis, the BCA result was tested for 20% (+ and -) changes to the following variables at a 4%, 7% and 10% discount rate:

- Opportunity costs of land;
- Capital costs;
- Operating costs;
- Decommissioning and rehabilitation costs;
- Value of coal;
- Greenhouse costs;
- Surface and groundwater impacts;
- Residual value of capital and land; and
- Non-market employment impacts.

What this analysis indicates (refer to Attachment 2) is that the results of the BCA are not sensitive to the changes made in assumptions regarding any of these variables. In particular, significant increases in the values used for external impacts such as greenhouse gas costs or surface water and groundwater costs did not change the positive sign of the net present value of the Modification BCA. Hence the Modification's desirability from an economic efficiency perspective is not changed.

The results were most sensitive to any potential decreases in the sale value of coal. A sustained reduction in coal price (60%) would be required to make the Modification inefficient.

# 3 ECONOMIC IMPACT ASSESSMENT

## 3.1 INTRODUCTION

The BCA in Section 2 is concerned with whether the incremental benefits of a project exceed the incremental costs and therefore whether the community would, in aggregate, be better off 'with' the project compared to 'without' it. In contrast, the focus of the regional economic impact assessment is the effect (impact) of a project on the economy in terms of a number of specific indicators of economic activity, such as gross regional output, value-added, income and employment.

These indicators can be defined as follows:

- ***Gross regional output*** – the gross value of business turnover;
- ***Value-added*** – the difference between the gross regional output and the costs of the inputs of raw materials, components and services bought in to produce the gross regional output;
- ***Income*** – the wages paid to employees including imputed wages for self-employed and business owners; and
- ***Employment*** – the number of people employed (including full-time and part-time).

An impacting agent may be an existing activity within an economy or may be a change to an economy (Powell *et al.,* 1985; Jensen and West, 1986). This assessment is concerned with the economic impact of average annual production over 7 years of the Modification.

## 3.2 ECONOMIES

The economy on which the impact is measured can range from a township to the entire nation (Powell *et al.,* 1985). In selecting the appropriate economy, regard needs to be had to capturing the local expenditure and employment associated with the production scenarios, but not making the economy so large that the impact of the proposal becomes trivial (Powell and Chalmers, 1995). For this study, the economic impacts have been estimated for two regions:

- The regional economy comprising the Local Government Areas (LGAs) of Muswellbrook, Singleton and Upper Hunter Shire; and
- The NSW economy.

## 3.3 METHOD OF ASSESSMENT

A range of methods can be used to examine the economic impacts of an activity on an economy including economic base theory, Keynesian multipliers, econometric models, mathematical programming models and input-output models (Powell *et al.,* 1985).

Economic base theory and Keynesian multipliers are relatively simple approaches that provide impact measurement only in aggregate terms. Mathematical programming models are especially useful in micro-level studies of firms and industries but become complex for whole economies. Mathematical programming models are therefore sometimes used to estimate direct effects on an industry or sector with input-output analysis used to assess economy-wide effects. Econometric models, particularly those of the general equilibrium type, have the potential to measure economic impacts in a similar way to that of input-output models with relaxation of some of the limitations of input-output analysis (Powell *et al.,* 1985).

Consistent with the DP&I's draft guideline, this study uses input-output analysis. The input-output method is based on a number of assumptions that are outlined in Attachment 3 and result in the estimated impacts being an upper bound impact estimate.

One of the key simplifying assumptions of input-output analysis is that there is unlimited labour and capital available to the region at fixed prices and therefore regional economic activity does not face capacity constraints that would result in increases in prices and crowding-out of other economic activity.

Crowding out would be most prevalent if the regional economy was at full employment and it was a closed economy with no potential to use labour and other resources that currently reside outside the region. In this situation a mining project requiring labour and other resources would compete for them with existing activities. However, the Hunter Region is not at full employment and is not a closed economy. It has potential access to employed and unemployed labour and capital resources from across the country and overseas. Even where a mining project utilises already employed labour resources from inside the region, there is a filter effect where these jobs are filled by other employed or unemployed labour resources[13], which creates vacancies that are then filled by other employed or unemployed labour resource[14] etc, with these employed and unemployed labour resources[15] coming from both inside or outside the region. The potential labour force to meet demand in the region is considerably greater than just the labour force in the region and hence from a regional perspective is virtually unlimited. Consequently, for small open economies, crowding out of other economic activity is likely to be negligible.

While more complex models such as Computable General Equilibrium (CGE) modelling can conceptually deal with the positive economic activity impacts of a project and any partially offsetting negative economic activity impacts, for small regional economies, it is unlikely that these more complex models will surpass the simpler input-output model. Firstly, the small open economy condition minimises the need to address offsetting impacts. Secondly, given the considerable difficulties associated with estimating a large number of coefficients and parameters required for CGE models when there is virtually no local data available, many exogenous assumptions are required to be made by the modeller and so the increased 'fuzziness' is likely to more than offset the increase in model sophistication. Consequently, CGE models are mostly used at the State and National level for large scale policy issues.

Input-output analysis essentially involves two steps:

- Construction of an appropriate input-output table (regional transaction table) that can be used to identify the economic structure of the region and multipliers for each sector of the economy; and
- Identification of the initial impact or stimulus of a project (construction and/or operation) in a form that is compatible with the input-output equations so that the input-output multipliers and flow-on effects can then be estimated (West, 1993).

Input-output analysis reports multipliers which are summary measures used for identifying the total impact on all industries in an economy from changes in the demand for the output of any one industry (ABS, 1995). There are many types of multipliers that can be generated from input-output analysis (refer to Attachment 3). Type 11A ratio multipliers (the kind reported in this assessment) summarise the total impact on all industries in an economy in relation to the initial own sector effect e.g. total income effect from an initial income effect and total employment effect from an initial employment effect, etc.

[13] Including the continual addition to the labour force from school leavers, TAFE and University graduates and potentially those not currently seeking employment.
[14] Including the continual addition to the labour force from school leavers, TAFE and University graduates and potentially those not currently seeking employment.
[15] Including the continual addition to the labour force from school leavers, TAFE and University graduates and potentially those not currently seeking employment.

The input-output method is based on a number of assumptions that are outlined in Attachment 3, and result in estimated impacts being an upper bound impact estimate. Key terminology used in the input-output assessment is also explained in Attachment 3.

### 3.4 INPUT-OUTPUT TABLES AND ECONOMIC STRUCTURE OF THE REGION

A 2012 input-output table of the local and regional economy was developed using the Generation of Input-Output Tables (GRIT) procedure (Attachment 4) using an input-output table of the NSW economy (developed by Monash University) as the parent table. The 109 sector input-output table of the regional economy was aggregated to 30 sectors and 6 sectors for the purpose of describing the economy.

Highly aggregated 2012 input-output tables for the regional economy is provided in Table 3.1. The rows of the table indicate how the gross regional output of an industry is allocated as sales to other industries, to households, to exports and other final demands (OFD - which includes stock changes, capital expenditure and government expenditure). The corresponding column shows the sources of inputs to produce that gross regional output. These include purchases of intermediate inputs from other industries, the use of labour (household income), the returns to capital or other value-added (OVA - which includes gross operating surplus and depreciation and net indirect taxes and subsidies) and goods and services imported from outside the region. The number of people employed in each industry is also indicated in the final row.

**Table 3.1 - Aggregated Transactions Table: Regional Economy 2012 ($'000)**

| | Ag, forestry, fishing | Mining | Manuf. | Utilities | Building | Services | TOTAL | Household Expenditure | OFD | Exports | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Ag, forestry, fishing | 24,250 | 171 | 70,285 | 7 | 241 | 3,596 | 98,549 | 8,021 | 68,101 | 200,562 | 375,233 |
| Mining | 42 | 192,113 | 6,276 | 60,867 | 1,722 | 1,150 | 262,170 | 374 | -173,849 | 5,012,765 | 5,101,460 |
| Manuf. | 13,759 | 97,101 | 126,741 | 3,743 | 36,284 | 72,799 | 350,428 | 48,118 | 205,079 | 736,066 | 1,339,690 |
| Utilities | 2,777 | 34,280 | 16,598 | 473,737 | 4,018 | 22,337 | 553,747 | 18,614 | 12,125 | 413,115 | 997,601 |
| Building | 2,152 | 33,922 | 2,022 | 11,336 | 108,610 | 32,712 | 190,753 | 0 | 426,398 | 18,364 | 635,515 |
| Services | 25,970 | 176,752 | 141,818 | 18,493 | 56,814 | 372,600 | 792,446 | 422,470 | 583,047 | 837,744 | 2,635,708 |
| **TOTAL** | 68,949 | 534,338 | 363,739 | 568,184 | 207,690 | 505,193 | 2,248,093 | 497,597 | 1,120,901 | 7,218,616 | 11,085,207 |
| Household Income | 109,263 | 682,120 | 263,658 | 73,109 | 167,962 | 1,049,953 | 2,346,066 | 0 | 0 | 0 | 2,346,066 |
| OVA | 75,587 | 3,158,100 | 122,492 | 173,655 | 64,873 | 237,214 | 3,831,920 | 93,353 | 39,633 | 12,974 | 3,977,881 |
| Imports | 121,433 | 726,901 | 589,802 | 182,653 | 194,990 | 843,348 | 2,659,127 | 1,100,964 | 212,941 | 511,754 | 4,484,786 |
| **TOTAL** | 375,233 | 5,101,460 | 1,339,690 | 997,601 | 635,515 | 2,635,708 | 11,085,207 | 1,691,914 | 1,373,475 | 7,743,344 | 21,893,940 |
| **Employment** | 2,127 | 8,037 | 2,550 | 783 | 1,707 | 13,455 | 28,660 | | | | |

Value-added for the regional economy is estimated at $6,324M, comprising $2,346M to households as wages and salaries (including payments to self employed persons and employers) and $3,978M in OVA.

The employment total working in the regional economy was 28,660.

The economic structure of the regional economy can be compared with that for NSW through a comparison of results from the respective input-output models (Figures 3.1 and 3.2). This reveals that the agriculture, mining and utilities sectors in the regional economy are of greater relative importance than they are to the NSW economy, while the manufacturing, building and services are of less relative importance than they are to the NSW economy.

**Figure 3.1 - Summary of Aggregated Sectors: Regional Economy**

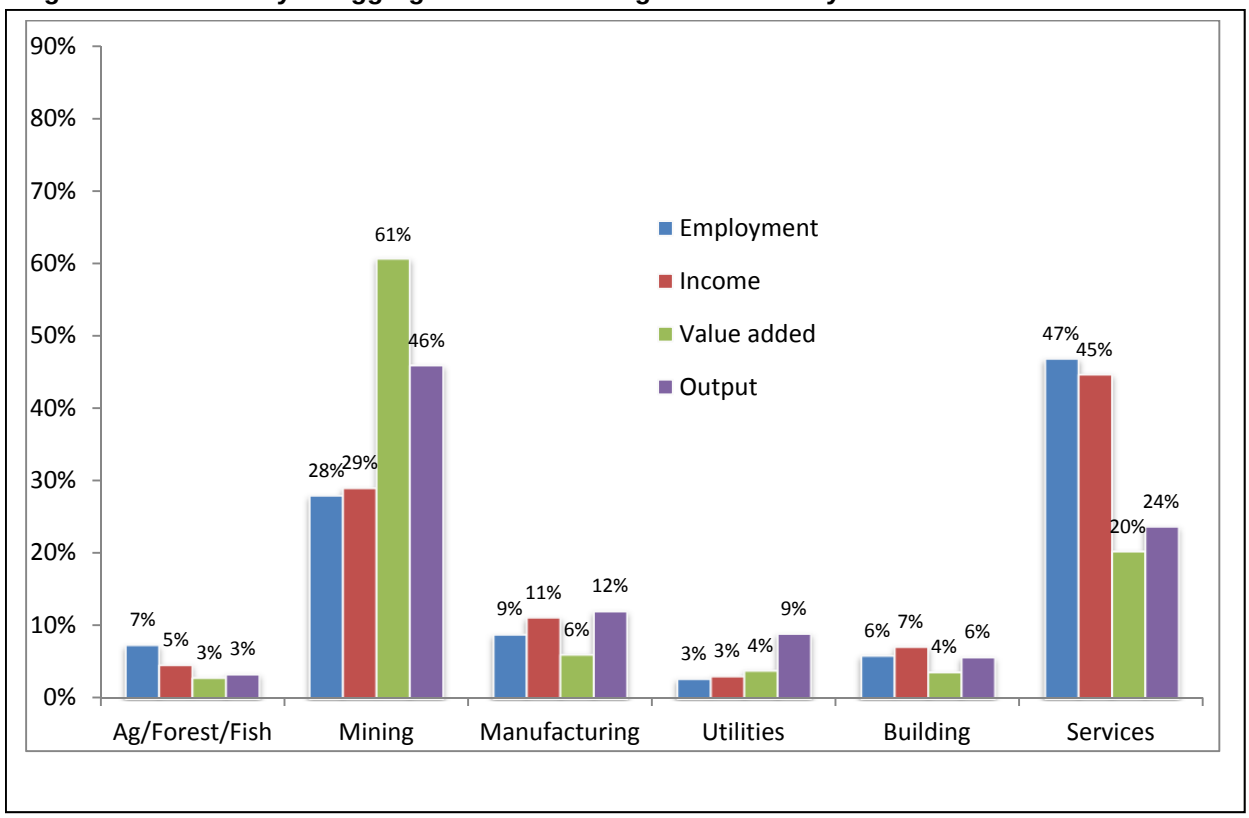
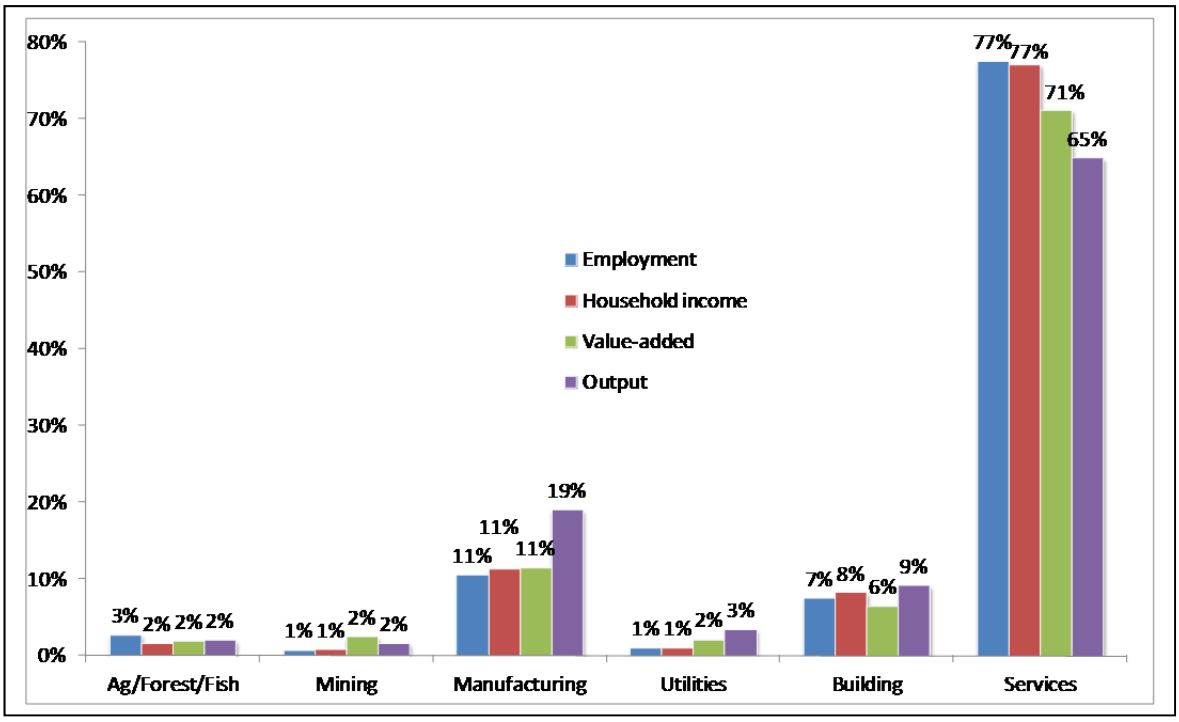



**Figure 3.2 - Summary of Aggregated Sectors: NSW Economy**

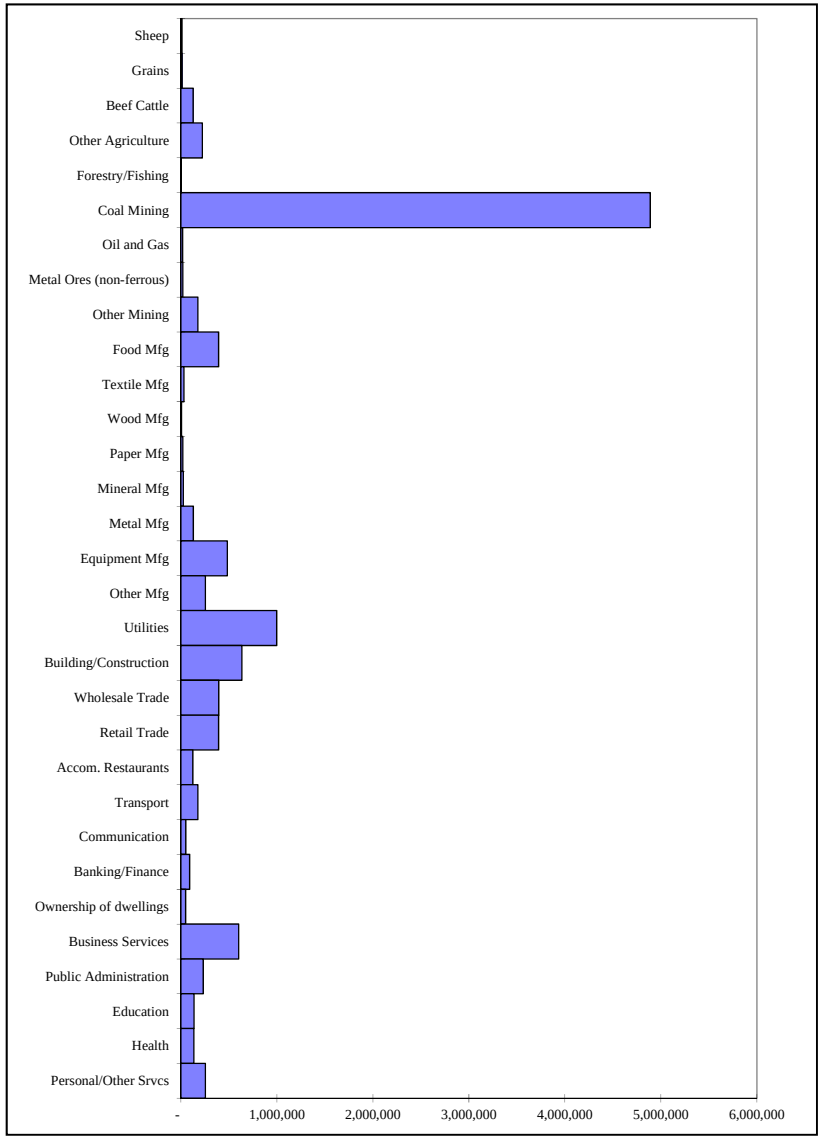


Figures 3.3 to 3.5 provide a more expansive sectoral distribution of gross regional output, employment, household income, value-added, exports and imports, and can be used to provide some more detail in the description of the economic structure of the regional economy.

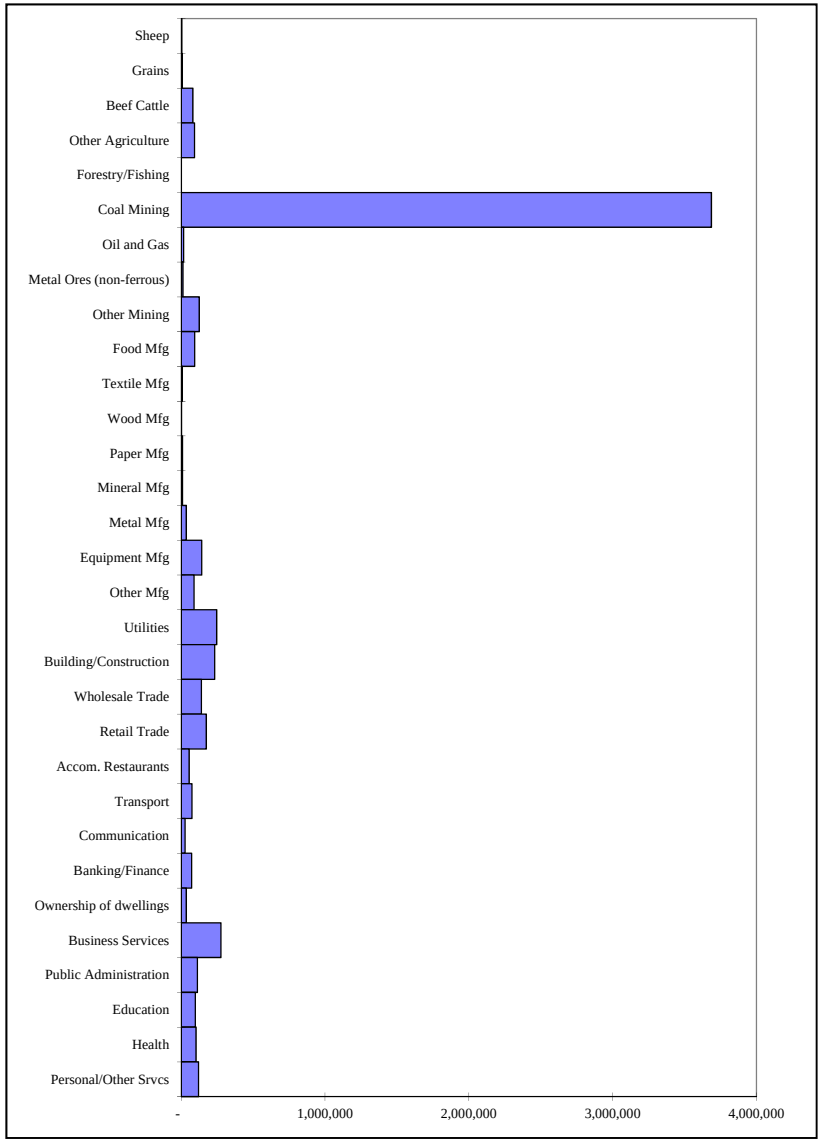
The coal mining sector is the by far the most significant sector in the region economy for output, value-added, income, employment imports and exports. The next most significant sectors are the businesses services sectors, retail trade sectors, building and construction sectors, utilities sectors and equipment manufacturing sectors. For comparison, the viticulture and horse studs are located in the other agriculture sector in Figures 3.3 to 3.5.

## Figure 3.3 Sectoral Distribution of Gross Regional Output and Value-Added ($'000)

### Output




### Value Added

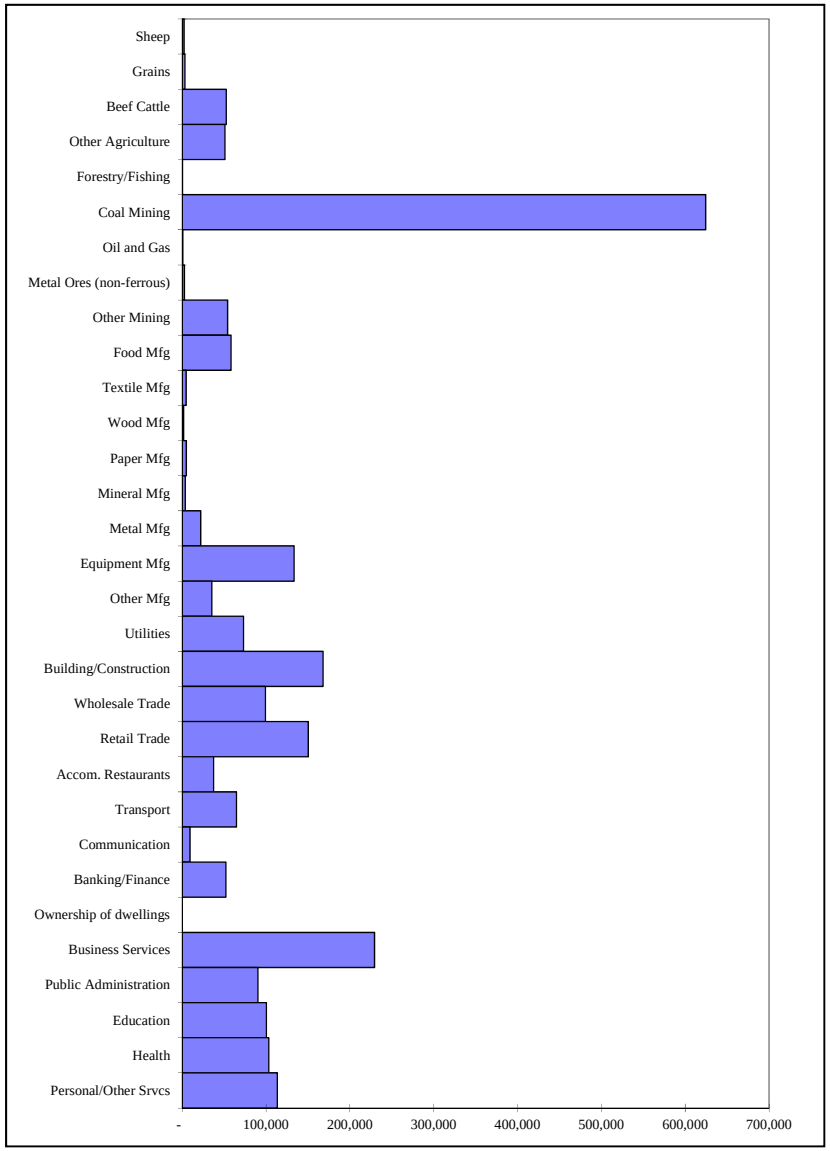




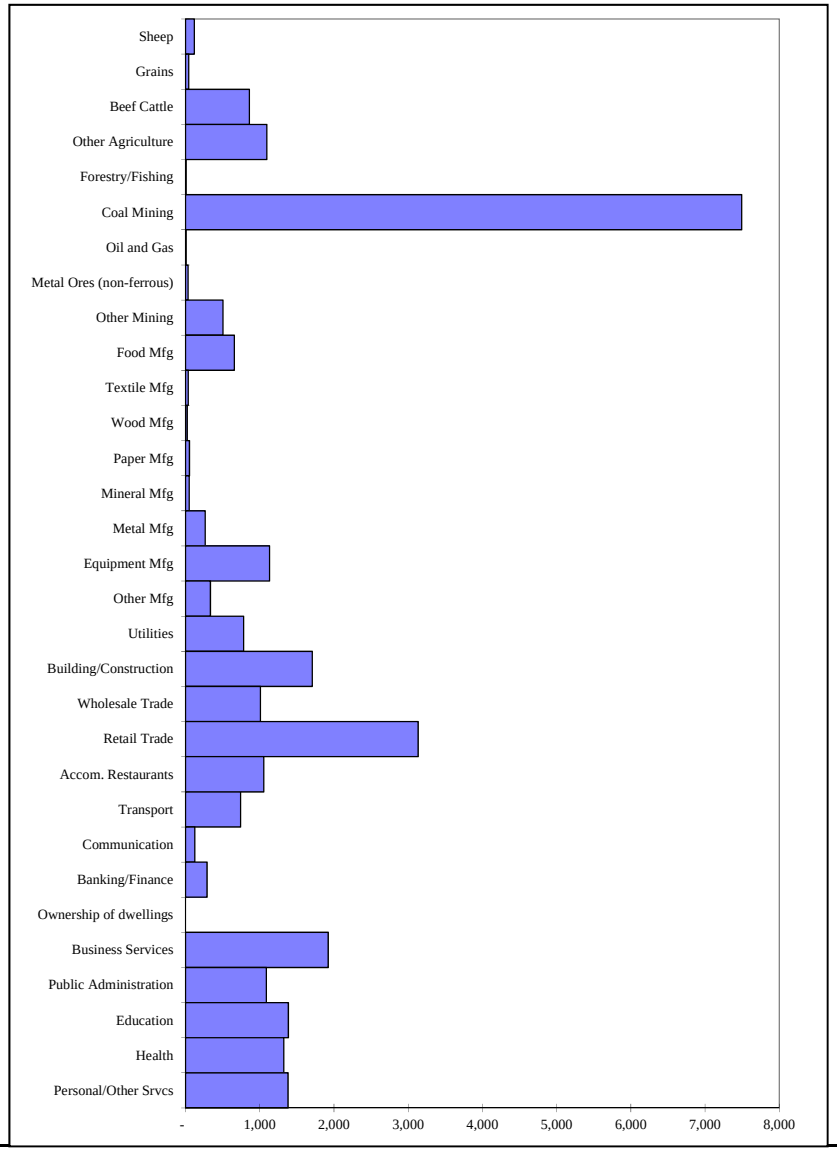
Economic Assessment

## Figure 3.4 Sectoral Distribution of Income ($'000) and Employment (No.)

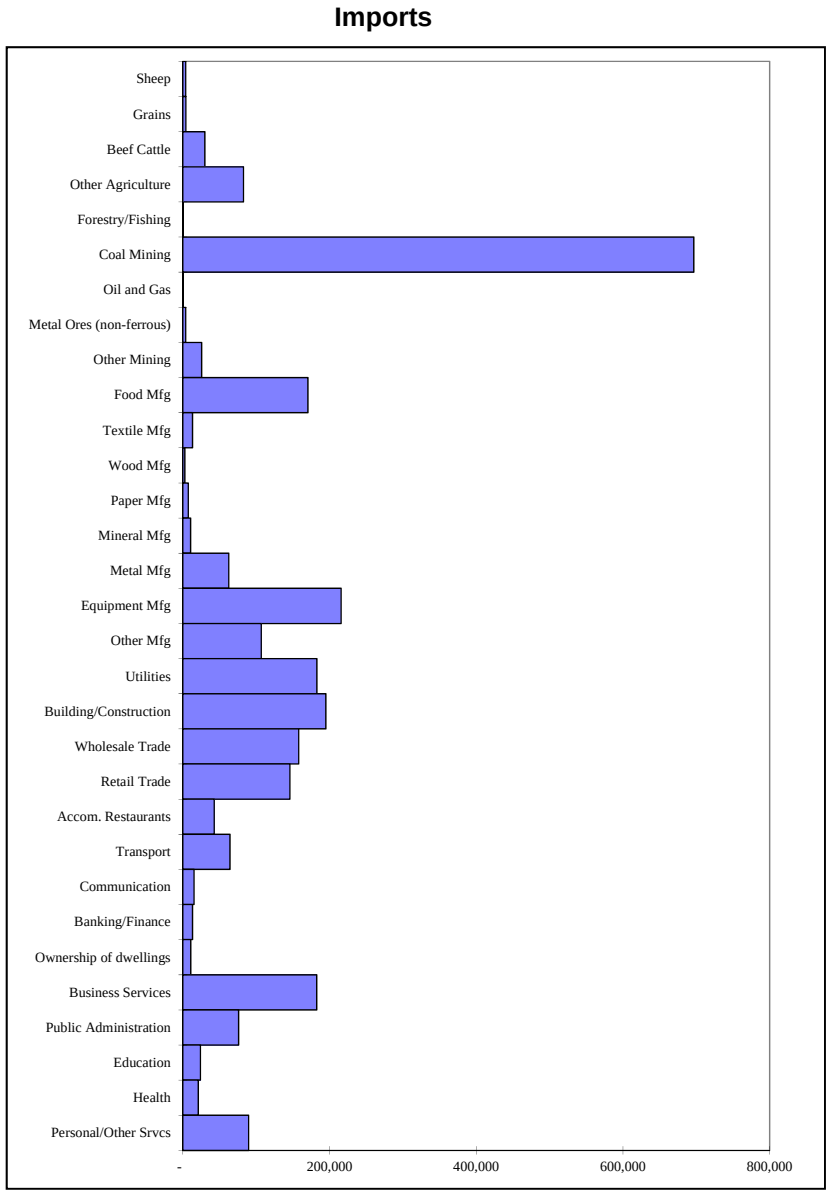
### Income

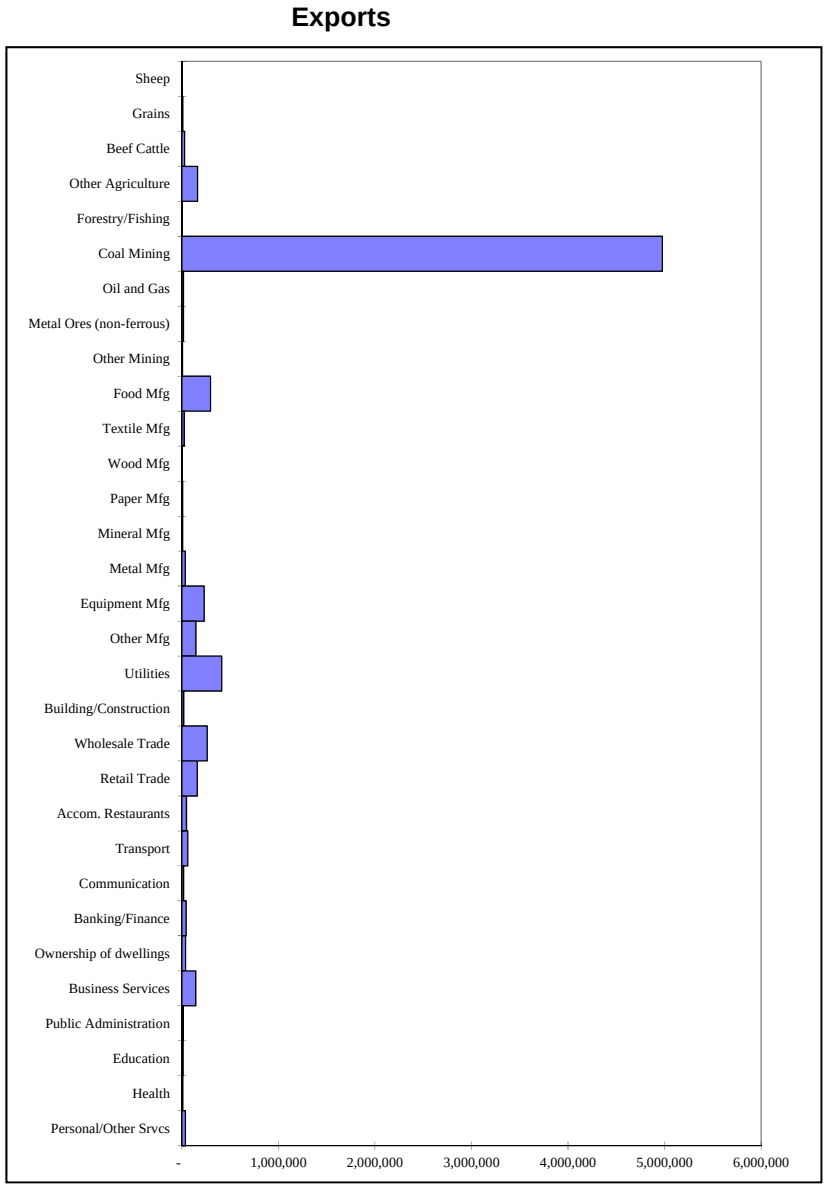



### Employment



## Figure 3.5 Sectoral Distribution of Imports and Exports ($'000)



## 3.5 ECONOMIC IMPACT OF THE MODIFICATION

### 3.5.1 Introduction

The revenue, expenditure and employment associated with the operation of the Modification would provide additional years of economic activity to the regional and NSW economy.

### 3.5.2 Impacts on the Regional Economy

*Introduction*

For the analysis of the economic activity associated with the Modification, a new Modification sector was inserted into the regional input-output table reflecting average annual production levels over the Modification period. The revenue and expenditure data for the new sector was obtained from financial information provided by LCO for the Modification. For this new sector:

- The estimated gross annual revenue was allocated to the Output row;
- The estimated wage bill of those residing in the region was allocated to the household wages row with the remainder allocated to a separate household wages row that is not included in the calculation of flow-on effect;
- Non-wage expenditure was initially allocated across the relevant intermediate sectors in the economy, imports and other value-added;
- Allocation was then made between intermediate sectors in the regional economy and imports based on advice from LCO and regional location quotients;
- Purchase prices for expenditure in the each sector in the region were adjusted to basic values and margins and taxes and allocated to appropriate sectors using relationships in the National Input-Output Tables;
- The difference between average total revenue and average total costs was allocated to the other value-added row; and
- Direct employment in the region provided by the Modification that was allocated to the employment row.

*Economic Activity*

The total and disaggregated annual impacts of the Modification on the regional economy (in 2012 dollars) is shown in Table 3.2.

**Table 3.2 - Economic Impacts of the Modification on the Regional Economy ($2012)**

| | Direct Effect | Production Induced | Consump. Induced | Total Flow-on | TOTAL EFFECT |
|---|---|---|---|---|---|
| **OUTPUT ($'000)** | 392,513 | 51,650 | 13,801 | 65,451 | 457,964 |
| *Type 11A Ratio* | 1.00 | 0.13 | 0.04 | 0.17 | 1.17 |
| **VALUE ADDED ($'000)** | 256,546 | 20,411 | 6,398 | 26,809 | 283,354 |
| *Type 11A Ratio* | 1.00 | 0.08 | 0.03 | 0.10 | 1.10 |
| **INCOME ($'000)** | 22,135 | 10,504 | 4,490 | 14,994 | 37,129 |
| *Type 11A Ratio* | 1.00 | 0.48 | 0.20 | 0.68 | 1.68 |
| **EMPL. (No.)** | 238 | 155 | 76 | 231 | 469 |
| *Type 11A Ratio* | 1.00 | 0.65 | 0.32 | 0.97 | 1.97 |

*Contractors are located in production-induced flow-ons.

The Modification is estimated to make up to the following direct and indirect average annual contribution to the regional economy for 7 years, with lessor impacts when the incremental production associated with the Modification is ramping up and ramping down:

- $458M in annual direct and indirect regional output or business turnover;
- $283M in annual direct and indirect regional value added;
- $37M in annual direct and indirect household income; and
- 469 direct and indirect jobs.

*Multipliers*

The Type 11A ratio multipliers for the Modification impact on the regional economy range from 1.10 for value-added up to 1.97 for employment.

Capital intensive industries such as coal mining tend to have a high level of linkage with other sectors in an economy thus contributing substantial flow-on employment while at the same time only having a lower level of direct employment (relative to output levels). This tends to lead to a relatively high ratio multiplier for employment. A lower ratio multiplier for income (compared to employment) also generally occur as a result of comparatively higher wage levels in the mining sectors compared to incomes in the sectors that would experience flow-on effects from the Modification. Capital intensive mining projects also typically have a relatively low ratio multiplier for output and value-added reflecting the relatively high direct output and value-added compared to that in flow-on sectors.

*Main Sectors Affected*

Flow-on impacts from the Modification are likely to affect a number of different sectors of the regional economy. The sectors most impacted by output, value-added and income flow-ons are likely to be the:

- Scientific research, technical and computer services sector;
- Other chemical products manufacturing sector;
- Electricity supply sector;
- Retail trade sector;
- Wholesale trade sector;
- Services to mining sector;
- Road transport sector;
- Rubber products manufacturing sector; and the
- Agricultural and mining machinery manufacturing sector.

Examination of the estimated direct and flow-on employment impacts gives an indication of the sectors in which employment opportunities would be generated by the Modification (Table 3.3).

**Table 3.3 - Sectoral Distribution of Employment Impacts on the Regional Economy**

| Sector | Average Direct Effects | Product.-induced | Consump.-induced | Total |
|---|---|---|---|---|
| Primary | 0 | 1 | 2 | 3 |
| Mining | 238 | 6 | 0 | 244 |
| Manufacturing | 0 | 28 | 3 | 31 |
| Utilities | 0 | 3 | 1 | 4 |
| Wholesale/Retail | 0 | 26 | 21 | 48 |
| Accommodation, cafes, restaurants | 0 | 2 | 11 | 13 |
| Building/Construction | 0 | 4 | 0 | 4 |
| Transport | 0 | 9 | 3 | 11 |
| Services | 0 | 77 | 35 | 112 |
| Total | 238 | 155 | 76 | 469 |

Note: Totals may have minor discrepancies due to rounding.

Table 3.3 indicates that direct, production-induced and consumption-induced employment impacts of the Modification on the regional economy are likely to have different distributions across sectors. Production-induced flow-on employment would occur mainly in services sectors, manufacturing sectors and wholesale/retail trade sectors, while consumption induced flow-on employment would be mainly in services sectors, wholesale/retail trade sectors and accommodation/cafes/restaurants sectors.

Businesses that can provide the inputs to the production process required by the Modification and/or the products and services required by employees would directly benefit from the Modification by way of an increased economic activity. However, because of the inter-linkages between sectors, many indirect businesses also obtain economic activity.

### 3.5.4 Impact on the NSW Economy

*Introduction*

The NSW economic impacts of the Modification were assessed by inserting a new Modification sector into a 2012 NSW input-output table in the same manner described in Section 3.5.2. The primary difference from the sector identified for the regional economy was that all direct employment was assumed to reside in NSW and a greater level of expenditure was captured by NSW economy compared to the regional economy.

*Economic Activity*

The total and disaggregated annual impacts of the Modification on the NSW economy (in 2012 dollars) are shown in Table 3.4.

**Table 3.4 - NSW Economic Impacts of the Modification**

| | Direct Effect | Production Induced | Consump. Induced | Total Flow-on | TOTAL EFFECT |
|---|---|---|---|---|---|
| **OUTPUT ($'000)** | 392,513 | 133,600 | 130,640 | 264,239 | 656,752 |
| Type 11A Ratio | 1.00 | 0.34 | 0.33 | 0.67 | 1.67 |
| **VALUE ADDED ($'000)** | 256,642 | 51,013 | 66,542 | 117,555 | 374,197 |
| Type 11A Ratio | 1.00 | 0.20 | 0.26 | 0.46 | 1.46 |
| **INCOME ($'000)** | 36,397 | 38,163 | 38,080 | 76,243 | 112,640 |
| Type 11A Ratio | 1.00 | 1.05 | 1.05 | 2.10 | 3.10 |
| **EMPL. (No.)** | 238 | 382 | 508 | 890 | 1,128 |
| Type 11A Ratio | 1.00 | 1.60 | 2.14 | 3.74 | 4.74 |

The Modification is estimated to make up to the following direct and indirect average annual contribution to the NSW economy for 7 years, with lessor impacts when the incremental production associated with the Modification is ramping up and ramping down:

- $657M in annual direct and indirect regional output or business turnover;
- $374M in annual direct and indirect regional value added;
- $113M in annual direct and indirect household income; and
- 1,128 direct and indirect jobs.

The impacts on the NSW economy are substantially greater than for the regional economy, as the NSW economy is able to capture more mine and household expenditure, and there is a greater level of intersectoral linkages in the larger NSW economy. At the NSW level, there is greater scope for labour and resources required for the Modification to be diverted from other sectors of the economy, particularly in times of near full employment of the economy, and hence for there to be some partially offsetting reduction in economic activity.

### 3.6 MINE CESSATION

As outlined in Section 3.5, the Modification will provide continued economic activity to the regional and NSW economy, for approximately seven years. Conversely, the cessation of the mining operations in the future would result in a contraction in regional and NSW economic activity. The Modification delays the contraction of economic activity in the regional economy

The magnitude of the regional economic impacts of cessation of the Modification would depend on a number of interrelated factors at the time, including:

- The movements of workers and their families;
- Alternative development opportunities; and
- Economic structure and trends in the regional economy at the time.

Ignoring all other influences, the impact of Modification cessation would depend on whether the workers and their families affected would leave the regional area. If it is assumed that some or all of the workers remain in the regional area, then the impacts of Modification cessation would not be as severe compared to a greater level leaving the regional area. This is because the consumption-induced flow-ons of the decline would be reduced through the continued consumption expenditure of those who stay (Economic and Planning Impact Consultants, 1989). Under this assumption, the regional economic impacts of Modification cessation would approximate the direct and production-induced effects in Table 3.2. However, if displaced workers and their families leave the region then impacts would be greater and begin to approximate the total effects in Table 3.2.

The decision by workers, on cessation of the Modification, to move or stay would be affected by a number of factors including the prospects of gaining employment in the regional economy compared to other regions, the likely loss or gain from homeowners selling, and the extent of "attachment" to the regional area (Economic and Planning Impact Consultants, 1989).

To the extent that alternative development opportunities arise in the regional economy, the regional economic impacts associated with mining closure that arise through reduced production and employment expenditure can be substantially ameliorated and absorbed by the growth of the region. One key factor in the growth potential of a region is its capacity to expand its factors of production by attracting investment and labour from outside the region (BIE, 1994). This in turn can depend on a region's natural endowments. In this respect, the regional area is highly prospective with considerable coal resources (NSW DPI, 2010).

It is therefore likely that, over time, new mining developments would occur, offering potential to strengthen and broaden the economic base of the regional area and hence buffer against impacts of the cessation of individual activities.

Ultimately, the significance of the economic impacts of cessation of the Modification would depend on the economic structure and trends in the regional economy at the time. For example, if Modification cessation takes place in a declining economy, the impacts might be significant. Alternatively, if Modification cessation takes place in a growing diversified economy where there are other development opportunities, the ultimate cessation of the Modification may not be a cause for concern.

Nevertheless, given the uncertainty about the future complementary mining activity in the regional economy it is not possible to foresee the likely circumstances within which Modification cessation would occur.

# 4 CONCLUSION

A BCA of the Modification indicated that it would have net production benefits to Australia of $316M. Provided the residual environmental, social and cultural impacts of the Modification that accrue to Australia are considered to be valued at less than $316M, the Modification can be considered to provide an improvement in economic efficiency and hence is justified on economic grounds.

Instead of leaving the environmental, cultural and social impacts unquantified an attempt was made to quantify them. The main quantifiable environmental impacts of the Modification that have not already been incorporated into the estimate of net production benefits, relate to greenhouse gas emissions, surface water impacts and groundwater impacts. These impacts to Australia are estimated at less than $1M, considerably less than the estimated net production benefits of the Modification. There may also be some non-market benefits of employment provided by the Modification which are estimated to be in the order of $46M. Overall, the Modification is estimated to have net benefits to Australia of between $315M and $362M and hence is desirable and justified from an economic efficiency perspective.

While the main environmental, cultural and social impacts have been quantified and included in the Modification BCA, any other residual environmental, cultural or social impacts that remain unquantified would need to be valued at greater than between $315M and $362M for the Modification to be questionable from an Australian economic efficiency perspective.

An economic impact analysis, using input-output analysis estimated that the Modification would make up to the following direct and indirect average annual contribution to the regional economy for 7 years, with lessor impacts when the incremental production associated with the Modification is ramping up and ramping down:

- $458M in annual direct and indirect regional output or business turnover;
- $283M in annual direct and indirect regional value added;
- $37M in annual direct and indirect household income; and
- 469 direct and indirect jobs.

The Modification is estimated to make up to the following direct and indirect average annual contribution to the NSW economy for 7 years, with lessor impacts when the incremental production associated with the Modification is ramping up and ramping down:

- $657M in annual direct and indirect regional output or business turnover;
- $374M in annual direct and indirect regional value added;
- $113M in annual direct and indirect household income; and
- 1,128 direct and indirect jobs.

The Modification will delay cessation of mining by up to 7 years. Cessation of the mining will lead to a reduction in economic activity in the region and NSW. The significance of these cessation impacts would depend on:

- The degree to which any displaced workers and their families remain within the region, even if they remain unemployed. This is because continued expenditure by these people in the regional economy (even at reduced levels) contributes to final demand.
- The economic structure and trends in the regional economy at the time. For example, if Modification cessation takes place in a declining economy the impacts might be felt more greatly than if it takes place in a growing diversified economy.

- Whether other mining developments or other opportunities in the region arise that allow employment of displaced workers.

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## ATTACHMENT 1 – VALUING GREENHOUSE GAS EMISSIONS

To place an economic value on carbon dioxide equivalent ($CO_2$-e) emissions a shadow price of carbon is required that reflects its social costs. The social cost of carbon is the present value of additional economic damages now and in the future caused by an additional tonne of carbon emissions.

A prerequisite to valuing this environmental damage is scientific dose-response functions identifying how incremental emissions of $CO_2$-e would impact climate change and subsequently impact human activities, health and the environment on a spatial basis. Only once these physical linkages are identified is it possible to begin to place economic values on the physical changes using a range of market and non market valuation methods. Neither the identification of the physical impacts of additional greenhouse gas nor valuation of these impacts is an easy task, although various attempts have been made using different climate and economic modelling tools. The result is a great range in the estimated damage costs of greenhouse gas.

The *Stern Review: Economics of Climate Change* (Stern, 2006) acknowledged that the academic literature provides a wide range of estimates of the social cost of carbon. It adopted an estimate of United States (US) $85 per tonne (/t) of carbon dioxide ($CO_2$) for the "business as usual" case (i.e. an environment in which there is an annually increasing concentration of greenhouse gas in the atmosphere).

Tol (2006) highlights some significant concerns with Stern's damage cost estimates including:

- that in estimating the damage of climate change Stern has consistently selected the most pessimistic study in the literature in relation to impacts;
- Stern's estimate of the social cost of carbon is based on a single integrated assessment model, PAGE2002, which assumes all climate change impacts are necessarily negative and that vulnerability to climate change is independent of development; and
- Stern uses a near zero discount rate which contravenes economic theory and the approach recommended by Treasury's around the world.

All these have the effect of magnifying the social cost of the carbon estimate, providing what Tol (2006) considers to be an outlier in the marginal damage cost literature.

Tol (2005) in a review of 103 estimates of the social cost of carbon from 28 published studies found that the range of estimates was right-skewed: the mode was US$0.55/t $CO_2$ (in 1995 US$), the median was US$3.82/t $CO_2$, the mean US$25.34/t $CO_2$ and the 95$^{th}$ percentile US$95.37/t $CO_2$. He also found that studies that used a lower discount rate and those that used equity weighting across regions with different average incomes per head, generated higher estimates and larger uncertainties. The studies did not use a standard reference scenario, but in general considered 'business as usual' trajectories.

Tol (2005) concluded that "it is unlikely that the marginal damage costs of $CO_2$ emissions exceed US$14/t $CO_2$ and are likely to be substantially smaller than that". Nordhaus's (2008) modelling using the DICE-2007 Model suggests a social cost of carbon with no emissions limitations of US$30 per tonne of carbon (US$8/t $CO_2$).

Tol (2011) surveyed the literature on the economic impact of climate change. Tol (2011) identifies the mean estimated from published studies is a marginal cost of carbon of $177/t C ($48/ tCO2-e) and a modal estimate of $49/t C ($13 tCo2-e) reflecting the fact that the mean estimate is driven by some very large estimates. For peer reviewed studies only, the mean estimate of the social cost of carbon is $80/tC ($22/tCo2-e).

An alternative method to trying to estimate the damage costs of $CO_2$ is to examine the price of carbon credits. This is relevant because emitters can essentially emit $CO_2$ resulting in climate change damage costs or may purchase credits that offset their $CO_2$ impacts, internalising the cost of the externality at

the price of the carbon credit. The price of carbon credits therefore provides an alternative estimate of the economic cost of greenhouse gas. However, the price is ultimately a function of the characteristics of the scheme and the scarcity of permits, etc. and hence may or may not reflect the actual social cost of carbon.

In the first half of 2008 the carbon price under the European Union Emissions Trading Scheme was over €20/t $CO_2$ The average price was €22/t $CO_2$ in the second half of 2008, and €13/t $CO_2$ in the first half of 2009. In March 2012, the permit price reduced to under €10 /t $CO_2$.

In 2008, spot prices in the Chicago Climate Exchange were in the order of US$3.95/t $CO_2$. However, the Chicago Climate Exchange cap and trade system ended on December 31, 2010.

In 2011, the greenhouse penalty for benchmark participants in the New South Wales Government Greenhouse Gas Reduction Scheme that fail to reduce emissions rose to $15.50 t $CO_2$.

Under the Australian Commonwealth Government's Climate Change Plan (Department of Climate Change and Energy Efficiency 2011) around 500 of the biggest polluters in Australia will need to buy and surrender to the Government a permit for every tonne of carbon pollution they produce. For the first three years, the carbon price will be fixed like a tax, before moving to an emissions trading scheme in 2015. In the fixed price stage, starting on 1 July 2012, the carbon price will start at $23 a tonne, rising at 2.5 per cent a year in real terms. From 1 July 2015, the carbon price will be set by the market.

Given the above information and the great uncertainty around damage cost estimates, the BCA uses the carbon price proposed by Australian Government's Climate Change Plan i.e. $23 a tonne, rising at 2.5 per cent a year in real terms for three years, as reflective of the global social damage cost of carbon. From 2015 it is assumed that the carbon price remains constant. A range for the social cost of greenhouse gas emissions from AUD$8/t $CO_2$-e to AUD$40/t $CO_2$-e was used in the sensitivity analysis described in Section 2.6 of this report.

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## ATTACHMENT 2 – BCA SENSITIVITY TESTING

**Table 2-1**
**Benefit Cost Analysis Sensitivity Testing, Project Australian Net Present Value ($Millions)**

| | 4% Discount Rate | 7% Discount Rate | 10% Discount Rate |
|---|---|---|---|
| **CENTRAL ANALYSIS** | $454 | $362 | $292 |
| **INCREASE 20%** | | | |
| Opportunity cost of land | $453 | $361 | $291 |
| Capital costs | $451 | $359 | $289 |
| Operating costs | $388 | $311 | $252 |
| Coal value | $604 | $478 | $383 |
| Decommissioning and rehabilitation | $454 | $362 | $292 |
| Residual value of capital and land | $455 | $363 | $292 |
| Surface water | $454 | $362 | $292 |
| Groundwater | $454 | $362 | $292 |
| Employment benefits | $463 | $371 | $301 |
| **GREENHOUSE COSTS @ $40/TONNE (T)** | $453 | $361 | $291 |

| | 4% Discount Rate | 7% Discount Rate | 10% Discount Rate |
|---|---|---|---|
| **DECREASE 20%** | | | |
| Opportunity cost of land | $454 | $362 | $292 |
| Capital costs | $457 | $364 | $294 |
| Operating costs | $519 | $413 | $332 |
| Coal value | $304 | $245 | $200 |
| Decommissioning and rehabilitation | $454 | $361 | $291 |
| Residual value of capital and land | $452 | $361 | $291 |
| Surface water | $454 | $362 | $292 |
| Groundwater | $454 | $362 | $292 |
| Employment benefits | $444 | $352 | $283 |
| **GREENHOUSE COSTS @ $8/T** | $454 | $362 | $292 |

## ATTACHMENT 3 – UNDERLYING ASSUMPTIONS AND INTERPRETATIONS OF INPUT-OUTPUT ANALYSIS AND MULTIPLIERS

1. "The *basic assumptions* in input-output analysis include the following:

   - there is a fixed input structure in each industry, described by fixed technological coefficients (evidence from comparisons between input-output tables for the same country over time have indicated that material input requirements tend to be stable and change but slowly; however, requirements for primary factors of production, that is labour and capital, are probably less constant);
   - all products of an industry are identical or are made in fixed proportions to each other;
   - each industry exhibits constant returns to scale in production;
   - unlimited labour and capital are available at fixed prices; that is, any change in the demand for productive factors will not induce any change in their cost (in reality, constraints such as limited skilled labour or investment funds lead to competition for resources among industries, which in turn raises the prices of these scarce factors of production and of industry output generally in the face of strong demand); and
   - there are no other constraints, such as the balance of payments or the actions of government, on the response of each industry to a stimulus.

2. The multipliers therefore describe *average effects, not marginal effects*, and thus do not take account of economies of scale, unused capacity or technological change. Generally, average effects are expected to be higher than the marginal effects.

3. The input-output tables underlying multiplier analysis only take account of one form of *interdependence***,** namely the sales and purchase links between industries. Other interdependence such as collective competition for factors of production, changes in commodity prices which induce producers and consumers to alter the mix of their purchases and other constraints which operate on the economy as a whole are not generally taken into account.

4. The combination of the assumptions used and the excluded interdependence means that input-output multipliers are higher than would realistically be the case. In other words, they tend to *overstate* the potential impact of final demand stimulus. The overstatement is potentially more serious when large changes in demand and production are considered.

5. The multipliers also do not account for some important pre-existing conditions. This is especially true of Type II multipliers, in which employment generated and income earned induce further increases in demand. The implicit assumption is that those taken into employment were previously unemployed and were previously consuming nothing. In reality, however, not all 'new' employment would be drawn from the ranks of the unemployed; and to the extent that it was, those previously unemployed would presumably have consumed out of income support measures and personal savings. Employment, output and income responses are therefore overstated by the multipliers for these additional reasons.

6. The most *appropriate interpretation* of multipliers is that they provide a relative measure (to be compared with other industries) of the interdependence between one industry and the rest of the economy which arises solely from purchases and sales of industry output based on estimates of transactions occurring over a (recent) historical period. Progressive departure from these conditions would progressively reduce the precision of multipliers as predictive device" (ABS 1995, p.24).

Multipliers therefore do not take account of economies of scale, unused capacity or technological change since they describe average effects rather than marginal effects (ABS, 1995).

Multipliers indicate the total impact of changes in demand for the output of any one industry on all industries in an economy (ABS, 1995). Conventional output, employment, value-added and income multipliers show the output, employment, value-added and income responses to an initial output stimulus (Jensen and West, 1986).

Components of the conventional output multiplier are as follows:

*Initial effect* - which is the initial output stimulus, usually a $1 change in output from a particular industry (Powell and Chalmers, 1995; ABS, 1995).

*First round effects* - the amount of output from all intermediate sectors of the economy required to produce the initial $1 change in output from the particular industry (Powell and Chalmers, 1995; ABS, 1995).

*Industrial support effects* - the subsequent or induced extra output from intermediate sectors arising from the first round effects (Powell and Chalmers, 1995; ABS, 1995).

*Production induced effects* - the sum of the first round effects and industrial support effects (i.e. the total amount of output from all industries in the economy required to produce the initial $1 change in output) (Powell and Chalmers, 1995; ABS, 1995).

*Consumption induced effects* - the spending by households of the extra income they derive from the production of the extra $1 of output and production induced effects. This spending in turn generates further production by industries (Powell and Chalmers, 1995; ABS, 1995).

The *simple multiplier* is the initial effect plus the production induced effects.

The *total multiplier* is the sum of the initial effect plus the production-induced effect and consumption-induced effect.

Conventional employment, value-added and income multipliers have similar components to the output multiplier, however, through conversion using the respective coefficients show the employment, value-added and income responses to an initial output stimulus (Jensen and West, 1986).

For employment, value-added and income, it is also possible to derive relationships between the initial or own sector effect and flow-on effects. For example, the flow-on income effects from an initial income effect or the flow-on employment effects from an initial employment effect, etc. These own sector relationships are referred to as ratio multipliers, although they are not technically multipliers because there is no direct line of causation between the elements of the multiplier. For instance, it is not the initial change in income that leads to income flow-on effects, both are the result of an output stimulus (Jensen and West, 1986).

A description of the different ratio multipliers is given below.

$$\text{Type 1A Ratio Multiplier} = \frac{\text{Initial + First Round Effects}}{\text{Initial Effects}}$$

$$\text{Type 1B Ratio Multiplier} = \frac{\text{Initial + Production Induced Effects}}{\text{Initial Effects}}$$

Type 11A Ratio Multiplier = $\frac{\text{Initial + Production Induced + Consumption Induced Effects}}{\text{Initial Effects}}$

Type 11B Ratio Multiplier = $\frac{\text{Flow-on Effects}}{\text{Initial Effects}}$

Source: Centre for Farm Planning and Land Management (1989).

**REFERENCES**


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## ATTACHMENT 4 – THE GRIT SYSTEM FOR GENERATING INPUT-OUTPUT TABLES

The Generation of Regional Input-Output Tables (GRIT) system was designed to:

- combine the benefits of survey based tables (accuracy and understanding of the economic structure) with those of non-survey tables (speed and low cost);
- enable the tables to be compiled from other recently compiled tables;
- allow tables to be constructed for any region for which certain minimum amounts of data were available;
- develop regional tables from national tables using available region-specific data;
- produce tables consistent with the national tables in terms of sector classification and accounting conventions;
- proceed in a number of clearly defined stages; and
- provide for the possibility of ready updates of the tables.

The resultant GRIT procedure has a number of well-defined steps. Of particular significance are those that involve the analyst incorporating region-specific data and information specific to the objectives of the study. The analyst has to be satisfied about the accuracy of the information used for the important sectors; in this case the coal mining sector. The method allows the analyst to allocate available research resources to improving the data for those sectors of the economy that are most important for the study.

An important characteristic of GRIT-produced tables relates to their accuracy. In the past, survey-based tables involved gathering data for every cell in the table, thereby building up a table with considerable accuracy. A fundamental principle of the GRIT method is that not all cells in the table are equally important. Some are not important because they are of very small value and, therefore, have no possibility of having a significant effect on the estimates of multipliers and economic impacts. Others are not important because of the lack of linkages that relate to the particular sectors that are being studied. Therefore, the GRIT procedure involves determining those sectors and, in some cases, cells that are of particular significance for the analysis. These represent the main targets for the allocation of research resources in data gathering. For the remainder of the table, the aim is for it to be 'holistically' accurate (Jensen, 1980). This means a generally accurate representation of the economy is provided by the table, but does not guarantee the accuracy of any particular cell. A summary of the steps involved in the GRIT process is shown in Table 4-1 (Powell and Chalmers, 1995).

**Table 4-1**
**The GRIT Method**

| Phase | Step | Action |
|---|---|---|
| PHASE I | | ADJUSTMENTS TO NATIONAL TABLE |
| | 1 | Selection of national input-output table (106-sector table with direct allocation of all imports, in basic values). |
| | 2 | Adjustment of national table for updating. |
| | 3 | Adjustment for international trade. |
| PHASE II | | ADJUSTMENTS FOR REGIONAL IMPORTS |
| | | (*Steps 4-14 apply to each region for which input-output tables are required*) |
| | 4 | Calculation of 'non-existent' sectors. |
| | 5 | Calculation of remaining imports. |
| PHASE III | | DEFINITION OF REGIONAL SECTORS |
| | 6 | Insertion of disaggregated superior data. |
| | 7 | Aggregation of sectors. |
| | 8 | Insertion of aggregated superior data. |
| PHASE IV | | DERIVATION OF PROTOTYPE TRANSACTIONS TABLES |
| | 9 | Derivation of transactions values. |
| | 10 | Adjustments to complete the prototype tables. |
| | 11 | Derivation of inverses and multipliers for prototype tables. |
| PHASE V | | DERIVATION OF FINAL TRANSACTIONS TABLES |
| | 12 | Final superior data insertions and other adjustments. |
| | 13 | Derivation of final transactions tables. |
| | 14 | Derivation of inverses and multipliers for final tables. |

Source: Bayne and West (1988).

## REFERENCES


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