APPENDIX O
ECONOMIC ASSESSMENT

resourcing the future

Mt Arthur Coal Consolidation Project
Economic Assessment

Prepared for

Hunter Valley Energy Coal Pty Ltd

By

Gillespie Economics
Tel: (02) 9804 8562
Email: gillecon@bigpond.net.au

August 2009

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

EXECUTIVE SUMMARY

Hunter Valley Energy Coal Pty Ltd (HVEC) is applying for a new Project Approval under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to gain a single, contemporary planning approval for its open cut operations and facilitate the mining of additional areas within the current Mt Arthur Coal Mining Leases (ML) (the Project).

Specifically, the Project involves an increase in the Mt Arthur Coal Complex approved production levels by 8 Million tonnes per annum (Mtpa) up to 36 Mtpa ROM coal. This will be achieved by:

- Increasing open cut coal production by up to 8 Mtpa; and
- Having the flexibility to increase either open cut or underground production by an additional 4 Mtpa if the maximum production from either underground or open cut methods is not being met (total to not exceed 36 Mtpa).

The Project requires the preparation of an Environmental Assessment (EA) in accordance with the requirements of the EP&A Act. An economic assessment is required as part of the EA.

From an economic perspective there are two important aspects of the Project that are considered:

- The economic efficiency of the Project (i.e. consideration of economic costs and benefits); and
- The economic impacts of the Project (i.e. the economic stimulus that the Project will provide to the local or State economy).

A benefit cost analysis of the Project identified a range of potential economic costs and benefits of the Project. Net production benefits of the Project were estimated at $2,121Million (M). However, the Project will also have a range of potential external costs and benefits. Air quality impacts, noise and vibration impacts, groundwater impacts and the costs of ecological and archaeological offsets have been included in the estimate of capital costs for the Project and therefore have already been accounted for in the estimate of net production benefits. In addition, the economic costs associated with the proposed Edderton Road realignment, greenhouse gas generation and ecological impacts were estimated at $309M (assuming a conservative high greenhouse gas social cost).

This gives a quantified net benefit of the Project of $1,812M, including $215M in royalty payments. However, some of the external environmental impacts of the Project – namely, consumer values for Aboriginal and non-Aboriginal cultural heritage impacts, visual impacts and some of the transport and traffic impacts - have not been able to be fully quantified. The economic and social benefits of employment provided by the Project have also not been included. The quantified net benefits of the Project of $1,812M can therefore be considered as a minimum threshold value. This threshold value is the minimum opportunity cost to society of not proceeding with the Project. Interpreted another way, the unquantified environmental impacts of the Project, after mitigation by HVEC, would need to be valued at greater than $1,812M to make the Project questionable from an economic efficiency perspective.

To put this threshold value in some context, every household in the region (Upper Hunter Statistical Local Area (SLA), Muswellbrook SLA and Singleton SLA) would need to be willing to pay in the order of $95,000 to avoid any of the residual environmental impacts of the Project, after mitigation by HVEC, to make it questionable from an economic efficiency perspective. The equivalent figure for NSW is $720 per household.

A regional economic impact analysis, using input-output analysis, estimated that in total, the Project will contribute the following to the regional economy:

- $635M in annual direct and indirect regional output or business turnover;
- $343M in annual direct and indirect regional value added;
- $79M in annual household income; and
- 860 direct and indirect jobs.

At the State level the Project will make the following contribution to the economy:

- $948M in annual direct and indirect output or business turnover;
- $496M in annual direct and indirect value added;
- $169M in annual household income; and
- 1,989 direct and indirect jobs.

The regional sectors most impacted by output, value-added and income flow-ons are likely to be the mining services sector, agricultural and mining machinery manufacturing sector, retail trade sector, wholesale trade sector, wholesale mechanical repairs sector, road transport sector and technical services sector.

Employment stimulus is also likely to be felt across a number of sectors including the mining, manufacturing, wholesale/retail and transport sectors, accommodation/cafes/restaurants and services sectors.

The Project is seeking approval until 2022, consistent with the approved mining life of Mt Arthur North as provided in existing approvals. In the unlikely event of mine closure after 2022, cessation of the Project may lead to a reduction in economic activity. The significance of Project cessation impacts will 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 Project cessation takes place in a declining economy the impacts might be felt more greatly than if it takes place in a growing diversified economy; and
- Whether other mining developments or other opportunities in the region arise that allow employment of displaced workers.

However, it is anticipated that mining at the Mt Arthur Coal Complex will continue to the west beyond 2022, pending further Planning Approvals being sought in the future. Hence, impacts of Project cessation may not be felt for many years.

Nevertheless, given the uncertainties about the possible timing of mine cessation and the circumstances within which Project cessation will occur, it is important for regional authorities and leaders to take every advantage from the stimulation to regional economic activity and skills and expertise that the Project brings to the region, to strengthen and broaden the region's economic base.

1 INTRODUCTION

Hunter Valley Energy Coal Pty Ltd (HVEC) is a wholly owned subsidiary of BHP Billiton and owns the Mt Arthur Coal Complex, consisting of open cut and underground mining operations (Mt Arthur Coal Complex). The Mt Arthur Coal Complex is located south west of Muswellbrook in the Upper Hunter Valley in New South Wales.

HVEC currently has approval to produce up to 28 Million tonnes per annum (Mtpa) of Run-of-Mine (ROM) coal production - 20 Mtpa from open cut mining methods and 8 Mtpa from underground mining methods.

HVEC is applying for a new Project Approval under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to gain a single, contemporary planning approval for its open cut operations and facilitate the mining of additional areas within Mt Arthur Coal's current Mining Leases (ML) (the Project).

Specifically, the Project involves an increase in the Mt Arthur Coal approved production levels by 8 Million tonnes per annum (Mtpa) up to 36 Mtpa ROM coal. This will be achieved by:

- Increasing open cut coal production by up to 8 Mtpa; and
- Having the flexibility to increase either open cut or underground production by an additional 4 Mtpa if the maximum production from either underground or open cut methods is not being met (total to not exceed 36 Mtpa).

Hansen Bailey has been commissioned by HVEC to prepare an Environmental Assessment (EA) for the Mt Arthur Coal Consolidation Project (the Project) in accordance with the requirements of EP&A Act. The NSW Department of Planning (DoP) Director-Generals Requirements for the Project indicate that an economic assessment is required as part of the EA.

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

- The economic efficiency of the Project (i.e. consideration of economic costs and benefits); and
- The economic impacts of the Project (i.e. the economic stimulus that the Project will provide to the regional or State economy).

Planning NSW (James and Gillespie, 2002) draft *Guideline for Economic Effects and Evaluation in EIA* identified 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 guidelines identified BCA as essential to undertaking a proper economic evaluation of proposed developments that are likely to have significant environmental impacts.

The above draft guideline indicates that economic impact assessment may provide additional information as an adjunct to the economic efficiency analysis. Economic stimulus to the regional and State economy can be estimated using input-output modelling.

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

- A BCA (threshold value analysis) of the Project; and
- An economic impact assessment of the Project.

2 BENEFIT COST ANALYSIS

2.1 INTRODUCTION

For the Project to be economically desirable from an Australian community perspective, it must be economically efficient. Technically, a project is economically efficient and desirable on economic grounds if the benefits to society exceed the costs (James and Gillespie, 2002). For mining projects, the main economic benefit is the producer surplus generated by the mine and the employment benefits it provides, while the main economic costs relate to environmental costs. The main technique that is used to weigh up these benefits and costs is BCA.

BCA involves the following key steps:

- Identification of the base case;
- Identification of the Project and its implications;
- Identification and valuation of the incremental benefits and costs;
- Consolidation of value estimates;
- Sensitivity testing;
- Application of decision criteria; and
- Consideration of non-quantified benefits and costs.

The Sections below provides a BCA of the Project based on financial, technical and environmental advice provided by HVEC and its specialist consultants.

2.2 IDENTIFICATION OF THE BASE CASE AND PROJECT

Identification of the “base case” or “without” Project scenario is required in order to facilitate the identification and measurement of the incremental economic benefits and costs of the Project.

Under the base case, coal mining at the Mt Arthur Coal Complex is assumed to continue until 2022 at the approved production levels of up to 20 Mtpa ROM from open cut and up to 8 Mtpa ROM from underground mining.

In contrast, the Project involves:

- An extension of the mine footprint to uncover additional coal reserves within Mt Arthur Coal’s current Mining leases (ML);
- An increase in the Mt Arthur Coal approved production levels by 8 Mtpa, up to 36 Mtpa ROM coal. This will be achieved by;
  - Increasing open cut coal production by up to 8 Mtpa; and
  - Having the flexibility to increase either open cut or underground production by an additional 4 Mtpa if the maximum production from either underground or open cut methods is not being met (total to not exceed 36 Mtpa);
- Relocation of a section of Edderton Road in approximately 2019;
- Upgrading the existing Mt Arthur Coal Coal Handling and Preparation Plant (CHPP) to wash additional coal and allow the inclusion of an ultra-fine circuit to re-process fines and facilitate increased resource recovery and reduced water demand;

- Increasing the approved rail haulage capacity in line with the increased coal production from 19 Mtpa to 27 Mtpa product coal, and the construction of a second rail loading facility and associated conveyor system;
- Modification to existing infrastructure (such as workshop and bath house), construction of additional ROM coal hoppers and the extension of ROM and product coal stockpiles; and
- A total workforce of approximately 2,600 at peak production, which represents an increase of approximately 1,610 from current staffing levels and an estimated additional 720 positions directly attributable to the Project.

The Project does not alter the currently approved life of the Mt Arthur Coal Complex.

HVEC's alternatives for the mining of coal are essentially limited to different scales, designs, technologies, processes, modes of transport, timing, impact mitigation measures etc. However, these alternatives could be considered to be variants of the preferred proposal rather than distinct alternatives. Consequently, this BCA focuses on HVEC's preferred proposal (the Project) compared to the base case identified above.

2.3 IDENTIFICATION OF BENEFITS AND COSTS

Relative to the base case or "without" scenario of mining cessation, the Project may have the potential incremental economic benefits and costs shown in Table 2.1.

Table 2.1
Incremental Economic Benefits and Costs of the Project

Category	Costs	Benefits
Production	Opportunity cost of additional land required for open cut extension Capital costs associated with additional production and ancillary works Operating costs, including administration, mining, processing and transportation, associated with additional production Rehabilitation costs associated with additional mine footprint	Additional sale value of export and domestic coal Additional residual value of capital and land at the cessation of the Project
Potential Externalities	Air quality Greenhouse gases Noise and vibration Ecology Groundwater Traffic and transport Aboriginal archaeology and cultural heritage Non-Aboriginal heritage Visual impacts Surface water and sediment/erosion control	Economic and social benefits of employment provided by the Project

It should be noted that the potential external 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 are mitigated to the extent where community wellbeing is insignificantly affected, then no external economic costs arise.

2.4 QUANTIFICATION/VALUATION OF BENEFITS AND COSTS

In accordance with NSW *Treasury Guidelines for Economic Appraisal* (NSW Treasury, 2002), where competitive market prices are available, they have generally been used as an indicator of economic values.

2.4.1 *Production Costs and Benefits*

Production Costs

Opportunity Cost of Land

While most of the land subject to the Project is owned by HVEC, with the exception of the Sub-lease area owned by Drayton, there is an opportunity cost associated with using this land for additional coal production instead of its next best use i.e. rural production. An indication of the opportunity cost of the land (1,200ha) can be gained from its market value, estimated at $3M.

Capital Cost of the Project

Incremental capital costs of the Project are associated with a range of plant and infrastructure including land acquisition costs. These incremental capital costs over the life of the mine (including contingencies) are estimated at $1,096M. These costs are included in the economic analysis in the years that that they are expected to occur.

Annual Operating Costs of the Project

The incremental operating costs of the Project include those associated with overburden stripping, mining, processing, rail and port charges, rehabilitation, marketing and general administration. Average annual operating costs of the mine are estimated at $118M.

While royalties are a cost to HVEC they are part of the overall producer surplus benefit of the mining and processing activity that is redistributed by government. Royalties are therefore not included in the calculation of the resource costs of operating the Project. Nevertheless, it should be noted that the Project will generate total royalties in the order of $386M (undiscounted).

Rehabilitation Costs

The additional mine footprint as a result of the Project will require the completion of rehabilitation at the cessation of mining at a cost in the order of $43M.

Production Benefits

Sale Value of Coal

Incremental open cut ROM coal production is assumed to ramp up by 8 Mtpa (36 Mtpa in total from the Mt Arthur Coal Complex) by 2013 and remain at this level until 2022.

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

Demand for thermal coal is derived demand, i.e. dependent on demand for the end products within which the coal resource is used (i.e. electricity). Demand for thermal coal therefore fluctuates considerably based on numerous market factors including the demand for goods and services requiring electricity as an input to production, the price of coal fired electricity, alternative technologies for electricity generation, income of consumers, population growth, etc.

World supply of thermal coal also fluctuates depending on price of electricity, prices of factors of production, prices of related goods, expected future prices, the number of suppliers, technology, greenhouse gas emission policy, etc.

Projected prices for low sulphur high energy thermal coal were based on Wood Mackenzie, Coal Market Service, Coal Forecast (Dec 2008) and ranged from a low of US$54.91/t in 2012, increasing over time in real terms to US$94.22 in 2022. An average AUD/USD exchange rate of 0.75 was used to convert these values to Australian dollars.

There is obviously considerable uncertainty around future coal prices and hence assumed coal prices have been subjected to sensitivity testing (see Section 2.6).

Residual Value at End of the Evaluation Period

At the end of the Project, rehabilitated land and purchased capital equipment may have some residual value that could be realised by sale. HVEC has advised that the final rehabilitated landform is likely to be mainly woodland and pasture and hence, conservatively, no residual market value is assumed. Capital equipment purchased as part of the Project, e.g. a shovel, is assumed to have a residual value of $8M in 2022. This residual value is likely to be conservative since components of CHPP upgrade are also likely to have some residual value.

2.4.2 ***External Costs and Benefits***

<u>Air quality</u> – thirteen private receivers are predicted to be impacted by dust levels above the relevant NSW Department of Environment and Climate Change (DECC) criteria, once the proposed mitigation measures are implemented. Of these thirteen private receivers, two are rural residential residences subject to existing purchase rights by an adjacent mining operation and Mt Arthur Coal and one receiver is the Muswellbrook Race Club, which is a commercial property. Impacts that reduce the enjoyment associated with a property can potentially be valued by examining changes in property value (i.e. the property valuation method). However, it is expected that the owners of those properties impacted above DECC guidelines will be granted options to sell their properties to HVEC and therefore the full costs of such land acquisition have been incorporated into the analysis, rather than the partial property value change.

<u>Noise and Blasting</u> - noise and blasting onsite has the potential to impact on sensitive receptors such as nearby residences and buildings. Again these impacts can potentially be valued using the property value method. Two residences were identified as likely to experience noise impacts above the relevant criteria. One of these residences is subject to existing purchase rights by Mt Arthur Coal. The cost of acquiring the second property has been incorporated into the analysis. Further to this, 27 residences (owned by 23 landowners) are predicted to receive minor to moderate noise exceedances of the noise level. However, it is assumed that these impacts are likely to have a negligible effect on amenity and hence property values.

<u>Greenhouse gases</u> – the Project is predicted to generate in the order of 5.57 Mt of greenhouse gas emissions associated with mining and transport of product coal by rail to the port[1]. 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. There is great uncertainty around the social cost of carbon with a wide range of estimated damage costs reported in the literature. An alternative method to trying to estimate the damage costs of carbon dioxide is to examine the price of carbon credits. Again, however, there is a wide range of permit prices. For this analysis, a shadow price of carbon of AUS$30/t CO_2-e was used, with sensitivity testing from AUS$8/t CO_2-e to AUS$40/t CO_2-e (refer to Appendix 1).

[1] It should be noted that greenhouse gas generation associated with sea transport and usage of the product coal is considered to be outside of the scope of the BCA of the Project.

Ecology – Approximately 240 ha of forest and woodland (including 116 ha of State listed Box Gum Woodland) and 750 ha of native understorey (including 700 ha of State – listed Boxgum Woodland Understorey and known individuals of the grass *Bothriochloa biloba*), are proposed to be cleared as a result of the Project. This will remove habitat for a range of threatened fauna species. These areas may have non-use values to the community that could potentially be estimated using non-market valuation methods such as choice modelling or contingent valuation. A range of values from the literature are summarised in Table 2.2.

Table 2.2

Non-market Valuation Studies for Native Vegetation Conservation

Reference	Vegetation Value	Other Values
Lockwood and Carberry (1998)	$607/ ha of native vegetation conserved that would otherwise have been cleared	$3.6M for every extra native plant and animal species conserved in the region
		$67M when use of native vegetation goes from extensive use to moderate use consistent with species conservation
Van Bueren and Bennett (2000)	$325/ha of farmland repaired or bushland protected	$44M per species protected from extinction
Rolfe (2008)	$800/ha increase in vegetation that is in healthy condition	
Rolfe et al (1997)	$7.5M per percentage reduction in the area of a unique ecosystem in the region	$23.3M per endangered species lost from region
		$3.4M per percentage reduction in the population size of non threatened species in the region
URS (2007)	$200,000 / ha of rainforest protected	$3.2M per breeding owl pair protected
	$12,000 / ha of old growth protected	$270,000 per individual Potoroo protected

Application of these values is problematic because of the different metrics for estimating impacts (e.g. percentage reduction in unique ecosystem in the region, hectares impacted, number of endangered species lost from the region) and the different contexts (e.g. different regions and States) within which studies were undertaken. However, based on the values for protection of higher conservation vegetation such as old growth and rainforest, the impact of the Project will range from $11M to $191M (when aggregated to 67% of NSW households[2]).

It should also be noted that as part of the Project, a 1,200 ha Biodiversity & Heritage Offset Area will be established. This area will be reserved for conservation of woodland and forest communities as well as Derived Understory. The capital and operating cost of this Offset have been incorporated into the analysis. However, this may not capture the full level of impact on consumers.

Aboriginal heritage – 105 Aboriginal sites will be impacted by the Project. Any impacts on heritage may impact the consumer surplus of individuals within the indigenous and broader community. It should also be noted that as part of the Project, a 495 ha Biodiversity & Heritage Offset Area will be established. The capital and operating cost of this Offset have been incorporated into the analysis. However, this may not capture the full level of impact on consumers.

[2] This study surveyed a sample of State households and hence it is appropriate to aggregate the average WTP value to the population of NSW households adjusted for the questionnaire response and assuming 30% of non respondents had the same values as respondents.

Groundwater – the main economic impacts on groundwater relate to two registered bores on the south side of the Hunter River within the anticipated cone of depressurisation. Both of these registered bores are located on HVEC land. Where water levels in existing landholder bores decline as a result of the Project, leading to an adverse impact on water supply from the bore, the supply will be re-instated by HVEC in consultation with the landholder. The costs of this have been included in the analysis.

Traffic and transport – a range of predicted traffic impacts are summarised in the EA. HVEC will consult with the Muswellbrook Shire Council and the Roads and Traffic Authority regarding contributions to any upgrade works for the two intersections that are predicted to perform poorly due to the increased traffic levels from the Project workforce. In addition, HVEC will fund the Edderton Road Realignment, the cost of which has been included in the analysis. In this way, some of the traffic and transport impacts of the Project (i.e. Edderton Road realignment) have been internalised into the Project costs.

Non - Aboriginal cultural heritage – the Project will impact on two non-Aboriginal heritage items, the Belmont Homestead Complex and the Beer Homestead slab hut sites. The Belmont Homestead Complex will be destroyed, with a full archival recording of the site to be carried out as described in the *Mt Arthur Underground Project Environmental Assessment* (Umwelt, 2007). The Beer Homestead will be relocated to a suitable location outside of the Project area. This could potentially impact on non-use values of the community and could potentially be estimated using non-market valuation methods such as choice modelling or contingent valuation. However, in this study these impacts remain unquantified.

Visual impacts – the Project will result in a range of visual impacts to a number of surrounding receptors including:

- Areas of South and North Muswellbrook that have extensive views over the eastern face of the overburden emplacement areas;
- Rural residences along Roxburgh Road, Denman Road, Ironbark Ridge Estate, in the vicinity of Saddlers Creek and west of the Project with an orientation towards Mount Arthur;
- Surrounding road network; and
- Tourist locations such as Roxburgh Vineyard.

Visual impacts can potentially impact the consumer surplus of affected households (reflected in changes in property values of affected lands). Impacts on tourism destinations may impact on both the consumer surplus of visitors (which can potentially be measured via the contingent valuation method or travel cost method) as well as the producer surplus of tourist business (which can be estimated from market data). However, in this study these impacts remain unquantified.

Surface water impacts – the Project may potentially have a range of impacts in relation to surface water including:

- Increased water usage for the CHPP, dust suppression on haul roads, coal stockpiles, for the industrial areas, underground mine dust suppression, cooling of mine equipment etc;
- Changes to flows in local ephemeral creeks due to expansion and subsequent capture and use of drainage from mine area catchments;
- Potential for export of contaminants (principally sediments and soluble salts) in mine area runoff and accidental spills from containment storages (principally sediments, soluble salts, oils and greases), causing degradation of local and regional water courses; and

- Short term increases in salinity during periods of licensed discharge under the Hunter River Salinity Trading Scheme (HRSTS).

However, these impacts are assumed to have negligible environmental effects as additional water requirements will be met through the purchase of additional water entitlements if necessary, changes in flow to local streams will be very localised with negligible impacts on major streams and rivers, export of contaminants will be prevented through a network of sediment and runoff control mechanisms and saline discharges will occur during periods of high flow (as mandated in the HRSTS) and will therefore not affect Hunter River low flows or salinity levels.

Social and economic value of employment – the Project will generate an additional workforce at the Mt Arthur Coal Complex of 720 full time equivalent jobs for a period of 10 years. Historically employment benefits of projects has tended to be omitted from BCA on the implicit assumption that labour resources used in a project would otherwise be employed elsewhere. Where this is not the case and labour resources would otherwise be unemployed for some period of time, Streeting and Hamilton (1991) and Bennett (1996) outline that otherwise unemployed labour resources utilised in a project should be valued in a BCA at their opportunity cost (wages less social security payments and income tax) rather than the wage rate which has the effect of increasing the net production benefits of the project. In addition, there may be social costs of unemployment that require the estimation of people's willingness to pay to avoid the trauma created by unemployment. These are non-market values.

More recently, it has been recognised that the broader community may hold non-environmental, non-market values (Portney 1994) for social outcomes such as employment (Johnson and Desvouges 1997) and the viability of rural communities (Bennett et al 2004) etc. Gillespie Economics (2008) estimated the values the community hold for each year as part of the Metropolitan Colliery Project. It was estimated that the Metropolitan Colliery provides 320 jobs, at $4.17 per household per annum for 20 years, or $33M (present value) per year of mine life. A simple extrapolation of this result to the Project, which will provide an additional 720 jobs for 12 years, suggests a resulting community value of the Project in order of $880M. Conservatively, these potential economic benefits of employment are omitted from the analysis.

2.5 CONSOLIDATION OF VALUE ESTIMATES

The present value of costs and benefits, using a 7% discount rate are provided in Table 2.3.

Table 2.3
Benefit Cost Analysis Results of the Project (Present Values @7% discount rate)

COSTS ($M)		BENEFITS ($M)	
Production			
Opportunity cost of land	$3	Revenue	$3,893
Capital costs	$863	Residual value of capital and land	$3
Operating costs	$892		
Rehabilitation costs	$18		
Total Production Costs	**$1,775**	**Total Production Benefits**	**$3,896**
		Net Production Benefits	**$2,121**
Potential Externalities			
Air quality	Acquisition costs included above	Social and economic values of employment	Up to $880 but conservatively omitted from the analysis
Greenhouse gases	$98		
Noise and vibration	Acquisition costs included above		
Ecology	$191 plus costs of offsets that are included above		
Groundwater	Provision of comparable water supply to affected properties included above		
Traffic and transport	Road realignment included at $20. Intersection upgrades not included		
Aboriginal heritage	88 sites impacted plus costs of offsets that are included above		
Non-Aboriginal heritage	2 items impacted		
Visual impacts	Some impacts		
Surface water	Negligible impacts		
TOTAL QUANTIFIED	**$2,084M**	**TOTAL QUANTIFIED**	**$3,896M**
NET QUANTIFIED BENEFITS		**$1,812 M**	

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. Table 2.3 indicates that the Project will have net production benefits of $2,121M.

The net production benefit shown in Table 2.3 is distributed amongst a range of stakeholders including:

- The local community in the form of donations and community support programs;
- HVEC shareholders;
- The NSW Government via royalties; and
- The Commonwealth Government in the form of Company tax.

The NSW Government receives additional benefits in the form of payroll tax and local councils also benefit through rates and development contributions.

The Project also has a range of potential external costs and benefits. Air quality impacts, noise and vibration impacts, groundwater impacts and the costs of ecological and archaeological offsets have been included in the estimate of capital costs for the Project. In addition, the economic costs associated with the proposed Edderton Road realignment, greenhouse gas generation and ecological impacts have been estimated at $309M (assuming a conservative high greenhouse gas social cost).

This gives a quantified net benefit of the Project of $1,812M. However, some of the external environmental impacts of the Project – Aboriginal and non-Aboriginal cultural heritage impacts, visual impacts and some of the transport and traffic impacts - have not been able to be quantified.

The quantified net benefits of the Project of $1,812M can therefore be considered as a minimum threshold value. It is a minimum threshold value because the economic and social benefits of employment provided by the Project have also not been quantified. This threshold value is the minimum opportunity cost to society of not proceeding with the Project. Interpreted another way, the unquantified environmental impacts of the Project, after mitigation by HVEC, would need to be valued at greater than $1,812M to make the Project questionable from an economic efficiency perspective.

To put this into a regional context, this is equivalent to each household in the region (Upper Hunter SLA, Muswellbrook SLA and Singleton SLA) having a willingness to pay of over $95,000 to avoid any of the residual environmental impacts of the Project, after mitigation by HVEC. The equivalent figure for NSW households is over $720.

2.6 SENSITIVITY ANALYSIS

This NPV presented in Table 2.3 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% changes to the following variables at a 4%, 7% and 10% discount rate:

- Opportunity cost of land;
- Capital costs;
- Operating costs;
- Rehabilitation costs;
- Revenues;
- Residual value of capital and land;
- Ecological costs; and
- Greenhouse costs.

What this analysis indicated (refer to Appendix 2) is that the results of the BCA are not sensitive to reasonable changes in assumptions regarding any of these variables. In particular, significant increases in the values used for external impact such as greenhouse gas costs or ecological impacts had little impact on the economic desirability of the Project.

The results were most sensitive to increases in capital and operating costs and decreases in the sale value of coal.

3 ECONOMIC IMPACT ASSESSMENT

3.1 INPUT-OUTPUT TABLE AND ECONOMIC STRUCTURE OF THE REGION

Economic impact assessment is primarily concerned with the effect of an impacting agent on an economy in terms of a number of specific indicators, 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 a local economy (Powell *et al.,* 1985; Jensen and West, 1986). This assessment is concerned with the impact of increased production at the Mt Arthur Coal Complex to enable an additional 8 Mtpa of ROM coal production.

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 Mt Arthur Coal Complex, but not making the economy so large that the impact of the Project becomes trivial (Powell and Chalmers, 1995). Data on the residential location of current employees at the Mt Arthur Coal Complex indicates that 82% live in Muswellbrook, Scone or Singleton area. Consequently, for this study, the economic impacts of the Project have been estimated for the Australian Bureau of Statistics (ABS) Statistical Local Areas (SLA) of Upper Hunter (which encompasses Scone), Singleton and Muswellbrook.

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). This study uses input-output analysis.

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 the 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).

A 2005-06 input-output table of the regional economy (Upper Hunter SLA, Muswellbrook SLA and Singleton SLA) was developed using the Generation of Input-Output Tables (GRIT) procedure (Appendix 3) with a 2005-06 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 economies.

A highly aggregated 2005-06 input-output table 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 2005-06 ($'000)

	Ag, forestry, fishing	Mining	Manuf.	Utilities	Building	Services	TOTAL	Household Expenditure	OFD	Exports	Total
Ag, forestry, fishing	22,617	82	49,848	6	152	2,895	**75,600**	6,577	72,535	189,590	**344,301**
Mining	39	106,136	4,149	57,239	995	821	**169,379**	319	-91,080	2,789,060	**2,867,678**
Manuf.	4,043	50,938	118,889	3,498	24,771	54,895	**257,035**	40,670	136,100	631,731	**1,065,536**
Utilities	2,594	18,850	12,695	445,448	2,372	16,664	**498,623**	15,949	11,510	409,114	**935,196**
Building	1,966	18,390	1,434	10,206	69,203	26,313	**127,512**	0	263,601	18,373	**409,485**
Services	26,080	105,969	117,869	18,672	37,342	306,685	**612,618**	400,447	479,356	665,726	**2,158,147**
TOTAL	**57,339**	**300,365**	**304,885**	**535,069**	**134,835**	**408,274**	**1,740,767**	**463,961**	**872,022**	**4,703,593**	**7,780,342**
Household wages	99,848	391,132	192,406	68,063	110,962	831,996	**1,694,408**	0	0	0	**1,694,408**
OVA	69,422	1,767,288	123,983	162,029	37,217	255,815	**2,415,754**	79,626	30,833	8,454	**2,534,668**
Imports	117,691	408,892	444,263	170,035	126,471	662,061	**1,929,414**	899,544	165,661	333,455	**3,328,073**
TOTAL	**344,301**	**2,867,678**	**1,065,536**	**935,196**	**409,485**	**2,158,147**	**7,780,342**	**1,443,131**	**1,068,515**	**5,045,502**	**15,337,491**
Employment	2,317	5,435	2,286	861	1,383	12,648	**24,930**				

Note: Totals may have minor discrepancies due to rounding.

Gross regional product (GRP) for the regional economy is estimated at $4,229M, comprising $1,694M to households as wages and salaries (including payments to self employed persons and employers) and $2,535M in OVA.

The employment total in the region was 24,930 people.

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 sectors, mining sectors and utilities sectors in the regional economy are of greater relative importance than it is to the NSW economy, while the manufacturing sectors and building sectors are of less relative importance than they are to the NSW economy.

Figure 3.1
Summary of Aggregated Sectors: Regional Economy (2005-06)

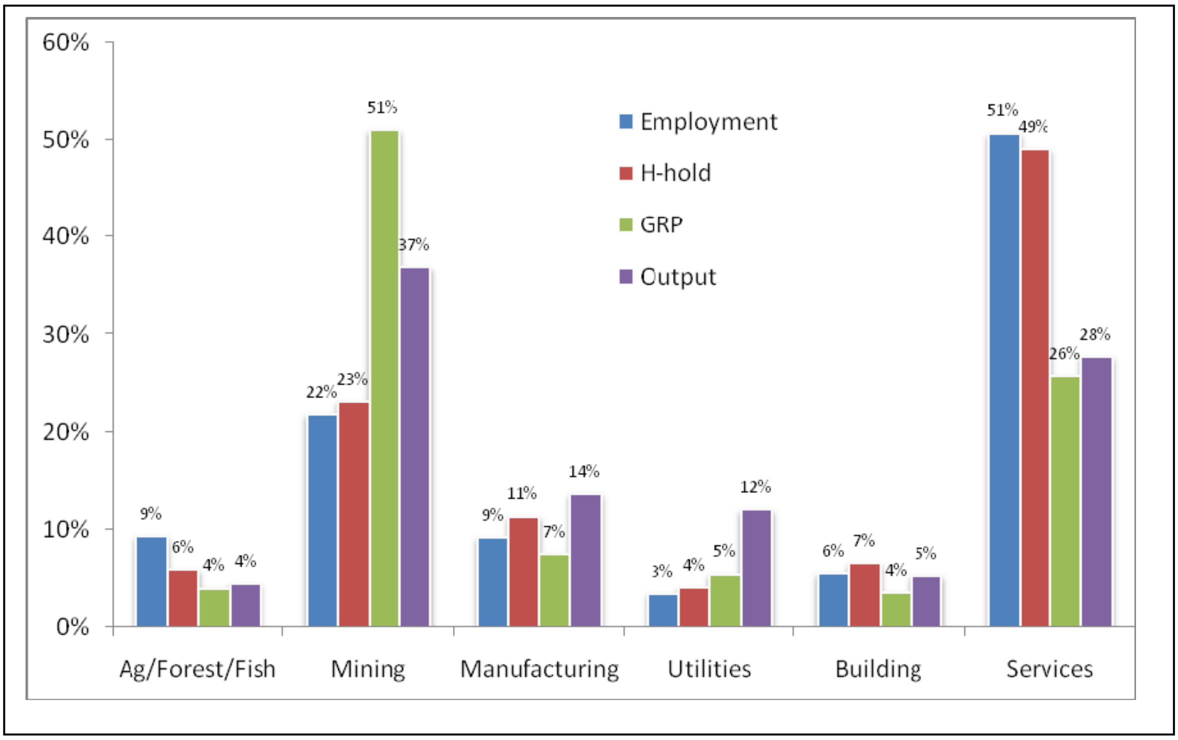
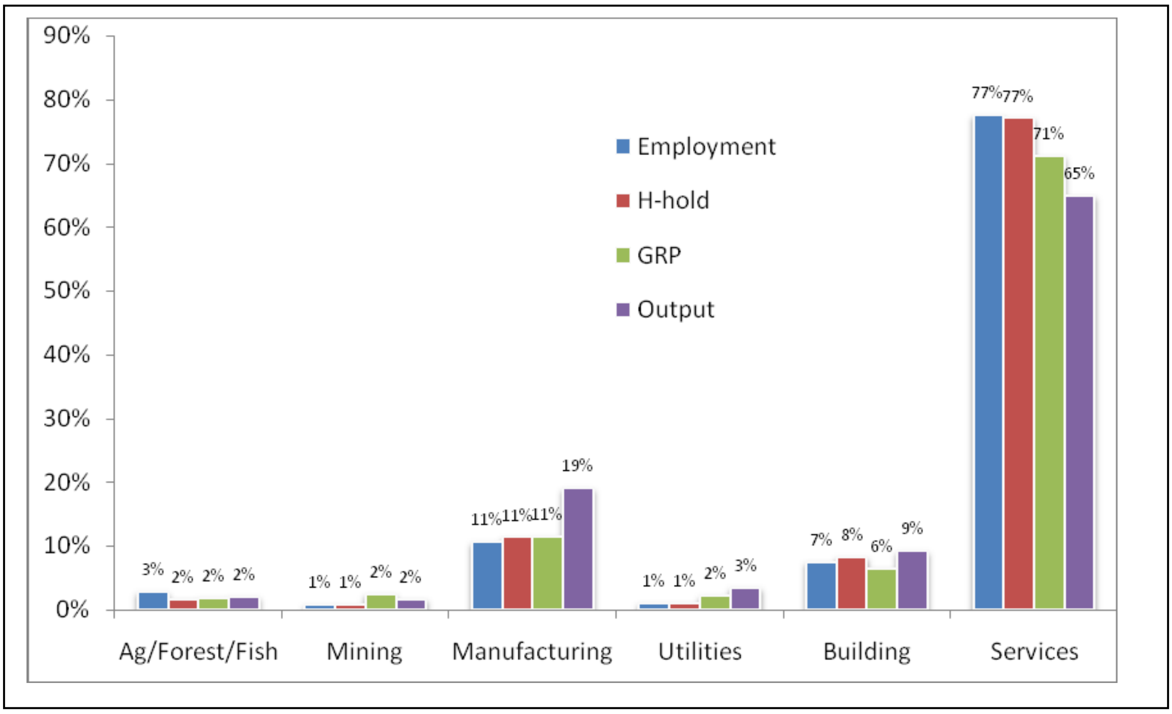


Figure 3.2
Summary of Aggregated Sectors: NSW Economy (2005-06)



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 economy.

What is clear from these figures is that in terms of gross regional output, value-added, income, employment, imports and exports, coal mining is the most significant sector of the regional economy. The next most significant sectors for output and value-added are the utilities sector and business services sector. For income and employment the next most significant sectors are business services and retail trade. The food manufacturing sectors and utilities sectors are the next most important sectors in the region for imports and exports.

For comparison, the horse breeding and grape growing sectors are located within the other agriculture sector in Figures 3.3 to 3.5, while wine manufacturing is located in the food manufacturing sector.

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

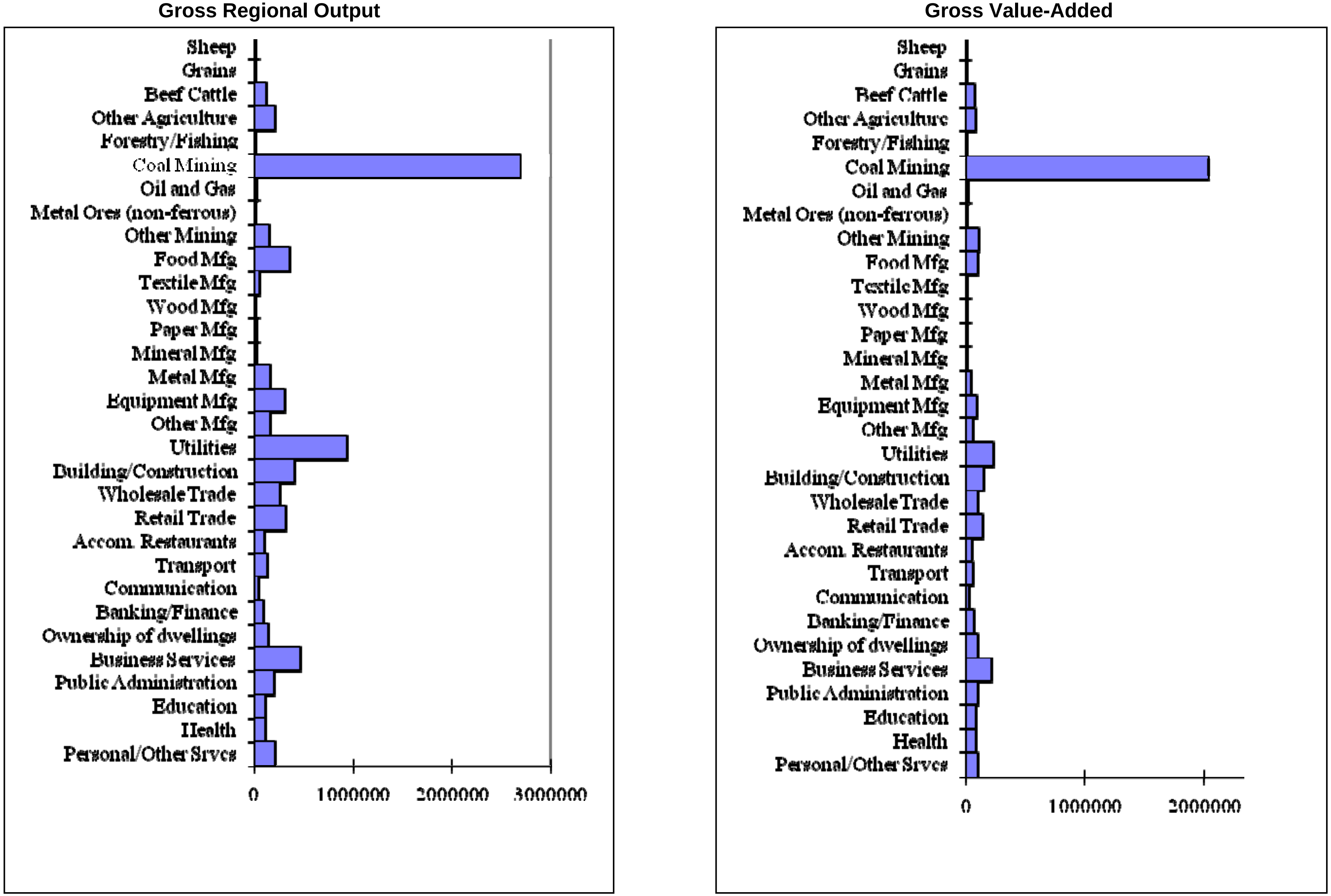
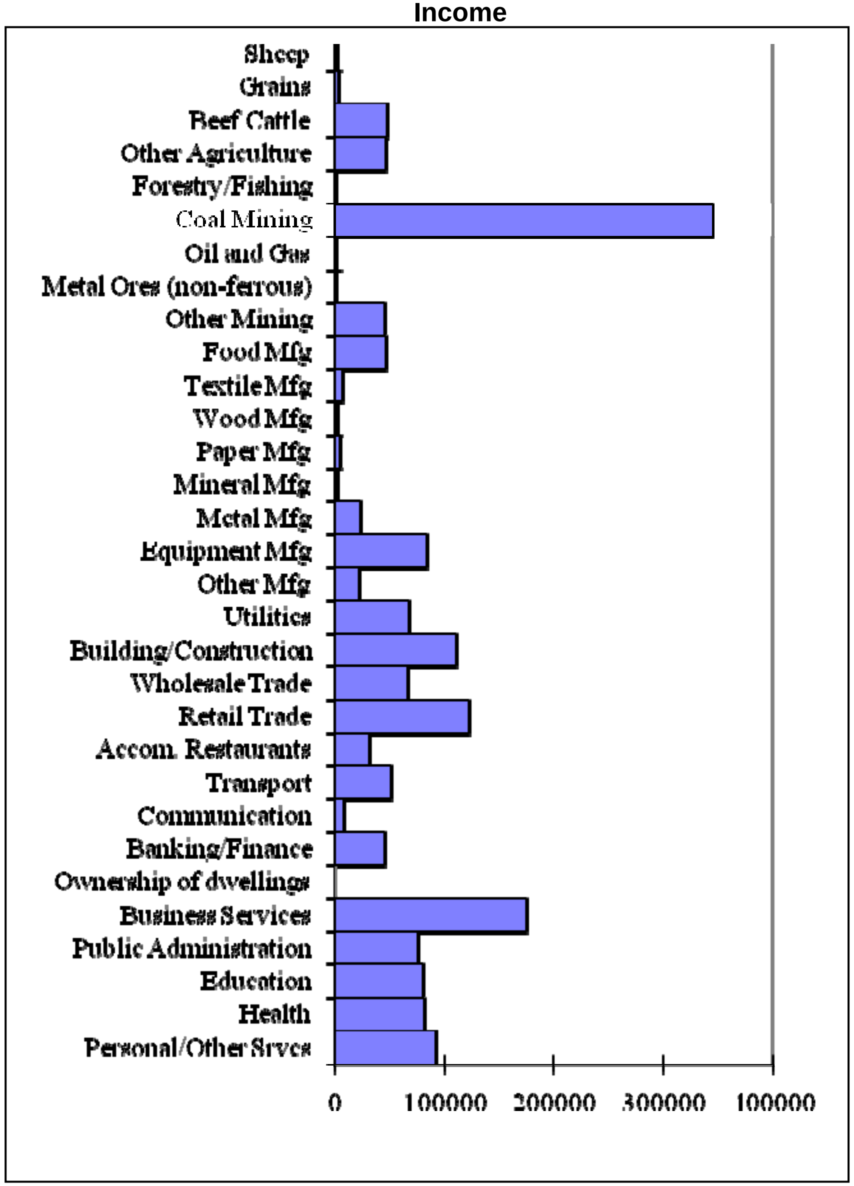


Figure 3.4 Sectoral Distribution of Gross Regional Income ($'000) and Employment (No.)



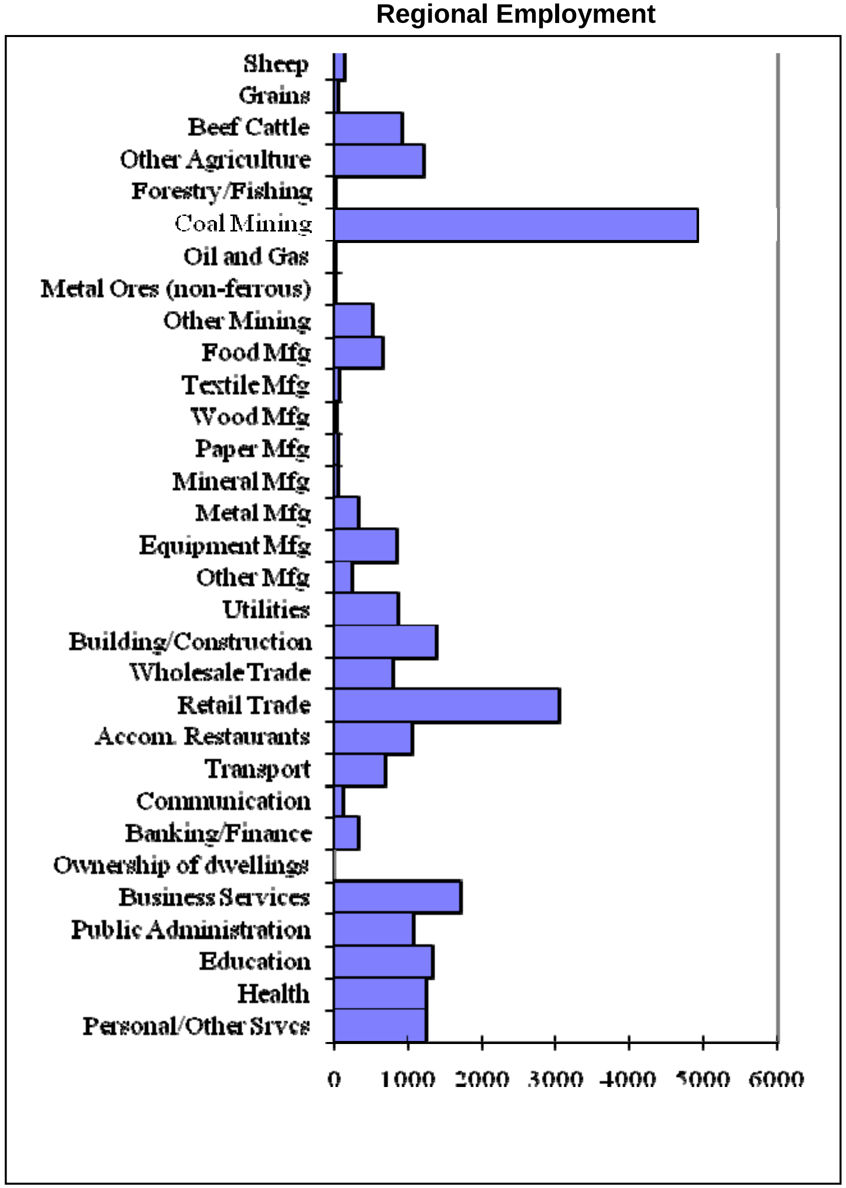
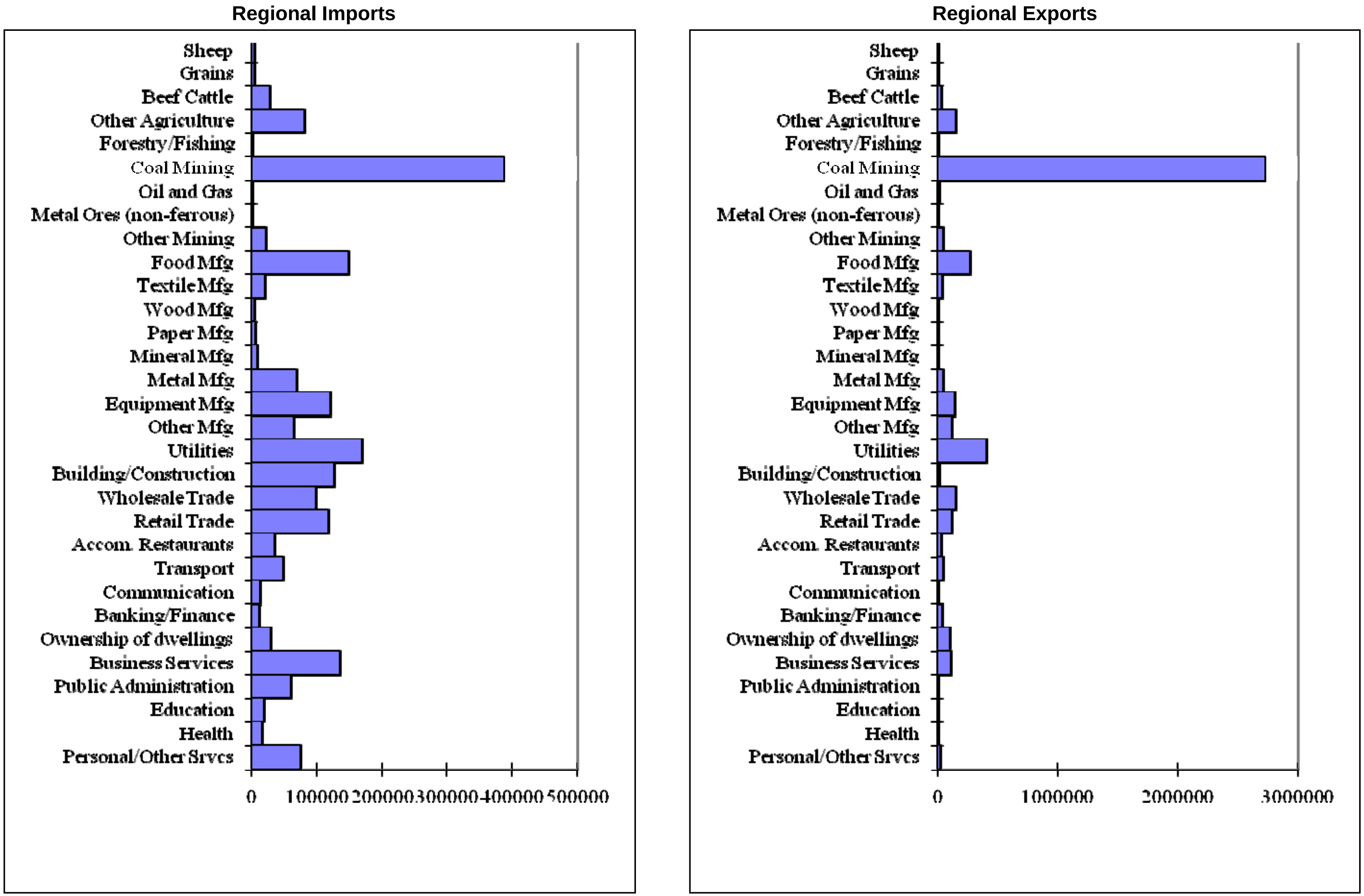


Figure 3.5 Sectoral Distribution of Imports and Exports ($'000)



3.2 REGIONAL ECONOMIC IMPACT OF THE PROJECT

3.2.1 *Introduction*

For the analysis of the additional mining at the Mt Arthur Coal Complex, a new Mt Arthur Coal sector was inserted into the regional input-output table reflecting the additional 8 Mtpa of ROM production for the Project. The revenue and expenditure data for this new sector was obtained via a financial survey of the current Mt Arthur Coal open cut operations in the last (2007/08) financial year, adjusted to 8 Mtpa ROM. 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;
- 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 local economy and *imports* based on 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 latest (2001-02) National Input-Output Tables;
- The difference between total revenue and total costs was allocated to the *other value-added* row*;* and
- Direct employment by HVEC (not including contractors) that reside in the region was allocated to the *employment* row.

3.2.2 *Impacts of the Project on the Regional Economy*

The total and disaggregated annual impacts of the Project on the regional economy in terms of output, value-added, income and employment (in 2008 dollars) are shown in Table 3.2.

Table 3.2
Annual Regional Economic Impacts of the Project

	Direct Effect	Production Induced	Consump. Induced	Total Flow-on	TOTAL EFFECT
OUTPUT ($'000)	509,292	93,107	32,209	125,316	634,608
Type 11A Ratio	*1.00*	*0.18*	*0.06*	*0.25*	*1.25*
VALUE ADDED ($'000)	288,004	39,769	14,981	54,749	342,753
Type 11A Ratio	*1.00*	*0.14*	*0.05*	*0.19*	*1.19*
INCOME ($'000)	41,779	24,787	12,413	37,200	78,979
Type 11A Ratio	*1.00*	*0.59*	*0.30*	*0.89*	*1.89*
EMPL. (No.)	404	265	191	456	860
Type 11A Ratio	*1.00*	*0.66*	*0.47*	*1.13*	*2.13*

Note: contractors are included in the Production-Induced column.

In total, the Project is estimated to make the following contribution to the regional economy:

- $635M in annual direct and indirect regional output or business turnover;
- $343M in annual direct and indirect regional value added;
- $79M in annual household income; and
- 860 direct and indirect jobs.

While the Project is reported as providing 720 jobs, 493 of these are estimated to be direct employees and 227 are estimated to be contractors. Some 82% of these are estimated to reside in the region based on current employment patterns i.e. 404 direct employees and 186 contractors (included within the production-induced employment in Table 3.4). A further 89 employees and 41 on-site contractors are estimated to reside outside the region.

3.2.3 ***Multipliers***

The adjusted Type 11A ratio multipliers for the Project range from 1.19 for value-added up to 2.13 for employment.

Capital intensive industries 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 Project. Capital intensive mining projects also typically have a relatively low ratio multiplier for value-added reflecting the relatively high direct value-added for the Project compared to that in flow-on sectors. The low output ratio multiplier largely reflects the high direct output value of the Project compared to those sectors that experience flow-on effects from the Project.

3.2.4 ***Main Sectors Affected***

Flow-on impacts from the Project 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:

- Mining services sector;
- Agricultural and mining machinery manufacturing sector;
- Retail trade sector;
- Wholesale trade sector;
- Wholesale mechanical repairs sector;
- Road transport sector; and
- Technical services sector.

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

Table 3.3
Sectoral Distribution of Total Regional Employment Impacts

Sector	Average Direct Effects	Production induced	Consumption-induced	Total
Primary	0	1	4	5
Mining	404	54	0	458
Manufacturing	0	67	7	74
Utilities	0	5	2	7
Wholesale/Retail	0	67	53	120
Accommodation, cafes, restaurants	0	3	30	32
Building/Construction	0	5	1	6
Transport	0	18	6	24
Services	0	47	88	134
Total	**404**	**265**	**191**	**860**

Note: Totals may have minor discrepancies due to rounding.

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

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

3.3 STATE ECONOMIC IMPACTS OF THE PROJECT

3.3.1 *Introduction*

The State economic impacts of the Project were assessed in the same manner as for estimation of the regional impacts. A new Mt Arthur Coal sector was inserted into a 2008 NSW input-output table in the same manner described in Section 3.2.1. The primary difference from the sector identified for the regional economy was that all direct employment and contractor employment was assumed to reside in NSW and a greater level of expenditure was captured by NSW economy compared to the regional economy.

3.3.2 *Impacts of the Project on NSW*

The total and disaggregated annual impacts of the Project on the NSW economy in terms of output, value-added, income and employment (in 2008 dollars) are shown in Table 3.4.

Table 3.4
Annual State Economic Impacts of the Project

	Direct Effect	Production Induced	Consump. Induced	Total Flow-on	TOTAL EFFECT
OUTPUT ($'000)	509,292	242,942	196,142	439,084	948,376
Type 11A Ratio	*1.00*	*0.48*	*0.39*	*0.86*	*1.86*
VALUE ADDED ($'000)	300,413	95,754	99,906	195,660	496,073
Type 11A Ratio	*1.00*	*0.32*	*0.33*	*0.65*	*1.65*
INCOME ($'000)	50,950	60,994	57,173	118,167	169,117
Type 11A Ratio	*1.00*	*1.20*	*1.12*	*2.32*	*3.32*
EMPL. (No.)	493	691	805	1,496	1,989
Type 11A Ratio	*1.00*	*1.40*	*1.63*	*3.03*	*4.03*

In total, the Project is estimated to make the following contribution to the NSW economy:

- $948M in annual direct and indirect output or business turnover;
- $496M in annual direct and indirect value added;
- $169M in annual household income; and
- 1,989 direct and indirect jobs.

While the Project is reported as providing 720 jobs, 493 of these are estimated to be direct employees and 227 are estimated to be contractors (located within the production-induced flow-on effects in Table 3.5). 100% of these are estimated to reside in NSW.

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.

3.4 PROJECT CESSATION

The establishment and operation of the Project will stimulate demand in the regional and NSW economy leading to increased business turnover in a range of sectors and increased employment opportunities. Conversely, the unlikely event of cessation of the mining operations at the Mt Arthur Coal Complex after 2022 would result in a contraction in regional economic activity.

The magnitude of the regional economic impacts of cessation of the Project 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 Project cessation would depend on whether the workers and their families affected would leave the region. If it is assumed that some or all of the workers remain in the region, then the impacts of Project cessation would not be as severe compared to a greater level leaving the region. 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 Project cessation would approximate the direct and production-induced effects in Table 3.3. However, if displaced workers and their families leave the region then impacts would be greater and begin to approximate the total effects in Table 3.3.

The decision by workers, on cessation of the Project, to move or stay would be affected by a number of factors including the prospects of gaining employment in the local region compared to other regions, the likely loss or gain from homeowners selling, and the extent of "attachment" to the local region (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 region is a region's capacity to expand its factors of productions 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 Hunter region is highly prospective with considerable coal resources (DPI, 2008).

It is therefore likely that over time, new mining developments will occur, offering potential to strengthen and broaden the economic base of the region and hence buffer against impacts of the cessation of individual activities. However, it should be noted that mining at the Mt Arthur Coal Complex is anticipated to continue to the west beyond 2022, pending further Planning Approvals being sought in the future.

Ultimately, the significance of the economic impacts of cessation of the Project would depend on the economic structure and trends in the regional economy at the time. For example, if Project cessation takes place in a declining economy, the impacts might be significant.

Alternatively, if Project cessation takes place in a growing diversified economy where there are other development opportunities, the ultimate cessation of the Project may not be a cause for concern.

Nevertheless, given the uncertainty about the future complementary mining activity in the region it is not possible to foresee the likely circumstances within which Project cessation would occur. It is therefore important for regional authorities and leaders to take every advantage from the stimulation to regional economic activity and skills and expertise that the Project would maintain in the region.

4 CONCLUSION

A benefit cost analysis of the Project identified a range of potential economic costs and benefits of the Project. Values were placed on production costs and benefits as well as most external costs. The net quantified benefits of the Project were estimated at $1,812M. However, some of the external environmental impacts of the Project – namely consumer values for Aboriginal and non-Aboriginal cultural heritage impacts, visual impacts and some of the transport and traffic impacts - have not been able to be fully quantified. The quantified net benefits of the Project of $1,812M can therefore be considered as a minimum threshold value that the unquantified environmental impacts of the Project, after mitigation by HVEC, would need to exceed to make the Project questionable from an economic efficiency perspective.

A regional economic impact analysis, using input-output analysis, estimated that in total, the Project will contribute the following to the regional economy:

- $635M in annual direct and indirect regional output or business turnover;
- $343M in annual direct and indirect regional value added;
- $79M in annual household income; and
- 860 direct and indirect jobs.

At the State level the Project will make the following contribution to the economy:

- $948M in annual direct and indirect output or business turnover;
- $496M in annual direct and indirect value added;
- $169M in annual household income; and
- 1,989 direct and indirect jobs.

This stimulus would be felt across a range of sectors in the economy including the coal mining sector, mining services sector, agricultural and mining machinery manufacturing sector, retail trade sector, wholesale trade sector, wholesale mechanical repairs sector, road transport sector, technical services sector, accommodation/cafes/restaurants and services sectors.

The Project is seeking approval until 2022, consistent with the approved mining life of Mt Arthur North as provided in existing approvals. In the unlikely event of mine closure after 2022, cessation of the Project may lead to a reduction in economic activity. However, it is anticipated that mining at the Mt Arthur Coal Complex will continue to the west beyond 2022, pending further Planning Approvals being sought in the future. Hence, impacts of Project cessation may not be felt for many years.

Nevertheless, given the uncertainties about the likely timing of mine cessation and the circumstances within which Project cessation will occur, it is important for regional authorities and leaders to take every advantage from the stimulation to regional economic activity and skills and expertise that the Project brings to the region, to strengthen and broaden the region's economic base.

5 REFERENCES

Bayne, B. and West, G. (1988), *GRIT – Generation of Regional Input-Output Tables: Users Reference Manual*. Australian Regional Developments No. 15, Office of Local Government, Department of Immigration, Local Government and Ethnic Affairs, AGPS.

Bennett, J. (1996) *The Economic Efficiency of RACAC Resource Allocation Options: A Conceptual Framework*, prepared for the Resource and Conservation Assessment Council.

Bennett, J., van Bueren, M., and Whitten, S. Estimating society's willingness to pay to maintain viable rural communities, *Australian Journal of Agricultural and Resource Economics*, 48:3, pp. 487-512.

Bureau of Industry Economics (BIE) (1994), *Regional Development: Patterns and Policy Implications*. AGPS, Canberra.

Economic and Planning Impact Consultants (1989) *The Economic Impact of the Woodchipping Industry in South Eastern NSW.* Report to the Wilderness Society.

Gillespie Economics (2008) *Managing the Impacts of a Mine in the Southern Coalfield, A Survey of Community Attitudes*, prepared for Helensburgh Coal Pty Ltd, In Peabody (2009) Metropolitan Coal Project Responses to Planning Assessment Commissions Queries.

Johnson, F. and W. Desvouges (1997). Estimating Stated Preferences with Rated-Pair Data: Environmental, Health and Employment Effects of Energy Programs.*Journal of Environmental Economics and Management,* 34, 75-99

James, D. and Gillespie, R. (2002) *Guidelines for Economic Effects and Evaluation for EIA*. Prepared for NSW Department of Urban Affairs and Planning.

Jensen, R. and West, G. (1986), *Input-output for Practitioners: Theory and Applications*. Prepared for Department of Local Government and Administrative Services, Local Government and Regional Development Division, Australian Government Publishing Service.

Lockwood, M. and Carberry, D. (1998) *State Preference Surveys of Remnant Native Vegetation Conservation*, Johnstone Centre Report No.104, Charles Sturt University, Albury.

Morrison, M. and J. Bennett (1999). .Valuing Changes to the Macquarie Marshes Using Choice Modelling., *Water Resources Research*, 35(9), 2805-2814

Nordhaus, W. (2008) *A Question of Balance: Weighing the Options on Global Warming Policies*, Yales University Press, New Haven and London.

NSW Department of Primary Industries (DPI) (2008) *New South Wales Coal Industry Profile*.

NSW Treasury (2007) *Treasury Guidelines for Economic Appraisal*. Website: www.treasury.nsw.gov.au. Date Accessed: 10 July 2008.

Portney, P. (1994). .The Contingent Valuation Debate: Why Economists Should Care., *Journal of Economic Perspectives,* 8(4), 3-18

Powell, R. and Chalmers, L. (1995), *The Regional Economic Impact of Gibraltar Range and Dorrigo National Park*. A Report for the NSW National Parks and Wildlife Service.

Powell, R., Jensen, R. and Gibson, A. (1985), *The Economic Impact of Irrigated Agriculture in NSW*. A report to the NSW Irrigators' Council Limited.

Rolfe, J. (2008) *A Systematic Database for Benefit Transfer of NRM Values in Queensland, http://resourceeconomics.cqu.edu.au/FCWViewer/view.do;jsessionid=8a4d179b30dba2529bac0503497db974cc5f075c017d.e34MaxeRbhuObi0LbxyMbNaKaxaTe6fznA5Pp7ftolbGmkTy?page=2598*

Rolfe, J., Blamey, R. and Bennett, J. (1997) *Remnant Vegetation and Broadscale Tree Clearing in the Desert Uplands Region of Queenslan*d, Choice Modelling Research Report No. 3, University of NSW.

Stern, N. (2006) *Stern Review: The Economics of Climate Change – Executive Summary*, Cabinet Office – HM Treasury, www.hm-treasury.gov.uk/media/8AC/F7/Executive_Summary.pdf

Streeting, M. and Hamilton, C. (1991) *Economic analysis of the forests of south-eastern Australia*, prepared for the Resource Assessment Commission.

Tol, R. (2005) *The marginal damage costs of carbon dioxide emissions: an assessment of the uncertainties*, Energy Policy 33 (2005) p. 2064-2074.

Tol, R. (2006) *The Stern Review of the Economics of Climate Change: A Comment.* Economic and Social Research Institute, Hamburg, Vrije and Carnegie Mellon Universities.

URS (2007) *Non-Use Values of Victorian Public Lands: Case Studies of River Red Gum and East Gippsland Forests*, prepared for the Victorian Environmental Assessment Council.

Van Bueren, M. and J. Bennett (2000) "*Estimating Community Values for Land and Water Degradation Impacts" Draft Report to the National Land and Water Resource Audit*, Unisearch Pty Ltd, Canberra.

West, G. (1993), *Input-Output Analysis for Practitioners, Version 7.1, User's Guide*.

Wood Mackenzie, Coal Market Service (Dec 2008), *Coal Forecast*.

Appendix 1 – Valuing Greenhouse Gas Emissions

To place an economic value on 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 US$85/t CO_2-e 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;
- 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 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$0.55/t CO_2-e (in 1995 US$), the median was US$3.82/t CO_2-e, the mean US$25.34/t CO_2-e and the 95^{th} percentile US$95.37/t CO_2-e. 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 carbon dioxide emissions exceed US$14/t CO_2-e 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 (/tC) (US$8/t CO_2-e).

An alternative method to trying to estimate the damage costs of carbon dioxide is to examine the price of carbon credits. This is relevant because emitters can essentially emit CO_2-e resulting in climate change damage costs or may purchase credits that offset their CO_2-e 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.

The price of carbon credits under the European Union Emissions Trading Scheme are currently around €24/t CO_2-e, the equivalent of about US$38 t CO_2-e while spot prices in the Chicago Climate Exchange are in the order of US$3.95 t CO_2-e.

More recent information on the cost of carbon credits can be obtained from the carbon reduction schemes in Australia. As of July 2008 the spot price under the NSW Government Greenhouse Gas Reduction Scheme was AUS$7.25 t CO_2-e. Prices under the Commonwealth Governments Greenhouse Friendly Voluntary Scheme were AUS$8.30 t CO_2-e and Australian Emissions Trading Unit (in advance of the Australian Governments Emissions Trading Scheme) was priced at AUS$21 t CO_2-e (Next Generation Energy Solutions pers. comms. 24 July 2008).

A National Emissions Trading Scheme is foreshadowed in Australia by 2010. While the ultimate design and hence liabilities under the scheme are still a work in progress, the National Emissions Trading Taskforce cited a carbon permit price of around AUS$35 t CO_2-e.

The Carbon Pollution Reduction Scheme: Australia's Low Pollution Future White Paper (Australian Government,2008) cited a carbon permit price of AUS$23/t CO_2-e in 2010 and AUS$35/t CO_2-e in 2020 (in 2005) dollars for a 5% reduction in carbon pollution below 2000 levels by 2020.

Given the above information and the great uncertainty around damage cost estimates, a range for the social cost of greenhouse gas emissions from AUS$8/ t CO_2-e to AUS$40/ t CO_2-e was used in the sensitivity analysis in Section 2.6, with a conservatively high central value of AUS$30/ t CO_2-e.

Appendix 2 – Sensitivity Testing (NPV A$M)

INCREASE 20%	4%	7%	10%
Opportunity cost of land	$2,466	$1,812	$1,334
Capital costs	$2,276	$1,640	$1,178
Operating costs	$2,243	$1,634	$1,190
Rehabilitation costs	$2,461	$1,809	$1,332
Revenue	$3,447	$2,591	$1,962
Residual value of capital and land	$2,467	$1,813	$1,335
Greenhouse costs	$2,442	$1,793	$1,319
Ecological costs	$2,427	$1,774	$1,298
DECREASE 20%			
Opportunity cost of land	$2,467	$1,813	$1,335
Capital costs	$2,657	$1,985	$1,491
Operating costs	$2,689	$1,991	$1,479
Rehabilitation costs	$2,471	$1,816	$1,337
Revenue	$1,486	$1,034	$708
Residual value of capital and land	$2,465	$1,812	$1,334
Greenhouse costs	$2,491	$1,832	$1,351
Ecological costs	$2,506	$1,851	$1,372

Appendix 3 – 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 non-ferrous metals and building and construction sectors. 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. It also means that the method should be used by an analyst who is familiar with the economy being modelled, or at least someone with that familiarity should be consulted.

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). That 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 A-1" (Powell and Chalmers, 1995).

Table A-1
The GRIT Method

Phase	Step	Action
PHASE 1		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)