NSW GOVERNMENT | Planning & Environment

Technical Notes supporting the Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals

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Contents

Introduction to Technical Notes

Developing a cost-benefit analysis

Technical Notes have been developed to support the 'Guidelines for Economic Assessment of Mining and Coal Seam Gas Proposals'. The Technical Notes provide additional information on options and approaches relevant to completion of a robust and comprehensive economic assessment of a range of environmental, social and transport related impacts for new State Significant Development mining and coal seam gas proposals in NSW.

It is intended that the Technical Notes will be subject to ongoing review to ensure they are consistent with new research, changes in best practice and contemporary Government policy development. Project proponents should ensure that they are using the most recent published version of the Technical Notes.

The Technical Notes relate to the following impacts:

1. Aboriginal heritage
2. Environmental heritage
3. Noise
4. Visual amenity
5. Air quality
6. Ground and surface water impacts
7. Biodiversity
8. Transport impacts, and
9. Greenhouse gas emissions output.

All project analyses should address the set of third party impacts highlighted in the Technical Notes. This is desirable if only to note that the project will have no material impact in the areas considered or that, for reasons of estimation or synergy, two or more issues have been considered together.

Proponents should note that the methods listed in the Technical Notes are not exhaustive in their coverage of possible impacts, as outlined in the Guidelines themselves.

Final detailed analysis should be accompanied by a summary analysis and / or table that addresses estimated project impacts (and, where applicable, annual social or environmental cost estimates) for each of these impacts.

Workbook layout

Proponents will need to input cost and benefit data into relevant sections of a CBA workbook in three steps:

1. Defining key assumptions
2. Manually filling-in all 'input' cells in relevant worksheets
3. Transcribing values from Environmental, Social and Transport workbooks into relevant worksheets.

The cost benefit analysis should include:

- A summary results table built off aggregates of greater detail from accompanying worksheets.
- A summary page of the key assumptions made. This includes assumptions such as: project start, duration and end; construction period; estimated Australian share of project ownership; and Royalty rates applied.
- Data and results for the entire evaluation period attributable to the project, to provide transparency and rigour around the determination of key results.

- Transparent calculations and methods to enable an understanding of the key results. The use of hard coded data is not recommended.
- Adequate space for text to explain methods and results that may aid in the understanding of key results.
- Adequate space for text to detail the qualitative elements of the cost-benefit analysis, particularly in relation to the indirect costs and benefits associated with environmental, social and transport-related themes.
- Worksheets that express value streams over time to express both undiscounted and discounted costs and benefits, to enable tracking of the process from initial data entry through to summary results.

Overview of non-market valuation techniques

When valuing the impacts of projects on communities and the environment, market prices are not always available as some amenities are not explicitly traded. In these cases, non-market or intangible valuation methods can help estimate the community valuation of environmental impacts. The most relevant non-market valuation techniques are described below.

Revealed preference methods

Revealed preference methods rely on observations of people's behaviour to examine the trade-offs they make between market goods and non-market goods, such as recreation, amenity or improved health outcomes. Inferences are then made about people's preferences and valuations based on these observations.

Hedonic pricing

Hedonic pricing attempts to identify the extent to which the price of market assets is influenced by non-market impacts. This approach most commonly uses differences in asset prices in different locations to impute a value for changes in environmental conditions such as air, noise and visual amenity. In most hedonic price studies, regression analysis is undertaken to estimate asset prices as a function of all the attributes of the asset, including its environmental quality characteristics. The effect of marginal differences in environmental quality on asset prices can then be quantified. Hedonic pricing commonly examines variations in property prices because the large stock of houses compared to other assets lends itself better to statistical analysis. However other marketable assets, such as the capital value of businesses, may also be examined.

Hedonic pricing is limited by assumptions that:

- environmental and other non-market attributes are fully and reliably reflected in asset prices, and
- purchasers of the asset are fully aware of the environmental attributes and weigh these up against the prices of all available houses in the area.

Travel costs

The travel-cost method imputes the value people place on a specific site by examining how much they spend to visit the site (transport costs, accommodation, entry fees, cost of time). Adjustments then need to be made for the surplus that people derive from their purchases, that is, the extra value they derive after full payment has been made.

Stated preference methods

Stated preference methods are based on the notion that there is some amount of money that people would be willing to pay for the benefit of a non-market good. These methods have also been used to estimate how much compensation people would be willing to accept to give up a non-market good (such as environmental amenity) from which they have already received benefit.

Contingent valuation and choice modelling

Contingent valuation involves asking people to express their willingness to pay to obtain a non-market outcome, or willingness to accept to give up a non-market outcome. As an example, a survey would present people with a set amount and ask if they would be willing to pay that amount for the non-market outcome to be achieved. The amount is varied across participants in a way that allows statistical models to be used to calculate average willingness to pay.

Choice modelling involves asking people to choose their most preferred option from a set of alternatives, each of which consists of a bundle of attributes that comprise the non-market outcome. By varying the mix of attributes and presenting people with several choice sets, statistical methods can be used to quantify the trade-offs that people make between attributes (including implicit valuations).

Stated preference methods use a hypothetical situation or 'thought experiment' to obtain valuations and this can affect the reliability of estimates. Key assumptions (and requirements) include:

- people know how much they would be willing to pay for a non-market good, and that this is constrained by their wealth and preferences to consume market goods and,
- people answer the survey questions honestly and rationally with their income and need for real world trade-offs in mind.

Benefit transfer

Benefit transfer involves drawing on estimates from previous studies. This approach can reduce the need for resource intensive primary studies, but relies on the results of previous studies being relevant and transferable to the issue at hand. This includes results concerning the type of non-market factor being examined, the type of impact and other attributes (population affected, income, tastes, geography, background environment and climate).[1]

In some cases, an estimate from a previous study may be directly relevant and comparable to the non-market impact in question. In other cases, a proponent would need to use a prior study (or studies) as a starting point for deriving an estimate that better captures the attributes of the case at hand.

Qualitative description

Some assets and attributes can be very difficult to value using either market or non-market valuation techniques. Environmental and aboriginal heritage provides examples where:

- the value of a newly discovered heritage object or site will not be reflected in asset prices within the local area, and in fact there may be little nearby market activity to rely on
- stated preference techniques may struggle to put a reliable monetary value on the significance of the heritage object or site.

In these cases, consultation with heritage or indigenous experts or elders may be essential to confirm the significance of the site, the dimensions of its value and the materiality of the impact of the project on the site. Community and expert input should form a significant part of the process of cost-benefit analysis

[1] Van Bueren, M. and Bennett, J. 2004, 'Towards the development of a transferable set of value estimates for environmental attributes', Australian Journal of Agricultural and Resource Economics, vol. 48, no. 1, pp. 1–32.

where quantitative approaches are likely to present significant 'gaps' (particularly with respect to heritage) and such consultation should be reported in the analysis.

Choosing a method

Australian studies using these methods are limited[2], and there is significant variability in the estimates generated using these techniques.

The decision to undertake any one of the methods described above depends on the specific circumstances of the project, and the materiality of findings and issues from a preliminary assessment. A summary of factors to be considered include:[3]

Assessment method	Advantages	Disadvantages
Qualitative assessment only	Potentially less resource intensive than other methods. Useful when market and non-market valuation techniques are inadequate or impractical.	Explicit valuation not able to be included as part of CBA. Can be reliant on a small pool of experts, which may be perceived to diminish objectivity.
Hedonic pricing	References tangible market values. Draws on existing knowledge and expertise from validated economic analysis of previous studies	Data intensive, estimates of specific environmental externalities (noise, visual, air, non-use impacts) not easily isolated. Captures market values rather than personal impacts.
Travel Costs	References tangible market values. Based on actual behaviour, so less subject to behavioural and strategic bias associated with stated preference methods.	Unsuitable for measuring the value of unique sites, features, or functions that are not visited, but still valued. Challenges in valuing a person's time spent traveling. Assumptions around the purpose of site visits can lead to unreliable results.
Contingent Valuation	Flexible - Allows a wide range of use and non-use impacts to be valued	Resource intensive, results contentious, can be unreliable, requires careful survey design to

[2] Examples include:

Baker, R. and Ruting, B., 2014, "Environmental Policy Analysis: A Guide to Non-Market Valuation", Productivity Commission Staff Working Paper, Appendix B

Gillespie, R. & M. E. Kragt, 2012, "Accounting for nonmarket impacts in a benefit-cost analysis of underground coal mining in New South Wales, Australia." Journal of Benefit-Cost Analysis 3(2): article 4.

Neelawala, P., Wilson, C., and Athukorala, W., 2012," The impact of mining and smelting activities on property values: a study of Mount Isa city, Queensland, Australia", Australian Journal of Agricultural and Resource Economics, vol. 57, pp-60-78

[3] More information can be found at sources including Baker, R. and Ruting, B., 2014, "Environmental Policy Analysis: A Guide to Non-Market Valuation", Productivity Commission Staff Working Paper and NSW Treasury, "NSW Government Guide to Cost-Benefit Analysis", March 2017

		avoid behavioural and strategic bias and gaming
Choice Modelling	Flexible - Allows a wide range of use and non-use impacts to be valued. Results more robust than contingent valuation.	More resource intensive than contingent valuation, results contentious, can be unreliable, requires careful survey design to avoid behavioural and strategic bias
Benefit Transfer	Relies on existing estimates, so less resource intensive than other methods	Limited use as it relies on availability of existing and relevant non-market studies

These methods are not necessarily mutually exclusive – depending on the specific factors associated with a project. A combination of methods may lead to the most robust assessment of non-market goods. However, if combining methods, care should be taken not to double count impacts.

Risk and uncertainty

As noted in the Guidelines, a detailed discussion of risk and uncertainty should be incorporated in key areas of the cost-benefit analysis. While expected (and 'averaged') outcomes and values for impacts represent critical information for project appraisal, a discussion of the likelihood and range of feasible alternatives is also important (see Guidelines, p.4). Concerns about potential high impact/low probability outcomes should be explicitly considered and addressed in the analysis – along with a discussion of relevant risk minimisation strategies adopted as part of the project design and their implications.

Technical Note 1
Aboriginal Cultural Heritage

This Technical Note supports the 'Guidelines for Economic Assessment of Mining and Coal Seam Gas Proposals'. It is intended that the Technical Notes will provide additional information on options and approaches relevant to completion of a robust and comprehensive economic assessment of a range of environmental, social and transport related impacts for new State Significant Development mining and coal seam gas proposals in NSW.

The Technical Notes will be subject to ongoing review to ensure consistency with contemporary Government legislation, policies and guidelines. Project proponents should ensure that they are using the most recent published version of the Technical Notes.

Aboriginal cultural heritage provides links between the past and present – it is an essential part of Aboriginal people's cultural identity, connection and sense of belonging to Country. Aboriginal cultural heritage is dynamic and may comprise physical (tangible) and/or non-physical (intangible) elements. Tangible heritage such as stone tools, art sites and ceremonial grounds, is situated in a broader cultural landscape and needs to be considered in that context and in a holistic manner. The effective protection and conservation of this heritage is important in maintaining the identity, health and wellbeing of Aboriginal people.

The identification and assessment of items or places of Aboriginal cultural significance is underpinned by the four values in the ICOMOS Burra Charter[1], which are the basis for cultural heritage assessment in Australia. These values include:

- historical significance,
- aesthetic significance,
- research/technical significance, and
- social significance.

Mining and coal seam gas projects may impact on Aboriginal cultural heritage values including Aboriginal objects and places (defined in the *National parks and Wildlife Act 1974*) resulting from blasting, subsidence, vibration, land clearing and harm to aquifers.

Any proposal that effects Aboriginal cultural heritage values must investigate, assess and report on the impact.

The following legislation provides the primary context for Aboriginal cultural heritage in NSW[2]:

- National Parks and Wildlife Act 1974,
- Environmental Planning and Assessment Act 1979,
- Heritage Act 1977,
- Aboriginal Land Rights Act 1983,
- Native Title Act 1993 (Cth) and NSW Native Title Act 1994, and
- Other Australian Government legislation

Consistent with this legislation, policies exist for investigating and assessing Aboriginal cultural heritage. For State Significant Developments, it is necessary to prepare an Environmental Impact Statement (EIS)[3].

The EIS must identify and describe the Aboriginal cultural heritage values that exist across the whole area that will be affected by the project. This may include the need for surface survey and test excavation. The identification of cultural heritage values should be guided in accordance with the Guide to investigating,

[1] The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance, 2013.
[2] NSW Office of Environment and Heritage, 2011, Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW
[3] Environmental Planning and Assessment Act 1979, Part 4

assessing and reporting on Aboriginal Cultural Heritage in NSW[4] and in consultation with OEH Regional Offices.

Where Aboriginal cultural heritage values are identified, consultation with Aboriginal people must be undertaken and documented. Consultation should occur in accordance with the Aboriginal cultural heritage consultation requirements for proponents.[5] The significance of cultural heritage values for Aboriginal people who have a cultural heritage association with the land must be documented in the EIS.

The EIS must assess and document all impacts on Aboriginal cultural heritage values. The EIS must also demonstrate the proponent's attempts to avoid impact upon cultural heritage values and identify any conservation impacts. Where impacts are unavoidable, the EIS must identify and describe measures to mitigate and manage these impacts.

Economic valuation of the Aboriginal cultural heritage impact

Aboriginal culture and heritage includes both tangible sites or objects and intangible aspects such as stories, songs and ceremonies associated with landscapes or sacred sites. There are substantive challenges in quantifying these intrinsic cultural values in monetary terms. Existing valuation methods do not possess the requisite degree of cultural competence to satisfactorily achieve an accurate quantification.

Consultation with Traditional Owners and local Aboriginal people with cultural knowledge and authority remains the predominant pathway for understanding and assessing Aboriginal culture and heritage. Consultation should reflect that Aboriginal people are the only people with authority to assess and speak for the cultural value and significance of their heritage.

Although the primary intrinsic value of Aboriginal culture and heritage cannot be quantified, there are costs associated with potential impacts and benefits to Aboriginal culture and heritage that can be identified in some circumstances.

The proponent should consider the following approach in addressing Aboriginal cultural heritage impacts.

The cost and benefits of any management or mitigation measures stemming from compliance with policies described above should be included and explicitly identified in the proponent's operating and capital costs. This is likely to include any costs associated with complying with Aboriginal culture, heritage assessments and permit processes, and should include compliance costs such as fees for engaging cultural heritage monitors. The cost of any compensation arising from affected native title rights and interests relating to culture and heritage in the project area should also be included. As well as providing initial cost estimates, the proponent should provide an assessment of potential future costs and benefits associated with compliance with legislation and mitigation measures.

The proponent should undertake qualitative analysis derived from consultation with Traditional Owners and local Aboriginal people, including any Local Aboriginal Land Councils, native title representatives and Elders' groups, in accordance with the Aboriginal cultural heritage consultation requirements for proponents 2010.[6] Proponents should also consider best practice international standards including the United Nations Declaration on the Rights of Indigenous Peoples[7] and the International Labour Organisation, Indigenous and Tribal Peoples Convention.[8] Where appropriate, the proponent may

[4] NSW Office of Environment and Heritage, 2011, Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW
[5] NSW Office of Environment and Heritage, 2010, Aboriginal cultural heritage consultation requirements for proponents 2010
[6] ibid
[7] United Nations, 2008, UN Declaration of the Rights of Indigenous People
[8] International Labour Organisation, 1989, C169 – Indigenous and Tribal Peoples Convention

incorporate relevant Aboriginal cultural heritage consultation undertaken as part of the EIS process described above into the cost benefit analysis.

The proponent should then assess any material indirect costs and benefits to the NSW community (as outlined on page 4 of the Guidelines). To the extent possible, these costs and benefits should be identified to provide a more accurate assessment of a project's costs and benefits to the community. Examples of possible material costs due to the proposed project may include an assessment of the economic impacts on enterprises based on cultural tourism, or economic impacts due to changes in national park visitor numbers. The decision to undertake such a study may rely on factors including:

- Whether the valuation of any material impact is likely to materially influence the cost-benefit analysis, and
- The cost of these studies relative to the likely value of the non-market impact.

If preliminary analysis suggests that these impacts are likely to be immaterial, relative to the overall result of the CBA, it may be sufficient to note this as a part of the cost-benefit analysis.

Should a more detailed investigation be deemed appropriate, then non-market valuation options may be considered. These options are described in more detail in the Introduction to Technical Notes section. However, in considering these methods, it should be noted that a quantitative approach may not allow for the explicit determination of material heritage impact values among environmental / heritage impacts more generally. In these cases, it may be appropriate to limit value estimates to these broader environmental / heritage impacts and restrict analysis around material secondary heritage impacts to a qualitative appraisal. In undertaking any further analysis of material heritage impacts, the proponent should recognise the likelihood of the overlaps between the estimates of primary qualitative analysis derived from consultation and material costs and benefits that have been valued.

To the extent that material Aboriginal cultural heritage impacts exist, the portion of these impacts that are incurred within the locality will need to be estimated and presented within the Local Effects Analysis (LEA).

Technical Note 2
Environmental Heritage

This Technical Note supports the 'Guidelines for Economic Assessment of Mining and Coal Seam Gas Proposals'. It is intended that the Technical Notes will provide additional information on options and approaches relevant to completion of a robust and comprehensive economic assessment of a range of environmental, social and transport related impacts for new State Significant Development mining and coal seam gas proposals in NSW. Proponent should report The Technical Notes will be subject to ongoing review to ensure consistency with contemporary Government legislation, policies and guidelines. Project proponents should ensure that they are using the most recent published version of the Technical Notes.

The *Heritage Act 1977* defines environmental heritage as 'those places, buildings, works, relics, moveable objects, and precincts, of State or local heritage significance'.[1]

Mining and coal seam gas projects may impact environmental heritage items, objects and places because of blasting, subsidence, vibration, and land clearing.

In NSW, the *Environmental Planning and Assessment Act 1979* and the *Heritage Act 1977* provide the legislative framework for managing heritage items, objects and places. Impacts associated with mining or coal seam gas extraction must be identified and assessed in accordance with this legislation.

The NSW heritage assessment system encompasses the four values in the ICOMOS Burra Charter[2], which form the basis for cultural heritage assessment in Australia. These values of heritage significance include:

- historical significance,
- aesthetic significance,
- research/technical significance, and
- social significance.

To provide further clarity and consistency, these four values are extended to seven detailed assessment criteria which specifically address key areas of possible significance. The grade of significance then informs the relative contribution made by the item to the heritage value of the place. Finally, the level of significance for NSW (state or local) is then determined by comparison with other like items.

A project proponent is required to actively assess the heritage significance of an item, place or area even if it is not listed on the State Heritage Register.

A Statement of Heritage Impact (SOHI)[3] or a Conservation Management Plan (CMP) must be submitted with any application that affects environmental heritage items, objects or places. Each needs to include a succinct statement of heritage significance which summarises an item's heritage values[4].

Statement of Heritage Impact

The SOHI identifies the heritage significance of the item, place or area, the impacts of any changes being proposed to it and how any impacts arising from the changes will be mitigated.

The SOHI is expected to

- identify why the item, place or area is of heritage significance (statement of heritage significance)
- describe the works, change of use and any physical changes to the place

[1] NSW Heritage Act 1977
[2] The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance, 2013.
[3] NSW Heritage Office and Department of Urban Affairs & Planning, 2002, Statements of Heritage Impact
[4] NSW Heritage Office, 2001, Assessing Heritage Significance

- identify the impact(s) the proposed changes to the heritage item will have on its heritage significance
- identify and describe any measures being proposed to lessen negative impacts of the proposed changes
- identify why more sympathetic solutions to those being proposed are not viable.[5]

Conservation Management Plan

A Conservation Management Plan (CMP) guides the future development and management of a heritage item, place or area in a way that protects its heritage significance. It not only identifies a preferred use for the item, place or area but also how any proposed changes will be implemented so that the maximum heritage significance is retained. As such, it provides a framework for investigating, assessing and managing the heritage significance of heritage items, places or areas.

The process associated with undertaking a CMP is outlined in Table 1 below:

Table 1 – The Conservation Management Plan Process[6]

Stage	Work Required
Stage 1 – Understanding the Item, Place, or Area.	• Collect documentary and physical evidence on the item, place or area. • Coordinate collected material • Develop a Statement of Significance
Stage 2 – Developing Conservation Policies and Implementation Strategies	• Collect information necessary to develop Conservation Policy. This should include client requirements, budget constraints and viable uses, physical condition of the place, legal, legislative or other requirements and measures necessary to retain the significance of the item, place or area. • Develop and state Conservation Policy • Identify Strategy for implementing Conservation Policy

Economic valuation of the environmental heritage impact

The cost of any management or mitigation measures stemming from the policies described above should be specifically noted and included in the proponent's operating and capital costs. Additionally, the proponent should provide an assessment of potential future costs associated with compliance with legislation, mitigation and control measures.

Following management or mitigation, the proponent should assess and estimate the value any outstanding material costs and benefits to the NSW community.

It may be possible to adopt non-market valuation techniques to estimate the value of project's material impacts on environmental heritage. The decision to undertake such a study may rely on factors including:

- Whether the valuation of the heritage impact is likely to materially influence the cost-benefit analysis, and

[5] NSW Heritage Office, 2002, Local Government Heritage Guidelines, p. 56.
[6] NSW Heritage Office, 2002, Local Government Heritage Guidelines, p. 59.

- The cost of valuation study options relative to the likely value of the non-market impact.

While the options outlined in the Technical Notes Overview may be considered, environmental heritage is an example of an amenity where either market or non-market valuation techniques may be unsuitable since:

- the amenity of the heritage object or site may not be capitalised in local asset prices, which precludes the use of revealed preference techniques, and/or
- stated preference techniques may not appropriately value the significance of the heritage object or site.

In these cases, thorough and robust consultation with environmental heritage experts may provide the most accurate assessment of the materiality of the residual impacts (post-mitigation) of the project on the heritage site. Even if an explicit quantitative valuation is not provided, the cost-benefit analysis should include a qualitative analysis of these discussions. This analysis should be provided with as much prominence as the items of the report that provide explicit quantitative valuations.

Should a more detailed investigation be deemed necessary, then the non-market valuation options outlined in the Introduction to Technical Notes section may be considered. In considering these methods, it should be noted that a quantitative approach may not allow for the explicit determination of material residual heritage impact values among environmental impacts more generally. In these cases, it may be appropriate to limit value estimates to these broader environmental impacts and restrict analysis around material residual heritage impacts to a qualitative appraisal. In undertaking any further analysis of material residual heritage impacts, care should be taken not to double-count heritage impact values embodied in estimates from other studies of environmental valuation contained within the economic assessment.

To the extent that material residual heritage impacts exist, the portion of these impacts that are incurred within the locality will need to be estimated and presented within the Local Effects Analysis (LEA).

Technical Note 3
Noise

This Technical Note supports the 'Guidelines for Economic Assessment of Mining and Coal Seam Gas Proposals'. It is intended that the Technical Notes will provide additional information on options and approaches relevant to completion of a robust and comprehensive economic assessment of a range of environmental, social and transport related impacts for new State Significant Development mining and coal seam gas proposals in NSW. The Technical Notes will be subject to ongoing review to ensure consistency with contemporary Government legislation, policies and guidelines. Project proponents should ensure that they are using the most recent published version of the Technical Notes.

Noise associated with mining has the potential to impact the surrounding community. Impacts may include interference with daily activities, annoyance, sleep disturbance, and health impacts. Noise may also impact the quality of environmental or Aboriginal cultural heritage sites.

Noise from mining and extractive industry developments may be produced by light and heavy vehicle engines, coal handling and minerals processing machinery, power generation, the loading and unloading of ores and waste products, drilling, and blasting.

Noise from road or rail associated with the transportation of mine output to port or processing facilities has the potential to impact local communities along haulage routes.

Regulatory Framework

There are two key regulators of noise impacts from state significant mining, petroleum and extractive industry developments in NSW:

- The Department of Planning and Environment (DPE) is responsible for assessing development applications and enforcing conditions of development consents for State significant developments under the Environmental Planning and Assessment Act 1979 on behalf of the Minister for Planning; and
- The Environment Protection Authority (EPA) is responsible for issuing and enforcing Environment Protection Licences under the Protection of the Environment Operations Act 1997 (POEO Act). This includes responsibility for compliance and enforcement of the conditions associated with the development consents for State significant developments.

The associated policies and guidelines which regulate noise and aim to balance the need for industrial activity while minimising adverse community impacts include the:

- NSW Noise Policy for Industry[1];
- Rail Infrastructure Noise Guideline[2];
- Interim Construction Noise Guideline[3],
- NSW Road Noise Policy[4]

Noise from vehicle movements associated with an industrial source is covered by the NSW Noise Policy for Industry if the vehicles are not on a public road. If the vehicles are on a public road, the NSW Road Noise Policy applies.

[1] NSW Environment Protection Authority, 2017, Noise Policy for Industry. Note: The superseded Industrial Noise Policy (EPA, 2000) may be relevant for some developments due to Noise Policy for industry transitional and implementation arrangements available at http://www.epa.nsw.gov.au/publications/noise/17p0293-implement-transition-arrange-noise-pol-industry
[2] NSW Environment Protection Authority, 2013, Rail Infrastructure Noise Guideline
[3] NSW Environment Protection Authority, 2009, Interim Construction Noise Guideline
[4] NSW Environment Protection Authority, 2011, NSW Road Noise Policy

Industrial Noise Criteria

The NSW Noise Policy for Industry applies two separate noise criteria that are used to assess the noise from a proposal and determine if noise mitigation should be investigated:

- Intrusive noise level – which aims to protect the community from intrusive noise by limiting the extent to which an industrial noise source can exceed the background noise level.
- Amenity noise level – which aims to preserve community amenity by identifying an upper level for exposure to industrial noise for different types of land use.

The project noise trigger level is the lower (most stringent) value of the two different noise level criteria and is used to assess the predicted noise impact of the proposal and determine if noise mitigation should be investigated.

Appraisal of Noise Impact

A noise impact assessment is required as part of a project's environmental assessment. Information and data available from the noise impact assessment should be drawn on for the appraisal of noise impacts. The noise impact assessment aims to:

- Establish the existing ambient noise levels at representative locations and establish the project noise trigger level against which a development will be assessed.
- Predict the noise level from the proposed development for day, evening and night periods
- Determine if noise impacts are likely to occur
- Where impacts are predicted, identify feasible and reasonable mitigation measures to seek to reduce noise to the project noise trigger level and, where necessary, assess the acceptability of noise that cannot be reduced to the project noise trigger level.

If a project exceeds the project noise trigger level after all reasonable and feasible mitigation measures have been implemented, the NSW Voluntary Land Acquisition and Mitigation Policy may, under certain circumstances, enable these exceedances to be managed by the proponent through negotiated agreements with affected landowners or voluntary land acquisition.

Economic valuation of residual noise impacts

The cost of any mitigation measures, negotiated agreements or land acquisition stemming from the policies described above should be specifically noted and included in the proponent's operating and capital costs. Additionally, the proponent should provide an assessment of potential future costs associated with compliance with legislation, mitigation and control measures.

In most cases noise levels will be managed and/or mitigated through the application of the NSW Noise Policy for Industry and the NSW Voluntary Land Acquisition and Mitigation Policy through the development phase. Road and rail transport impacts should be managed through the application of the NSW Road Noise Policy and the Rail Infrastructure Noise Guideline during the development assessment phase. Therefore, cases of residual noise impacts should only arise in isolated cases where mitigation may not be feasible and/or reasonable.

After taking the actions described above to manage or mitigate the noise impact, the proponent should identify any material noise impacts to the NSW community that remain, and estimate their value.

Non-market valuation methods may be used to determine the value of environmental impacts, including noise impacts, to the NSW community. The decision to undertake such a study may rely on factors including:

- Whether the valuation of the residual noise impact is likely to materially influence the cost-benefit analysis, and
- The cost of valuation study options relative to the likely value of the non-market impact.

If preliminary analysis and community consultation suggests that noise impacts are likely to be minor or non-existent, it may be sufficient to note this as a part of the cost-benefit analysis.

Should a more detailed investigation be deemed necessary, then the non-market valuation options outlined in the Introduction to Technical Notes section may be considered. In considering these methods, it should be noted that a quantitative approach may not allow for the explicit determination of material residual noise impact values among environmental impacts more generally. In these cases, it may be appropriate to limit value estimates to these broader environmental impacts and restrict analysis around material residual noise impacts to a qualitative appraisal. In undertaking any further analysis of material residual noise impacts, care should be taken not to double-count noise impact values embodied in estimates from other studies of environmental valuation contained within the economic assessment.

More direct methods to determine explicit valuations of noise impacts associated with industrial noise are neither widely accepted nor widely used, with most existing studies focussed on valuing transport noise impacts.

To the extent that material residual noise impacts exist, the portion of these impacts that are incurred within the locality will need to be estimated and presented within the Local Effects Analysis (LEA).

Technical Note 4
Visual Amenity

This Technical Note supports the 'Guidelines for Economic Assessment of Mining and Coal Seam Gas Proposals'. It is intended that the Technical Notes will provide additional information on options and approaches relevant to completion of a robust and comprehensive economic assessment of a range of environmental, social and transport related impacts for new State Significant Development mining and coal seam gas proposals in NSW. The Technical Notes will be subject to ongoing review to ensure consistency with contemporary Government legislation, policies and guidelines. Project proponents should ensure that they are using the most recent published version of the Technical Notes.

Mining and coal seam gas activities may alter the visual amenity for nearby residents and the local community. The main causes of change to visual amenity include:

- modification of topographic features including new and / or increased views of mine waste rock emplacements and / or open cut sections into the landscape
- realignment of access roads and utilities
- vegetation clearance
- temporary soil stockpiles
- use of night-lighting
- dust clouds
- flood and earth bunds.

Visual assessment forms an essential part of an Environmental Impact Statement. Visual assessment identifies properties and sites, including environmental heritage and Aboriginal objects and places, which may be impacted by a mining project.

In undertaking an appraisal of visual amenity impacts, it is first necessary to describe the existing landscape and visual setting by:

- identifying the existing landscape (topography, vegetation, hydrology and land use features) and visual setting
- identifying existing environmental heritage and Aboriginal objects, places, and their settings
- identifying distinct land use types and landscape units of varying levels of landscape quality
- assessing how the existing landscape is seen from various viewing locations and distances.

The impact of the proposed mining or CSG project must be scoped. Potential changes to the landscape and visual setting should be determined by assessing the likely visual characteristics of the project against the existing landscape and visual setting. This may include assessing:

- how the project alters the landscape and visual setting at different locations
- the potential impact of night-lighting from mobile machinery lights and operational lighting on nearby locations and dwellings
- the potential visual modification of topographic features and / or clearing of vegetation due to the project
- the potential to impact both Aboriginal and non-Aboriginal heritage sites and landscapes
- the potential visual modification of altered service lines and road networks
- both potential short term and long term visual impacts, including those of environmental heritage and Aboriginal objects and places.

The visual impact assessment must demonstrate attempts to avoid impact on environmental heritage and Aboriginal objects and places, and identify conservation outcomes. Where impacts are unavoidable, the visual impact assessment must outline measures proposed to mitigate proposed impacts.

Economic valuation of the visual impact

The cost of any mitigation measures, negotiated agreements or land acquisition stemming from the actions described above should be estimated over then project evaluation period and included in the proponent's operating and capital costs.

After taking the actions described above to manage or mitigate the visual amenity impact, the proponent should identify any material visual amenity impact to the NSW community that remains, and estimate this value if possible.

Non-market valuation methods may be used to determine the value of environmental impacts, including visual amenity impacts, to the NSW community. The decision to attempt to provide estimates of these impacts may rely on factors including:

- Whether the valuation of the visual amenity impact is likely to materially influence the cost-benefit analysis, and
- The cost of valuation study options relative to the likely value of the non-market impact.

If preliminary analysis and community consultation suggests that visual amenity impacts are likely to be minor or non-existent, it may be sufficient to note this as a part of the cost-benefit analysis.

Should a more detailed investigation be deemed necessary, then the non-market valuation options outlined in the Introduction to Technical Notes section may be considered.

In considering these methods, it should be noted that a quantitative approach may not allow for the explicit determination of material residual visual amenity impact values among environmental impacts more generally. In these cases, it may be appropriate to limit value estimates to these broader environmental impacts and restrict treatment of material residual visual amenity impacts to a qualitative appraisal.

In undertaking any further analysis of material residual visual amenity impacts, care should be taken not to double-count visual amenity impact values embodied in estimates from other studies of environmental valuation contained within the economic assessment.

To the extent that material residual visual amenity impacts exist, the portion of these impacts that are incurred within the locality will need to be estimated and presented within the Local Effects Analysis (LEA).

Technical Note 5
Air Quality

This Technical Note supports the 'Guidelines for Economic Assessment of Mining and Coal Seam Gas Proposals'. It is intended that the Technical Notes will provide additional information on options and approaches relevant to completion of a robust and comprehensive economic assessment of a range of environmental, social and transport related impacts for new State Significant Development mining and coal seam gas proposals in NSW. The Technical Notes will be subject to ongoing review to ensure consistency with contemporary Government legislation, policies and guidelines. Project proponents should ensure that they are using the most recent published version of the Technical Notes.

Air pollution can harm human health, animal health and the environment. Adverse health effects are strongly associated with exposure to coarse particulates (PM_{10}) and fine particulates ($PM_{2.5}$). Other key pollutants of concern include oxides of nitrogen, sulphur dioxide, and ammonia. Short and long term human exposure to air pollution is associated with a range of health effects including premature mortality, cardiovascular and respiratory disease, chronic and acute bronchitis, asthma attacks, restricted activity days, reduced lung function and reduced birth weights.

The health impacts of fine particulates ($PM_{2.5}$) can be significant as they can reach the air sacs deep in the lungs impacting the respiratory and cardiovascular systems. Segments of the community that are most susceptible are infants and children, elderly people, and people with existing respiratory conditions, heart disease or diabetes. Health studies show that there is no threshold concentration for exposure to particle emissions, below which health impacts are not observed.

Mining and coal seam gas activities may contribute to air pollution during exploration, development, construction, operational, and post-operational project phases. Emission sources include wind erosion, vehicles using unsealed roads, blasting, power generation, airborne by-products from chemical and mechanical processes, and moving and loading coal stockpiles.

Appraisal of air quality impacts

The following legislation provides the primary context for air quality impact assessments:

- Environmental Planning and Assessment Act 1979
- Environmental Planning Instruments such as Local Environmental Plans and State Environmental Planning Policies
- Environmental Planning and Assessment Regulation 2000
- National Environment Protection (Ambient Air Quality) Measure

In line with this legislation, assessments of air quality impacts are required as part of the planning process. The extent of the assessments depends on the stage of the planning process and the nature and scale of the project. For State Significant Developments, an Environmental Impact Statement is required, which includes an Air Quality Impact Assessment (AQIA).

The statutory methodology for modelling and assessing emissions of air pollution from stationary sources, is the Approved Methods for the Modelling and Assessing of Air Pollutants in New South Wales.[1] These methods outline five steps in the appraisal of air quality impacts:

1. Input data collection
2. Dispersion modelling
3. Processing dispersion model output data
4. Interpretation of dispersion modelling results
5. Preparation of an impact assessment report

[1] NSW Environmental Protection Authority, 2016, Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales

The predicted concentrations of pollutants in the region surrounding the project are then compared with the independent Environment Protection Authority's impact assessment criteria.

If a project doesn't comply with the impact assessment criteria set out in the statutory methodology, the assessment needs to be revised to incorporate additional control or mitigation measures.

If a project still exceeds the impact assessment criteria after all reasonable and feasible mitigation measures have been implemented, the NSW Voluntary Land Acquisition and Mitigation Policy may, under certain circumstances, enable these exceedances to be managed by the proponent through negotiated agreements with affected landowners or voluntary land acquisition.

Estimate the economic value of the impact

The actual costs of compliance with the legislation, and any mitigation or control measures, should be noted and included as a direct cost in the proponents operating and capital costs within the cost benefit analysis. Additionally, the proponent should provide an assessment of potential future operational and capital costs associated with compliance with legislation, mitigation and control measures.

Mitigating and controlling air pollution, as described above, may reduce but not fully ameliorate economic impacts to the NSW community. The subsequent economic value of changes in air quality can be assessed using the various methodologies described below.2 These approaches are not intended to be exhaustive or prescriptive – the approach taken in assessing air quality impacts should be adapted to the characteristics of the project. Where possible, proponents should use the emissions inventory data and dispersion modelling results already obtained as part of the AQIA.

Impact Pathway Approach

The impact pathway approach is a resource intensive valuation approach following a bottom-up pathway from emissions to cost via ambient air quality concentrations, population exposure, morbidity and mortality health impacts, and non-health impacts (such as soil contamination).

Key elements of the impact pathway approach to value air quality impacts include an emissions inventory of key pollutants, dispersion and chemical transport models, detailed information on the current air quality sourced from air quality monitoring networks, and detailed population statistics used to determine the exposed population.

The full impact pathway approach can be used to estimate a robust set of unit damage costs, based on location-specific inputs and data, which are subsequently used to evaluate projects, policies and measures.

Further steps require quantifying the morbidity and mortality impacts of air pollution, and then assigning a monetary value to these impacts. Valuations tend to be based around using unit costs for the value of a statistical life, value of a statistical life year, and hospitalisation for cardiovascular and respiratory disease. A

[2] The following sources provide some further discussion of these methodologies

- Department for Environment, Food and Rural Affairs (UK), 2013, Impact Pathway Guidance for Valuing Changes in Air Quality
- Department for Environment, Food and Rural Affairs (UK), 2013, Air Quality Appraisal – Damage Cost Methodology
- Jalaludin, B., Salkeld, G., Morgan, G., Beer, T., & Nisar, Y. B. (2009). A methodology for cost-benefit analysis of ambient air pollution health impacts
- PAEHolmes, 2013, Methodology for valuing the health impacts of changes in particle emissions final report. Prepared for NSW Environment Protection Authority (EPA).

description and analysis of the uncertainties associated with the quantification and valuation of impacts should also occur.

Damage Cost Approach

The damage cost approach allows direct valuation of the health costs associated with emissions by attributing dollar-per-tonne costs to emissions based on a set of pre-determined damage costs. Damage costs are estimates of the costs to society due to the impact of changes in emissions. The level of detail used to generate damage costs varies. Some approaches involve the detailed quantification of health impacts as well as monetary values, while other approaches use disaggregated values that differentiate emissions and health costs according to the location of emissions.

Care should be taken in using damage costs in NSW, to ensure:

- Pre-determined damage costs used are relevant and transferable to the project conditions and geography.
- Possible non-constant dispersion of air quality impacts across a defined geographical area from point sources (such as mines) is appropriately considered
- Any key diversity of conditions present across the NSW geography and environment are appropriately considered.

Intermediate Pathway Approach

An intermediate pathway approach incorporates key location-specific factors that may influence the economic costs of air quality impacts, without requiring a full impact pathway analysis. This approach combines the methods described above by utilising the available location-specific data with pre-determined data that may be impractical, cost prohibitive, or unavailable at a location-specific level. This method enables the proponent to assess the data needs and assumption required for a robust impact assessment, and suitably modify the level of primary data collection required.

Non-Market Valuation Methods

The above methods empirically capture health and productivity losses associated with airborne emissions, and should represent the primary approach to the valuation of air quality impacts. However, to reflect the full extent of air quality impacts on the NSW community, other intangible qualities such as the recreational amenity of an area, sense of local community, and regional reputation associated with characteristics such as fresh produce and livestock may be considered. Non-market valuation methods may help estimate the value the community places on these intangible impacts.

The decision to undertake a non-market valuation study, or to include air quality in any existing assessment of non-market impacts, may rely on factors including:

- whether the valuation of the air quality impacts, beyond those captured by the damage cost approach or the impact pathway approach, is likely to materially influence the cost-benefit analysis, and
- The cost of non-market valuation study options relative to the likely value of the non-market impact.

If preliminary analysis and community consultation suggests that non-market impacts are likely to be immaterial or non-existent, it may be sufficient to either disregard or describe any non-market impacts qualitatively as a part of the cost-benefit analysis.

Should further in-depth analysis be necessary based on the above factors, then the non-market valuation options outlined in the Introduction to Technical Notes section may be considered. In considering these methods, it should be noted that a quantitative approach may not enable an explicit determination of material residual air quality impact values as part of environmental impacts more generally. In these cases, it may be appropriate to limit value estimates to these broader environmental impacts and restrict analysis around material residual air quality impacts to a qualitative appraisal.

In undertaking such an analysis, care should be taken to avoid double-counting the air quality costs and benefits, as the values estimated through non-market valuation techniques will, at least partially, overlap with those estimated via the damage cost approach or the impact pathway approach.

To the extent that material residual air quality impacts exist, the portion of these impacts that are incurred within the locality will need to be estimated and presented within the Local Effects Analysis (LEA).

Technical Note 6
Ground and Surface Water

This Technical Note supports the 'Guidelines for Economic Assessment of Mining and Coal Seam Gas Proposals'. It is intended that the Technical Notes will provide additional information on options and approaches relevant to completion of a robust and comprehensive economic assessment of a range of environmental, social and transport related impacts for new State Significant Development mining and coal seam gas proposals in NSW. The Technical Notes will be subject to ongoing review to ensure consistency with contemporary Government legislation, policies and guidelines. Project proponents should ensure that they are using the most recent published version of the Technical Notes.

Water policy implementation and management in the State is the responsibility of the Crown Lands and Water Division of the Department of Industry. Key powers and obligations relating to the management of NSW water resources are set out in the *Water Management Act 2000* and the *Water Act 1912*. These Acts cover water access, licensing, sharing plans and trading regimes across the State, and management of groundwater and surface water systems. Their requirements are also reflected in the Secretary's Environmental Assessment Requirements (SEARs) promulgated by the NSW Department of Planning and Environment (DPE).

These laws and regulations seek to promote sustainable use and management of NSW water resources, recognising competition among users and the environment for access to water as well as the need to ensure that water quality is protected or enhanced. An overview of relevant NSW regulations and administering agencies is provided in NSW DPE (October 2015) 'Water Regulation Overview: Application to Mining and Coal Seam Gas Development in NSW'.

New mining and CSG projects are required to provide robust analysis of their likely impacts on water sources, and the risks they pose to ongoing access to supply and quality. All water users in NSW are subject to the rules in water sharing plans and associated licencing and approval requirements unless an exemption applies.

Project proponents should provide analysis of their water take requirements, risks that their water take and mining or extractive activity might pose for nearby surface and groundwater resources, and likely and potential net costs imposed on other water users as a result of their activities. Analysis should be commensurate with the level of impact, risks and uncertainties involved.

Ground water

Groundwater refers to the water contained that occurs beneath the ground surface in the saturated zone. The sustainable management of groundwater systems including water table pressure levels, and water quality is important for the following reasons:

- groundwater is a vital source of drinking water and urban water supplies in many parts of NSW.
- To preserve recreational value and / or the values of culturally significant sites.
- To maintain access to groundwater users relying on groundwater for agricultural production. In some areas, groundwater can be the only source of drinking water for livestock.
- reliance on groundwater for commercial operations.
- in some aquifers, the maintenance of groundwater heads is necessary to prevent land subsidence, loss of aquifer storage and saline water intrusion.
- to maintain and support groundwater-dependent ecosystems (GDEs), whose extent and life processes are dependent on groundwater.
- To maintain water source connection including between groundwater and surface water systems, and connection between and within water sources.

Proponents are required to hold a water licence for all water taken from a groundwater source during the life of the activity and after the activity has ceased. A licence entitles a person to a share of the water in a groundwater source

A licence is only granted if the Minister for Primary Industries is satisfied that arrangements are in place to ensure no more than 'minimal' harm will be done to any water source as a result of water being taken.[1] Water take includes the:

- removal of water from a water source
- movement of water from one part of an aquifer to another part of an aquifer
- movement of water from one water source to another water source[2].

Project proponents must comply with the requirements of the NSW Aquifer Interference Policy (AIP) which sets out criteria and thresholds for Minimal Impact Consideration for Aquifer Interference Activities.[3]

For the purposes of the AIP, 'aquifer' has the same meaning as 'groundwater system' and includes low yielding and saline systems. Proponents should also refer to the NSW Crown Lands and Water Division of the Department of Industry document: 'Groundwater Monitoring and Modelling Plans – Information for prospective mining and petroleum exploration activities'. NSW Crown Lands and Water Division of the Department of Industry requires an assessment to be undertaken in line with the AIP where a proposed activity has the potential to impact an aquifer or its dependent users and ecosystems.

An activity can impact on a range of important aquifer characteristics. Impact assessment thresholds also differ according to whether the aquifer is a 'named' highly productive water source or a less productive water source (which are unnamed).

Activities that are assessed as having impacts below designated thresholds are categorised by the AIP as 'Level 1: Acceptable'. An activity whose impact exceeds a designated threshold will be categorised as 'Level 2'. The assessment includes determining the rigour of impact predictions and the suitability of proposed mitigation, prevention or avoidance strategies.

Mining and CSG projects may impact on groundwater and connected water resources during exploration, development, construction, operational, post-operational, and rehabilitation phases. Pathways for impacts include:

- reducing the quantity of available water through extraction or dewatering[4]
- raising or lowering the water table around the mine
- polluting or otherwise contaminating the water
- affecting aquifer structures leading to increased flow transfers and potential impact on groundwater quality such as increased salinity[5]
- causing subsidence or aquifer compaction
- induce cross aquifer flows otherwise not established under natural conditions
- changing water flow paths.
- Impacting the base flow contribution to streamflow

[1] Crown Lands and Water Division of the Department of Industry (previously DPI –Water) (2012) 'NSW Aquifer Interference Policy', p.5.
[2] NSW Department of Primary Industries - Water, 2012, *NSW Aquifer Interference Policy.*
[3] NSW Department of Primary Industries - Water, 2012, *NSW Aquifer Interference Policy.* Table 1 page 15.
[4] In-Situ Inc., 2008, *Application Note – Mine Dewatering,* available at http://www.thermofisher.com.au/Uploads/file/Mine-Dewatering.pdf
[5] NSW Department of Planning, 2005, *Coal Mining Potential in the Upper Hunter Valley Strategic Assessment,* available at http://www.planning.nsw.gov.au/regional/pdf/final-draft1_5.pdf

A robust geological study and risk assessment is critical for proposed mining and CSG projects. This modelling should address the potential of a project to interfere with water resources, and identify the efforts of the proponent in characterising and minimising these risks. A water balance plan setting out estimates of water usage and returns is also required.

An environmental assessment of a project's groundwater impacts should determine:

- the modelled zone of influence of the project to groundwater resources
- groundwater resources that may be affected by the mining activity
- the significance of the resource to the area
- the project's total groundwater demand
- the potential impacts of the proposed project, including maximum potential impact, and the level of confidence for model projections.

When scoping the impact on groundwater resources, it is important to keep in mind that there may be cumulative impacts. From the information presented in the environmental assessment, any interactions with the existing activities and the proposed activities can be identified. This will provide an indication of the cumulative impacts to the immediate locality and the overall region.

Surface water

Surface water comes from rivers, streams and lakes. It can also be connected to a groundwater system. In such case, these water resources must be managed jointly.

Project proponents should recognise and take proper account of activities and risks affecting the quantity and quality of surface water needed to:

- supply drinking water and household needs
- support recreational activities
- provide for the needs of local industries such as agriculture, viticulture and mining
- support ecosystems and delivery of ecological services including biodiversity.

Potential impacts to surface water from mining and coal seam gas activities that can occur during and post operation include:

- reduced surface water quantity
- reduced surface water quality including pollution and changes to salinity and ionic balance
- changes to natural water flows and probability of flood events
- altered connectivity between surface water and groundwater systems
- dryland salinity.

As with groundwater management, the regulatory framework for surface water resources seeks to avoid and minimise harm caused by access and use. A water licence or other approval from NSW Crown Lands and Water Division of the Department of Industry is generally required to extract water from rivers or aquifers to use for commercial purposes.[6] It is an offence to take water when not authorised by a licence.

[6] Crown Lands and Water Division of the Department of Industry (previously DPI Office of Water), About licenses, www.water.nsw.gov.au/water-licensing/about-licences

The NSW EPA regulates discharges of water through conditions it places on a premise's environment protection licence. Exceedances above licence conditions should not occur. When they do, proponents can expect to face regulatory action.

To enable economic valuation of surface water impacts, project proponents should develop and provide:

- an accurate estimate of the water budget for the mine, through all stages of the project
- accurate modelling of the impacts of groundwater drawdown on base flow to streams and induced loss from surface water to groundwater
- an understanding of onsite storage and potential for reuse
- analysis of the quantity and value of licences required to account for any surface water impact (noting the magnitude of the project requirement relative to the volume of licences on issue), either because of groundwater drawdown impacts on surface water, or the need for additional water supplies for onsite use (eg. for dust suppression and coal washery use).
- An accurate estimate of potential water quality changes from the mine or CSG extraction, through all stages of the project

Surface water assessment should model predicted impacts to local and regional surface water resources from the project's point and diffuse sources of pollution under the range of conditions likely to be encountered. Potential surface water impacts during exploration, development, construction, operation, post-operation, and rehabilitation may include impacts to flow regime of:

- controlled release
- runoff from progressively rehabilitated landforms, or
- impacts on the local flood regime.
- The surface water assessment should outline predicted impacts, extent of impacts and characteristics such as the change in water quality indicators, the duration over which the water quality is altered and the extent of the surface water resource that is impacted. It should identify and characterise the potentially impacted downstream surface water uses and values (e.g. landholders with water access licences, recreational users, and aquatic ecosystems), including:
- the location of downstream user (relative to the project site) to determine if and when they will be impacted by water quality change events
- water use (e.g. drinking water, agriculture, industrial purpose, recreational, aquatic ecosystems)
- quantity extracted
- reliability of water entitlement (whether general or high security)
- whether treated or untreated water is used.

Any appraisal of impacts on surface water must include consideration of the relevant NSW Water Quality Objectives for a catchment and address the National Water Quality Management Strategy policy principle of protecting and enhancing water quality to reserve the maximum opportunity for other present and future uses of a waterway.

Estimating the non-market cost of project impacts

The economic value of water reflects its potential to deliver benefits to industry and the community. These benefits are reflected in the costs that different users are prepared to absorb to access water, and alternative users can explicitly compete at times of scarcity.

The economics of water usage and costs can be influenced by:[7]

- uncertainty in the volumes available in different groundwater resources
- connectivity between surface water and groundwater
- scarcity of water in many areas
- difficulty in defining environmental impacts and therefore sustainable yields
- differences in water quality
- challenges in monitoring water access and usage
- temporal aspects of recharge, extraction and discharge.
- value of water in competing uses.

These characteristics influence water supply and quality in a region and the benefits it delivers to the wider community. NSW seeks to manage water resources to maximise long term benefits to all users, taking account of both its productive and environmental value.

Where water is sourced from markets, one user effectively acquires additional units from another on a voluntary basis and helps generate a price for the resource that explicitly reflects its value in production. However, issues of quality and incomplete market coverage can remain.

To avoid double counting, ecological impacts should not be reflected in downstream user impact calculations. Ecological analysis should be undertaken in the context of the biodiversity impact assessment.

Approach to evaluating impact on water resources

The focus of cost-benefit analysis is to identify and value (to the extent practicable) unpriced factors that can generate a material difference between the costs and pay-offs perceived by project proponents and those likely to impact other users and the NSW community more generally.

There are three key requirements to evaluating the unpriced impacts of mining and CSG activities on water resources:

Step 1: Assess the nature and magnitude of potential impacts of the proposed project

Step 2: Assess the wider implications of these impacts for users of the water resource

Step 3: Evaluate the economic significance of potential impacts on water resources

These steps are explained below. Valuation and impact risks and uncertainties should be made explicit in the appraisal process.

Step 1: Assess the nature and magnitude of potential impacts of the proposed project

An environmental assessment should consider the likely and potential implications of a project on the community's ability to use the water resource. This involves a consideration of project impacts on water quality or quantity - especially where the community is heavily reliant on the water supply.[8] The environmental assessment should also outline instances of beneficial reuse of treated water.

[7] Marsden Jacob Associates, 2012, Assessing the value of groundwater, prepared for the National Water Commission, available at http://archive.nwc.gov.au/__data/assets/pdf_file/0009/23310/FINAL-for-publishing-Assessing-the-value-of-groundwater.pdf

[8] NSW Department of Industry, Resources & Energy (2015), *ESG2: Guidelines for Preparing a Review of Environmental Factors*, p.18-19

The environmental assessment should estimate the potential importance of each likely impact. The impact should be considered with reference to:

- its likelihood
- the duration and reversibility of the impact
- the effectiveness of proposed methods to manage or mitigate the impact
- compliance with any relevant policies or plans
- the extent of public interest
- information gaps and their implications for the reliability of impact estimates.

In general, the impact of a proposed project on water supplies can be either negligible (i.e. no material impact on the resource) or adverse (i.e. a material reduction in water availability or quality is feasible). This assessment should be made based on impacts on the community, and be independent of the importance that the groundwater resource presents to others in the region (which are assessed below in Step 2).

Table 1 sets out guidance from ESG2 guidelines on categorising the magnitude of impacts in undertaking a Review of Environmental Factors (REF). It details the characteristics underpinning a 'low' or 'high' adverse categorisation. Project proponents should consider these characteristics (including accounting for cumulative impacts where relevant) in describing and assessing the potential impact of their proposed activity.

Table 1 Guide to categorising the extent of mining activity impacts on the water system

Analysis of impact	Low adverse	High adverse
Size	Small scale size/volume	Large scale/volume
Scope	Localised	Extensive
Intensity	Small impact dispersed over a long period	Large impact over a short or long period
Duration	Short term	Long term
Level of confidence in predicting impacts	High confidence/knowledge and past experience	Low confidence, numerous uncertainties and unknowns
Level of reversibility of impacts	Impacts are reversible and rehabilitation likely to be successful	Reversibility impossible or unlikely due to cost or other factors
Ability to manage or mitigate the impacts	Effective mitigation measures available	Mitigation measures untested or unavailable
Ability of the impacts to comply with standards, plans or policies	Total compliance	Uncertain or part compliance
Level of public interest	Low interest and predictable impacts on community	High interest and uncertain impacts on continuity
Requirement for further information on the impacts of the activity or mitigation	High level of understanding and information on the impact	Low level of information on and understanding of key issues

Source: NSW Department of Industry, Resources & Energy (2015), ESG2: Guidelines for Preparing a Review of Environmental Factors, p.18

In line with the Guidelines, potentially large adverse effects that are feasible but have a low probability should be considered as being 'High adverse' and discussed appropriately.

Step 2: Assess the wider implications of these impacts for users of the water resource

The water resources that the mining project is expected to affect need to be identified. Then, to determine the importance of the water resources, the following factors should be considered:

- quality and quantity of these ground and surface water resources [9]
- nature and projected requirements of those using the water resources (including environmental uses)
- reliance of other users on the water resource (and availability of viable substitutes or impact mitigation options)

The level of economic analysis should be commensurate with the importance of the water resources being impacted, and the potential quantitative and qualitative impact of the project.

Step 3: Evaluate the economic significance of potential impacts on water resources

The economic significance of potential impacts on water resources can be measured by:

- the market price of water, and
- other factors potentially not captured by the market price.

The specifics of these economic impacts need to be assessed on a project-by-project basis. The following material provides a discussion of the aspects a proponent should consider when assessing the economic impacts on water resources.

Market prices provide an indication of the value of water in competing uses, and should be considered the primary way to value the impacts on water quantity. The cost of water entitlements and water access rights are direct costs and should be specifically noted and included in the proponent's operating and capital costs. These assets may hold a material value at the end of the project evaluation time period, which should be included as a direct benefit for inclusion as part of the CBA, in line with the Guidelines.

However, market prices will be critically affected by seasonal demand and supply factors as well as the number and nature of participants in the market. Different locations exhibit different levels of demand and water availability and differing access to mature water markets. As far as possible, each proponent should reference supply and demand characteristics specific to the water resources that will or may be materially impacted by their project. Seasonal variation in prices should also be considered.

Where water is readily accessible and in plentiful supply, the price of water can be very low even though it is valued highly by those that use it. This is appropriate provided that all costs – including environmental costs - are adequately reflected in the price.

Where water markets exist, water prices can be used as a guide to the value that commercial users place on the resource. Importantly, purchase of water entitlements from these markets reflects a willingness to sell part of an entitlement. When current users are unwilling to sell, the price a new participant must pay to secure their water requirement will be bid up. In these situations, a new entrant to a water market must convince an existing holder of a water entitlement to part with some portion of it. Each seller has a private valuation of the amount they would require to convince them to sell some of their entitlement. Buyers also

[9] see Australian Drinking Water Guidelines 2011 (ADWG) for drinking water and Australian and New Zealand guidelines for fresh and marine water quality 2000 (ANZECC) for ecosystem protection.

have an incentive to seek offers from a wide range of sellers to find the water owners that are willing to part with their entitlements at the lowest price.

In cases where a mine or CSG development needs to obtain water from a water market, pricing and trading operate to ensure that owners of existing entitlements are effectively compensated for the value of the water they relinquish, and help ensure that water resources are being allocated to higher value uses.

Water markets and licences provide a guide to the scarcity impacts of water use, recognising that major new demands will drive up prices and seasonal impacts can also be critical. Direct water purchases from markets are an explicit mechanism for covering off and compensating for scarcity impacts on commercial users. As discussed above however, the market price paid as part of these purchases may only partly reflect the economic impacts to the NSW community of water use. Beyond this, proposed mining and CSG projects will need to provide robust estimates of likely quantitative and qualitative impact on the water resources they will or may affect, and the likely cost implications for third parties.

Table 2 illustrates low, mid-range and high economic valuations for groundwater applied in competing Australian uses. Although the data is historical and not specific to NSW, it illustrates the significant value range for water within and across competing uses – noting that the value range of water in environmental applications is not estimated. When scarcity is an issue and there is competition between potential users, it is important to support value transparency and opportunities for water to go to its highest value use. Properly operating markets can facilitate this transparency and allocation by allowing new entrants to source water from those that place a lower value on it.

Table 2 Sample economic values of groundwater in key Australian activities

Sector	Direct value($/ML)		
	Low	Mid-range	High
Agriculture - irrigation	30	200	500
Mining	500	2750	5000
Urban water supply	1000	2000	3000
Households	1400	2500	6400
Manufacturing and other industries	1000	2000	3000

Note: Values in 2013 dollars. *Source*: Deloitte Access Economics, 2013, National Centre for Groundwater in Australia.

More recent and local ground water trading outcomes are shown in Table 3. It shows prices paid for units purchased in a controlled allocation round for groundwater sources managed under a NSW water sharing plan in the period from September 2014 to April 2016. Recorded unit values vary from $800 (the reserve value) in the Upper Darling Alluvial aquifer to $1,000 per unit in the Cox's River Fractured Rock aquifer near Sydney and the New England Fold Belt aquifer in the Murray Darling Basin.

Table 3 Recent NSW ground water allocation outcomes, by water source (Outcomes of Controlled Allocation Order (groundwater sources) commenced on 9 September 2014

Water sharing plan	Groundwater source	Units of access licence share component made available 04/09/14	Quantity of share units issued	Price paid per unit share $	Total price paid $
NSW Murray Darling Basin Fractured Rock Groundwater Sources 2011	Adelaide Fold Belt MDB	130	-	-	-
	Kanmantoo Fold Belt MDB	451	-	-	-
	Lachlan Fold Belt MDB	5,114	-	-	-
	New England Fold Belt MDB	842	100	1,000	100,000
NSW Murray Darling Basin Porous Rock Groundwater Sources 2011	Sydney Basin MDB	704	704	800	563,200
	Gunnedah–Oxley Basin MDB	4,405	600	801	480,600
			80	800	64,000
	Western Murray Porous Rock	8,145	-	-	-
North Western Unregulated and Fractured Rock Water Sources 2011	Adelaide Fold Belt North Western	1,398	-	-	-
	Kanmantoo Fold Belt North Western	1,285	-	-	-
Barwon-Darling Unregulated and Alluvial Water Sources 2012	Upper Darling Alluvial	5	5	800	4,000
Dorrigo Plateau Surface Water Source and Dorrigo Basalt Groundwater Source 2003	Dorrigo Basalt	212	-	-	-
Greater Metropolitan Region Groundwater Sources 2011	Coxs River Fractured Rock	327	22	1,000	22,000
			20	800	16,000
	Goulburn Fractured Rock	2,273	1	805	805
			100	810	81,000
	Metropolitan Coastal Sands	1,203	-	-	-
	Sydney Basin Central	2,021	-	-	-
	Sydney Basin Coxs River	329	329	800	263,200
	Sydney Basin Nepean	3,767	25	800	20,000
			6	900	5,400
			10	900	9,000
			10	910	9,100
	Sydney Basin North	902	-	-	-
	Sydney Basin Richmond	145	25	850	21,250
			25	810	20,250
			20	850	17,000
			20	810	16,200
			20	850	17,000
			35	800	28,000
	Sydney Basin South	3,061	15	820	12,300
			2,500	850	2,125,000
			300	850	255,000

Source: http://www.water.nsw.gov.au/__data/assets/pdf_file/0011/572582/outcomes-of-controlled-alocation-order-2014.pdf (accessed 8 February 2018)

Surface water value estimates associated with ecological uses are provided in Table 4. It highlights estimates generated by various authors to value surface water impacts. They are historical and reference different times and locations. Nevertheless, they provide an example of the range that water values can have in different uses – including environmental uses.

Table 4 Examples of value estimates related to surface water impacts

Impact	Value estimate range	Source
Water prices		
Entitlement trading price	$1000 -$2000 per ML	National Water Commission, 2013, Australian Water Markets Report 2012-13.
Average water allocation price	$50-$200 per ML[1]	National Water Commission, 2013, Australian Water Markets Report 2012-13.
Use and non-use values from non-market valuation studies		
Waterway suitable for swimming	$0.93 per km per household per year for 10 years	Marsden Jacob Associates, 2013, Non-market valuation of river health benefits in the Hawkesbury-Nepean River, Final report prepared for the NSW Department of Finance and Services
Healthy waterways	$0.84 to $1.10 per household per year for 5 years for each kilometre of healthy waterways in the Hawkesbury Nepean	Mazur, K. and Bennett, J., 2009, Location differences in communities' preference for environmental improvements in selected NSW catchments: A Choice Modelling approach. Environmental Economics Research Hub Research Reports.
Increase in fish population	$0.5 to $5.1 per 1 per cent increase in fish populations for smaller to medium sized rivers/areas per household per year.	Morrison, M. and Hatton MacDonald, D., 2010, Economic valuation of Environmental Benefits in the Murray-Darling Basin.
Clear of non-native waterweeds	$0.85 to $1.12 per household per year for 10 years for each kilometre clear of non-native waterweeds	Marsden Jacob Associates, 2013, Non-market valuation of river health benefits in the Hawkesbury-Nepean River, Final report prepared for the NSW Department of Finance and Services.

Source: Various sources as listed in table.

[1] Average water allocation prices are very dependent on seasonal factors and location. An average range has been taken on water allocation prices over the past 3-4 years.

The total economic value of a predicted change in water availability or quality change is the sum of additional costs (or profits forgone) likely to be borne by impacted water users over the period that quantity and quality are affected. To avoid double counting, ecological impacts should not be reflected in downstream user impact' calculations. Ecological analysis should be undertaken in the context of the Biodiversity assessment.

Viable options for estimating the cost borne by impacted third parties that are not deemed to be already captured by the market price are suggested below. These options may also be used to value uncompensated costs such as reductions in water quality or pressure affecting costs or productivity, or impacts on environmental services.

- the cost of treating water (per ML) to return it to pre-impact levels (applicable to uses of treated water only)
- the cost of drawing on an alternative water source (e.g. accessing other ground or surface water supplies, source alternative groundwater or the cost to transport water from other locations) or reducing water requirements (e.g. by enhanced irrigation methods and other water saving technology)
- the value of lost income (i.e. revenue minus production costs) in cases where either the water cannot be treated or alternative water sources or substitutes are not feasible.
- estimates of use and non-use values for the surface water resource attained from market and non-market valuation techniques.[2]
- The value of discharge credits from schemes such as the Hunter River Salinity Trading Scheme to provide valuation of reductions in quality.

The above set of options is illustrative only - proponents should generate their own project specific estimates referencing the data, methodology and rationale used. As noted above, direct costs including water entitlements, water access rights, water storage, water rehabilitation, water treatment costs, and other direct project water costs should be included as operating and capital costs within the CBA.

[2] See the Introduction to Technical Notes for a more detailed discussion of environmental valuation techniques. Also see (UK) DEFRA (2007), An Introductory Guide to Valuing Ecosystem Services.

Technical Note 7
Biodiversity

This Technical Note supports the 'Guidelines for Economic Assessment of Mining and Coal Seam Gas Proposals'. It is intended that the Technical Notes will provide additional information on options and approaches relevant to completion of a robust and comprehensive economic assessment of a range of environmental, social and transport related impacts for new State Significant Development mining and coal seam gas proposals in NSW. The Technical Notes will be subject to ongoing review to ensure consistency with contemporary Government legislation, policies and guidelines. Project proponents should ensure that they are using the most recent published version of the Technical Notes.

Vegetation clearing and land subsidence associated with mining and coal seam gas activities can negatively affect biodiversity in the area. Some impacts can be short-term and confined to the mine/extraction site, while others might be longer term and affect biodiversity values off-site.

The Biodiversity Conservation Act and offsetting

NSW has an established policy and compliance structure for major projects aimed at maintaining biodiversity values in the State and streamlining the assessment and compliance process.

The *Biodiversity Conservation Act 2016* and *Biodiversity Conservation Regulation 2017* commenced on 25 August 2017.[1] These outline the framework for addressing impacts on biodiversity from development and clearing. They establish a framework to avoid, minimise and offset impacts on biodiversity from development through the Biodiversity Offsets Scheme.

Any development application for major projects will need to include a biodiversity development assessment report (BDAR) after applying the Biodiversity Assessment Methodology unless the Secretary of DPE and the Environment Agency Head determine that the proposed development is not likely to have any significant impact on biodiversity values. When determining the major project application, the Minister for Planning must take into consideration the likely impact of the proposed development on biodiversity values as described in the BDAR.

If consent is granted and the Biodiversity Offsets Scheme applies to the project, a condition of consent may be for the applicant to retire biodiversity credits to offset the residual impact on biodiversity values. The Biodiversity Offsets Scheme creates a transparent, consistent and scientifically based approach to biodiversity assessment and offsetting for all types of development that are likely to have a significant impact on biodiversity.

The Minister for Planning is also required to consider the impacts of any proposed major project which is likely to have serious and irreversible impacts on biodiversity values. If the proposed development is likely to have serious and irreversible impact on biodiversity values, the Minister will determine whether any additional measures are required that will minimise those impacts if consent is granted.

Transitional arrangements under the Biodiversity Conservation Act

Biodiversity assessment will be required in accordance with the Biodiversity Conservation Act for major projects. However, in some circumstances[2] the proponent will be able to continue to apply the former planning provisions including biodiversity assessment under the former legislations and offsetting in

[1] Refer to the following link for further information: http://www.environment.nsw.gov.au/biodiversity/offsetsscheme.htm
[2] Refer to the following link for further detail on transitional arrangements: http://www.environment.nsw.gov.au/biodiversity/transitional.htm

accordance with the *NSW Biodiversity Offsets Policy for Major Projects*. In this case the proponent will not be required to undertake biodiversity assessment under the Biodiversity Conservation Act. Additionally, the proponent will be able to continue to rely on the Bilateral Agreement under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act).[3]

Due to the commencement of the *Biodiversity Conservation Act 2016*, the NSW Government and the Commonwealth Government are reviewing the Bilateral Agreement. For projects which are required to assess biodiversity impacts under the new *Biodiversity Conservation Act 2016*, proponents will be required to undertake assessment under the *NSW Biodiversity Conservation Act 2016* and separate assessment under the *Commonwealth EPBC Act*, until a new Bilateral Agreement is in place.

Proponents are encouraged to make a referral to the Commonwealth Department of the Environment and Energy early in the assessment process to understand if Commonwealth approval is required and therefore whether the proposal is to be assessed under the Bilateral.

Should the proposal be expected to impact aquatic biodiversity, proponents should continue to refer to the existing swamp offsets policy[4] and the fact sheet for aquatic biodiversity[5]. In these cases, credits required for biodiversity offsets are to be calculated using the Biodiversity Assessment Methodology under the Biodiversity Offsets Scheme established by the *Biodiversity Conservation Act 2016*.

Economic appraisal of biodiversity impacts

Step 1 – Economic appraisal of costs associated with compliance with the Biodiversity Conservation Act and EPBC Act.

The onus is on the project proponent to consider and report on all significant biodiversity risks and values likely to be affected by project development. Costs associated with compliance with the *Biodiversity Conservation Act 2016* and *Commonwealth EPBC Act*, including measures to minimise and compensate for unavoidable impacts on biodiversity, should be made explicit and factored into the projects capital and operating costs.

The requirement to assess and quantify impacts, and that an offset requirement is described as a biodiversity credit, means that key impacts on biodiversity have a direct and quantifiable economic cost to a project. Projects that have no (or very minimal) impacts on biodiversity and are therefore unlikely to require an offset, will be at a market advantage compared to projects with large biodiversity impacts and consequent offset purchase requirements.

The *Biodiversity Conversation Act 2016* and *Commonwealth EPBC Act* requires project proponents to manage and compensate impacts to biodiversity through avoidance, mitigation, offsets or supplementary measures. If the proposed development is likely to have serious and irreversible impact on biodiversity values, additional measures may be required that will minimise those impacts.

[3] Refer to the following link for further information on the EPBC Act: http://www.environment.gov.au/protection/environment-assessments/bilateral-agreements/nsw

[4] NSW Office of Environment and Heritage, 'Addendum to NSW Biodiversity Offsets Policy for Major Projects', 2016, Accessed 22 November 2017, http://www.environment.nsw.gov.au/resources/biodiversity/swamp-addendum-biodiversity-offsets-policy-160766.pdf

[5] NSW Department of Primary Industries, 'NSW Biodiversity Offsets Policy for Major Projects, Fact Sheet: Aquatic Biodiversity', November 2014, Accessed 22 November 2017, http://www.environment.nsw.gov.au/resources/biodiversity/14817aqoffs.pdf

Step 2 – Economic appraisal of uncompensated costs

Biodiversity impacts falling outside those covered by the *Biodiversity Conservation Act 2016* and *Commonwealth EPBC Act* must be separately identified and evaluated. Where these are material, they are additional and uncompensated costs that would fall on the NSW community because of the project.

Non-market valuation methods may be used to determine the value of environmental impacts, including uncompensated biodiversity impacts, to the NSW community. The decision to undertake such a study may rely on factors including:

- Whether the valuation of the residual biodiversity impact is likely to materially influence the cost-benefit analysis, and
- The cost of valuation study options relative to the likely value of the non-market impact.

If preliminary analysis and community consultation suggests that biodiversity impacts are likely to be minor or non-existent, it may be sufficient to note this as a part of the cost-benefit analysis.

Various techniques can be applied to estimate biodiversity values, and proponents should consider which is most relevant to their project. Guidance on the range, suitability and strengths and weaknesses of techniques can be found in 'Making Economic Valuation Work for Biodiversity Conservation' published by the Australian Government Department of the Environment and Energy in 2005[6].

Broad methods include:

- market-based techniques - which rely on explicit markets and prices for biodiversity assets (where relevant markets exist)
- revealed preference techniques – which make inferences about the value of biodiversity 'assets' based on observed private expenditures and actions relating to conservation or enjoyment of the assets in question.
- stated preference techniques – which apply a questionnaire approach to elicit personal valuations for biodiversity assets, and seek to estimate a 'community' valuation on that basis.

The requirements, strengths and weaknesses of particular methods are discussed in more detail in the Introduction to Technical Notes section.

[6] Department of the Environment and Energy, 'Making Economic Valuation Work for Biodiversity Conservation', 2005

Technical Note 8
Transport Impacts

This Technical Note supports the 'Guidelines for Economic Assessment of Mining and Coal Seam Gas Proposals'. It is intended that the Technical Notes will provide additional information on options and approaches relevant to completion of a robust and comprehensive economic assessment of a range of environmental, social and transport related impacts for new State Significant Development mining and coal seam gas proposals in NSW. The Technical Notes will be subject to ongoing review to ensure consistency with contemporary Government legislation, policies and guidelines. Project proponents should ensure that they are using the most recent published version of the Technical Notes.

Mining and coal seam gas activities utilise road, rail and port transport infrastructure and can impose costs by virtue of maintenance, repair and load impacts. In general, rail and port impacts are internalised through the cost recovery and peak load pricing policies of the operators of this infrastructure. In these instances, it is reasonable to assume that infrastructure users are covering the full cost of their usage, including impacts on third parties. Although access to road infrastructure is not closely controlled, user charges on heavy vehicles are increasingly aimed at covering the cost of road damage and maintenance, although the degree of cost recovery will vary according to specific vehicles and trip characteristics.

Issues such as noise, air quality, greenhouse gas emissions and visual amenity are addressed separately in the accompanying assessment guidelines and technical papers. For this reason - and to avoid double counting – these impacts are outside the scope of this technical note and should not be reflected in the assessment and valuation of transport impacts. To the extent that they are relevant, they should be assessed in the relevant area of the EIS. The transport module focuses on congestion impacts, particularly those falling on road users. Congestion impacts tend to be priced and internalised in charges for rail and port services but, because public roads are generally 'open access', congestion impacts on road users are not.

The amount of traffic, delays and congestion generated will depend on the type, location and size of the project, freight movements and the capacity of the road network affected. The traffic and freight flows generated by the project can impact on road users by:

- increasing delays and travel time
- increasing variability in travel time
- increasing vehicle operating cost – due to fluctuations in speed and queuing.
- increasing the risk of accident.

In most cases, the value of travel time and delivery delays is likely to be the dominant transport related impact on existing road users and the most readily estimated, but each project will need to be assessed on its merits. For appraisal purposes this note focuses on estimated travel impacts, noting that any additional impacts on factors such as accident risk should be identified if they are likely to be a material and measurable outcome of the development and operation of the project.

Appraisal of transport related impacts

There are five steps in the appraisal of traffic impacts:

Step 1: Describe the project's traffic generating activities

Step 2: Define nature of the traffic impacts

Step 3: Estimate current traffic conditions (without the project)

Step 4: Estimate the incremental change in traffic generated by the project

Step 5: Estimate the economic value of the project's traffic impact and conduct sensitivity analysis.

These steps are explained in detail below.

This guidance module assists proponents to estimate the cost to existing road users[1] of increased travel time due to road traffic generated by the project. A traffic impact assessment is completed as part of the proponent's assessment. Information and data available in the proponent's traffic assessment is required for the appraisal of traffic impacts.

Step 1: Describe the project's traffic generating activities

The traffic impact assessment will outline the project's direct traffic generating activities and local road closures (where applicable) for all phases of the project including construction, operation and rehabilitation. Traffic generating activities may include:

- movement of drilling rigs and support vehicles to and from site for coal seam gas projects
- light vehicle traffic generated by construction and operational workforce travelling to and from the site at the start and end of shifts
- delivery of construction equipment and materials to and from the site
- delivery of consumables to the site
- visitors to the project site
- transport of product (e.g. coal haulage from the project site and coal reject haulage returning to the project site) to and from the site to a nearby intermediary facility, such as a coal handling and processing facility
- traffic movements during the decommissioning stage of the project.

Step 2: Define scope of traffic impact

The scope of the project's traffic impact needs to be defined in terms of the:

- location of the project – either in a non-urban or urban location.
- sections of the road network impacted – by identifying the traffic routes used by the project's activities.
- the duration of traffic impacts should be identified for all phases of the project (including construction, operation and rehabilitation phases).

Products from mining and coal seam gas activities are transported by various transport modes (rail, road, pipeline, ship) over various distances from the mine to the final market. This guidance module assesses the impact of road congestion and delays associated with transportation of people and product to and from the project site. The scope of interest extends from the project site to the next point in the supply chain (e.g. intermodal rail terminal, coal handling, processing or dispatch facilities). This scope recognises the freight and transport logistics choices that can be exercised by the project operator.

For key road and rail routes affected, and key phases of the project, project proponents should provide annual estimates of the:

- typical and peak (i.e. realistic upper bound estimate) light traffic movements per day, by key road route
- typical and peak number of freight movements per day by road and rail
- expected number of typical and peak freight movement days per year (by road and rail)
- expected percentage of typical and peak freight movements that will occur at significant periods in the day (egg. peak and non-peak traffic times)

[1] Existing road users includes existing and future road users under the base case (without the project) throughout the appraisal period.

- average tonnage per freight movement
- expected percentage of typical and peak light traffic movements that will occur at significant periods in the day (egg. peak and non-peak traffic times).

Step 3: Estimate the base case traffic conditions

The traffic impact assessment will estimate the base case (without the project) traffic volumes for the section(s) of the nearby road network impacted by the project for different modelled years. The base case should estimate the:

- number of cars, light commercial vehicles and heavy trucks currently sharing the route each day
- traffic volumes during AM peak, PM peak and non-peak periods
- background growth in traffic unrelated to the project or other developments due to population and economic growth over the appraisal period

The Department of Planning & Environment will also consider traffic impacts from newly approved major projects that the project proponent may not be aware of within the nearby area, including existing and approved mining and coal seam gas activities that will become operational in the region during the evaluation period (to account for cumulative impacts).

The traffic impact assessment should estimate the base case annual vehicle-hours travelled by existing users on the impacted section(s) of the road network accounting for variations in AM peak, PM peak and non-peak time periods.

Step 4: Estimate the change in traffic conditions generated by the project

Traffic generated by the project

This guidance module is for the appraisal of external traffic costs associated with the proposed project. Therefore, it is important the project's traffic impact is net of any road improvement or congestion mitigation measures that will be adopted as part of the proposed project. The cost of mitigation measures and road improvements should be included in the proponent's capital and operating costs and reflect efforts to reduce adverse impacts of the project on third parties.

The traffic impact assessment will estimate traffic volumes on the road network for the "with project" scenario for different modelled years. This should include estimation of traffic volumes (average vehicles per hour and transit times during peak and non-peak periods):

- for cars, light commercial vehicles and heavy trucks
- for different stages of the project (e.g. construction, operation and rehabilitation)
- over different time periods during the day, accounting for peak and off- peak periods and variation in projected future output levels.

The traffic impact assessment will estimate the vehicle-hours travelled for the "with project" scenario. This will capture the change in vehicle-hours travelled by existing users on the section of the road network identified as impacted by the project.

Incremental change in vehicle-hours travelled due to the project

The incremental change in vehicle-hours travelled by existing users, is the difference in vehicle-hours travelled between the 'with project' scenario and the base case. The incremental change in vehicle-hours travelled will depend on the traffic generated by the project (less any deductions associated with reduction in traffic associated with the current land use), capacity of the existing road network and the current level of

congestion on the road network, plus estimated delays associated with freight movements by road and rail (e.g. closures at level crossings).

A reference methodology for analysing transport infrastructure impacts is provided at: https://www.transport.nsw.gov.au/sites/default/files/media/documents/2017/principles-and-guidelines-for-economic-appraisal-of-transport-investment.pdf

Step 5: Estimate the economic impact of the project's traffic implications and conduct sensitivity analysis

The value of additional travel time for existing users[2] due to the project's traffic impact is estimated by multiplying the change in vehicle-hours travelled (for existing users only) by the value of time for each vehicle type and time period. The value of additional vehicle-hours travelled should be estimated for:

- Private cars (i.e. leisure trips)
- Business cars (work-related trips)
- Light commercial vehicles
- Heavy trucks and buses (including rigid and articulated vehicles).

Project proponents should refer to updates of the Transport for NSW (TfNSW), "Principles and Guidelines for Economic Appraisal of Transport Investment and Initiatives" for guidance on appropriate travel time valuations for different road users and locations, and parameter updates where available from sources including AustRoads. Where superior information on time costs is available, it should be discussed and applied. However, in general, we note the desirability of aligning values and parameters used by public and private entities in estimating project costs and benefits.

Some indicative values of travel time costs by vehicle and location, published in the 2013 transport economic appraisal guidelines, are reproduced below in Table 1. Project proponents should reference current and comprehensive parameter estimates and apply these in their analysis of traffic impacts based on 'expected' and 'upper bound' traffic impact estimates. Conversion of values to current year dollars should be applied in the project appraisal documents, with all key assumptions shown.

[2] Existing road users includes existing and future road users under the base case (without the project) throughout the appraisal period.

Table 1 Indicative travel time values for various vehicle types in urban and non-urban areas[3]

Vehicle Type	Non-urban			Urban		
	Occupancy rate (persons/ vehicle)	Value per occupant ($/person-hour)	Freight ($/ vehicle hour)	Occupancy rate (persons/ vehicle)	Value per occupant ($/person-hour)	Freight ($/ vehicle hour)
Cars - Private	1.7	16.26		1.5	16.26	
Cars - Business	1.3	52.76		1.1	52.76	
Rigid trucks						
Light commercial	1.3	27.57	0.78	1.2	27.57	1.54
Medium commercial	1.2	27.90	2.12	1.2	27.90	4.17
Heavy commercial	1	28.41	7.25	1.2	28.41	14.25
Articulated trucks – 4 axle	1	29.09	15.59	1.2	29.09	30.71
Articulated trucks – 5 axle	1	29.09	19.88	1.2	29.09	39.16
Articulated trucks – 6 axle	1	29.09	21.44	1.2	29.09	42.22
Combination Vehicles						
Rigid + 5 axle dog	1	29.51	30.36	1.2	29.51	63.23
B-Double	1	29.51	31.58	1.2	29.51	65.16
Twin Steer + 5 axle Dog	1	29.51	29.61	1.2	29.51	61.12
A-Double	1	30.36	41.47	1.2	30.36	85.57
B-Triple	1	30.36	42.33	1.2	30.36	87.34
A B combination	1	30.36	50.98	1.2	30.36	105.20
Double B-Double	1	30.86	61.82	1.2	30.86	127.57
Triple road train	1	30.86	61.12	1.2	30.86	126.12
Bus driver	1	27.90		1.2		
Bus Passenger	20	16.26		20.0		

[3] Source: Transport for NSW (TfNSW), 2016, Principles and Guidelines for Economic Appraisal of Transport Investment and Initiatives, page 243.

Technical Note 9
Greenhouse Gas Emissions

This Technical Note supports the 'Guidelines for Economic Assessment of Mining and Coal Seam Gas Proposals'. It is intended that the Technical Notes will provide additional information on options and approaches relevant to completion of a robust and comprehensive economic assessment of a range of environmental, social and transport related impacts for new State Significant Development mining and coal seam gas proposals in NSW. The Technical Notes will be subject to ongoing review to ensure consistency with contemporary Government legislation, policies and guidelines. Project proponents should ensure that they are using the most recent published version of the Technical Notes.

The likely greenhouse gas (GHG) emissions of mining and coal seam gas projects are a relevant consideration for consent authorities under the *Environmental Planning and Assessment Act 1979*. This Technical Note sets out the preferred approach for estimating and costing GHG emissions.

Carbon cost planning in Australia

The centrepiece of Australia's emission abatement effort for delivering on the 2020 targets is the Emission Reduction Fund (ERF). With a budget of $2.55 billion, the ERF uses an auction mechanism to purchase emission reductions from eligible projects. A 'safeguard' mechanism designed to constrain emission growth among large emitters is also being developed to complement the ERF.

To date, six ERF auctions have been held. The Commonwealth has awarded 404 contracts to purchase around 192 million tonnes of abatement in the period to 2020, at an average price of $11.90 per tonne. Abatement purchases under the ERF have been dominated by revegetation and commitments to reduce land clearing. The Commonwealth has not released detailed information on the price of bids received or the volume of abatement available at particular price levels. As a consequence, it is difficult to extrapolate an equivalent market clearing price from the average prices paid by the ERF, or the likely prices that would prevail as low-cost abatement opportunities are exhausted and emission reductions from other areas of the economy are required.

While there is some uncertainty regarding future domestic carbon prices, it is important that NSW industries and new projects take proper account of the impact of their emissions on GHG abatement efforts and the environment. Furthermore, the NSW Government has an aspirational objective of achieving net-zero emissions by 2050.[1]

With these considerations in mind, project proponents in their Economic Assessment should provide the following information.

Output 1: Estimate annual Scope 1 & Scope 2 GHG emissions output over project evaluation time period

Projects contribute to GHG emissions through:

Scope 1 emissions: Direct emissions, such as fossil fuel combustion and the release of methane

Scope 2 emissions: Offsite GHG emissions associated with generation of electricity, heat or steam purchased by the project, and

Scope 3 emissions: Indirect greenhouse gas emissions (other than Scope 2) that are generated in the wider economy. They occur as a consequence of the activities of a facility, but from sources not owned or

[1] See NSW Climate Change Policy Framework (1 October 2016), http://www.environment.nsw.gov.au/research-and-publications/publications-search/nsw-climate-change-policy-framework

controlled by that facility's business. Examples include production and transport of fuel and material inputs, use of sold products and services, and emissions associated with business travel.[2]

The concept of Scope 1, 2, and 3 emissions reflects the varying degree of control a project proponent has over GHG emissions output. Scope 1 emissions are a direct outcome of the choices and activities undertaken by a project proponent. Scope 2 emissions arise from the use of energy produced beyond the boundary of the project and the control of the project proponent. Scope 3 emissions reference the GHG output of other suppliers of goods and services to the business operation, and emissions of those who purchase (and own) the product – including those occurring overseas.

For the purposes of this analysis, only Scope 1 and Scope 2 emissions need to be reported, along with energy use and activity estimates used to derive these estimates.

Scope 1 and Scope 2 emissions can be readily estimated by the project proponent and should be an input to business decision making around carbon exposures and emission reduction opportunities. Many mine projects generate electricity on site and would be disadvantaged in an assessment process relative to a project that purchased electricity, should Scope 2 emissions be omitted. Inclusion of Scope 2 is also consistent with the framework cost-benefit approach described in the assessment guidelines published in December 2015 which highlights the focus on direct and indirect impacts of a project, but not 'secondary' impacts captured by scope 3 emissions.[3]

Proponents may also provide estimates of Scope 3 emission impacts. This additional information would be helpful in reducing residual uncertainty around total project emission impacts, and viewed favourably as evidence of the proponent's strategic consideration of future GHG emission levels and potential cost exposures. However, it is noted that the Scope 3 accounting framework is inconsistent with established national accounting rules established under the UN Framework Convention on Climate Change[4], and could potentially result in 'double counting' of emissions when applied in conjunction with Scope 1 and 2 because emissions 'ownership' would be attributed to both the producer and end-user of a product, service or fuel.

Recent estimates for Scope 2 and Scope 3 emissions associated with NSW electricity consumption are shown in Table 3. These are subject to periodic update in line with national greenhouse reporting outcomes, and proponents should use current values.

[2] See Clean Energy Regulator (17 November 2015), http://www.cleanenergyregulator.gov.au/NGER/About-the-National-Greenhouse-and-Energy-Reporting-scheme/Greenhouse-gases-and-energy (accessed 8 February 2018).

[3] See NSW Department of Planning and Environment (2015), Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals, page.4.

[4] See United Nations Framework Convention on Climate Change, http://unfccc.int/national_reports/annex_i_ghg_inventories/reporting_requirements/items/2759.php (accessed 8 February 2018).

Table 3 Scope 2 and 3 emissions factors for purchased electricity

Financial year	EF for scope 2		EF for scope 3		Full fuel cycle EF (EF for scope 2 + EF for scope 3)	
	A	B	C	D	E	F
	kg CO2-e/kWh	kg CO2-e/GJ	kg CO2-e/ksWh	kg CO2-e/GJ	kg CO2-e/kWh	kg CO2-e/GJ
NEW SOUTH WALES and AUSTRALIAN CAPITAL TERRITORY						
1989/90	0.90	249	0.09	24	0.98	273
1994/95	0.85	236	0.08	23	0.93	259
1999/2000	0.86	239	0.09	24	0.95	263
2004/05	0.89	247	0.11	31	1.00	278
2005/06	0.89	248	0.12	34	1.01	282
2006/07	0.89	248	0.11	32	1.01	279
2007/08	0.89	248	0.11	30	1.00	278
2008/09	0.89	248	0.11	29	1.00	277
2009/10	0.89	247	0.11	31	1.00	278
2010/11	0.88	244	0.12	33	1.00	277
2011/12	0.87	241	0.12	34	0.99	276
2012/13	0.86	238	0.12	33	0.98	271
2013/14	0.84	234	0.13	35	0.97	269
2014/15	0.83	232	0.12	34	0.96	266
Latest Estimate	0.83	230	0.12	33	0.95	263

Source: Department of the Environment and Energy (2017), National Greenhouse Accounts Factors: Australian National Greenhouse Accounts, Appendix 4.

GHG estimates should be reported by gas and in carbon dioxide equivalent units

The standard unit of measurement for GHG emissions is tonnes of carbon dioxide equivalent (tCO_2e).[5] That is, warming impacts of GHGs other than carbon dioxide (CO2) are converted to a carbon dioxide equivalent amount via Global Warming Potential (GWP) conversion factors agreed under the UN treaty on the global greenhouse response (the UNFCCC).

The GWP of a gas indicates its ability to enhance heat retention in the atmosphere, compared to an equivalent amount of carbon dioxide. For instance, 1 tonne of methane (CH_4) released into the atmosphere is estimated to have a global warming impact equivalent to 25 tonnes of carbon dioxide (CO2). GWPs for the three most common GHGs are shown in Table 4 below. Updated GWPs are to be applied to GHG emission estimates from 2015 onward and Scope 2 emission factors.

Scope 2 emission estimates should be based on the best information available or default values and methods described in the National Greenhouse Account Factors workbook and the NGERS Technical Guidelines for facility level reporting.[6]

Proponents should reference the current version of the National Greenhouse Account Factors published annually by the Commonwealth Department of the Environment and Energy for updated GWP values, emission factors and for an extended list of reportable greenhouse gases.

Table 4 Global Warming Potentials for use in the conversion of GHG tonnes to CO2 equivalent tonnes (tCO_2e)

Gas	Chemical formula	Molecular weight	Global Warming Potential
Carbon dioxide	CO_2	44	1
Methane	CH_4	16	25
Nitrous oxide	N_2O	44	298

Source: Department of the Environment and Energy (July 2017), National Greenhouse Accounts Factors: Australian National Greenhouse Accounts, Canberra.

The report of greenhouse gas emissions should estimate the Scope 1 and 2 emissions over the duration of the project, capturing variations in annual emissions occurring in different stages of the project (construction, operation and rehabilitation) or where changes in the project's activities change the project's annual emission of greenhouse gases (e.g. changes in the production level).

sAnnual best-estimates of future GHG emissions by gas and tCO2e for the project over the next 30 years (including seepage gas following the closure of the project, if relevant) should be provided.[7] This should be identified as the Central estimate. An upper and lower emission range in CO_2e tonnes should

[5] UK Department for Transport, TAG unit A3 environmental impact appraisal, 2014.

[6] See Department of the Environment and Energy," National Greenhouse Account Factors: Australian National Greenhouse Accounts" Commonwealth of Australia (July 2017) and "Technical Guidelines for the Estimation of Greenhouse Gas Emissions by Facilities in Australia" National Greenhouse and Energy Reporting (Measurement) Determination 2008, October 2017, 2014 update

[7] NSW Treasury (NSW Government Guide to Cost-Benefit Analysis, March 2017) recommends an outlook period of 20-30 years for project appraisal. Proposals to adopt longer analysis periods beyond the recommended 20-30 years should be discussed with Treasury, having regard to the plausibility of data and assumptions over long time periods – e.g. assessing climate change issues or early intervention programs.

also be provided where material annual variations (i.e. above and below 15% of the central estimate annual value) are feasible.

These estimates of CO_2e emissions should be provided on a business-as-usual basis, assuming the continuation of current production practices and technologies and reflecting the current business outlook.

Output 2: GHG emission costs and responsiveness

While at present there is no identified carbon price in Australia, it is suggested for NSW project appraisal purposes that proponents refer to the *NSW Government Guide to Cost-Benefit Analysis (TPP17-03)* which states that "Market prices should be used as a basis for valuing the costs of carbon emissions, where reliable evidence can demonstrate that those market prices are not significantly biased as a direct consequence of scheme design."

The Review of the NSW Energy Savings Scheme suggested that an appropriate reference price for the cost of carbon is the forecast price of emission allowances (EUAs) with the European Union Emissions Trading System (EU ETS) based on futures derivatives published by the European Energy Exchange.[8] In the Review, it is noted that:

> '… carbon emissions … contribute to impacts of climate change on net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services. This Cost Benefit Analysis considers these impacts as the 'cost of carbon'.

However, the report also noted that:

> 'In the absence of a locally appropriate study of the whole of economy cost of climate change impacts, the NSW Government preference is for market data to be used where it exists'.[9]

The availability of relevant market data for Australia is challenging. Nevertheless, it is particularly important for new projects to recognise and consider the potential costs associated with their emissions, and the prospect of constraints in the future.

To inform project appraisal, proponents should provide analysis of their emissions output and how this is likely to be affected by a possible future national carbon price or regulations embodying an equivalent impact on production costs.

Even though there is uncertainty around the future mix of price and regulatory approaches to GHG abatement, price expectations from the EU ETS currently provides one of the clearest indications of a market based carbon price linked to longer term emission targets.

As a central estimate of a carbon price, the EU ETS carbon price potentially provides a benchmark to proponents for examining the implications of domestic carbon pricing or other abatement measures on the emissions output of mining and CSG operations. However, a proponent may in their economic assessment, justify the use of a different central estimate carbon price.

Accordingly, project proponents should provide an analysis of:

- their business-as-usual (BAU) GHG emission output (central estimate) and the expected emissions profile of this central estimate (Scope 1 and 2);
- Estimate the economic impact of GHG emission output to NSW only;

[8] Based on European Union Emission A price trajectory from Independent Economics and Frontier Economics, 2014, Economic and Energy Market Forecasts, prepared for the Australian Energy Market Operator, accessed at www.aemo.com.au/Electricity/Planning/Forecasting/National-Electricity-Forecasting-Report/~/media/Files/Other/planning/NEFR/2014/2014%20Supplementary/IE_Economic_Forecast_2014_FINAL.ashx

[9] NSW Government (April 2015), Review of the Energy Savings Scheme, Part 2: Options Paper, page 127.

- Undertake a sensitivity analysis on anticipated project GHG emissions output (Scope 1 and 2) at carbon prices below and above the central estimate price.

The value of the externality is limited to the impact on NSW, consistent with the Guidelines and how all other costs/benefits are measured within the CBA. As noted in the Guidelines, the focus is on the costs and benefits of the project as they relate to the community of NSW.