DRAFT REPORT

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Tillegra Dam: Socioeconomics

Independent review

Prepared for

NSW Department of Planning

Centre for International Economics
Canberra & Sydney

21 June 2010

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Contents

Boxes, charts and tables

1 *Introduction*

On 13 November 2007, the Minister for Planning issued an Order (under section 75B of the NSW *Environmental Planning and Assessment Act 1979*, the NSW EPA Act) that declared that the Minister's approval under Part 3A of the Act was required for the proposed Tillegra Dam (the Dam) in Hunter Water Corporation's area of operation. On 13 May 2009, the Minister for Planning also declared the Dam to be a 'critical infrastructure project' under section 75C of the Act.

The NSW Department of Planning (NSW Planning) is responsible for providing advice to the Minister on (amongst other things) matters relating to the Dam. NSW Planning has commissioned the CIE to review the economic analysis undertaken by Hunter Water and other entities that supports the conclusion that the Dam is the best solution to meet the Hunter region's future water needs. This report outlines the CIE's findings.

The context for this review

Hunter Water Corporation (HWC) is seeking approval to construct a 450 gigalitre (GL) dam at Tillegra, near Dungog in the Upper Williams River catchment. The Dam is proposed to be located on the Upper Williams River, within the localities of Tillegra and Munni. The Dam would inundate an area of approximately 2100 hectares at Full Supply Level. The project is within the Dungog Local Government Area, within the Hunter region of NSW, approximately 70 kilometres north of Newcastle. The Dam would be operated by Hunter Water as part of its portfolio of other supply sources.

The proposal is a project to which Part 3A of the NSW EPA Act applies by virtue of an Order made by the Minister for Planning under section 75B of the Act on 13 November 2007. Consequently, the Minister for Planning is the approval authority for the project. On 13 May 2009, the Minister for Planning formed an Opinion under section 75C of the EPA Act that the project is essential for the State for economic and social reasons and therefore declared the project to be a critical infrastructure project.

The project was also declared a 'controlled action' on 23 January 2009 under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC), for downstream impacts to RAMSAR wetlands, in the Hunter Estuary.

The project will be assessed under Part 3A of the NSW EPA Act and will also be conducted in accordance with clause 13.2 of the Bilateral Agreement between NSW and the Commonwealth, made under the EPBC Act, relating to environmental impact assessment.

The Environmental Assessment for the proposal was exhibited from 10 September 2009 until 13 November 2009, and 2659 public submissions were received. Over 25 per cent of submissions questioned the need for the project and whether it had been appropriately justified.

The scope of this review

NSW Planning has engaged the CIE to the review the socioeconomic analysis undertaken in relation to the Dam. Our approach to this review is determined by the Terms of Reference specified and the committed budget for this project. The Terms of Reference require us to specifically review the:

- validity and appropriateness of the economic valuation technique used by the Proponent (Hunter Water) to identify the preferred solution;
- validity and appropriateness of the modelling used to assess the social and economic impacts of the proposal; and
- appropriateness and accuracy of the assumptions used in the socioeconomic valuation and modelling.

Where the modelling is found to be deficient we are required to provide suggestions of any amendments that would be required to improve the rigour of the modelling, its output or the interpretations drawn from it.

Additionally we are required to comment on:

- whether the economic analysis supports the conclusion that Tillegra Dam is the best solution to meet the future water supply needs of Hunter Water;
- whether there are alternative measures that could deliver similar economic and social benefits; and
- the Proponent's assessment of the performance of all water supply augmentation options (providing the same level of drought security over the same timeframe as the Tillegra Dam proposal).

Our approach

Our approach to this review focuses largely on the analytical framework used to examine the different options available and the socioeconomic modelling undertaken to support this. The framework and the modelling are the key stages in the analysis that consider the Dam against its alternatives. This is the critical phase of the analysis that supports the conclusion that the Dam is the best alternative to meet the long term water supply of the region.

Given the scope of the review we have chosen to focus on those aspects that could have a material impact on the conclusions reached in the analysis. In particular, we seek to comment on whether any identified gaps or limitations in the analysis could change the ranking of the different options considered.

preferred to dam

Without conducting detailed modelling of the alternative options it is not possible for us to comment conclusively on whether alternative options may be preferred to the Dam. Instead we focus on the assumptions and comment on the extent to which these options influence the conclusion regarding the Dam. We also seek to comment on how changing the assumptions would change the nature of the results.

costing

We are not in a position to comment on the detailed costings used to model the alternative options considered. This would require a more specific review of the individual assumptions. Where possible we have, however, drawn on relevant information available from economic analysis conducted in other jurisdictions throughout Australia. However, we can only draw general conclusions from this information due to the site specific nature of the costs and impacts associated with these projects.

In undertaking this study we have relied primarily on the publicly available documentation as well as some confidential information provided to us by NSW Planning. This includes the spreadsheet model prepared by Aurecon (and provided to NSW Planning) that was utilised as part of the Cost-Effectiveness Analysis (CEA).

It should be noted that this study reviews the robustness of the economic analysis related to the decision to construct the Dam. This does not extend to undertaking separate analysis to advise on our view of the optimal range of measures to meet the long term water needs of the region.

Documentation reviewed

The key documents that we have assessed for this review are presented in box 1.1 below.

1.1 Key documentation considered

The following areas of the Environmental Assessment Report (EAR) have been considered:

- the CEA and computable general equilibrium (CGE) modelling undertaken by the Proponent (Section 3.5 of the EAR and Working Paper G (review of CEA and CGE)); and
- the socioeconomic impacts of the Tillegra Dam proposal (chapter 12 and Working Paper G (review of socioeconomics)).

Additionally, we were also required to review the following documents:

- Proponent's Submissions Report;
- submission from Dr Geoffrey Wells (University of South Australia) titled 'Technical Comments on the 'Socio-economic Assessment' undertaken by HWC and Aurecon for the Tillegra Dam Planning and Environmental Assessment Report';
- report by G Kuczera 'Review of Tillegra Dam Project Justification as Presented in the HWC Submissions Report'; and
- Proponent Briefing Note — Tillegra Dam — combination of options for direct comparison.

We have also drawn on previous analysis undertaken by Hunter Water such as the 'Why Tillegra Now' document (Hunter Water Corporation 2007) and the $H_2 50$ Plan (Hunter Water Corporation 2008).

Structure of this report

The structure of this report is as follows:

- chapter 2 reviews the methodological framework adopted to assess the different options;
- chapter 3 considers the economic modelling undertaken in the CEA and the CGE analysis undertaken to assess the potential economywide impacts of the Dam; and
- chapter 4 draws together our findings on the robustness of the economic analysis in relation to the Dam and conclusions drawn from the analysis in regards to the choice of the Dam as the highest ranked option.

2 *Review of methodological framework for assessing options*

This chapter summarises the broad approach adopted by Hunter Water to assess the different options that were considered to meet the future water needs of the region. This is followed by a critique of this approach, with particular focus on some of the key elements.

Overview of Hunter Water's approach

In considering the range of options available to meet the future water supply requirements of the region, Hunter Water (with assistance from Aurecon) adopted the following approach.

- *Step 1.* Specify the water reliability and security objectives that all options are required to meet. The need for new infrastructure has been justified on the basis of a supply–demand imbalance.
- *Step 2.* Assess the direct financial impacts by using a CEA. The CEA was initially undertaken as part of the report *Why Tillegra Now?* and reproduced in Hunter Water's H_250 Plan. Additional analysis, based on slightly revised costing information (such as updated figures to incorporate inflation), was also undertaken by Aurecon as part of the EAR.
- *Step 3.* Assess the indirect impacts of all options through a qualitative analysis. This analysis was undertaken as part of the report *Why Tillegra Now?* and Hunter Water's H_250 Plan. The matrix table summarising the qualitative impacts was also reproduced in the analysis undertaken by Aurecon.
- *Step 4.* Report the economywide impacts of the Dam through the use of CGE analysis. This analysis was reported in the EAR, although it did not form part of the options analysis.

In summary, Hunter Water's approach to examining the choice of alternative options to meet the water needs of the lower Hunter region can be considered as an optimisation problem. This seeks to find the best solution (from a range of possibilities) to meet the specified objectives and constraints.

In regards to the analysis undertaken by Hunter Water the objective is to minimise costs subject to providing sufficient supply to ensure that demand can be met at all times (over the next 40 to 50 years) and quantitative water restrictions applying for no more than a specified level. In this instance cost is defined as the direct financial costs to Hunter Water associated with the different options.

The indirect impacts (particularly the indirect environmental and social impacts) of the different options are not quantified and do not form part of the optimisation problem. Instead these indirect impacts are separately considered in a qualitative framework.

Best Practice Approach

Determining the best options to deliver future water needs is a complex task. It requires a substantial amount of information to be collected and drawn together into a framework that allows systematic analysis of different options. The framework needs to draw together ideas from a range of disciplines such as hydrology, engineering, statistics, economics and environmental and social sciences.

It is worth considering some of the key features that need to be considered in a best practice approach. Some of the key features are presented in table 2.1 below. In the table we identify the extent to which these features have been incorporated in the Hunter Water and Aurecon's analysis. This is not intended to provide a detailed critique of Hunter Water's approach but provides a snapshot of the extent to which the approach incorporates some of the key features of a best practice approach.

2.1 **Key features of a Best Practice Approach**

Key Features	*Extent incorporated into Hunter Water's analysis*
Understanding of hydrology of system and long term system supply	Yes. Hunter Water utilises a complex hydrology model that generates simulated scenarios of possible future inflow events based on historical records.
Understanding of future demand	Yes. Hunter Water appears to have a good understanding of the potential impacts of factors such as population growth, the demographic shifts in the population and demand management programs.
Options available to meet demand	Yes. The analysis considers seven options. Other options could potentially be included.
Understanding of impact of alternatives on security and reliability	Limited. It is likely that Hunter Water has undertaken more detailed analysis but the information has not been presented. For example, information could be provided on the impacts on minimum storage levels under alternative inflow scenarios and information on the average time in restrictions.
Understanding of impacts of timing on alternative options	No. The alternative options are only considered to be introduced at a fixed point in time (e.g. 2011). There is limited consideration of how changing the timing of introduction of measures can impact on the costs (in net present value terms).

(Continued on next page)

2.1 **Key features of a Best Practice Approach** (continued)

Key Features	*Extent incorporated into Hunter Water's analysis*
Understanding of the value of deferring construction of costly infrastructure	No. The alternative supply options are costly and irreversible once constructed. It is important to consider options to defer the construction of this infrastructure without significantly compromising security.
Understanding of joint effects through 'portfolio analysis'	No. The analysis considers individual options and does not consider how these interact with other measures in the existing supply system.
Financial costs	Yes. Information is presented for all options. Greater transparency on some of the cost information is required.
Environmental and social impacts	Limited. There is limited analysis of presented on these impacts for all the options.

Source: The CIE.

It is important to recognise that meeting best practice requires significant information to assist in the decision making process. The extent to which a best practice approach can be readily applied, therefore, depends partly on the availability of information or the ability gather this information in a reasonable timeframe.

The remainder of this report considers in more detail the extent to which Hunter Water and Aurecon have incorporated these features into its approach to considering the Dam and alternative options.

Cost-effectiveness analysis versus cost-benefit analysis

The best practice approach is typically incorporated into an economic framework that allows consideration of the tradeoffs that exist between the different options. Hunter Water and Aurecon's analysis can be classified as a cost-effectiveness analysis (CEA) where a least cost solution is sought subject to meeting supply requirements and minimum levels of service.

The CEA approach has been criticised by Dr Geoffrey Wells (2009) in his submission to the EAR. Dr Wells argues that international best practice specifies the use of a wider BCA framework to review the different options. He refutes the arguments submitted by Aurecon that seek to justify the use of a more limited CEA and notes the preference specified in NSW Treasury guidelines for a BCA framework.

We support Dr Wells' conclusion that a BCA framework is preferable to the narrower CEA framework where robust information is available and can be incorporated into the analysis. In theory a BCA framework draws together significantly more information to assess the full impacts of the alternative options. It incorporates both the direct and indirect impacts as well as the use and non-use values. This is particularly relevant for large-scale infrastructure projects which often have a diverse range of impacts and where complex tradeoffs are required to be considered.

In Professor Kuczera's advice to Hunter Water he recognises that there are likely to be a range of complex tradeoffs that are required to be made between the different options. However, his advice is that these tradeoffs require value judgements to be made and that these are most appropriately made by policy makers. In a BCA framework these values are sought to be explicitly incorporated into the analysis.

In theory a BCA approach is preferred for examining complex infrastructure projects which have diverse impacts. However, in practice where robust information is not readily available then a BCA framework is difficult to apply in a robust manner. In this situation a CEA framework may be reasonable to adopt. That is, a CEA framework can offer decision makers with good information to assist decision makers to evaluate alternative options. For example, many of the features in a best practice approach noted above apply equally to a BCA and a CEA. A CEA approach can also be supplemented with other information to assist policy makers, such as detailed modelling of environmental and social impacts.

Further, it is the application of the approach that is often of greatest importance. For example, if a BCA applies assumptions that are not robust then it can result in misleading conclusions being reached. Therefore, the remainder of this report focuses largely on Hunter Water and Aurecon's application of the CEA framework.

The CEA approach adopted by Hunter Water to review the infrastructure options is similar to the approach used in Sydney's 2004 Metropolitan Water Plan to assess the different options. In this regard it was a typical approach to analyse alternative options at that point in time. However, since that time there has been significant enhancements to the approach adopted to analyse enhancements to the water supply system.

Sydney's 2006 Metropolitan Water Plan, for example, made significant changes in recognition of the limitations of the approach adopted in the 2004 Plan. Further improvements have also been made in the approach that was recently used to consider the range of options for Sydney's upcoming 2010 Metropolitan Water Plan, even though it is still classified as a CEA framework.

Therefore, while we believe that a more detailed BCA does (in theory) provide the most robust analysis, even under a CEA framework significant improvements can be made to the approach used by Hunter Water. Some of the limitations of Hunter Water's CEA framework are discussed further below.

Some limitations of Hunter Water's framework

Under Hunter Water's CEA framework the benefits of the alternative options being evaluated are considered to be the same across all options. CEA is often justified in the context of evaluating alternative water supply schemes on the grounds that all the measures seek to meet customers' demand for water related services. Customers need the service that water provides rather than the water itself.[1] Therefore, if the same service can be provided at a lower cost to the community by improving efficiency then this represents better value than providing more water, depending on the upfront costs of achieving the efficiency gain (White and Howe 1998). Hence in Hunter Water's CEA framework, the focus of the analysis is only on one side (the cost side) of the equation.

It is not clear to us that it is valid to assume that the benefits are the same across all the options examined by Hunter Water and Aurecon. This point was also raised by Professor Kuczera, although his comments related to the fact that the options reached a supply-demand imbalance at different times into the future. Hunter Water and Aurecon have attempted to overcome this issue by using 'levelised costs' that converts the costs into a dollar per unit of water delivered. This was believed to allow projects to be compared on an equal basis. There are a range of concerns regarding the use of levelised costs discussed further below.

Apart from the issue raised by Professor Kuczera there are also a range of other reasons why we believe that the benefits are not likely to be the same across each of the different options. These include differences in:

- the level of reliability provided by the options (i.e. water restrictions);
- the probability of hitting low storage levels and triggering the need for additional investments (under the Drought Emergency Management Plan); and
- the environmental and social impacts of the project.

However, perhaps the key limitations in Hunter Water's approach is the treatment of the timing of different options, the incorporation of risk and uncertainty and the approach taken to incorporate environmental and social impacts into the decision-making framework. These issues are discussed first, before considering the assumption that benefits are the same across all options.

Timing of the capital expenditure — the value of deferral

In Hunter Water's analysis the timing of alternative options is not considered in detail. In Hunter Water's approach the timing of when to introduce new options is largely based on the concept of supply-demand balance (using the reliable yield calculation). Hunter Water has estimated that there is supply- demand imbalance such that the current supply sources are not expected to be able to meet the demand over the long term. The estimated supply-demand balance is presented in table 2.2 below.

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[1] For example, customers can gain the same utility from showering with less water by showering using low-flow showerheads.

2.2 **Forecast supply-demand balance**

	2006	*2030*	*2050*
	GL	GL	GL
Reliable yield from existing sources[a]	67.5	67.5	67.5
Forecast demand	72.8	89.7	109.9
Shortfall	-5.3	-22.2	-42.4

[a] Attachment 4B provides an explanation of the concept of 'reliable yield'.

Note: Forecast demand includes estimated savings from demand management, recycling and leakage reduction programs. Existing sources include Grahamstown dam, Chicester dam, Tomago sandbeds and Anna Bay sandbeds.

Source: Hunter Water Corporation (2007, p. 19).

Given that there is currently a supply-demand deficit this is seen as the need for new investments immediately. In their analysis all options are assumed to occur at a fixed point in time (in approximately 2011). There does not appear to be recognition that there could be significant reduction in costs (in net present value terms) from being able to defer the construction of large scale infrastructure that is irreversible. In the context of options that have a significantly shorter lead time (such as a desalination plant).

This point has been recognised in the development of Sydney's Metropolitan Water Plans over the past decade. The focus on the analysis has shifted away from a sole reliance on the supply-demand balance to the use of other information such as the current storage levels and depletion rates as well as the introduction of measures that reduce the lead time for constructing infrastructure. This specifically recognises that there is value for the community in being able to defer the construction of expensive infrastructure to a 'just in time' basis. This point is particularly relevant for catchments such as in the Sydney and Hunter regions which have highly variable rainfall where dams can fill (as well as deplete) rapidly.

The timing of investment decisions should be based on the contribution of the options to the value of water in-use, including environmental water, compared with the costs. This recognises the tradeoff between the value of security and providing this extra service.

Therefore, the optimal timing to make additional large scale investments is a balance between delaying the decision to provide the greatest chance to capture large rainfall events (which provide a cheap source of water) and not allowing dam levels to deplete to such a level as to pose a threat to the security of the system. Based on the documentation that we have reviewed it does not appear that this analysis has been undertaken.

Risk and uncertainty

Policy makers that have to make investment decisions rarely have full information about the future. Therefore, they are required to make decisions in the context of a range of possible results for the key factors that impact on the costs and benefits from the project. This is particularly true for investment decisions in the water sector where there are a wide range of factors that are not known with certainty, such as:

- the future climatic conditions which determine the probabilities of being in restrictions;[2]
- the future demand for water, which is subject to variability both from consumption rates and overall population levels;
- the extent to which security is actually increased by a particular project; and
- the costs of the particular water supply option, including the capital costs in future years.

Risk and uncertainty capture the degree to which the future is unknown. The term risk refers to events about which a probability distribution for possible outcomes is known, while uncertainty refers to events about which there is no information on the probability distribution. In practice the terms are blurred and estimates of the probability distribution are made with greater or lesser accuracy.

The treatment of risk and uncertainty should be central to the decision regarding enhancements to the water supply system. This is being increasingly recognised and tools are gradually evolving to assist in the decision making process. For example, in Sydney's 2006 Metropolitan Water Plan there was a major shift toward an adaptive management approach, which recognised the value of having flexible systems that could develop as new information became available (for example, storage levels, short term and longer term rainfall expectations).

It is important to recognise that climate change is not only about potential changes in average rainfall. It is also expected to involve greater volatility and duration in rainfall patterns. This may potentially result in a greater chance of being at relatively low storage levels with a greater reliance on water restrictions.[3]

Climate change is also about a higher level of uncertainty regarding future supply. That is, there is no information about the probability of the extreme events occurring. In situations of increased uncertainty water supply strategies that offer greater flexibility in responding to new situations are likely to be more 'valuable' compared with those more traditional approaches. From the documentation that we have

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[2] The underlying rainfall characteristics are an important driver of the water supply options chosen. For example, the UK is characterised by a low intensity and steady rainfall pattern compared to, for example, Newcastle and Sydney where the systems are more volatile. In the more volatile systems there is greater probability that rainfall will be significantly different to the mean, compared to catchments with more stable rainfall.

[3] Climate change also touches on aspects of urban water management. For instance, there may be a higher risk of bushfires destroying water supply catchments or a greater volume of pollutants entering storages during extreme rainfall events.

reviewed it does not appear that these issues have been considered in any detail by Hunter Water and Aurecon.

Professor Kuczera's review recognises the importance of uncertainty in this context and suggests that scenario analysis could usefully be conducted. Using scenario analysis Hunter Water could usefully explore the performance of the different options under different drought situations such as the performance of the Dam if it were constructed in 2010 and the worst historical drought occurred over the next 5-10 years. It is important to understand whether the DMP would be triggered and additional investments required.[4] It would be useful to explore the drought performance under different assumptions regarding the 'starting storage level' when a drought commences as well as the performance under different levels of demand.

In the scenarios above, Hunter Water should also present the outcome of the combined costs of both the Dam and the DMP. This would provide a clearer picture of the costs that are likely to be faced under the different scenarios. It is also important that all costs are reported on a risk-weighted basis to take account of whether there is only some probability that the costs would be incurred.

The scenario analysis would provide decision makers and the community with a more detailed understanding of the potential risks faced and the extent to which they are willing to accept a higher risk at the expense of lower expected costs. It is important therefore that both the 'risk and return' outcomes are considered in the analysis.[5] The community is likely to place more value on those options that face less risk and uncertainty, where they have similar average outcome.

Treatment of joint effects

Hunter Water and Aurecon's analysis is based on an analysis of seven individual options. The examination of individual options has historically been adopted by utilities in considering additional water supply investments. For example, a similar approach was adopted in Sydney's 2004 Metropolitan Water Plan.

More recently, analysts have recognised the importance of examining 'portfolios' of options, rather than individual options in isolation. Undertaking analysis at the portfolio level takes into account the interactions between individual projects as well as the existing system assets. For example, the per unit water savings achieved by a demand management program may be reduced if it is combined with measures such

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[4] In this regard, Kingsford and Hankin 2010 (p. 42) noted that if a dry period similar to that which occurred in 1935 occurred it would have taken Tillegra Dam 15 years to fill. During a wet period similar to that which occurred in 1971 it would have taken approximately eight years to fill.

[5] Examination of the risk and return characteristics is a basic principle of investment analysis and covers all forms of investment.

as imposing restrictions more frequently because this reduces the amount of water used by households.

Finding the best, or 'optimal', portfolio will require consideration of the type, timing and sequencing of new projects and the operation of existing infrastructure and programs. Timing can determine both the level of a particular project, and in determining the present value of these costs from a portfolio. As new water supply options are often long term capital intensive investments, exactly when they are put in place and exactly when impacts on reliability/security start to accrue will have a large influence on their net costs (expressed in present value terms).

The concept of portfolio analysis is commonly used to analyse different water supply and demand side options. For example, the analysis undertaken in relation to the Traveston Crossing Dam in South-East Queensland considered five alternative portfolios. In each of the five portfolios examined, the 'existing' measures that were currently in place or would be operating in the near future (such as the Gold Coast desalination plant) were included as well as combinations of new measures.

The importance of portfolio analysis was also recognised in the 2006 Sydney Metropolitan Water Plan and is the basis of the upcoming 2010 Plan. In the 2010 Plan between 20 and 30 portfolios of different options were considered. These included combinations of different measures (which include, for example, different levels of quantitative restrictions) as well as consideration of the timing of new measures.

It is important that the analysis be undertaken in the context of portfolios so as to take account of the interaction or joint effects with other parts of the system.

Different environmental and social impacts

Typically a rigorous economic analysis would require an understanding of how the different options impact on the aggregate welfare of society. A full BCA brings together the wide range of direct and indirect benefits/costs into the same monetary terms so that the aggregate social welfare can be determined. This requires placing values on those impacts where observable market data may not be available. Often this information may not be readily available and requires detailed data collection from the community through systematic surveys that are specifically designed for this purpose. Alternatively, the findings from systematic surveys conducted in other regions can be used (this is known as the 'benefits transfer' technique). However, this may only be possible where there are sufficient similarities with the characteristics of the socioeconomic profile in the original study.

Further, detailed modelling of environmental and social impacts would be required to convert these impacts into monetary values. This requires, for example, an understanding of the potential impacts under a range of climatic scenarios. Often environmental impacts are 'non-linear' where, for example, impacts may be small up to a point but then become significant (and potentially irreversible) once a 'tipping-point' is reached.

It is also important to understand the potential indirect impacts of the alternative options. For example, in the case of Sydney's desalination plant it is becoming increasingly recognised that drawing more water from the plant also has the potential to reduce the amount of water required to be drawn from the catchment, providing environmental benefits particularly during dry times.

Where factors are not directly monetised and incorporated into the economic analysis, it is common for the analysis to seek to incorporate this information into the analysis in a qualitative fashion. Hunter Water has adopted this approach in its consideration of the environmental and social impacts. These are presented in a matrix summarised in table 3.1 of the EAR. The EAR also has a more detailed assessment of the potential environmental and social impacts of the Dam (although not the other options).[6]

While we believe that a BCA framework provides the most robust approach to incorporate the environmental and social impacts we recognise that, in practice, detailed information may not be available to conduct a full analysis of all the impacts. In the absence of this, alternative quantitative or qualitative approaches could be adopted.[7]

In our view the qualitative analysis undertaken by Hunter Water as presented in a matrix form only provides the first step in outlining the range of potential indirect impacts of the proposals. Some of the limitations of the approach presented in the matrix include the following.

- It appears that not all of the impacts have been addressed. For example, a key potential environmental impact associated with the Dam involves flows to the Kooragang Island Wetlands (Kingsford and Hankin 2010). Further, another issue that should be considered is the potential positive environmental impact of the desalination plant on the volume of water that needs to be drawn from catchments (particularly in droughts when rivers may be stressed). There are likely to be a range of other issues that have not been incorporated into the matrix.
- For each option the matrix does not provide any indication of the relative importance of the issues discussed. For example, in regards to the Dam it is not clear whether inundation of the major roadways is a more significant issue compared with inundation of the 2100 hectares of farmland.

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[6] Appendix A of the *Why Tillegra Now?*(Hunter Water Corporation 2007) document also provides a description of the environmental and social attributes of the different options.

[7] Other approaches such as Multi-Criteria Analysis are often commonly used to incorporate the non-market impacts. We have not discussed some of the limitations of these approaches. A critique of this can be found in Dobes and Bennett (2009).

- The matrix provides little information to judge the order of magnitude difference between the same issues raised for the different options. For example, one of the perceived advantages of the Dam is that it 'diversifies water source options'. A similar statement is made in relation to the desalination option considered. However, the matrix provides no information to judge how much larger (or smaller) the diversifications benefits of the Dam are versus the desalination plant.
- The matrix identifies the gross impacts rather than the net impacts. For example, one of the perceived advantages of the Dam is the potential recreational use. While this may be correct the increased recreational use of the Dam may come at the expense of recreational activities in other parts of the region. Therefore, it is net social gain that is most relevant.

Assumption that benefits are the same across all options

Different levels of reliability

The supply side in the supply–demand balance is typically calculated by the use of the concept of 'reliable yield'. The concept of reliable yield has been commonly used throughout Australia as a method to determine the average long term supply that can be delivered from only traditional rain-fed sources of water supply, such as dams.

However, non-traditional sources of supply have very different characteristics. For example, desalination plants can deliver the same quantity of water during drought periods. Therefore, while the desalination plant and the Dam may deliver the same quantity of water *on average*, the desalination plant could offer additional benefits such as comparatively less time in restrictions, as it can provide the same quantity of water in all climatic circumstances.[8]

In our view, where the different supply options offer higher levels of service compared with the minimum then this should be accounted for in the analysis. This can readily be incorporated into the analysis by explicitly placing a cost on restrictions.[9]

The community is likely to place value in having a more secure and reliable source of water. Given this, it is important to incorporate the differences in the reliability and

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[8] In the calculation of reliable yield minimum service levels are specified. While all the alternative options examined meet these minimum levels, it is important to also recognize that some options may deliver higher levels of service (above the minimum) compared to other options.

[9] The cost of restrictions can also be incorporated into a CEA framework. These costs were incorporated into the analysis recently completed for the upcoming 2010 Metropolitan Water Plan for Sydney.

security offered by alternative measures into the analysis. Further, modelling would be required to understand the different levels of service provided by each of the portfolios examined. If there are large differences in service level this could change the ranking of different options.

Probability of triggering Drought Management Plan

Hunter Water's analysis of the different options appears to be focused primarily on the seven options to meet future growth needs and does not consider the contribution of each of these options to meeting needs during drought. Hunter Water separately considers the additional investments that would be required in drought through its Drought Management Plan (DMP).

The investments proposed in the DMP are summarised in chapter 3 of the EAR.[10] Basically this involves the construction of a $1 billion desalination plant and additional investments to increase capacity to draw water from groundwater sources. It is anticipated that these additional investments would be made when dam levels drop to around 70 per cent of total capacity. Chart 2.3 below provides an illustration of the investments envisaged under the DMP if Hunter Water was faced with a worst drought on record over the next few years.

The options analysis undertaken by Hunter Water and Aurecon does not appear to consider the relationship between these investments and the investment that would be required if the DMP were triggered.

In our view there are clear interlinkages between the seven options that are primarily focused on meeting growth needs and the investments in the DMP. For example, while the Dam may result in significant excess capacity to meet current demand under average climatic conditions it also has the added benefit of providing a buffer that could prevent additional investments under the DMP in the advent of a bad drought.

If the seven options differ in their probability of triggering the DMP then it is important that these differences be accounted for in the options analysis. Given that the construction and fill period for the Dam is longer than, for example, the desalination plant option we would expect there to be significant differences between the options in the probability of triggering the DMP over the first 10 year period of the analysis. Given that in a discounted cashflow framework there is a higher weight placed on costs incurred in the initial periods of the analysis, we would expect that this could have a significant bearing on the costs (in net present value terms) used in the CEA.

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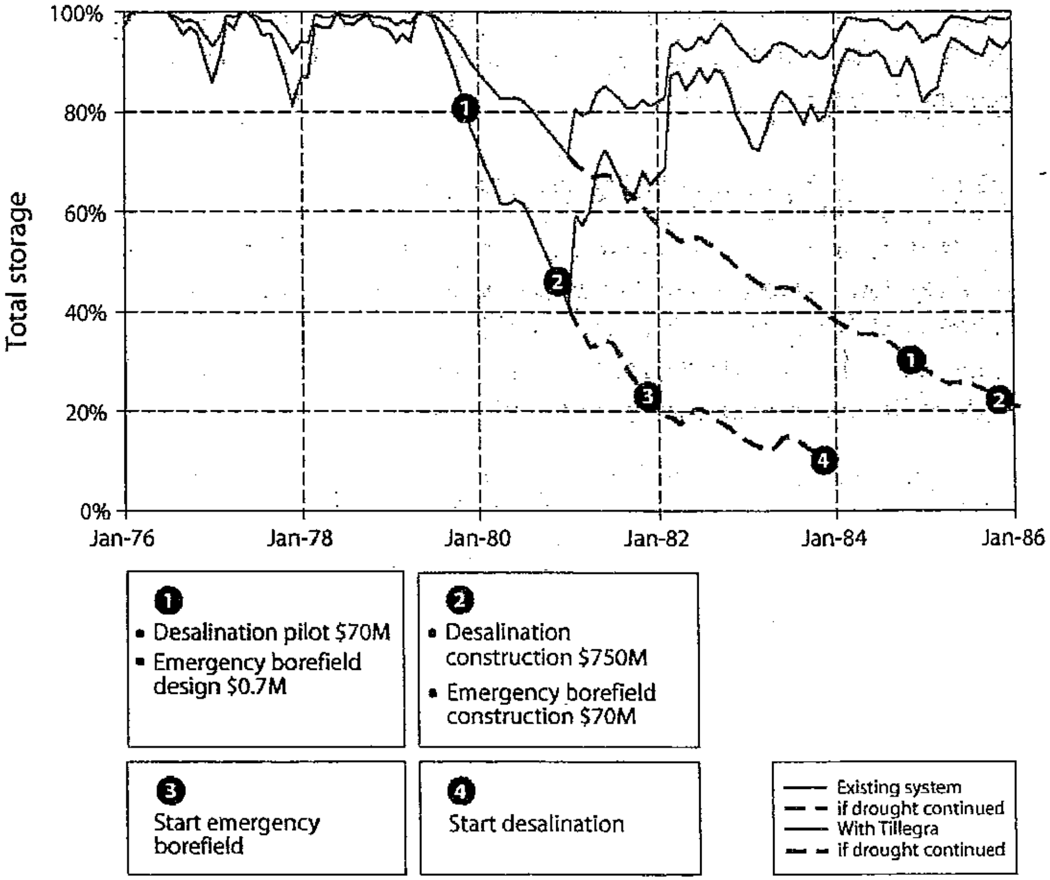
[10] Pages 3.10 and 3.11.

2.3 Hunter water supply system performance in drought



Data source: Hunter Water Corporation (2008, p. 84), *$H_2$50 Plan*.

Levelised costs

One way of expressing costs is through the use of levelised costs. Levelised cost looks at the cost of producing a unit of water under each measure. It converts the present value of a series of costs into an equivalent annual series of payments. In its calculations Aurecon calculates levelised cost as the Net Present Value (NPV) of costs divided by the NPV of additional yield produced by that supply option.

The concept of levelised cost has typically been used in the past where the benefits of particular options cannot be readily monetised. Therefore, the benefits are presented in terms of their contribution to an additional volume of water. So, for example, demand management programs have been evaluated according to the cost of the program per unit of water saved. In this instance, the use of levelised costs is likely to be more relevant because there is a direct relationship between the amount of money spent on a program and estimated water savings.

While the use of levelised costs can be a simple way of comparing options, it can be misleading because it usually does not adequately account for future changes in costs and quantities of water conserved. The use of levelised cost assumes that the marginal value of water remain constant into the future, which is often not the case.

In Aurecon's calculation of levelised cost it is assumed that the desalination plant is operating at full capacity. Therefore, it appears that even if there is excess supply in the initial years the desalination plant is assumed to be operating at full capacity. This would make the desalination plant a very expensive option because it is producing water even when it is not needed.

The use of levelised costs has been heavily criticised in assessing large regional infrastructure options. For example, Marsden Jacob Associates 2007, noted that 'levelised cost does not demonstrate the net change in costs of supplying water to the region under various options'. This study also noted another shortcoming of the levelised cost approach is that it lacks transparency when conducting triple-bottom-line assessments.

The use of levelised costs in Sydney's 2004 Metropolitan Water Plan was also criticised. As a result, the 2006 Plan moved away from the concept of project specific levelised cost and noted that it was crucial that costs and benefits be assessed at the portfolio level. This is due to the fact that individual project level costs and benefits could be misleading. The analysis supporting Sydney's upcoming 2010 Metropolitan Water Plan also does not use the concept of levelised costs of individual options.

3 The economic model

In order to assess the alternative portfolios of measures an economic model was developed by Hunter Water and Aurecon based on the analytical framework discussed above. The economic model developed incorporates a breakdown of costs for each of the portfolios considered, and includes a wide range of assumptions regarding inputs. The economic model uses a discounted cashflow analysis. The decision rule is to choose the option that has the lowest net present value of all future capital and operating costs, which has been converted into an equivalent levelised cost.

This section comments on the robustness of the economic model to undertake the CEA and the underlying assumptions used in the modelling.

Options analysed in the economic model

Hunter Water and Aurecon have considered seven alternative options in its analysis. However, policy makers have a wide range of other decision tools available that could be considered in alternative portfolios, including:

- providing smaller scale investments to increase supply combined with additional demand-side measures;
- changing the restrictions regime which may mean changing the duration, frequency and severity of restrictions;
- operating the existing assets in different ways under different circumstances (this is particularly relevant if a desalination plant were constructed); and
- developing 'readiness' strategies to deal with unforseen circumstances. These could include, for example, purchasing land (or key pieces of equipment) in advance in preparation for the need to construct an additional desalination plant.

All of these choices have their place in the toolkit of policy options. The key decision is to consider:

- which measure or combination of measures to use
- when to introduce the measures and in what sequence.

In our view, the CEA could usefully have considered a wider range of combinations of measures. These could include, for example, more flexible use of water restrictions, and different timing of the capital expenditure which includes triggering new capital expenditure based on a storage level rather than a point in time.

We believe that the investments under the DMP should be considered as a separate portfolio of options. That is, a new desalination plant being triggered if storage levels reached 70 per cent.[11] It would be useful to also consider other options related to the desalination plant such as:

- adopting a lower dam level for triggering the desalination plant investment such as 60 per cent and 50 per cent. This could be combined with having harsher quantitative water restrictions to reduce storage depletion rates;
- incorporating a relatively small desalination facility that has the flexibility to upscale at lower dam levels if this occurred; and
- allowing a desalination plant to be operated based on dam trigger levels such as only switching the plant on when dam levels reach 70 per cent. This could result in substantially lower operating costs compared with operating a plant at full capacity, particularly where the distribution of storage levels is skewed toward higher levels.

It is possible that there are alternative portfolios that involve, for example, higher levels of restrictions combined with a new desalination plant (constructed at relatively low dam levels) may deliver lower cost outcomes than the Dam. However, this would require further detailed modelling by Hunter Water.

Timing of expenditure in the model

The timing of expenditure in a discounted cashflow model has a very large impact on the results.[12] The assumptions regarding the construction period and the period before each option can deliver full supply are transparent in the Aurecon model.[13] In Aurecon's model the capital expenditure enters the model in the year in which it is incurred. The timing of when new capital expenditure is required is based on the specified assumptions that require all options to be fully operational by around 2013.

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[11] It is important that the costs are weighted to take account of the probability of triggering the investment. For example, if there is a 10 per cent chance of triggering a $500 million investment then the expected cost is $50 million. Further, the chance of triggering the investment would differ over time as the demand changes. It is also important to consider this in the discounted cashflow analysis.

[12] In the analysis a discount rate of 7 per cent is assumed with sensitivity testing of 4 and 10 per cent. This is standard practice as required by NSW Treasury Guidelines.

[13] These are also presented in Table 6 in Working Paper G of the EAR.

In the economic model, when new investment is triggered the capital costs are assumed to be distributed evenly over a specified construction period for the supply source. These assumptions are transparently provided in the economic model.

It would be useful for Hunter Water to consider alternative timing of the investment option, given that the options appear to deliver significant excess capacity in initial years and a supply-demand balance is reached in the outer period of the planning horizon.

Changing the assumptions regarding the construction period can have a significant impact on the present value of the costs. The extent to which future technological advancements can reduce the lead time of projects will substantially reduce the present value of costs. This highlights the value of portfolios that are flexible and allow policy makers to delay large infrastructure expenditure in response to new information that may arise in the future.

As noted above, Hunter Water could usefully consider additional portfolios of options with different assumptions regarding the timing of the expenditure. An obvious portfolio to consider is a portfolio based on the DMP where the construction of a desalination plant is triggered once storage levels fall below 70 per cent of capacity. If there is a 1 in 10 chance of falling below this level then, this implies a risk weighted construction cost of the desalination plant of around $90 million which is significantly lower than the $397 million construction cost of the Dam if it were constructed today. It is likely that this change alone would challenge the conclusion that the Dam is the least cost option.

The magnitude of the costs

The magnitude of the cost items assumed in the CEA will have an impact on the ranking of the different options. These cost items will not be known with certainty and reasonable estimates will need to be made to be included in the 50 year cashflow analysis. We are not in a position to comment in detail about the cost assumptions included in the analysis. This requires detailed site specific analysis by suitably qualified engineers.

While we are not able to comment in detail about the specific items, we offer some observations regarding the costs related to the desalination plant.

In the options analysis presented in the EAR the costs (in real 2008-09 dollars) related to the desalination plant are estimated to be $990 million in capital expenditure and $26.63 million in operating costs. This is based on a plant of 125ML per day and operating costs of approximately 60 cents per kL.[14] Hunter Water assumes that the desalination plant will be operating at full capacity.

We note that in the H_250 Plan (Hunter Water Corporation, 2008, p. 89) Hunter Water considered a 70 ML per day desalination plant with a capital cost of $500 million per annum (including $50 million to mitigate high energy requirements) and annual operating cost of $25 million per year.[15] It is not clear why the annual operating costs of the 70 ML per day plant presented in the H_250 Plan are equivalent to the operating costs of the much larger plant considered in the EAR. Using a figure of 60 cents per kL this equates to approximately $15 million per annum in operating costs. It would be useful for Hunter Water to clarify the assumed operating costs for a 70 ML per day plant.

Further, it is not clear to us how the capital costs for the Dam and desalination plant have been derived. Section 4.4.4 in Working Paper G of the EAR indicates that the capital costs relating to the desalination plant were increased commensurate with an increase in the capacity of the plant. The larger plant was expected to cost $688 million in 2006-07 dollars and this has been converted to $989 million in 2008-09 dollars. This equates to a 44 per cent increase in costs over a two year period. This does not appear to bear any relationship with either the consumer price index (CPI) or construction cost index. Similarly, the capital cost of the Dam was estimated at $300 million in 2006-07 dollars and converted to $397 million in 2008-09 dollars — a 32 per cent increase. It would useful for Hunter Water to review these cost estimates and to advise on whether these cost items are correctly reported.

The nature of the operating costs for the desalination plant is more complex compared to the capital costs. The variable operating costs are the largest component of the total operating costs. There are also standby, shut-down and start-up costs depending on how the plant is operated. As a comparison, Sydney Water's factsheet on the desalination plant indicate that total operating costs of 80 cents per kL are anticipated when the plant is running at full capacity. This incorporates the costs of renewable energy certificates to offset the greenhouse gas emissions.[16] This also includes fixed operating costs of the plant.

Hunter Water's assumption of 60 cents per kL appears to be within the same 'ballpark' as Sydney Water's assumed cost of operating the desalination plant. Nevertheless it would be useful for Hunter Water to provide more information

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[14] This is presented in table 3.1 in the EAR, p. 3.15.

[15] A larger 120 ML per day plant is anticipated as a drought contingency response (Hunter Water Corporation 2008, p. 89, H250 Plan).

[16] This is based on the plant capacity of 250 ML per day, resulting in annual operating costs of approximately $75 million per annum.

regarding its assumed costs associated with the desalination plant including the following.

- assumptions regarding whether the capital costs:
  - include the costs related to the pipeline as well
  - include activities to reduce the energy use of the desalination plant
  - incorporate the costs associated with purchasing land.
- assumptions regarding the operating costs.
  - what is the assumed electricity consumption (MWh per ML) of the plant and the pumping station?
  - what is the assumed purchase price of electricity ($ per MWh)?
  - do the costs incorporate any costs related to the purchase of 'green energy' and other costs that seek to offset the greenhouse gas emissions?

This information would allow readers to gain greater understanding of the cost items. For example, it appears that the assumed costs related to the desalination plant incorporate the cost of water filtration and the cost of 'green energy'. It appears that these cost items are not included in the costs associated with Tillegra Dam.

As noted above, it is particularly important to understand the operating rule for the desalination plant in the context of a system with highly volatile rainfall patterns such as in the lower Hunter region. Given that the chance of falling below 70 per cent storage levels is considered to be low and dams spill relatively frequently due to high inflow events, there may be limited benefit in operating a desalination plant at these high levels.[17] Therefore, the best rule for operating the desalination plant maybe to allow dams to fall to lower levels, allowing for sufficient 'headroom' to capture the high inflow events, but allowing dam levels not to fall to such low levels as to pose a risk to security.[18]

It is also important to recognise that the operating rule for a desalination plant needs to be developed in the context of the portfolio of existing measures. If for example, new demand management measures or harsher quantitative water restrictions were introduced this would also influence the way in which the desalination plant is operated because it may mean that storage levels can be allowed to fall to, for example, below 50 per cent before the desalination plants begins producing water.

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[17] In the EAR, page 3.10, Aurecon states that 'the first phase of emergency drought measures would need to be initiated at around 70 per cent of storage levels. On average, this situation could occur once every 10 years'.

[18] In February 2009 the CIE completed analysis to determine the appropriate operating rule for Sydney's desalination plant. This found that operating the desalination plant all the time was suboptimal. The Productivity Commission (2010) also recently reached similar conclusions — triggering the desalination plant when dam levels fell below 75 per cent was seen to be optimal (p. XVIII).

As demand increases into the future, it may be optimal to commence operating the plant at higher storage levels.

We believe that Hunter Water needs to undertake further detailed modelling regarding the cost impacts of alternative operating regimes for a desalination plant.

Costs excluded from the model

The economic model developed by Hunter Water and Aurecon incorporates the direct financial costs to the utility associated with the particular option and the timing of when these costs are incurred. There are a range of cost items that have not been included in the modelling.

Environmental and social costs

Typically a detailed economic analysis of alternative infrastructure options should incorporate the full range of costs associated with the portfolio. Apart from the direct capital and operating costs, there are also likely to be a range of indirect costs that need to be incorporated into the analysis. If the full range of costs are not included in the analysis it may distort the results.

One of the key gaps in the CEA is the exclusion of environmental and social impacts. These issues are left to the initial qualitative examination by Hunter Water. As noted previously, we have concerns regarding the robustness of the qualitative analysis undertaken to consider the environmental and social costs. In particular, the analysis presented in the matrix does not inform the reader on issues such as:

- the magnitude of these impacts;
- whether they occur frequently or only in drought periods; and
- whether they lead to irreversible damage or whether these impacts can be managed and, if so, what are the costs of doing so.[19]

Currently it is very difficult to consider how the financial costs and water security/reliability outcomes of different options compares against the environmental and social impacts of the options.

Exclusion of cost of water restrictions

Another key factor that is not included in the analysis is the costs associated with water restrictions. The analysis on the impacts of water security and reliability on the

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[19] This is not intended to be an exhaustive list but provides some indication of the types of issues that would need to be considered in examining the potential tradeoffs between the financial costs and water security/reliability outcomes.

community (conducted in various jurisdictions in Australia) indicates that there is a cost associated with restrictions.[20]

In Hunter Water's framework all options considered are required to meet minimum service levels in regards to security and reliability. However, the options may differ in the level of service provided above the minimum level. In particular, it is possible that, for example, the desalination plant option will result in less time in restrictions compared with those options that are rainfall dependent because it provides a less variable supply of water. Given that the costs of water restrictions are significant, it is possible that this may change the ranking of the portfolios – depending on the magnitude of the cost of restrictions and the differences in the level of service provided, the desalination portfolio is likely to be higher.

In order to calculate the optimal level of service to the community (in terms of providing a more reliable and secure water supply), the costs of water restrictions need to be incorporated into the analysis. This view has been supported strongly by the Water Services Association of Australia (WSAA) which released a paper that outlined an approach to calculating the optimal level of water security.[21]

We believe that Hunter Water needs to incorporate this cost item into its analysis to ensure that there is a more comprehensive consideration of all cost items.

Economywide effects of the Dam

As part of the assessment of the Tillegra Dam, modelling has been undertaken by the Centre of Policy Studies (CoPS) to assess the potential economywide impacts of the construction of the dam and the impacts on economic activity from the additional supply provided by the Dam. A CGE model is used to assess the impacts.

CGE modelling is a tool used to provide an understanding of the potential flow-on impacts throughout the economy. In simple terms, the CGE models provide an understanding of the net economic benefits resulting from shifting resources toward the construction of the dam and away from other productive activities in the economy. The net welfare gains will be dependent on a range of factors such as assumptions regarding the:

- time period before the Dam begins to provide water for the economy
- importance of improving water security in the Hunter region to the economy.

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[20] Recent studies in Australia relating to the cost of water restrictions are presented in appendix B.

[21] Erlanger and Neal 2005.

The role of CGE modelling in the analysis of options

The use of CGE modelling as a tool for evaluating alternative options has been criticised in submissions to the review. In particular, Professor Wells notes that the CGE modelling is not the right tool for examining the net welfare gains under the different options. For example, Professor Wells' notes one of the limitations (amongst others) is that the CGE modelling only considers impacts that have a direct market impact and does not consider non-market factors.

We support Professor Wells' view that a CGE is not the most appropriate approach to consider the net social welfare impacts of alternative options. Hunter Water also recognises that the CGE modelling was not used as part of the options analysis and was only seeking to provide an indication of the potential economywide impacts of the Dam. In email correspondence, Hunter Water noted that:

> The CGE model simply describes the flow on effects of the economic stimulus from the project should it be approved including increases in financial aspects of the economy and likely changes to employment. Understanding these consequential positive impacts are ancillary to selecting the project which has the least cost and/or the best or least environmental outcomes. CGE modelling is therefore arguably not a project option assessment tool and whilst it helps characterise the effects of the proposal, should it be approved, the results of the CGE model should never be considered in isolation to the broader assessment.[22]

In its EAR, the primary tool for examining the options is the CEA, however, Aurecon states that the:

> CEA should not be considered in isolation from other elements reported upon in the EA Report. Other non-financial factors have been subject to qualitative analysis which is complemented by CGE modelling of the impacts on the region.[23]

Given that the CEA undertaken only focuses on the direct financial costs of the different options, we support the need to consider a wide range of other information to take account of the indirect impacts in order to allow a 'full' comparison of the different options. However, given that the CGE modelling was only undertaken in relation to Tillegra Dam it does not provide additional information to assist policy makers decide between the different options available. At best it provides information to suggest that the construction of the Dam will have net economic benefits under certain assumptions. The next section provides a critique of some of the assumptions in the CGE modelling presented in Working Paper G of the report.

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[22] Email from Hunter Water to NSW Department of Planning, 1 June 2010.

[23] Working Paper G, p. 4.2.

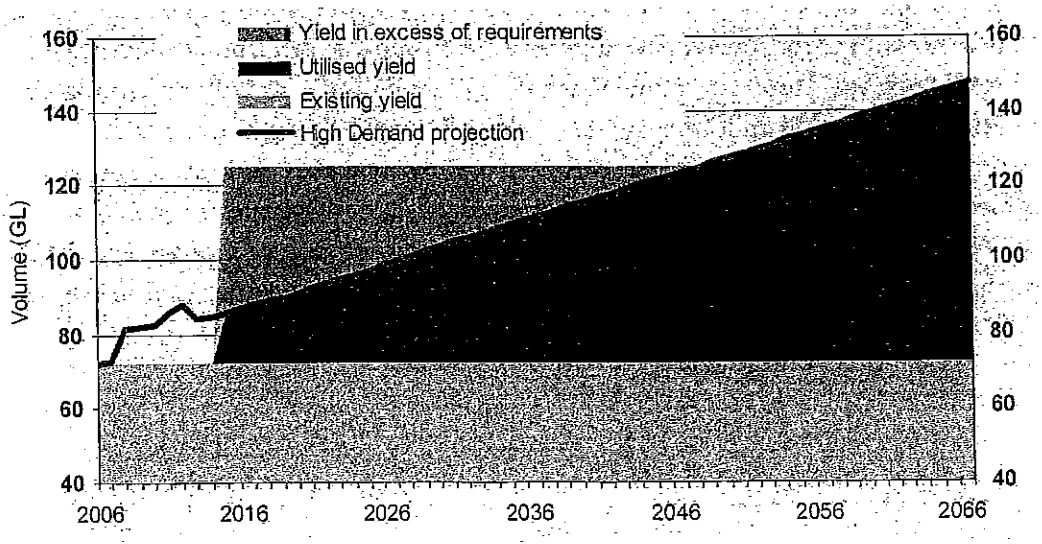
Review of the modelling assumptions

The CGE modelling appears to largely ignore Hunter Water's demand projections. Instead the modelling assumes that the output of water and drainage sector will increase by 50 per cent from 2015 onwards, thereby significantly increasing the demand for water.[24] The 50 per cent increase in the sectoral output was equivalent to a water yield increase of 72 per cent from 72 GL to 125 GL. This significant level of increase in economic activity from 2015 onwards appears to be inconsistent to Hunter Water's demand projections.

It is not clear why the CGE analysis has been structured in this way. In our view, the simulation should be about understanding the impact of increasing the supply of water (from the Dam) to meet the underlying demand for water. This would be a more realistic approach given that Hunter Water's demand projections have already incorporated assumptions regarding the increases in economic activity in the region. Further, given that the economic activity in the region is currently not constrained by water scarcity (and is not likely to be constrained for some time) the assumption that an additional 72 GL of water is required to meet demand from 2015 onwards would appear unrealistic. This is particularly true given that water prices are currently regulated by the Independent Pricing and Regulatory Tribunal of NSW (IPART) and do not reflect the scarcity of water. For example, in periods of low water availability, prices do not rise to reflect the scarcity value of water which would be expected if the price of water was not regulated.

Further, the EAR also recognises that the construction of the Dam will result in significant excess capacity for the next 30 years. The following chart, which is reproduced from the Working Paper G highlights this point.

3.1 Water supply and demand



Data source: Working Paper G, p. 4.11, appendix A.

The chart is based on Hunter Water's high demand projections. According to the high demand projection, in 2015 the demand for water in the lower Hunter Valley region will be only 85.8 GL. As a result, 39.2 GL of the annual water yield of the Dam will not be required. The full amount of the annual yield of 125 GL will not be required until 2048. If these high demand projections do not eventuate there will be excess capacity for a longer period of time.

The following table compares the CGE modelling assumption of an increase in water and drainage output (CoPS 2008, table 2) against the likely increase calculated using the formula in footnote 1 of CoPS (2008) with the assumption of the high demand projection in Working Paper G (Aurecon 2009). Based on this we conclude that the economic impact of the Tillegra Dam is likely to be overstated by 270 per cent in 2015 to 56 per cent in 2031.

3.2 Likely over stated benefit

	Increase in water and drainage output		
	CGE modeling assumption	*Likely increase assuming high demand projection*	*Likely overstated impact by*
	%	%	%
2015	50	13.5	271
2016	50	14.5	246
2017	50	15.4	224
2018	50	16.5	203
2019	50	17.5	186
2020	50	18.5	171
2021	50	19.8	152
2022	50	20.9	139
2023	50	22.0	128
2024	50	23.2	115
2025	50	24.4	105
2026	50	25.6	95
2027	50	26.8	87
2028	50	28.1	78
2029	50	29.3	71
2030	50	30.7	63
2031	50	32.0	56

Note: Likely increase in water and drainage sectoral output is estimated assuming high demand projection in Working Paper G (Aurecon 2009).

Source: The CIE.

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[24] CoPS (2008), table 2.

A further assumption that is likely to overestimate the net benefits from the Dam relates to the calculation of the water and drainage sectoral output shock explained in footnote 1 of CoPS (2008). It was assumed that all capital in the sector is for water. This assumption is unlikely justified — at least some capital in the sector is for drainage. In correcting this assumption, the shocks and thus the impact would be even smaller.

Some other observations regarding the CGE modelling undertaken are listed below.

- It is assumed that the construction of Dam will be completed in 2014 and the Dam will produce full yield in 2015. How realistic is this assumption?
- In explaining the negative impact on welfare in the lower Hunter Valley in 2014, CoPS (2008, p. 4) states, '[w]ithin the model, idle capital contributes to a technological deterioration, which reduces both real disposable income and aggregation consumption in the lower Hunter Valley in 2014 relative to forecast'. It is not easy to understand the explanation. Why does idle capital contribute to a technological deterioration? One would think that idle capital does no harm. An alternative explanation might be that the payment of interest of foreign money for the construction reduces the real disposable income as the idle capital does not produce any output.
- It is hard to follow the explanation in the 'Industry outputs' section of CoPS (2008, p. 9). 'Even sectors that do not benefit directly from an increased water resource, either through the direct productivity gain or via the income effect, eventually benefit through the real depreciation.' What is 'the direct productivity gain' if 'the sectors do not benefit directly from an increased water resource'?
- It is hard to understand why sectors like education and health and community services in the lower Hunter Valley suffers (CoPS 2008, p. 10, table 2), given that the region will have more people moving in due to a boost in economic activity and employment.
- It is not clear why baseline macro growth assumptions (CoPS 2008, p. 14) have dips between 2014 and 2017. For example, aggregate investment growth in the lower Hunter Valley and the rest of Australia falls below zero.
- Inconsistent statement of current water supply: it is 67 GL in chapter 12 (p. 12.12) and Working Paper G (p. 5.2), while 72 GL in CoPS (2008, p. 2.3).
- Inconsistent statement of present value of welfare gain from the Dam: 2.3 billion in chapter 12 (p. 12.16) and Working Paper G (p. 5.6), but 3 000 million in CoPS (2008, p. 2.12).

While we present comments regarding the CGE modelling undertaken by CoPS we believe that it is not worth seeking greater clarification of the assumptions used in the modelling. Given that the CGE modelling is a secondary tool and does not form part of the options analysis, gaining greater clarity of the assumptions would not assist in understanding whether the Dam is considered to be a better option than other options analysed..

Sensitivity testing

Sensitivity testing is an important part of any economic analysis (whether it be a CEA or more comprehensive BCA) because the analysis requires placing estimates on a large number of 'inputs' into economic model. Therefore, assumptions are required to be made in regards to these estimates. The purpose of the sensitivity testing is to understand how changing the assumption used in the CEA can change the results of the analysis. This is important given that there often not consensus on some of the assumptions used. For example, there is likely to be some range of 'reasonableness' for assumptions, rather than a single parameter. The sensitivity testing helps to understand how important these assumptions are in influencing the results of the analysis and whether changing the assumptions can change the ranking of alternative options considered.

In the CEA presented in the EAR, a range of sensitivity tests have been undertaken including:

- changes to the discount rate, with rates of 4 per cent and 10 per cent (real) also being considered;
- a 50 per cent increase in capital costs and (separately) for operating costs; and
- high and low demand forecasts.[25]

The sensitivity testing conducted in the CEA provides some useful additional information. However, the most important issue regarding the uncertain impact of different climatic scenarios is omitted. In our view, this should be one of the key elements of the sensitivity analysis given that this is likely to be a key feature that helps policy makers distinguish between the Dam and alternative options being considered.

It is useful to consider the impact of alternative climatic scenarios that includes other expected characteristics of climate change, including a reduction in average inflows, increased volatility of inflows, longer duration of droughts and changing rainfall/runoff characteristics of the catchment. These changes could result in more severe water shortage issues than, for example, a 10 per cent reduction in average rainfall would suggest. Given the significant investment being considered we believe that the CEA needs to be expanded significantly to consider these issues.

It would also be useful to also test the impact of lower operating costs has on the results. This is particularly important for the desalination facilities which are

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[25] These are presented in section 4.5 of Working Paper G.

relatively energy intensive and where technological advancements are expected to reduce the energy needs of desalination facilities in the future.

While it is useful to conduct sensitivity testing by changing a single parameter at a time, it is also useful to consider changes in more than one parameter at a time. This is particularly important where there are 'correlated risks' such as the climate change having an impact on the supply side but also on the demand side (if, for example, hot and dry conditions result in higher demand). This would be particularly important for those options that are considered that are rainfall dependent sources of supply.

4 Conclusions

The approach that Hunter Water has adopted to assess the different options is consistent with past approaches that have been traditionally utilised to assess alternative water supply options, where there was reliance primarily on rain-fed sources of water that were required to be constructed with long lead times.

There have been numerous advances in the methodological approaches adopted over the past few years that overcome some of the limitations of the more 'traditional' approach, particularly when evaluating new sources of supply such as desalination facilities. An example of this is the changes to approach adopted in Sydney to evaluate alternative options since the 2004 Metropolitan Water Plan. In particular, there have been significant changes in the approach adopted for the 2006 Plan and this approach has been further refined for the upcoming 2010 Metropolitan Water Plan. Some of the changes compared to the 2004 approach include:

- the adaptive management framework that places greater emphasis on the flexibility of systems and the value of deferring decisions to take account of new information as it develops;
- moving towards portfolio analysis and away from analysis of individual options;
- moving away from levelised cost and toward whole-of-life costs;
- moving away from the use of system yield and to explicitly recognise the costs of quantitative water restrictions;
- more complex incorporation of risk and uncertainty into the evaluation framework; and
- detailed scenario analysis that presents the security and reliability performance of alternatives.

Given the limitations in the analytical framework used by Hunter Water and Aurecon, we do not support the conclusion that "the economic analysis supports the conclusion that Tillegra Dam is the best solution to meet the future water supply needs of Hunter Water". We believe that Hunter Water needs to reconsider its analytical framework to address a range of the limitations noted in this report.

Hunter Water and Aurecon's analysis also does not consider a sufficient number of different types of portfolios of options. In particular, portfolios based on additional investment in desalination facilities that are triggered at different dam levels (similar to the DMP) should be considered. This will result in a significantly lower probability-weighted cost compared to investments that are constructed at a particular point in time irrespective of dam levels at that time. The documentation reviewed for this project indicates that (in broad terms) there is a 10 per cent probability of falling below 70 per cent storage levels. If a desalination plant cost $900 million to build now, this equates to a $90 million probability weighted cost. This is significantly lower than the construction cost of the Dam if it were built in 2013. Further, a portfolio that included a more flexible operation of a desalination plant (rather than operating at full capacity all the time) would also lower the operating costs.

Given these factors, we conclude that there is a strong chance that there are other portfolios of options that would result in a greater improvement in net social welfare compared to the Dam. In our view this warrants further detailed analysis to be undertaken by Hunter Water to investigate a range of other options, using a revised analytical framework.

In order to assist NSW Planning to reach its conclusions regarding the merits of the Dam compared to other options we would recommend the following approach.

- *Step 1.* Hunter Water should provide NSW Planning with more detailed information on some of the cost items noted in this report so as to provide decision makers with greater clarity on whether all items have been incorporated to allow a like-for-like comparison. For example, greater clarity is needed on whether the:
  - operating costs related to the desalination plant include the cost of filtration and pumping and whether similar costs have been incorporated in the other options;
  - operating costs of the desalination plant assumes the purchase of green energy and whether similar assumptions have been made for the electricity requirements of other options;
  - capital costs of the desalination plant have been correctly inflated and whether these include the costs of related capital expenditure such as pipelines and pumping stations; and
  - capital costs of the Dam include all the cost items that have been discussed in the EAR such as mitigation measures and additional pipelines or pumping stations.
- *Step 2.* We would recommend that Hunter Water should adopt a revised CEA approach similar to the framework used in the recent development of the (upcoming) 2010 Metropolitan Water Plan for Sydney and for the development of the operating rules for Sydney's desalination plant. This would also include a detailed consideration of a range of different portfolios that incorporated the construction of the desalination facilities at different trigger levels rather than at a fixed point in time. We would anticipate that this analysis could be largely undertaken with existing information and could be readily undertaken by Hunter Water without external assistance.

- *Step 3.* In tandem with Step 2, Hunter Water should gather more detailed information about the range of environmental and social impacts of the alternative portfolios considered. This should provide decision makers with additional information such as:
  - the range of potential impacts;
  - the relative importance of the impacts to each other;
  - the magnitude of the impacts; and
  - whether the magnitude of the impacts changes under alternative climate scenarios.

Step 2 would provide more detailed information that would allow decision makers to consider the ranking of portfolios on cost and security grounds. Step 3 would provide further information to understand whether incorporating information on environmental and social impacts would change the rankings from Step 2. A full BCA should also be considered where there is robust information available. However, the extent to which this is required would depend on the findings in Steps 2 and 3 above.

Appendixes

A The cost of water restrictions

A summary of recent studies that have sought to provide a measure of the cost of water restrictions to the residential sector are presented in this section.

Queensland

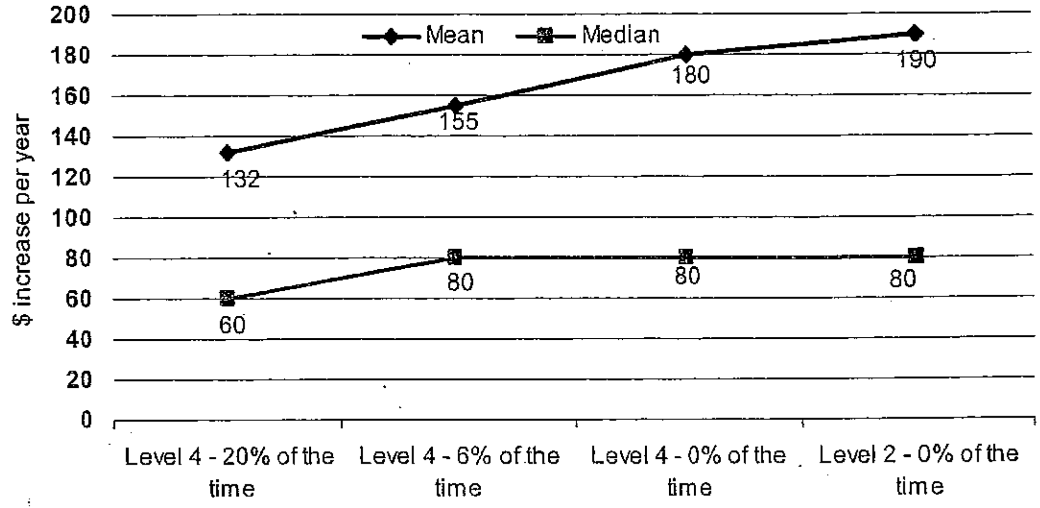
The Queensland Water QWI has previously undertaken two studies to examine the cost of water restrictions to residential customers in South-East Queensland (SEQ):

- The Allen Consulting Group (2007) to understand the willingness to pay for increased reliability in the SEQ region. The study used a Contingent Valuation method to estimate households' willingness to pay for increased water security for residential use.
- DBM Consulting (2007) to estimate the economic benefits to the community of improvements in water security in SEQ. A choice modelling study was used to assess the community's willingness to pay for increased water supply reliability in SEQ.

The Allen Consulting Group

The findings of the Allen Consulting Group (2007) are presented in the chart below. They found that households were willing to pay higher amounts for higher levels of reliability. For example, households were willing to pay an additional $132 per annum to reduce the frequency of Level 4 restrictions from 50 per cent of the time to 20 per cent of the time. Households were willing to pay an additional $190 per annum to remove the need for Level 2 (or worse) restrictions.

A.1 **Household's willingness to pay for increased water security**



Data source: The Allen Consulting Group (2007, p. vi).

DBM Consultants

In undertaking its study on the willingness to pay for increased reliability of supply DBM Consultants (2007) separated the community into five separate household groups. 'Conservationists' were found to have the lowest willingness to pay ($2 per annum) to increase water supply reliability from Level 4 water restrictions 1 in every 4 years with a duration of 24 months to restrictions 1 in every 30 years with 12 months duration. The highest willingness to pay for this same change was with the 'Devoted Gardeners' who were willing to pay $270 per annum. The average across all groups was $134 per household per annum. For the highest set of water security outcomes considered in the study (Level 4 restrictions 1 in 100 years, duration 6 months, mostly green public parks) the average willingness to pay was $174 per annum per household.

Other jurisdictions

Throughout Australia there have been a limited number of studies that have sought to estimate the costs of water restrictions through the use of willingness to pay studies.[26]

- Henscher et al. (2006) used a choice modelling approach in Canberra in 2002 and 2003 to calculate the marginal willingness to pay to avoid drought induced

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[26] We also understand that a study on the willingness to pay for reliability of supply is also currently being undertaken in Victoria, although these results have not been published as yet.

restrictions. They estimated the cost of restrictions at $239 per household per year for relatively severe restrictions.

- Gordon et al. (2001) also conducted a choice modelling survey of Canberra households in the late 1990s to compare alternative demand and supply options to water scarcity. The results suggested that residents were willing to pay, on average, a small amount ($10 in 1997 dollars) to prevent a 10 per cent reduction in water use.
- Brennan et al. (2007) calculated the welfare costs in water restrictions in Perth using a household production function and experimental studies to develop a model to examine how bans on the use of sprinklers impacted on the amount of time that households had to spend watering from buckets or using hand-held hoses.

There is difficulty in comparing the findings from other jurisdictions to the Hunter region. For example, the hydrology in the lower Hunter is significantly different to that in Canberra or Perth. This influences the frequency, severity and duration of water restrictions in each area. Further, the demographic profile of particular areas can also impact on the costs to households of restrictions. The residential housing stock may also differ between regions — for example, if there are a significant number of new suburban sub-divisions in the area, households may place a higher value on having less water restrictions to ensure that their new gardens can be established.

However, these studies can be used as a 'sense check' on the upper bound of costs. As noted above, for the ACT, the most recent estimate is that the cost of restrictions is $239 per household per year for relatively severe restrictions in 2002-03. The cost of restrictions is expected to be higher for the ACT because it experiences much less rainfall compared with the lower Hunter region (particularly coastal areas). Therefore there is a greater need for outdoor water use, such as watering of gardens and lawns. Without the ability to apply water, gardens can more readily deteriorate and not recover.

However, if the lower Hunter and Central Coast are considered to be growth regions it can be expected that there is likely to be new housing established over the planning period. Typically, new homes will require a greater volume of water to assist gardens to get established. Therefore, it can be anticipated that these households are likely to pay a greater amount to avoid water restrictions that may curtail their outdoor water use.

B Calculation of reliable yield

The supply side is calculated by using the concept of reliable yield. The yield represents the long term average supply that can be expected from the system subject to meeting minimum levels of service. The level of service in this instance relates to the expected reliability and security of the system.

Hunter Water's definition of yield is,

> Yield is the amount of water that can be supplied such that the system does not enter restrictions more often that once per 10 years, is not in restrictions more than 5 per cent of months and such that the risk of reaching the '48 month' trigger in the Drought Management Plan does not exceed 1 in 100. These quantities shall be assessed using headworks simulation models.[27]

The premise of Hunter Water's calculation of yield is that the damage to the community and economy of running out of water is so great such that the community would not tolerate it. Hunter Water has adopted an approach which specifies that there is no chance of running out of water. This zero tolerance was incorporated into the system performance.

There are several points to note about the concept of yield.

- It is a long term average and there may be significant differences in reliability between different options, although all options may meet the minimum level of service. This is particularly relevant when comparing desalination facilities with other supply sources that are reliant on rainfall. It is important to understand the extent to which options differ in meeting the minimum levels.
- The concept of yield does not account for the higher level of volatility of supply associated with rain-fed sources of water. Typically, when examining alternative investment options, both the risk and return characteristics need to be considered. Options that deliver the same return (on average) could have substantially different risk profiles. Given that the planners and the community are more likely to be risk-averse, options that deliver the same mean but low variability are likely to be favoured over more volatile options.
- Yield does not provide information to inform the timing of the decision to implement new measures. For example, there may currently be a supply-demand

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[27] Hunter Water Corporation 2007, p. 15.

imbalance but storage levels could be at full capacity. Therefore, yield only takes a long term outlook and needs to be supplemented with additional 'short term' information.

References

Australian Government 2007, *Best Practice Regulation Handbook*, Office of Best Practice Regulation, August, Canberra.

Brennan, D. Tapsuwan, S. and Ingram, G. 2007, 'The welfare costs of urban water restrictions', *Australian Journal of Agricultural and Resource Economics*, vol. 51.

Centre of Policy Studies (CoPS) 2008, *The Economic Effects of the Tillegra Dam in the Lower Hunter Valley region*, prepared for Connell Wagner, March, Melbourne.

DBM Consultants 2007, *Economic Valuation of Water Reliability in South-East Queensland Using Choice Modelling*, prepared for Queensland Water Infrastructure, Victoria.

Dobes, L. and Bennett, J. 2009, *Multi-Criteria Analysis: 'Good Enough' for Government Work?*, Agenda, vol. 16(3), pp. 7-30.

Erlanger, P. and Neal, B. 2005, *Framework for Urban Water Resource Planning*, prepared for Water Service Association of Australia, Occasional Paper No. 14, June.

Gordon, J. Chapman, R. and Blamey, R. 2001, *Assessing the options for the Canberra water supply: an application of choice modelling*, in Bennett J and Blamey R (eds) *The Choice Modelling Approach to Environmental Valuation*, Edward Elgar, Cheltenham, UK.

Hensher, D. Shore, N. and Train, K. 2006, *Water supply and willingness to pay to avoid drought restrictions*, The Economic Record, vol. 82(256), pp. 56-66.

Hunter Water Corporation 2007, *Why Tillegra Now?*, August.

—— 2008, *H250 Plan. Securing Our Water Future, A long term strategy to meet water supply needs for the Lower Hunter*, December.

Kingsford, R and Hankin, C (2010), *The impact of the proposed Tillegra Dam on the Hunter River estuary, its Ramsar wetlands and migratory shore birds*, UNSW and Australian Wetlands and Rivers Centre, June.

Kuczera, G (2010), *Review of Tillegra Dam Project Justification as Presented in the HWC Submissions Report*, March.

Marsden Jacob Associates 2008, *Cost benefit analysis for Traveston Crossing Dam – Supplementary Report*, prepared for the Queensland Water Infrastructure, April, Brisbane.

—— 2007, *An economic evaluation of the proposed Traveston Crossing Dam in South East Queensland*, prepared for the Queensland Water Infrastructure, September, Brisbane.

Productivity Commission 2010, *Developing a Partial Equilibrium Model of an Urban Water System*, Staff Working Paper, March.

The Allen Consulting Group 2007, *Willingness to Pay for Increased Reliability of Water Supply in South East Queensland*, A contingent valuation study, prepared for Queensland Water Infrastructure Pty Ltd, April.

Wells, G. 2009, *Technical Comments on the Socio-economic assessment undertaken by Hunter Water Corporation and Aurecon for the Tillegra Dam Planning and Environmental Assessment Report.*

White, S. and Howe, C. 1998, *Water efficiency and reuse: a least cost planning approach,* 6th NSW Recycled Water Seminar.