REPORT

www.TheCIE.com.au

Review of economic aspects of Traveston Crossing Dam Environmental Impact Assessment documentation

Prepared for Department of Environment, Water, Heritage and the Arts

Centre for International Economics
Canberra & Sydney

November 2009

The Centre for International Economics is a private economic research agency that provides professional, independent and timely analysis of international and domestic events and policies.

TheCIE's professional staff arrange, undertake and publish commissioned economic research and analysis for industry, corporations, governments, international agencies and individuals.

Canberra

Centre for International Economics
11 Lancaster Place, Majura Park
Canberra ACT 2601

GPO Box 2203
Canberra ACT Australia 2601

Telephone	+61 2 6245 7800
Facsimile	+61 2 6245 7888
Email	cie@TheCIE.com.au
Website	www.TheCIE.com.au

Sydney

Centre for International Economics
Suite 2, Level 16, 1 York Street
Sydney NSW 2000

GPO Box 397
Sydney NSW Australia 2001

Telephone	+61 2 9250 0800
Facsimile	+61 2 9250 0888
Email	ciesyd@TheCIE.com.au
Website	www.TheCIE.com.au

Contents

Boxes, charts and tables

Executive Summary

This report serves to assist the Department of Environment, Water, Heritage and the Arts (DEWHA) to review the proposed Traveston Crossing Dam (TCD) in line with Part 9 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The report provides independent advice on the robustness of the economic analysis that has been undertaken in relation to the TCD and whether the analysis is sufficient to support the conclusion that the TCD is the best solution to meet the South East Queensland (SEQ) communities' water needs. It is also intended to inform DEWHA on whether there are alternative measures that could deliver similar economic and social benefits.

The context for this review

The proposed TCD is a key feature of the draft South-East Queensland Water Supply Strategy which aims to provide a secure and sustainable long term water supply to SEQ. Stage 1 of the TCD is expected to deliver up to 70 000 ML per year for urban water supplies.[1] The Queensland Government has indicated that no decision will be made about pursuing a possible extension to the TCD (Stage 2) until around 2035.

On 29 November 2006 the then Federal Minister for the Environment and Heritage decided that the TCD was a 'controlled action' under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) due to the likely and potential impacts on matters of national environmental significance. This means that the TCD proposal requires assessment and approval under Part 9 of the EPBC Act before it can proceed.

A key consideration for the Minister in deciding to grant approval for the proposed TCD is whether the economic and social benefits associated with the project are sufficiently large to outweigh any significant environmental impacts. In making this decision the Minister is also required to consider whether there are alternative strategies that could deliver similar economic and social benefits but at a lower cost to the environment.

1 This represents approximately 14 per cent of currently annual unrestricted demand.

The scope of this review

In undertaking this study, the CIE was required to review the economic analysis conducted as part of the EIS documentation provided by Queensland Water Infrastructure Pty Ltd (QWI), the proponent of the TCD.

This primarily involved reviewing the overall robustness of the economic analysis conducted and considering whether the economic analysis is sufficient to support the decision to construct Stage 1 of the TCD. This also involved reviewing the key assumptions underpinning the analysis and how these assumptions influence the results.

This review also considers whether there are alternative options (such as additional desalination facilities or demand management programs) that may deliver similar (or better) net benefits to the community than the TCD.

It should be noted that while this study may draw on information presented in the Queensland Government's draft Water Supply Strategy (the draft Strategy) it is not intended to be a review of the draft Strategy itself or to provide any recommendations in relation to alternative options that could be considered in the draft Strategy.

The findings

In reaching its decision to support the construction of Stage 1 of the TCD project, the QWI commissioned a range of studies that support the economic analysis presented in the EIS documentation. The economic analysis has covered a wide range of issues which has been used to support the decision including:

- an economic evaluation of the costs of the TCD compared with a range of other alternatives. This is the central piece of economic analysis that compares the benefits and costs of alternatives in a consistent framework and that supports the case for the TCD against these alternatives. While the analysis is broadly described as a Benefit-Cost Analysis (BCA), it focuses primarily on the *costs* of each alternative. The implicit assumption is that the benefits are the same under each of the alternatives and that each delivers the same quantity, security and reliability of water. The preferred option is the one that delivers the least cost outcome;
- studies of the potential impact of a less secure/reliable supply on the community and businesses and their willingness to pay to increase security/reliability; and
- studies of the potential indirect economic impacts of the TCD.

While there has been a significant amount of economic analysis undertaken, it has largely been undertaken in a piecemeal way. It does not allow a systematic comparison of the range of options available to meet the water supply needs. For example, the BCA focuses primarily on a comparison that includes the direct financial costs associated with the range of options. The indirect economic, social and environmental impacts were examined separately to the BCA, with this analysis focused primarily on the impact associated with the TCD. The economic analysis, therefore, does not provide a complete picture that would allow the alternative options to be ranked in a consistent manner that allows a comparison of both the direct and indirect impacts associated with all options. If the indirect impacts are large (and differ between the alternative options) then the inclusion of these impacts could influence conclusions about the preferred option.

Further, as noted above, the BCA was conducted using a least cost approach while the indirect impacts were considered in a benefit–cost framework. The two approaches therefore use different assumptions, making it difficult to combine the results.

The findings of the BCA in support of the TCD are based on a number of assumptions that are contentious:

- **Objectives.** One objective of the Queensland Government is to require that 88 000 megalitres (ML) of additional water supply be available by 2012.[2] This in effect means that all alternative strategies considered are required to make substantial investment upfront to meet this objective. This is likely to lead to excess capacity, until demand rises to a point that this additional capacity is required. In the BCA, this objective is treated as a 'constraint' (or requirement) that all options considered must meet. The BCA recognises the importance of the requirement and the impact that it has on the results – removing this requirement reduces the cost differential (in present value terms) between the TCD and a desalination portfolio from $318 million to $45 million (although the TCD still remains the highest ranked). Given the current storage levels in SEQ and the recent commencement of the desalination plant in the Gold Coast, it is not clear whether the community would be willing to pay for the additional security offered by making additional infrastructure investment in the next few years.
- **Discount rate.** The BCA has been undertaken using a discounted cashflow model which requires the use of a discount rate to 'convert' costs incurred in the future into 'dollars of today' (present value). The BCA is undertaken using a 4 per cent real discount rate which is outside the normal range used throughout Australia in analysing infrastructure investments (typically between 6 to 8 per cent real). The influence of adopting a lower discount rate is that it places less value on those portfolios that are able to defer major expenditure into later years of the analysis. The BCA recognises the importance of the discount rate and notes that the ranking of the portfolios changes at 'higher discount rates' (although it does not disclose what is meant by a high discount rate). Given that the discount appears

2 This includes 70 000 megalitres (ML) of water from the TCD Stage 1.

to impact on the ranking of portfolios, then there needs to be a strong justification for the discount rate chosen. This is absent in the BCA.

- **Cost of restrictions.** The analysis does not explicitly include a cost to the community of quantitative water restrictions. Given the significant costs to the community of water restrictions (as indicated in the economic analysis undertaken in the EIS) it is important to include these costs in the analysis. There are likely to be differences in the time in water restrictions, particularly between rainfed and other supply sources that deliver similar average supply. Given this, these differences are likely to influence the results (even when all options considered meet the minimum standards set).

The assumptions used in the BCA are not always transparent and make it difficult to understand the analysis.

- **Operating costs of desalination**. The operating assumptions regarding the desalination plant are an important factor and have a bearing on the result, particularly given that the desalination plant is characterised by relatively high operating costs due to the energy consumption of the plant. At the time of undertaking the BCA, its author (Marsden Jacob Associates, MJA) indicated that the operating rules had not been developed for the SEQ Water Grid Manager,[3] therefore, the BCA adopted a decision rule based on the least cost supply at a given point in time. It would be useful to obtain information about how this assumption impacts on the amount of time the desalination plant is operating, although MJA indicate that this has a 'small bearing on the overall operating costs for each supply portfolio modelled.'[4] Based on our calculations, the present value of the energy costs of the desalination plant are approximately $500 million, assuming the plant is operating at full capacity. However, if the plant is assumed to operate at 70 per cent capacity (a realistic assumption) the present value of the energy costs is approximately $350 million. In our view the difference in assumptions regarding the operation of the desalination plant can significantly impact on the ranking of the projects, particularly projects that are relatively energy intensive.
- **Lead-time for construction**. The lead-time for the TCD and each of the alternatives considered is not clear. While the BCA indicates a lead-time of between 3 to 5 years, it is not clear which assumptions relate specifically to the TCD versus, for example, the desalination facilities. The lead-times are important because they influence the expenditure profile in the cashflow analysis. If the TCD has a longer lead time it would mean that there is more expenditure required to be undertaken in earlier years (compared to projects with shorter lead times), which influences the present value of these costs. Further, dams typically require

3 MJA (2007a), p. 23.

4 MJA (2007a), p. 20.

an additional 'filling' period which means that the construction needs to commence well in advance of say, a desalination plant. In order to illustrate this, based on the information presented in the BCA, if the TCD Stage 1 is undertaken 2 years in advance of the desalination plant it would reduce the costs (in present value terms) of the desalination plant by approximately $90 million dollars (compared to a case where both projects commenced at the same time and had the same construction period).

The BCA also has a number of limitations in its underlying methodology:

- **Risk.** The treatment of risk associated with alternative supply sources in the BCA is limited. There are risk-related issues that are central to the decision making process for any new investments in the water supply system — there is typically a risk-return trade-off in making any new investment decisions. For rain-fed sources of supply there are a range of possible outcomes that can occur.[5] The BCA analysis focuses mainly on the average water supply and does not consider the possibilities that the supply may be either higher or lower than the average. Therefore, in the short term there is a chance that the supply may be substantially less than the average. This may actually trigger the need for new investments in infrastructure (assuming that the community and policy makers are risk averse). Therefore, it is important that the BCA takes account of the difference in risks associated with the alternatives examined.
- **Climate change and uncertainty.** The issue of climate change should be central to the decision making framework for considering any new investments in water supply. The BCA incorporates the impact of climate change in a simplistic way (as acknowledged by the authors) by reducing the average supply from the TCD by 10 per cent. However, climate change is much more complex and is anticipated to change other rainfall characteristics such as the volatility and duration of rainfall patterns. In particular, if climate change results in longer periods of low inflows it significantly increases the risk of investing in rain-fed storages. It should be acknowledged that the understanding of the climate change is still developing, highlighting that there is significant uncertainty associated with climate change - that is, where the future outcomes are not known.[6] In situations of uncertainty there may be value in having a more flexible supply system, rather than

5 The hydrological modeling typically considers a range of possible future outcomes using the hydrological characteristics of the catchment (as represented by, for example, the past 100 years of data). The average is derived from these difference scenarios of possible future events.

6 Uncertainty relates to a situation where there is insufficient information to assign a probability distribution around an outcome — 'the unknown unknowns.' Risk refers to a situation where there is some knowledge about the range of outcomes that could be faced and the chance of particular outcomes occurring.

traditional approach of relying on large infrastructure projects that require significant upfront funding and long lead times to construct.

- **Sensitivity testing.** The sensitivity testing undertaken is limited and does not consider a range of important variables where a precise single estimate is not available. In particular, it is important to explore how changing the discount rate impacts on the ranking of the projects, particularly the TCD and desalination portfolio. It would also be useful to conduct sensitivity testing by varying more than one factor — such as changing the discount rate, combined with removing the requirement to provide an additional 88 000 ML of supply by 2012. This is likely to provide a useful insight into how the ranking of projects can change as a result of the analysis. It will also provide greater insight into the robustness of the conclusions drawn from this analysis.

Conclusions

In our view there is considerable scope for the economic analysis underlying the EIS documentation to provide a better decision making guide. The economic analysis has been undertaken in a piecemeal way and does not bring together the findings in regards to the indirect economic, social and environmental impacts in a way that enables a systematic comparison of the TCD option against the alternatives.[7] It is possible that incorporating the indirect impacts into the BCA in a systematic way will change the ranking of the portfolios such that the TCD is no longer the preferred option. This would depend on the magnitude of the indirect impacts and how they differ amongst the alternative options.

The conclusions reached in the EIS in regards to the ranking of alternative options is heavily influenced by the assumptions adopted such as the requirement imposed in the analysis that the alternatives considered need to deliver an additional supply of 88 000 ML per annum. This is likely to result in a high cost outcome for the community and (if average conditions prevail into the future) significant excess capacity. Given that current storage levels in SEQ are over 70 per cent of capacity (as at 30 October 2009) and that the Gold Coast desalination plant has recently commenced operation the imposition of this requirement in the analysis requires further justification.

The conclusion reached in the EIS is also significantly influenced by the assumed discount rate of 4 per cent. Additional sensitivity testing is required to determine whether the choice of the discount rate changes the ranking of the alternative options

---

7 The need for a systematic framework to incorporate the economic, social and environmental impacts is recognized by MJA, the authors of the BCA. In a supplementary report for the QWI MJA noted that “the Government must apply a triple bottom line performance of major infrastructure projects and there is no single decision support tool that can act as a substitute for this process” (MJA 2008, p8).

considered. If it does change the ranking of the options then this would indicate that there is less robustness around the findings of the BCA. This would also place more emphasis on the indirect impacts, such as the social and environmental impacts, to determine whether the TCD is the preferred option.

There are a range of other assumptions adopted in the BCA that require further explanation. These include the timing of capital expenditure for all the options and the percentage of time the desalination plants included in any portfolio are operating.

Based on the information provided in the EIS documentation we believe that the economic analysis is not sufficiently robust to support the finding that the TCD is the best option to meet the SEQ water needs. In our view, there is sufficient likelihood that once some of the shortcomings are addressed that an alternative combination of measures, such as an additional desalination plant, could deliver similar (or higher) economic benefits to the community than the TCD. There is also a reasonable likelihood that the economic analysis may not provide a clear ranking of options. For example, the TCD may be the preferred option under some assumptions while a desalination plant portfolio may be preferred under other assumptions. Given this, the assessment of environmental and social impacts of the TCD is likely to play an important role in determining whether the TCD is the preferred option compared to other alternatives.

1 Introduction

The proposed Traveston Crossing Dam (TCD) is a key feature of the draft South-East Queensland (SEQ) Water Supply Strategy which aims to provide a secure and sustainable long term water supply to SEQ. The TCD involves the construction and operation of a new dam on the Mary River, approximately 207 kilometres from the mouth of the river and 27 kilometres upstream of Gympie, Queensland. The dam was announced by the Queensland Government as part of the South East Queensland Water Grid — a network of water transfer pipelines between existing and proposed water storages, a water recycling scheme, a desalination plant and other measures.

Stage 1 of the TCD involves a storage of around 153 000 ML, with an inundation area of approximately 3000 hectares when full. It is proposed to extract up to 70 000 ML per year for urban water supplies. The Queensland Government has indicated that no decision will be made about pursuing a possible extension to the TCD (Stage 2) until around 2035.

On 29 November 2006 the then Federal Minister for the Environment and Heritage decided that the Dam was a 'controlled action' under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) due to the likely and potential impacts on matters of national environmental significance. This means that the Dam proposal requires assessment and approval under Part 9 of the EPBC Act before it can proceed.

Under the EPBC Act the Minister is required to make a decision based on the potential or likely impacts on matters of national environmental significance (NES) of the proposed TCD. In general, where the environmental impacts on matters relating to the NES are substantial and mitigation measures or offsets may potentially be ineffective, the Minister is required to consider 'economic and social matters.'

A key consideration for the Minister in deciding to grant approval for the proposed TCD is whether the economic and social benefits associated with the project are sufficiently large to outweigh any significant environmental impacts. In making this decision the Minister is also required to consider whether there are alternative strategies that could deliver similar economic and social benefits but at a lower cost to the environment.

In October 2007 Queensland Water Infrastructure Pty Ltd (QWI) released the Environmental Impact Statement (EIS) for public submission. Submissions to the EIS closed on 14 January 2008. Following this, a Supplementary EIS was completed which, in part, sought to respond to issues raised in the public submissions. In March 2008 the Queensland Government released its draft SEQ Water Supply Strategy which included Stage 1 of the TCD project to be completed by the end of 2011.

Following the release of the EIS and supplementary documentation the Department of Environment, Water, Heritage and the Arts (DEWHA) commissioned a number of independent expert reviews to provide advice on the TCD proposal. These studies related mainly to reviewing the potential environmental impacts of the TCD proposal.

DEWHA engaged the CIE to provide independent advice on the economic analysis that has been undertaken in relation to the TCD. The CIE's findings, presented in this report, are intended to assist the Minister to assess the potential economic and social impacts of the proposed Dam.[8]

Terms of Reference

The intention of this study is to conduct an economic review of the TCD Assessment Documentation. In undertaking this review, the CIE was required to:

- review the information, assumptions and interpretations presented in the sections of the proponent's documentation relevant to the cost of the proposal and alternatives to the proposal, in particular, the nearest cost alternative identified in the proponent's documentation;
- review and provide comment on the scope and breadth of the sensitivity analysis undertaken, and whether any further sensitivity testing would be likely to substantially alter the conclusions presented;
- review the potential impact on the supply-demand balance, and on the relative costs of the project and alternatives, of varying the date of completion of construction to 2015, 2020 and 2030;
- review and provide comment on the assumptions and cost inputs relating to the whole-of-life costs of the project and the nearest cost alternative presented in the proponent's documentation, and the project cost implications of variations in these assumptions and inputs;
- undertake an analysis of the differing views expressed in the proponent's documentation and in key public comments regarding the implementation of additional demand management as an alternative to providing additional water supplies of 70 000 ML per annum; and

8 The Commonwealth Government has commissioned a range of other independent studies relating to other aspects of the TCD to provide further information on the potential impact of the TCD, particularly in relation to the potential environmental impacts.

- provide a report to the Department detailing the findings from the above analysis.

Any other relevant issues raised in key public comments made on the EIS and summarised in the Supplementary Report that may impact on the economic analysis should be considered, such as the Queensland Government's draft Water Supply Strategy (the draft Strategy).

It should be noted that while this study may draw on information presented in the draft Strategy it is not intended to be a review of the draft Strategy itself or to provide any recommendations in relation to alternative options that could be considered in the draft Strategy.

Structure of this report

The structure of the report is as follows:

- chapter 2 provides an overview of the CIE's approach to reviewing the TCD economic assessment documentation;
- chapter 3 reviews conclusions regarding the impact on the community of reduced water reliability and security an their willingness to pay for a higher level of service;
- chapter 4 reviews the analytical framework established to undertake the BCA, including the objectives that any additional water supply options is required to meet;
- chapter 5 considers the economic modelling undertaken in the BCA, including the range of options considered in the modelling; and
- chapter 6 draws together our findings on the robustness of the economic analysis in relation to the TCD and conclusions drawn from the analysis in regards to the TCD portfolio being the highest ranked option.

2 Our approach

This chapter discusses our approach to reviewing the economic analysis of the TCD Assessment documentation.

Key areas of economic analysis in the TCD decision-making framework

The methodology for conducting the economic analysis of the TCD proposal and alternatives is presented in Appendix F-11.2.1 of the EIS. Broadly, the economic analysis undertaken in relation to the TCD and alternative portfolios includes:

- **Regional Economic Profiling.** The aim of this part of the project is to characterise the local and regional economies in the Wide bay and Sunshine Coast. This will help to understand the potential impacts of the TCD and alternative projects on the economy.
- **Assessment of the importance to the community on water security and reliability.** This phase of the economic analysis seeks to obtain a greater understanding of the potential impacts of a less secure water supply for businesses and the community. It also examines the extent to which the community and businesses are willing to pay to maintain or improve the level of water security.
- **Benefit–cost analysis of alternatives.** The benefit–cost analysis (BCA) is the central part of the economic analysis where the alternative supply and demand measures are considered. The alternative measures are compared against their ability to achieve the defined policy objectives and the cost of doing so.
- **Impact analysis.** This phase of the economic analysis analyses the potential impact of the TCD project (including the environmental and social impacts) and examines ways to ameliorate any negative impacts.

While the economic analysis has been broadly undertaken it has not been undertaken in a step-wise fashion. For example, some of the independent studies relating to the Impact Analysis were commissioned prior to the BCA. Therefore, we have not structured our review under these broad topic areas.

Overview of approach

Our review has focused largely on the analytical framework underpinning the BCA and the economic modelling undertaken to support this.[9] This in part reflects the Terms of Reference established for this review. However, it also reflects that these are the key stages in the analysis that consider the TCD against alternatives such as additional desalination facilities and demand management programs. It is the critical phase in the economic analysis that led to the conclusion in support of the TCD, in favour of the alternative options. If the analysis is not sufficiently robust it can signal that there may be a range of other alternatives that could be superior to the TCD option.

Rather than providing comment on all parts of the economic analysis undertaken we have focused on the identified gaps and limitations in the analysis that could to have a material impact on the conclusions reached from the analysis. In particular, whether these identified gaps and limitations may change the ranking of the measures considered such that the TCD project is no longer the preferred option.

In undertaking our review we recognise that the economic analysis undertaken in relation to the TCD project will be based on assumptions regarding a range of inputs into the analysis. Often these inputs will not be known with certainty and there is likely to be a range where the assumption may fall. In these instances we have tried to assess whether the assumption is within an 'acceptable' bounds and the impact on the economic analysis of altering these assumptions.

We also comment on whether there is sufficient information available to undertake robust economic analysis. Where there are gaps in information we seek to identify these gaps and comments on how significant are these gaps and whether it will alter the robustness of the analysis.

In undertaking this study we have relied primarily on the publicly available documentation as well as some confidential information provided to us by DEWHA. Detailed economic modelling that has been undertaken as part of the analysis of the TCD was not available to us for review. Therefore, we have relied primarily on the information provided in the available documentation.

Where possible, we have also sought to draw on relevant information available from the economic analysis of alternative supply options that has been undertaken 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.

9 As specified in the Terms of Reference, we are required to review issues such as the costing assumptions of the TCD project (and alternatives), the scope and breadth of the sensitivity analysis undertaken and how changing the assumptions impacts on the ranking of the alternatives. This analysis typically forms part for a BCA.

There are a range of studies undertaken to collect data on the SEQ region, such as the industry profile in the region, the water use patterns of households and their willingness to pay for higher levels of service (in respect to security and reliability of the system). In these instances it is difficult for us to verify whether the underlying data is 'correct'. Therefore, our commentary in these sections is more limited and focuses on the inferences drawn from the analysis.

Key documentation assessed

Our role is to review the economic analysis presented in the EIS documentation. However, the EIS documentation often relies on detailed studies conducted by consultants engaged by QWI. Therefore, our review also necessarily involves a review of the economic analysis presented in various consultants' reports. The key reports reviewed are listed in table 2.1 below.

2.1 **Key Documentation Assessed**

Reports

Stage 1. Regional economic profiling

- Appendix 11.2H. Synergies Economic Consulting (2007) conducted a study which aimed to characterise the local and regional economies in the Wide bay and Sunshine Coast.

Stage 2. Importance of water security and reliability to households/business

- Appendix 11.2C. Allen Consulting Group (2007) undertook a contingent valuation of the value that households place on water supply security
- Appendix 11.2E. DBM Consultants (2007) undertook a choice modelling study of the value that households place on water supply reliability
- Appendix 11.2B. ACIL Tasman et al (2007) undertook an assessment of the impacts to SEQ businesses (non urban) from a reduction in water supply. The study comprised a survey of 550 businesses to gauge the level of impact and computable general equilibrium modelling to identify and assess the macroeconomic effect to SEQ.

Stage 3. Benefit-Cost Analysis

- Appendix F, Part 11.2F. Marsden Jacob Associates (September, 2007) conducted a study to assess the costs and benefits of the TCD project relative to other options such as alternative dams in the Mary Valley and Clarence Rivers and additional desalinisation and recycling facilities.
- Appendix C22 of the EIS Supplementary Report. Marsden Jacob Associates (April, 2008) provided a supplementary report that considered a range of specific issues.
- Chapter 12, Vol 1, EIS Supplementary Technical Report. Marsden Jacob Associates (April, 2007) critically reviewed a report prepared by the Institute of Sustainable Futures and Cardno which proposed an alternative that relied more heavily on demand management strategies to meet the supply-demand balance.
- Appendix C19 of the EIS Supplementary Report. Energy Edge (2008) that compared the energy costs for TCD compared with desalination plants located at different points on the coast.

(Continued on next page)

2.1 Key Documentation Assessed (continued)

Reports

Stage 4. Impact Analysis

A number of studies were undertaken to assess the potential impacts (both positive and negative) of the TCD project and ways to change this. The studies include:

- Appendix C23 of the EIS Supplementary Report. Centre of Policy Studies (2007) to assess the macroeconomic impacts at State and National levels that arise from provision of 70,000 ML of water annually and the capital injection resulting from the Project construction. Computable General Equilibrium modelling was used to identify and assess the impacts on regional and state output, employment and household income.
- Appendix 11.2A. ACIL Tasman (February, 2007) to characterise the regional economy in the Traveston Region and Cooloola Shire.

Source: SKM and QWI (2007), *Traveston Crossing Dam — Environmental Impact Statement*, October.
Note: Additional reports by Price Waterhouse Coopers (2007) and the Queensland Department of Primary Industries and Fisheries (2007) were also considered but are less relevant for analysing the potential impacts of the TCD.

We have also drawn on the draft Strategy that provides some insights into the decision-making process regarding the TCD project which may be relevant for this project. However, the draft Strategy was released more recently and therefore may contain more updated information compared with that in the EIS documentation. We have, therefore, relied on the data presented in the EIS which formed the basis of the economic analysis in relation to the TCD proposal. Although, where possible, we have tried to draw on updated data and discuss the potential implications of this.[10]

10 As noted previously, while this study may draw on information provided in the draft Strategy it is not a review of the draft Strategy.

3 Water security and reliability impact

In the initial phase of the economic analysis the EIS seeks to obtain a greater understanding of the potential impacts of a less secure water supply for businesses and the community.

Understanding the communities' views on their willingness to pay for increased levels of security and reliability is a key piece of information that is required prior to making decisions regarding new investments that impact on security and reliability. If the community is willing to pay for additional security and reliability, then the policy makers should seek to provide additional investments to meet the specified level of service. However, if the community is satisfied with the current level of service offered by the water supply system then this signals that additional investment is not required.

There are a range of survey techniques available that can be used to understand the potential willingness to pay for different levels of water security and reliability. The QWI engaged:

- the Allen Consulting Group (2007) to study 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 undertake a study to estimate the economic benefits to the community of improvements in water security in South-East Queensland. A choice modelling study was used to assess the community's willingness to pay for increased water supply reliability in South-East Queensland.
- ACIL Tasman (2007) to conduct a high level assessment to assess the impacts on commerce of a loss or reduction in water supply at a broad level in SEQ. It uses a combination of business surveys and Computable General Equilibrium (CGE) modelling to derive its findings.

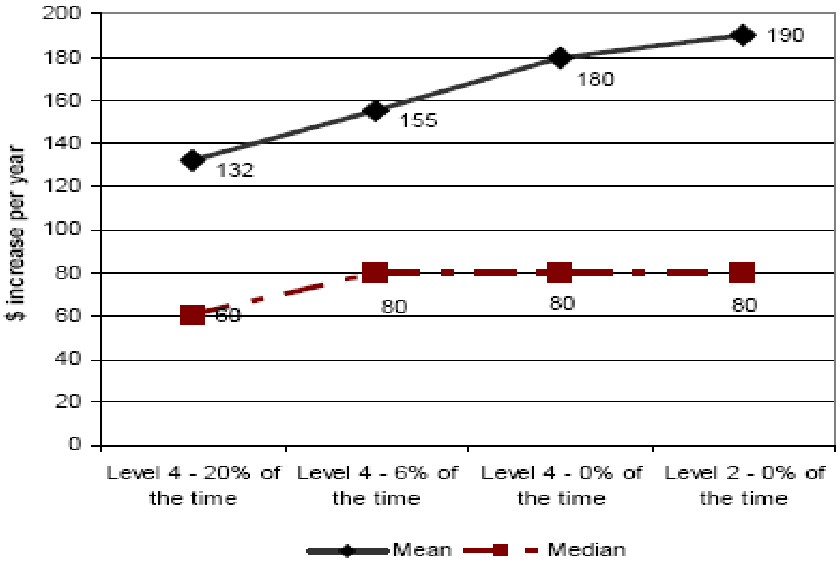
This chapter reviews the findings of the findings.

Residential sector

Allen Consulting

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.

3.1 **Household's willingness to pay for increased water security**



Data source: 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.[11]

- 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 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 SEQ context. For example, the hydrology in the SEQ region 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 the 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 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 SEQ region (particularly coastal areas) and therefore 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, given that the SEQ region in a growth region 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 the gardens to get established.

---

11 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.

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.

Comment: Given the site specific issues that can influence the results, it is difficult to test the veracity of the exact values placed on water security and reliability derived from the studies by Allen Consulting Group (2007) and DBM Consulting (2007). Nevertheless, the results appear broadly similar to the findings in other jurisdictions and it is reasonable to assume that households in the region do place value on having a secure and reliable water supply.

Non-residential sector

As noted above, ACIL Tasman (2007b) was engaged to

> undertake a high level assessment of water use by commercial industry and a more focused business survey to assess the impact of a reduction or loss of water supply on commercial activity in SEQ.

The high level assessment required ACIL Tasman to assess the impacts on commerce of a loss or reduction in water supply at a broad level in SEQ. The detailed assessment task required ACIL Tasman to:

> Estimate the impact to commercial business from a loss or reduction in water supply, and rank by level of impact. For example, Tier 1 level impacted industries (most impact), Tier 2 level impacted industries (lesser impact), and Tier 3 level impacted industries (least impact).

The study consists of three parts:

1. a Computable General Equilibrium (CGE) model of the SEQ economy under three scenarios of water shortage detailing short run costs;
2. a survey of 550 businesses in SEQ on their perception of the impact of water shortages; and
3. ten case studies of business adjustment to water shortage.[12]

The study found that there were short term costs of water restrictions. It recognised that the longer term impacts would be less, although these impacts weren't considered.

The CGE model considered three scenarios of short-run macroeconomic impacts: 15, 25 and 35 per cent cuts in water usage. The short run impact of water shortage was considerable and included both loss in production and employment. The results compared to the 'base case' are presented in the table below.

12 ACIL Tasman (2007b), p. 7.

3.2 Impact on SEQ non-residential sector of water shortages

	Gross Regional Product	*Gross Domestic Product SEQ Economy*	*Employment SEQ Economy*
	$'m 2007	$'m 2007	No.
Scenario 1 – 15 per cent reduction	-1 233	- 1 603	- 6 600
Scenario 2 – 25 per cent reduction	- 3 895	- 5 064	- 20 000
Scenario 1 – 35 per cent reduction	- 5 744	- 7 467	- 36 000

Source: ACIL Tasman (2007b)

It should be noted that these results are higher than the estimated impacts from water shortage that are derived from the modelling undertaken by the Centre of Policy Studies (2008), COPS, that was commissioned by QWI. For example, the ACIL Tasman modelling estimates that real GDP would reduce by 1.4 per cent for Brisbane and Moreton as a result of a 15 per cent cut is water supply.[13] The modelling by the COPS shows that will be a 0.15 to 0.25 increase in real GDP after the TCD is built which will produce 70 000ML of additional supply (which is approximately 10 to 12 per cent of water demand in 2026).

The difference may be due to a number of reasons including:

- The short- run nature of the impacts in the ACIL Tasman report. As the report correctly points out, "the industries have insufficient time to invest in plant and machinery that may assist in using water more efficiently. Consequently, the simulated results are somewhat pessimistic".[14]
- The assumption of productivity losses used in the ACIL Tasman report compared to the COPS analysis. The ACIL Tasman modelling does not model the water supply shortage directly but through an assumed decrease in productivity caused by water supply shortage.[15]

The differences in the results highlight the need for greater transparency in the assumptions. It would be useful to gain a further understanding of the following assumptions:

- the assumed productivity losses and whether sensitivity testing has been conducted using different assumptions of these losses. Sensitivity testing is important because the productivity losses are an estimate but the impact across businesses of water shortages is not likely to be uniform;
- the types of productivity that have been 'shocked' in the modelling. Is it a labour productivity, an input productivity or a total productivity shock? and

---

[13] ACIL Tasman (2007b), table 13, p31.

[14] ACIL Tasman (2007b), p. 28.

[15] The reason for this is because the demand for water is dominated by the household sector which makes up approximately 70 per cent of usage.

- the assumptions regarding whether the water supply shortage is region specific or whether it is assumed to apply across Queensland or the rest of Australia and whether changing these assumptions would materially impact on the results.

The assumptions regarding the population projections also appear to differ from that used in the EIS process. In the ACIL Tasman report the assumption is there is a demand supply gap of between 120-200 GL in 2026 and 300-500 GL in 2050, compared to a demand supply gap of between 140-210 GL in 2026 and 330-490 GL in 2050.[16]

Comment. There are a number of assumptions adopted in the ACIL Tasman study that are not sufficiently transparent. It would be important to clarify some of these assumptions before accepting the conclusions drawn from the analysis, given that some of these assumptions may have a significant impact on the findings.

The findings

The economic analysis highlights that residential and non-residential customers are willing to pay to have a secure and reliable source of water supply. The analysis also highlights that restrictions do impose some cost on households and that households would be willing to pay to reduce restrictions (particularly high level restrictions). To the extent that alternative supply options deliver different levels of reliability and security, these factors should also be included in the ranking of the options.

The analysis indicates that the non-residential sector is likely to also be impacted by water shortage, with the impacts being larger in the shorter term due to the difficulty of businesses to respond to these changes. Therefore, the ACIL Tasman results are likely to overestimate the potential impacts of water shortages. Nevertheless, it does highlight that businesses will face losses in productivity as water scarcity increases. Further transparency of the assumptions used in the ACIL Tasman modelling is required to provide a greater understanding of the ‘drivers’ of the results. It would also be useful to conduct some sensitivity testing to understand how the results change using different assumptions of productivity losses resulting from water shortages.

16 See p. 27 of ACIL Tasman (2007) and table 2.5 of the EIS.

4 Analytical framework

The BCA is the key tool used to rank the alternative options available to meet the needs of the community. In the EIS documentation, the BCA is one of the key tools used to justify the proposed construction of the TCD. The findings of the BCA are, however, dependent on the assumptions or constraints imposed on the analysis. Therefore, a review of the BCA necessarily involves a review of the analytical framework adopted.

This chapter reviews the analytical approach adopted for the BCA. The next chapter reviews the economic model formed undertake the analysis.

Constraints in the analysis

The MJA study considers a range of alternative portfolios that meet the three separate objectives defined in the SEQ Water Supply Strategy that includes:

- Objective 1. Achieving a water balance for SE Queensland's rapidly growing population at each point in time over the planning horizon (2007–56).
- Objective 2. Obtaining the level of medium-term supply security afforded by the increment in supply capacity obtained from Stage 1 of TCD and Wyaralong Dam (ie 88 000 ML/annum by 2012).[17]
- Objective 3. Level of Service (LOS) requirements that specify the overarching system security and reliability criteria.

It is important to note that the policy objectives adopted to undertake the BCA can influence the ranking of the different measures considered. Objective 2, in particular, is likely to have a substantial influence on the results because it, in effect, requires that substantial investment be made upfront in all the options considered (irrespective of whether this likely to result in an 'oversupply' for many years to come).

Therefore, by imposing objective 2, it forces capital expenditure to be incurred upfront irrespective of whether that supply is required now. Imposing this objective disadvantages those measures that can be adopted in a modularised form, such as desalination facilities. Given that the timing of expenditure incurred has a significant

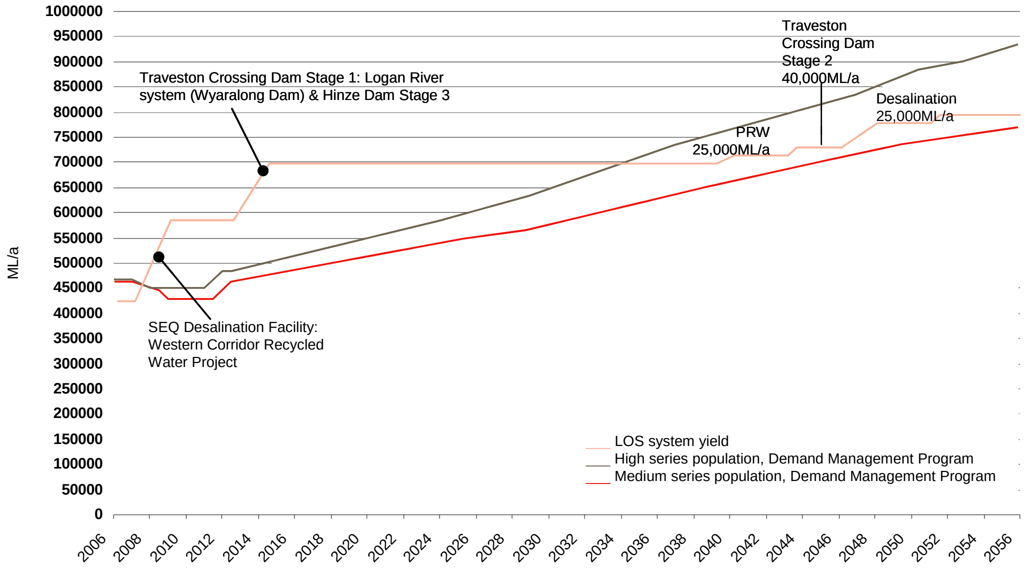
---

17 MJA (2007a), p. ES ii, (September). The TCD is expected to contribute 70 000 ML per annum.

bearing on the results in a discounted cashflow analysis (discussed later), imposing Objective 2 will have a significant impact on the results.

Chart 4.1 below illustrates the impact on the supply demand balance in SEQ over the next 50 years of adopting these objectives. It highlights that there is estimated to be excess capacity from 2008 to 2038 (assuming a medium demand projection) – that is, average supply is estimated to exceed demand over the next 30 years. Using a high demand projection, there is only expected to be a supply deficit after 2030.

4.1 **Projected supply-demand balance**



Data source: QWC (2008), *South East Queensland Water Supply Strategy* (draft).

The requirement to have excess capacity over the next 30 years relates largely to the objective to have additional supply of 88 000 ML by 2012. The Queensland Government has adopted this objective to 'mitigate the risks associated with slow recovery of yields from surface water storages as a result of extended drought (and/or delayed recovery from drought conditions).[18]

However, there are a range of other options that could be considered to provide additional insurance against future drought conditions such as upscaling the Gold Coast desalination plant.[19] This offers a more flexible strategy to deal with future climatic conditions and, in present value terms, could be a lower cost outcome compared to constructing the TCD Stage 1 over the next 3 years.[20] Further, there is substantial benefit of being able to delay making these decisions to take account of

18 MJA (2007a), p. 8.

19 Based on media reports, the Queensland Government is currently considering this option.

20 The impact of timing of capital expenditure on the present value of costs is discussed in more detail later in this report.

new information such as technological advancements in desalination technology, the potential impacts of climate change and population growth.

The MJA BCA recognises the implication of imposing Objective 2 and tests for the sensitivity of the results to removing this constraint. As the study notes,

> The deferment of capital expenditure reduces the cost of both TCD and desalination portfolios. Due to the modularised nature of desalination plant, there is greater scope to defer capital expenditure for the desalination portfolio. This results in the cost of the desalination portfolio declining by a slightly greater amount than the cost of the TCD portfolio. Nonetheless, the cost of the TCD Portfolio remains $45 million lower than the cost of the desalination portfolio.[21]

Given the importance of Objective 2 in influencing the results we believe that this objective needs to be considered carefully. As noted below, storage levels in the SEQ dams have risen considerably over the past few years and combined with the commencement of the Gold Coast desalination plant, it is likely that requiring new infrastructure to be built over the next two years may not be the most economically efficient outcome.

Comment: The objective of providing an additional 88 000 ML of water by 2012 has not been sufficiently justified. It will result in a significant increase in the cost (in present value terms) to the community. It is not clear whether the community will be willing to pay for this high level of security. There also may be alternative cheaper ways of providing additional security to the community, through a flexible portfolio that allows, for example, the upscaling the existing Gold Coast desalination plant.

If Objective 2 cannot be sufficiently justified and/or the community is not willing to pay for the additional security, then Objective 2 should be removed from the economic analysis. In this instance the difference between the TCD portfolio and the desalination portfolio (ranked second) is $45 million (in Present Value terms), rather than $318 million when both objectives are met.[22]

Least cost approach

The MJA study adopts a least cost planning approach to meet the objectives of the Plan. Least cost planning means evaluating the costs of a range of measures to meet customers' demand for water related services. Water is an essential commodity for sustaining human life. However, as long as the water provided meets the minimum

---

21 MJA (2007a), p. 32.

22 This assumes all other assumptions adopted in the MJA study remain. As discussed later there is a strong argument to change other assumptions in the analysis, which could change the ranking of the alternatives considered.

standards in terms of quality, quantity and availability, then the source of the water should not be of concern to customers.

Customers need the service that water provides rather than the water itself.[23] Therefore, if the same service can be provided at a lower cost to the community by improving efficiency then this represents the better value than providing more water, depending on the upfront costs of achieving the efficiency gain.[24]

Given this, the MJA study assumes that the an extra unit of water offers the same benefits, irrespective of whether it is sourced from a dam, desalination plant or other method. Therefore, the focus of the analysis is on the costs of alternative projects given that all projects are assumed to deliver the same benefits.

Differences in service levels

The least cost approach is commonly used throughout Australia as a method for comparing alternative water supply measures. It has arisen from periods where there were only traditional rain-fed sources of water supply such as dams. Typically, these traditional supply measures had similar characteristics and, therefore, the benefits of the projects could be defined in terms of the average quantity of water delivered. Given that the average quantity of water delivered is the same across all options considered by MJA, it is assumed that the benefits derived from each are the same.

However, non-traditional sources of supply have very different characteristics. For example, desalinations plants can deliver the same quantity of water during drought periods. Therefore, while the desalination plant and the TCD 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 quantify of water in all climatic circumstances.[25]

In its supplementary report to the QWI, MJA (2008)

> Acknowledge that the economic benefits of water supplied from alternative new water infrastructure developments will differ where reliability of supply varies between the alternatives. However, this is not a point of difference between supply options given that all options must meet regional level of service (LOS) objectives.[26]

---

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

24 White and Howe (1998).

25 The LOS requirements (Objective 3) provide specifies the minimum service levels that must be achieved. While all the alternative portfolios examined meet these minimum levels, it is important to also recognize that some portfolios may deliver higher levels of service (above the minimum) compared to other portfolios.

26 MJA (2007a), p. 3.

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

As noted in the previous chapter, the community does value having a more secure and reliable source of water. Given this, it is important to incorporate the differences in the reliability and security offered by alternative measures into the BCA. 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 the portfolios.

Indirect impacts

In its supplementary report to the QWI MJA (2008) recognise that in a pure BCA it seeks to identify aggregate social welfare between alternative projects. This 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. However, given the difficulties of placing monetary values on a range of non-market factors (such as environmental and social impacts), MJA have not sought to incorporate these indirect impacts into the analysis.

It is important to note that MJA (2008) states that

> While Marsden Jacob applies the broader CBA framework in this report we would stress that Governments must assess the triple bottom line performance on major infrastructure projects and there is no single decision support tool that can act as a substitute for this process.[27]
>
> It is important to stress that CBA (or broader economic evaluations) should only be used as a decision support tool along with other relevant social, cultural heritage, environmental, and technical studies.[28]

We agree with MJA's view that where factors are not directly monetised and incorporated into the economic analysis, rather than being ignored, these factors should be incorporated into the analysis in qualitative fashion. This highlights the fact that MJA's findings in its 2007 BCA that supports the TCD as the highest ranked portfolio is only a partial analysis of the full set of issues.

MJA (2008) and the EIS documentation provides some discussion about the potential indirect impacts but this is largely focused on the TCD option, and does not consider the potential costs and benefits of alternative water supply options. In the next chapter we consider some of the separate economic analysis undertaken relating to the indirect impact of the TCD.

---

[27] MJA (2007a), p. 8.

[28] MJA (2007a), p. 9.

Comment: Adopting a least cost approach (in the form used in the MJA study) does not take account the potential additional benefits from non rain-dependent sources of supply such as the desalination plant compared with the TCD portfolio. In particular, where the portfolios examined result in differences in the level of service reliability these benefits should be included in the analysis. It is likely that the differences in service reliability would narrow the difference between the TCD portfolio and desalination plant portfolio.

The MJA BCA is only a partial analysis and does not include a wide range of indirect impacts. Therefore its conclusions in support of the TCD as the most economically efficient option should not be interpreted that the TCD is the 'best' option. Further systematic analysis of the indirect impacts of each of the alternatives would need to be considered before reaching a conclusion on what is the best water supply option for the community.

The long term average supply

The calculation of the volume of water produced by water storages is typically measured using the concept of 'supply yield'. The yield is the maximum annual average amount that can be supplied over the long-term based on a range of factors:

- system configuration and operational rules;
- variability of water inflows (typically streamflows) to the system and any other climatic factors affecting the system;
- seasonal and geographic pattern of water supply from the system and any associated impacts of climatic variability; and
- pre-determined level of service (LOS) which relates to the frequency, duration and severity of water restrictions. This is calculated using stochastic hydrology models that simulate inflow sequences using historical inflow data.

The concept of yield is therefore based on a long term average supply. The QWI has calculated that the system yield from Stage 1 of the TCD to be 70 000 ML per annum (the 'annual take'). This figure is used in the MJA study to compare it against a desalination plant that produces an equivalent volume of water.

As noted above, the 'annual take' is an average volume of water that can be produced over the long term. In practice, however, there are likely to be substantial deviations from the average for those rain-dependent sources of supply. The concept of yield, therefore, 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. Portfolios 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, portfolios that deliver the same mean but low variability are likely to be favoured over more volatile portfolios.

Comment: The concept of supply yield is based on the average long term performance of storages and does not account for the potential variability of supply from the mean. Alternative supply options may deliver a different distribution around the mean. For example, a desalination plant producing a 70 000 ML per annum is likely to provide a less variable supply of water compared to a rain-fed supply that provides an equivalent volume of water. If policy makers and the community are risk-averse then it would be important to take account of differences in the downside risks associated with the different options examined.

Demand–supply balance

In the analysis the supply yield concept has been combined with the projected demand from the system to determine the demand–supply balance.

The intention of the demand–supply balance concept is to provide a long term view of the future demand for water in the SEQ Region and the ability of the supply system to meet this demand into the future. In this context the supply-demand balance is primarily focused on ensuring that there is sufficient water to meet the long term growth needs of the region.

If the projected demand (consumptive and environmental) was likely to lead to a greater frequency, duration or severity of restrictions compared with the LOS targets then this indicates that a new water supply source or reduction in potable water demand was required. This approach is traditionally used in a framework where long lead times are required in order to make pre-emptive investments.

Therefore, the criterion that determines when each new augmentation is entered into the model is when the demand curve reaches the current supply capacity (represented by the 'supply yield'). Augmentations are scheduled to occur such that the demand curve never exceeds the supply schedule.[29]

In the BCA measures and strategies were compared on their potential to ensure that the system is never in deficit. Demand management and recycling measures were seen to reduce future demand while supply strategies are seen to increase 'supply yield', with the goal being to balance supply and demand over the planning period at the least cost to society. Therefore, in the MJA framework the supply-demand balance is the critical factor that determines the size and timing of the new investments.

---

29 MJA (2007a), p. 23.

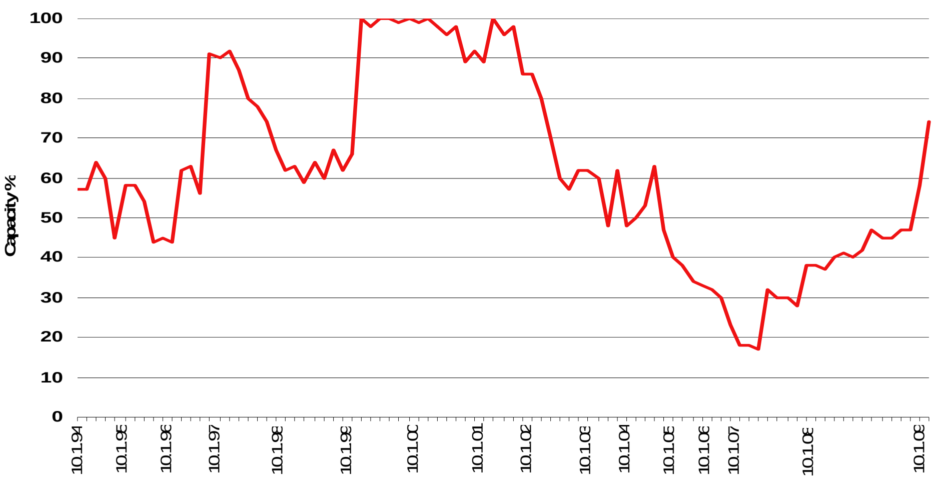
Historically, the demand–supply balance has been used as the trigger for new investments because dams were the primary source of water. The construction of dams involved long lead times which incorporated the planning, construction and time for the dam to capture water. [30] However, with the availability of non-rainfed supply sources, policy makers are moving away from using the demand–supply balance as the trigger for new investments.

The concept of demand–supply balance (using the supply yield calculation) also does not adequately take into account the potential variability of the system from the average. For example, if there is currently a demand-supply gap this would trigger the need for additional investments to remove this gap, even if there dams are currently at full capacity and there may be several years supply available.

Therefore, policy makers are now also using additional information such as the current storage levels or the 'number of months of available supply remaining' to inform the timing of new augmentation. Under this decision making criteria, portfolios that offer greater flexibility in terms of timing of new augmentation, can potentially result in a substantial reduction in the net present value of costs.

The current situation in SEQ offers a useful example of this. Chart 4.2 illustrates total storage levels in the SEQ dams since 1994.

4.2 **Wivenhoe, Somerset & North Pine Dam combined storage capacity 10 January 1994 to 25 May 2009**



Data source:

Over the past two years, storage levels in SEQ have increased from their low of 18 per cent in May 2007. Storages were over 70 per cent capacity in January 2009. The

---

30 Although there is still a lead time of several years from the commencement and completion of the construction of a desalination plant. Any 'readiness' strategies to reduce the lead time such as purchasing the land and obtaining pre-approval can substantially reduce the net present value of the costs, by offering the scope to defer the infrastructure.

combined storage levels of Wivenhoe, Somerset and North Pine dams we 76.3 per cent of capacity. Further, the Gold Coast desalination plant commenced operation in mid-2009 which will produce an additional 125 ML per day.

Comment: The use of the demand-supply balance does not provide a useful indicator of when new investments should be triggered and does not take account other information at a particular point in time (such as currently available supply, storage depletion rates, and lead times for new supply measures). This is important because the ability to defer capital expenditure can substantially change the cost differential between alternatives and the ranking of these alternatives. This is likely to favour those portfolios with more flexible investment options that can respond more quickly to new information as it arises.

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 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;[31]
- 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.

Chapter 15 of the EIS Supplementary Report includes some analysis of the potential impact of climate change of the inflows into the TCD. The analysis is largely based on

31 The underlying rainfall characteristics are an important driver of the water supply options chosen. For example, in the UK is characterised by a low intensity and steady rainfall pattern compared to Brisbane 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.

the findings of the CSIRO (2007).[32] The modelling in the CSIRO report is based on a range of global climate change models. Chapter 4.2.3 of the report discusses the reliability of the modelling. Of particular note is that the confidence in the models diminishes significantly when trying to explain potential impacts at a regional level.[33] At this stage, the CSIRO modelling also does not incorporate how climate change may impact on characteristics such as the volatility and duration of rainfall events.

The treatment of risk and uncertainty in the BCA is relatively simple and undertaken through scenario analysis.[34] In particular, the treatment of climate change in the BCA is to reduce the average long term water supply by 10 per cent. MJA recognises that this is a simplistic approach but at that stage there was limited information available.

It is important to recognise that climate change is not only about potential changes in average rainfall. It also expected to involve greater volatility and duration in rainfall patterns, potentially resulting in a greater chance of being at relatively low storage levels and greater reliance on water restrictions. Climate change also touches on aspects of urban water management such as higher risk of bushfires destroying water supply catchments and a greater volume of pollutants entering storages during extreme rainfall events. More severe storm events can cause flash flooding which may also impact on other sources of supply such as recycling and desalination facilities.

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 (the ‘unknown unknowns’). 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. Therefore, for example, portfolios that rely to a lesser extent on rainfed sources of supply (either through desalination facilities or measures that control demand) may offer advantages in terms of flexibility.

The BCA also does not consider the communities tolerance for higher levels of risk. So, for example, if a new desalination facility delivers the same annual volume of water to the TCD portfolio, the desalination facility is likely to be preferred by the community given that there is greater certainty in its supply (assuming all other factors are equal, such as the cost of the alternatives).

---

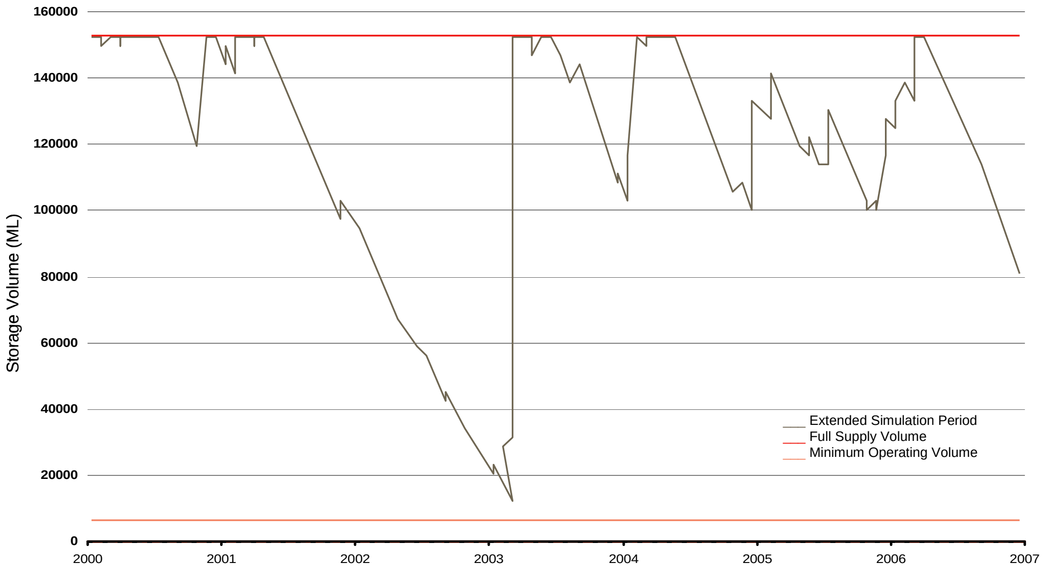
32 CSIRO (2007), *Climate Change in Australia – Technical Report*, Canberra.

33 CSIRO (2007), p. 41.

34 Apart from climate risk MJA also recognize the risk associated with forecasting demand over a long period of time. This is illustrated in table 3.1 and section 4.4.2.

The BCA is also based on the assumption that the average supply of 70,000ML can be met at all times. Chart 4.3 is presented in the EIS Supplementary Report to illustrate that a supply from the TCD Stage 1 of 70,000ML per annum would have able to be provided even in the recent drought.

4.3 **Modelled TCD Storage Volume (2000 to 2007)**



Data source: EIS Supplementary Report, p15-7.

While this chart provides useful information about the performance of the TCD under the recent drought it also does illustrate the risks faced. In particular, it does illustrate that the TCD came close to failing under the recent drought. With the potential impacts of climate change it does highlight the exposure of the TCD to supply failure – that is, it may not be able to supply the 70,000 ML per annum in all circumstances.

Comment: The MJA BCA does not consider risks and uncertainty in any detail and is largely undertaken through the sensitivity analysis. Risk and uncertainty is crucial to the analysis of any water supply system. Climate change is likely to be a central part of the analysis of risk and uncertainty and any portfolio that is more heavily exposed to climate change outcomes. It is likely that the TCD portfolio and other portfolios are likely to be exposed to higher risk and uncertainty, compared with other portfolios that are less reliant on rain-fed sources of supply – although a detailed analysis would be required to confirm whether this is correct. The community is likely to place more value on those portfolios that face less risk and uncertainty.

The findings

In our view, there are some limitations in the overall analytical framework adopted which is based on a more traditional approach for evaluating additional rain-fed infrastructure options. For example,

- Adopting the concept of yield to represent the supply from the TCD (and other rain-fed sources of supply) masks some of the greater risks associated with these sources of supply. While the yield reflects the long term average supply, at any point in time there are likely to be substantial deviations from the average.
- The concept of demand-supply balance does not offer useful information to inform the timing of investments in new projects. There are potentially portfolios of options that deliver lower cost outcomes by using additional information such as storage levels at particular points in time and adopting projects with can be constructed with much shorter lead times.
- The approach does not take account of risk and uncertainty in a meaningful way. Climate change is as much about uncertainty as it is about potential reductions in supply. In this context, a desalination plant offers greater certainty that a rain-fed supply source. This 'value' associated with the desalination plant has not been included in the analysis.

5 The economic model

In order to assess the alternative portfolios of measures an economic model was developed by MJA 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 of inputs. The economic model uses a discounted cashflow analysis. The decision rule is to choose the portfolio that minimises the net present value of all future capital and operating costs associated with the portfolio over a 50 year period from 2007 to 2056.

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

Options analysed in the economic model

The MJA study is based on an analysis of portfolios of projects, rather than individual projects in isolation. The concept of a portfolio is important because it takes account of the interaction effects of a new measure with the existing measures in place as well as other new measures that are combined into the portfolio. In some cases, two measures combined may deliver more water than the sum of the individual elements.

In the MJA study five alternative portfolios are compared in terms of their ability to meet the policy objectives and their cost of doing so. In each of the five portfolios examined, it includes the 'existing' measures that are currently in place or will be operating in the near future (such as the Gold Coast desalination plant) as well as combinations of new measures.

While we support the use of the portfolio approach to comparing measures, the MJA study only considers a relatively small number of portfolios. Policy makers have a range of decision tools available that could be considered in alternative portfolios including:

- providing new investments to increase supply or reduce demand;
- changing the restrictions regime which may mean changing duration, frequency and severity of restrictions;
- operating the existing assets in different ways under different circumstances. For example, the desalination plant at Tugun can be operated in different ways in

three broad circumstances — with no drought, in anticipation of a drought and in situations of drought; 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; and
- when to introduce the measures and in what sequence.

In our view the BCA analysis should consider a wider range of portfolios which include, for example, more flexible use of water restrictions, different timing of the capital expenditure and different options for operating the desalination plant.[35] It is possible that there are alternative portfolios that involve, for example, higher levels of restrictions combined with a new desalination plant (constructed at a later point in time) that may deliver lower cost outcomes than the TCD portfolio.

Demand management options

All the portfolios analysed by MJA includes demand management programs to reduce the demand. There appears to be strong debate about whether additional demand management programs provide a viable and cheaper cost option compared with the other portfolios. This issue has been raised in a number of studies undertaken by other interested parties.

The key study is that undertaken by ISF/Cardno (2007) which argued that a supply demand deficit did not occur until 2030. In this instance, ISF/Cardno believe that adopting additional demand management measures combined with recycling measures would defer the need for the TCD until 2050. ISF/Cardno supports the use of adopting readiness strategies:

> which are non rainfall dependent, offer a much lower risk and lower unit cost alternative to the Traveston Crossing scheme. The idea of readiness options is that the planning, design, land acquisition and approvals are all obtained. However, the construction is triggered only in the event of a deep and prolonged drought, thus offering effective insurance against a low probability event and the ability to adaptively respond to changed circumstances. The risk-weighted cost of such a strategy is a fraction of the cost of pre-emptively building new supply options, especially such a high cost, high-risk alternative as the proposed dam at Traveston Crossing on the Mary River.[36]

---

35 In the CIE's current work in developing the 2010 Sydney Metropolitan Water Plan, for example, in the order of 30 alternative combinations of measures will be evaluated.

36 ISF/Cardno, pii.

In response the Queensland Water Commission commissioned MJA and Montgomery Watson Harza to review the ISF/Cardno report.[37] MJA/MWH argued that the ISF/Cardno report was flawed and based on a range of simplifying assumptions, particularly in relation to the level of demand savings that could be achieved through the demand management savings. MJA/Cardno report argues that the demand savings incorporated into the demand forecasts used in the BCA has been based on a detailed analysis of the range of options available.

We are not in a position to verify the detailed modelling undertaken by either ISF/Cardno or MJA/MWH. However, it is important to recognise several points:

- Costs of demand management programs increase significantly once the initial 'low hanging fruit' options are exhausted.
- The supply side if often more dominant than the demand side. That is, in highly volatile systems (such as the SEQ region or the Sydney region) there storages fill and spill more frequently. Therefore, any demand savings achieved that may be achieved over several years are 'washed away' when storages spill. However, when droughts occur they are characteristised by sharp declines in inflow patterns.
- In these circumstances the key benefit of demand management programs is their ability to defer the need for new large scale investments to be made.
- It would also need to include the cost that the household is incurring in relation to this, such as including the cost to the Government of providing a subsidy for rainwater tanks but also the cost to the household of purchasing and installing rainwater tanks.
- Demand management programs also are not without risk. It is based, for example, on assumptions of the uptake of certain programs.

Therefore, while demand management programs are important, it requires detailed modelling of the range of options and the behaviour of the system to be able to make an informed assessment as to whether there are other viable options compared to the TCD.

The MJA/MWH report also argues that the ISF/Cardno approach

> was recommended to Sydney Water by ISF and these demand reduction targets have proven unachievable. The NSW Government is now considering bringing forward major supply augmentations.[38]

This does not reflect the reality of the situation faced in Sydney. Storage levels were depleting rapidly and there was significant uncertainty regarding the potential impact of climate change on the water availability. This led the NSW Government to

---

[37] MJA and MWH (2007).

[38] MJA/Cardno, pii.

make a decision to construct a desalination plant in Sydney when dam levels were around 35 per cent of capacity. This was estimated to provide a 2 year timeframe to have the desalination plant operating, if dam levels were to continue to decline. Therefore, the decision regarding the desalination plant was largely about the uncertainty of climate change and the NSW Government's risk tolerance.

The recent Sydney experience does highlight that even with an intensive demand management program, the supply-side is a critical factor for catchments with broadly similar rainfall/inflow characteristics. Sydney and SEQ both have highly volatile inflow patterns mixed with periodic droughts where inflows can drop sharply for an extended period of time.

Nevertheless, demand management programs have their place as they can help to defer the need for costly infrastructure options such as a desalination plant or a dam. However, the analysis of the cost-effectiveness of additional demand management programs needs to be examined as part of the portfolio analysis using a discounted cashflow model, consistent with the approach used in the BCA.

It is important to recognise that demand management programs typically involve relatively small expenditure incurred over, say, a 10 year period. In present value terms it may be more cost-effective compared to a large expenditure item being required over the next few years. Therefore, we believe that there is merit in conducting further analysis to test the TCD and additional demand management programs in a portfolio context using a discounted cashflow analysis (consistent with the BCA).

It is also important that the additional demand management programs are not dismissed completely. It is important to recognise that with technological advancements into the future it may reduce the cost of demand management programs.

Comment: The use of the portfolio approach to ranking measures is preferable to a ranking based on individual measures. However, the BCA only considers a limited range of portfolios and does not consider other options such as trigger rules for restrictions and the operation of the Gold Coast desalination, in combination with new projects that might deliver a lower cost outcome than the TCD portfolio. The BCA also does not consider portfolios with additional demand management programs (combined with other measures) that may result in a lower cost outcome (in present value terms) compared to the TCD. It is also important that all options are not disregarded in any future analysis, given that technological advancements into the future can reduce the cost of these measures.

Timing of capital expenditure costs

In the 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 objectives. As noted above, one of the objectives specified is that any portfolio considered must provide an additional 88 000ML of water by 2012. After that point, additional investment is triggered at a point that ensures that the estimated long term average supply exceeds demand.

As MJA note, the timing of expenditure in a discounted cashflow model has a very large impact on the results.[39] In the MJA economic model, when new investment is triggered the capital costs are assumed to be distributed evenly over a specified construction period for supply source. The report assumes a construction period of between 3 to 5 years[40] and states that the Queensland Government plans to construct TCD Stage 1 and Wyaralong Dam over the 2009-11 periods.[41] In a separate report in 2006 the Queensland Government also indicated that it is working to have both these dams constructed by the end of 2011.[42]

While these separate Queensland Government statements provide some indication on the timing of the capital expenditure in relation to the TCD Stage 1 and Wyaralong Dam, it is not transparent what assumptions have been made in the cashflow modelling for these and other projects (ie which projects are assumed to have a 3, 4 and 5 year lead time).

The assumptions used on this issue can have a substantial impact on the net present value of costs, therefore, it is important that the BCA provide transparency on its assumptions. The importance of this assumption can be illustrated in using the following example:

- the capital expenditure of Traveston Crossing Dam Stage 1 (estimated at $1592 million) and a 200 ML per day desalination plant (estimated at $1341);
- it is assumed that the capital expenditure is incurred equally in each year of the construction period; and
- the construction period varies:
  - In **example 1**, it is assumed that the period of construction for both infrastructure options is over a 3 year period from 2009 to 2011. This assumes that the TCD Stage 1 can supply an equivalent volume of water to the desalination plant by the beginning of 2012.

---

[39] MJA (2007a), p. 22.

[40] MJA (2007a), p. 25.

[41] MJA (2007a), p. 1.

[42] Department of Natural Resources, Mines and Water (DNRMW) (2006), p. 29.

– In **example 2**, we assume that the TCD Stage 1 is constructed over a 3 year period from the beginning of 2009 to the end of 2011 and supply is available by the end of 2013, the construction of the desalination infrastructure is assumed to progress over a 3 year period, commencing in the beginning of 2011 with supply available by the end of 2013.

The results from the net present value are illustrated in the following table. It highlights that this minor change in assumption on the timing of the capital expenditure can make a significant difference to the result. In this example, if the expenditure on the desalination plant is pushed back two years to allow for a two year 'fill' time for TCD Stage 1, this reduces the present value of the desalination plant by a further $90 million (from $223 million to $313 million). If operating costs are also included in the analysis it will reduce the costs of the desalination option even further.

5.1 Impact of changing capital expenditure profile

Infrastructure	*Total project cost*	*PV (example 1)*	*PV (example 2)*
	$m	$m	$m
TCD Stage 1	1 592	1 416	1 416
Desalination plant (200 ML/day)	1 341	1 193	1 103
Difference		**223**	**313**

Note: A real pre-tax discount rate of 4 per cent is assumed, consistent with the MJA BCA. The figures are in 2007-08 dollars.
Source: CIE estimates

This simple example also highlights the potential impact that changing the lead time of large infrastructure projects can have on the present value of the costs. The extent to which future technological advancements can reduce the lead time of projects this 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.

It is questionable whether a 3 year construction period followed by no 'fill' time for TCD Stage 1 is a realistic assumption. This would require site specific analysis that we are not in a position to undertake. However, it is interesting to note that in the Queensland Government's long-term solution report (DNRMW 2006) it notes that

> An advantage of the desalination plant is that the plant may be modularised and upgraded over time to the maximum capacity. The plant could be operational in about 2.5 years, as compared with a major dam which could take five years to design and construct followed by a period to fill.[43]

Comment. The assumptions regarding the timing of capital expenditure in relation to the TCD and the alternative infrastructure is not transparent. This assumption

43 DNRMW (2006), p. 51.

should be made clear which would enable it to be critically reviewed. However, based on our desktop analysis we would anticipate a larger difference in the lead time between the TCD and a desalination plant, taking account a prudent fill time for the TCD Stage 1. This minor change can have a significant impact on the present value of the costs.

The discount rate

In a cashflow model the discount rate is used to 'convert' costs (and benefits) incurred at some point in the future into current dollars. This allows a comparison of costs/benefits across different time periods. If the discount rate is zero then costs and benefits are equivalent in all time periods. A higher discount rate implies that less value is attached to cost/benefits in future years.

In the cashflow model developed by MJA a real pre-tax discount rate of 4 per cent is assumed. This is based on a Queensland Government policy determination specified in the Water Amendment Regulation. This appears inconsistent to a separate study undertaken by MJA (at a similar period) for the National Water Commission on the cost-effectiveness of rainwater tanks. In this study MJA adopted a real pre-tax discount rate of 6 per cent, although it noted that a typical range used by other government bodies is between 5 per cent and 8 per cent.[44]

Currently, the New South Wales Treasury and Commonwealth Department of Finance generally use of a 7 per cent real discount rate in economic appraisal and the Victorian Government directs use of a 6 per cent real rate.[45]

In the MJA economic model, the outcome of using a relatively low discount rate is that it will 'disadvantage' those projects with costs occurring in later years. That is, costs occurring into the future will have a higher present value if a low discount rate is assumed. For example, a modularised desalination portfolio where expenditure is incurred at different points in the future will have a higher cost (in present value terms) if a discount rate of 4 per cent is used compared with a 7 per cent discount rate.

There is often significant debate over the choice of the discount rate. This has been evident in the recent debates over the incorporation of climate change impacts in the Stern Report and the Garnaut reports.[46] In this debate, a low discount rate is often favoured because the impacts of actions (or non-action) today can have significant impact on future generations. Using a low discount rate ensures that the impacts on

44 MJA (2007b), p. 29.

45 Australian Government (2007), p. 130.

46 In the Garnaut review two discount rates of 1.35 per cent and 2.65 per cent were used (Garnaut final report).

future generations are not discounted away and these impacts have an equivalent value whether they occur today or in the future.

While a low discount rate is often favoured when incorporating the environmental and social impacts on future generations (particularly where there is irreversible environmental impacts), this assumes that these impacts are incorporated into the cashflow modelling. As discussed above, the cashflow modelling undertaken by MJA in its BCA focuses on the financial costs. The potential long term environmental and social impacts are discussed separately outside of the cashflow modelling. This diminishes the reason for MJA of using the relatively low discount rate in its BCA.

There is likely to be some debate about the discount rate, however, there is unlikely to be consensus on the precise estimate chosen. Therefore, it is important that the sensitivity analysis tests the impacts of alternative discount rates on the ranking of the portfolios. The difference between using a 4 per cent discount rate is likely to deliver significantly different results compared with a discount rate of 7 per cent. If the ranking of options changes as a result of using a different discount rate it highlights that there may not be a clear ranking of options. If this is the case, then it is likely that the indirect impacts such as the environmental and social impacts will be a key in determining the preferred option.

Comment. The discount rate of 4 per cent real pre-tax is on the low side of the range commonly used by other jurisdictions throughout Australia for analysis of infrastructure options. It is important that the sensitivity testing consider a number of alternative discount rates to examine how the results change. If the rankings are sensitive to the discount rate it is likely to indicate that social/environmental impacts of the portfolios is likely to have a significant impact on the ranking of the alternative options.

The magnitude of the costs

The magnitude of the costs used in the BCA will have an impact on the ranking of the projects. These cost items will not be known with certainty and reasonable estimates will need to be made to be included in the 50 year cash flow analysis.

The MJA BCA states that,

> An important caveat on the above results is that, despite considerable work undertaken for this study to resolve data gaps, the cost estimates for the TCD Portfolio remains far more detailed than any other option examine. During planning for major infrastructure, as progress is made through each incremental planning phase, the level of detail in cost estimates increases and hence there is a much greater degree of accuracy and confidence in the results.[47]

[47] MJA (2007a), p. 28.

Given this it is useful to consider the reasonableness of the costings, particularly in relation to the desalination portfolio (the second ranked portfolio). As noted earlier in this report, while we can make some observations regarding costs information, this is likely to be site-specific and require separate analysis. Table 5.2 provides information on the desalination projects that have recently been undertaken throughout Australia.

5.2 Desalination plant projects throughout Australia

Region: Perth
Commence completion: 6 November 2006
Cost: $387m plus annual running costs of under $20m. Anticipated water cost is estimated at $1.17/kL
Capacity: 45GL annum. Initial capacity of 140 000m^3 per day with designed expansion to 250 000m^3 per day
Comments: 17 per cent of Perth's freshwater needs
Powered by renewable energy wind farm
Currently planning for second plant at $1bn
50-60 per cent of water use from groundwater
http://www.water-technology.net/projects/perth/

Region: Gold Coast (Tugun — next to airport)
Commence completion: Operational from February 2009
Cost: $1.2 billion
Capacity: 133ML per day
Comments: GCD Alliance (John Holland, Veolia, SKM, Cardno) Plant will feed into the SEQ Grid

The Queensland Environmental Protection Agency (EPA) completed an Environmentally Relevant Activity (ERA) report, summarising material from over 40 environmental impact assessments undertaken on each aspect of the project (this is a study very similar to an Environmental Impact Statement) (EIS). As this research was undertaken, a formal EIS was not required under existing legislation (local, State and Commonwealth). http://www.watersecure.com.au/
http://www.goldcoastwater.com.au/attachment/goldcoastwater/Desal_FAQs_2009.pdf

(Continued on next page)

5.2 **Desalination plant projects throughout Australia** (continued)

Region: Sydney
Commence completion: June 2007 to March 2010
Cost: $1.76bn, including $500m for distribution pipelines and $300m for other project costs
Capacity: 250ML per day, with scope to upscale to 500ML per day
Comments: Provides up to 15 per cent of Sydney's water needs. The Water Delivery Alliance (WDA), which includes Sydney Water, Bovis Lend Lease, McConnell Dowell, Kellogg Brown & Root, Worley Parsons and Environment Resources Management, is building the pipeline.
Blue Water – a joint venture between Veolia and John Holland – is building the desalination plant

http://www.sydneywater.com.au/WhoWeAre/MediaCentre/MediaView.cfm?ID=382
http://www.sydneywater.com.au/Water4Life/Desalination/

Region: Melbourne (Wonthaggi region, Gippsland)
Commence completion: 2009-11
Cost: $3.5bn. Includes interconnecting pipes
Capital costs estimated at $3.5b, while operating costs are approximately $130 million per year (in 2007 dollars). This is based on the use of renewable energy
Capacity: 450 ML per day
Comments: Supply 30 per cent of Melbourne's annual supply
90MW energy pa, fully offset through the purchase of renewable energy credits
Plant has capacity to be expanded to 200bn litres per day.
The contract is expected to be awarded in mid-2009
Env Effects Statement completed Dec-Jan 09
http://www.ourwater.vic.gov.au/__data/assets/pdf_file/0008/6011/B.ExecSummary2of121.pdf, updated by WSAA Report Card 2008-09

Region: Adelaide (Port Stanvac)
Commence completion: 10 December 2009, completion date of December 2012
Cost: $1.83 bn
– doubling the size will cost an extra $450m for process plant and marine works and power supply and associated infrastructure upgrades.
Operating costs for the originally planned 50GL plant were estimated at $91.8m (in 2015/16 dollars) including $86.0m desalination plant operating costs and $5.8m in transfer pipeline operating costs.
Capacity: Initially planned for 50GL per year but now planned for 100 GL per year.
Comments: AdelaideAqua (Acciona Aqua, United Utilities, McDonnel Dowell, AbiGroup Contractors)

It would supply more than 70% of Adelaide's 2007-08 water consumption when completed..
http://www.sawater.com.au/NR/rdonlyres/E47D55A8-91F9-4029-A9A6-79A3EC21BE62/0/MedRelDesalMay09.pdf
http://www.parliament.sa.gov.au/NR/rdonlyres/916DDE67-C94A-4ACD-893E-24EDE82DFD9E/12629/ReportAdelaideDesalinationPlant.pdf, updated by WSAA Report Card 2008-09

In undertaking its investigations of the cost of constructing a desalination facility in Sydney, GHD (2005) estimated that the plants in the range of 100 to 500 ML/day would cost in the order of $450 million to $1.75 billion.[48] However, the recent actual cost of constructing desalination plants throughout Australia may be a more accurate reflection on the current construction costs. For example, as noted in the table above, Sydney's 250 ML per day desalination plant cost approximately $1.8 billion in July 2007. This is broadly consistent with the estimated cost of $1.5 billion for a 240ML per day plant in MJA's report. The cost for a desalination plant of 120ML per day is estimated at $1.2 billion in the MJA report, consistent with the recently constructed desalination facility in the Gold Coast.[49]

48 GHD (2005), p. 1.

49 See table 3.2 of the MJA BCA for the assumptions on capital expenditure for different items (MJA (2007a), op. cit).

The operating costs estimates available in the public domain are less transparent because these costs are often confidential in nature as they are an integral part of the contractual arrangement with the operator. This particularly relates to the fixed operating costs and will differ based the contractual obligations of the owner and operator in the individual cases. Therefore, we have not considered these fixed operating costs. The next section, however, considers the assumptions regarding the energy related costs of the desalination plant.

Comment. The cost estimates of the different infrastructure options considered in the BCA are likely to include a range of site specific issues. Therefore, it is difficult to compare the capital cost estimates with any precision. Nevertheless, based on our analysis of alternative desalination plants that are currently being constructed throughout Australia, the estimates provided in the analysis appear reasonable.

Variable operating costs associated with the desalination plant

The economic model developed in the BCA uses an optimisation procedure to estimate the variable operating costs in the portfolio. That is, it develops a 'merit order' of supply sources in order to meet required demand year, with the least variable cost option chosen to meet the supply at a particular given point in time.[50] The variable costs are calculated based on the actual volume of water supplied by a particular source.

The report does not offer a transparent explanation of this procedure for determining the merit order. For example, it is not clear how often the desalination plant is operating. This is critical given that the desalination plant has higher variable operating costs compared with the TCD portfolio.

Attachment 2 in the MJA report provides information on the costings of the different options. It indicates that the total variable operating costs is $386 per ML which equates to $28.2 million per annum for a 200 ML per day desalination plant. If the plant is operating at 70 per cent capacity for the first 10 years, then this would reduce the net present value of the variable operating costs by approximately $68 million compared with a plant operating at full capacity for that period.[51] This can have a significant bearing on the ranking of the preferred portfolios.

Following the BCA, QWI engaged Energy Edge (2008) to provide separate analysis of the potential energy costs associated with different desalination plant options, the

50 MJA (2007a), p. 25.

51 This is based on a 'saving' in variable operating cost of $8.45 million per annum. Over a 10 year period, using a discount rate of 4 per cent, this equates to $68.56 million in net present value terms.

associated carbon costs and the costs if the desalination plant were assumed to be powered by 'green energy'. The analysis assumed that a desalination plant was operating at full capacity. In a supplementary report MJA (2008) used the findings from the Energy Edge report to derive revised energy costs that could be used in its original BCA. Again, the assumptions regarding the amount of time that a desalination plant is operating are not clear.

It is particularly important to understand the operating rule for the desalination plant in the context of a system which highly volatile rainfall patterns such as in SEQ. Given that the average storage levels are close to 80 per cent of capacity and dams spill relatively frequently due to high inflow events, there may be limited benefit in operating a desalination plant at these high levels. 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.

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 including the Gold Coast desalination plant. Therefore, any additional desalination plant facility is likely to also alter the optimal operating rule for the Gold Coast desalination plant as well as the new facility. For example, the combination of the Gold Coast desalination plant and a new facility may mean that storage levels can be allowed to fall to, for example, below 50 per cent before the desalination plants begins producing water. As demand increases into the future, it may be optimal to commence operating the plant at higher storage levels.

Detailed modelling will be required to determine the optimum rules for operating a desalination plant. However, the discussion illustrates that the operation of the desalination plant will depend on the existing portfolio of measures as well as issues such as the demand levels at different points in time.

Comment. The assumption regarding the operation of the desalination plants in the BCA is not transparent and should be explained in more detail. For example, it would be useful to understand how often the Gold Coast desalination plant and any additional desalination facilities are assumed to be operating in each of the alternative portfolios examined in the BCA. Given the energy-intensive nature of desalination facilities, the assumptions regarding the frequency which the plant is operating is likely to have a significant impact on the ranking of the alternative options.

Costs excluded from the model

The economic model developed by MJA incorporates the costs associated with the particular portfolio and the timing of when these costs are incurred. The MJA economic model is primarily based on the direct capital and operating costs associated with the portfolio.

Environmental and social costs

Typically a BCA 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 MJA analysis is the exclusion on environmental and social impacts. These are issues are left to the broader EIS process. However, the EIS does not appear to have fully considered the impacts of the alternatives. Instead it focuses primarily on the TCD portfolio and discusses the potential impacts associated with this project. The analysis in the EIS also does not bring together the environmental and social impacts into a systematic framework that can be compared against the full financial costs.

Exclusion of cost of water restrictions

Another key factor that is not included in the analysis is the costs associated with the water restrictions. As the analysis (discussed in the previous chapter) on the impacts of water security and reliability on the community indicates, there is a cost associated with restrictions. All portfolios analysed are required to provide the same supply yield which incorporates meeting the LOS targets. However, the portfolios may differ in the level of service provided above the minimum level. In particular, it is possible that the desalination plant portfolio will result in less time in restrictions compared with the TCD portfolio 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.[52]

Comment. The BCA undertaken by MJA and supplemented by analysis in the EIS does not comprehensively deal with a range of cost items, particularly the differences in the social and environmental impacts as well as the cost of water

52 Erlanger and Neal (2005).

restrictions. It is likely that the portfolios that are less exposed to rainfall variability are likely to face greater levels of water restrictions. In regards to the environmental and social impact costs, it is difficult to say whether these costs are likely to be higher in the TCD portfolio or other portfolios. However, this information is required to be brought together in a systematic way and compared with the results from the financial modelling in the MJA study. This could significantly change the ranking of the portfolios.

Treatment of indirect economic costs

As discussed in the previous chapter, the BCA undertaken by MJA (2007a) largely focuses on the direct costs associated with the project, although there are some indirect costs also included in relation to the TCD such as flood-mitigation costs of $70 million and social impact mitigation costs of $50 million.[53] MJA (2008) recognise that these indirect impacts need to be incorporated into the decision making process in a systematic way to complement the analysis undertaken in their BCA.

The EIS, however, adopts a piecemeal (as opposed to a systematic) approach to incorporating the indirect economic impacts associated with the projects. The analysis focuses on the indirect impacts associated with the TCD and does not consider the indirect impacts associated with the other portfolios analysed in the BCA. This is the case for the environmental, social and economic impacts, where only the indirect impacts of the TCD are considered.

Therefore, the analysis of the indirect impacts cannot be brought together into a systematic manner to complement the BCA because it only considers the impact in relation to one of the options analysed by MJA, the TCD project. Using the information provided in the EIS and supporting documentation, it is not possible to compare the indirect impacts of the TCD and the other portfolios considered in the MJA report. Additional information would be required on the indirect impacts of the other portfolios before conclusions can be drawn regarding the relative magnitude of the indirect impacts of the TCD relative to other water supply options.

Regional impacts of TCD

MJA (2008) does seek to consider the indirect impacts of the TCD. It concludes that:

> Many business owners and workers in the region will be better off as a result of the project, and, due to the extensive mitigation strategy, very few individuals or entities are likely to be 'worse off' as a result of the project. Hence, it is reasonable to conclude that the project will deliver net social benefit for the community.[54]

53 MJA (2008), p. 8.

54 P11.

Chapter 15 of the EIS also discusses in detail the potential economic benefits of the TCD.

There are several points to note about this analysis:

- the comments only relate to the TCD and do not consider the net social benefits of any of the other alternatives. The net social benefits of the alternative options may be significantly higher but this issue has not been considered; and
- the analysis focuses on the impact on the TCD region. While the TCD region may benefit from the project, it may draw resources away from other parts of Queensland (or Australia). Therefore, it is the net benefits across Queensland that needs to be considered, not just the localised net benefit.

Economy-wide impacts

The Centre of Policy Studies (2007) conducted general equilibrium modelling to analyse the economy-wide impacts of the TCD. A general equilibrium framework is a more appropriate approach to examine the economy-wide effects of the project as it takes account of the flow-on impacts through changes in one part (or region) of the economy. The study is based on the time period 2009 to 2030 which differs from the 50 year period of analysis used in the BCA.

The study concludes that the project results in an:

> Increased real GDP to South East Queensland. For example, during the construction period real GDP increases by approximately 0.16 per cent (some $219 million) and continues to rise during operation due to the ongoing supply of water from the Project. For example, in 2013, when the Project is providing full yield, real GDP increases by 0.15 per cent (approximately $244 Million);
>
> Increased aggregate employment in South East Queensland that in the construction period peaks in 2009 at approximately 0.14 per cent (some 1745 jobs) – a level maintained in the longer term relative to the baseline forecast once the Project is providing full yield. For example, in 2013, aggregate employment increases by approximately 0.06 per cent (around 778 jobs);[55]

These benefits occur through the initial construction phase and through a reduction in water scarcity in the region.

In general the COPS report does not provide enough material for readers to make an informed judgement. In particular, introduction of specific assumptions and the counterfactual baseline, such as the demographic change, economic growth, water supply, composition of water demand (households versus industrial use) and water price, would be useful for readers to understand what the reported results mean in percentage change terms.

---

55 P2.

An understanding of these assumptions is particularly important given that one of the key drivers of the results is the benefits derived from a reduction in water scarcity. As outlined in the previous chapter, from a supply-demand perspective, there is only likely to be a shortage of supply from around 2025. Therefore, it is not clear the extent to which the TCD Stage 1 contributes to a reduction in scarcity during this period.

The report also does not present the result on the price of water, the sole commodity/resource produced by the project being evaluated. Information on changes in water price would help readers to understand the increased industrial activity and real consumption. Water price change is probably a more important result than the GRP change because three quarters of water supply in SEQ Queensland is for residential/household use according to ACIL Tasman (2007b).[56]

Another issue is the sensitivity analysis. The study assumes 'water available for economic use in SEQ Queensland remains constant', and 'in the baseline that neither industry nor household savings are as rapid as output and population growth so that the relative scarcity of water worsens over time'.[57] It would be useful to report the actual level of these assumptions. As the report correctly pointed out:

> '[d]ifferent assumptions concerning water availability and to a lesser extent water savings over time affect this calculation critically. Were South-east Queensland's rainfall to return to average levels over the next decade or so, the welfare benefits as measured in the CGE framework would diminish.'[58]

It is therefore helpful to provide sensitivity analysis around the assumptions of water supply and water savings and to examine how this changes the results.

The study 'measure[s] welfare at the national rather than regional level'.[59] It would be also informative to provide the welfare measurement for the SEQ region. It should also specify what discount rate is used to calculate the present value of welfare. It is not clear whether this is the same as that assumed in the MJA (2007) BCA.

Some of the results appear inconsistent with the information contained in other reports. For example, table 7 of ACIL Tasman (2007b) reports water consumption and GSP contribution by industry in Queensland.[60] The water intensity varies from the most intensive use of 438.3 ML/$m GSP by agriculture to the least intensive use of 2.1 ML/$m GSP by other industries. The average intensity of the industries in table 7 is 29.6 ML/$m GSP. If water is the only binding resource constraint of the

56 P18.

57 P9.

58 P16.

59 P16.

60 P20.

economy, the most water intensive industry (agriculture) would be the marginal industry. In this sense, one more ML of water available would lead to an increase in GSP of at least $2281.5 (reciprocal of the water intensity in agriculture). The COPS modelling shows that real GDP increases by $244 million when the project is providing full yield in 2013.[61] Given the assumption of the project yield of 70 GL, the result implies a contribution rate of $3485.7 per ML of water.

Comment. The examination of the indirect impacts of the alternative supply options is limited and is focused on the impact of the TCD. It does not bring together the indirect impacts in a systematic way that allows a robust comparison of the 'total effects' arising from each of the alternatives. It is possible that alternative options have a larger net social benefits compared to the TCD once the indirect impacts are taken into account. However, this proposition has not been tested.

Sensitivity testing

Sensitivity testing is an important part of any 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 BCA 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 BCA presented in the EIS, a range of sensitivity tests have been undertaken including:

- the potential impact of climate change on the analysis, by reducing the supply yield by 10 per cent;
- changing the assumptions on the forecast growth in demand;
- potential increases in energy costs as a result of the implementation of carbon trading and augmentation of generating capacity;
- increasing the capital costs by 30 per cent, recognising that the capital costs included in the BCA are only estimates;
- removing the constraint imposed by Objective 2. That is, 88 000 ML of additional supply would not be required by 2012. Instead supply increments would be made

---

61 P2.

at different points in the future to ensure that there is no supply deficit at any point in time in the future.

- augmenting supplies by 70 000 ML by 2012 instead of 88 000 ML as proposed in Objective 2; and
- changes in the sequencing of desalination modules prior to Borumba Raising and TCD Stage 2 to take account of concerns regarding climate change; and
- undertaking a direct comparison of Stage 1 TCD (70 000 ML per annum) and a desalination plant that delivers an equivalent volume (ie 73 000 ML per annum or 200 kL).

The sensitivity testing conducted in the BCA provides useful information. Of most interest is the fact that removing the constraint imposed by Objective 2 substantially lowers the differential between the TCD portfolio and the second ranked portfolio. It highlights that the validity of this objective needs to be critically analysed.

There are, however, a number of limitations in the sensitivity analysis:

- The treatment of climate change is simplistic, as acknowledged by MJA, and involves reducing the average supply by 10 per cent. Climate change, however, is more complex than a reduction in the average rainfall and is anticipated to result in changing the rainfall/runoff characteristics which may include, for example, increased volatility and duration of rainfall. This could result in more severe water shortage issues compared with the average.
- The BCA does not clearly report the sensitivity testing on the discount rate. The MJA report reports that the TCD Portfolio is the least cost supply option in 'all except one of the scenarios examined (ie where a very high discount rate is applied)'.[62] The report, however, does not disclose what is meant by a 'very high discount rate'.
- The analysis does not consider how incorporating environmental releases from the TCD storage (and other storages) would impact on the 'annual take' and whether this significantly increases the risks of more extreme dam levels.
- There is sensitivity analysis undertaken on a higher than expected demand. However, it would also be useful to consider how the results would change if demand is lower than the medium result.
- Likewise, the sensitivity analysis tests for increases in future energy costs. However, it would also be useful to consider lower than expected energy costs. This is particularly important for the desalination facilities which are relatively

62 MJA (2007a), p. 27.

energy intensive and where technological advancements are expected to reduce the energy needs of desalination facilities in the future.[63]

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. For example, it will be interesting to test how the results would change by removing the requirement to produce 88 000 ML per annum by 2012, combined with a real discount rate of 7 per cent which is more commonly used in other jurisdictions. This scenario is likely to significantly change the results of the analysis. Combined with a more comprehensive treatment of climate change is likely to further tilt the balance further away from rain-fed supply options.

Comment. The sensitivity testing undertaken does provide some useful insights about how changing the key assumptions can impact on the ranking of the alternative options. However, additional sensitivity testing is required to provide further insights, particularly in relation to the discount rate as well as changing a number of assumptions at the same time. This could significantly change the conclusions reached from the analysis.

Key findings

This section highlights some of the limitations in the economic modelling undertaken to estimate the preferred portfolio of options. The analysis is undertaken in a piecemeal approach and does not bring together the direct and indirect impacts in a systematic manner that allows the tradeoffs between the costs and benefits to be evaluated. It also does not consider the indirect impacts of the alternative options and, therefore, does not allow a comparison of whether, for example, the construction of a desalination plant results in greater net benefits compared to the TCD.

We also believe that there are some limitations in the discounted cashflow modelling that underpins the BCA:

- The discount rate is significantly lower than that commonly used by Governments in other Australian jurisdictions for evaluating infrastructure projects. The choice of the discount rate is likely to have a significant bearing on the results. A lower discount rate is likely to favour those investments with larger upfront capital expenditure and longer lead times from the commencement of construction to the time which the infrastructure is operational.

63 The MJA BCA notes that 'the energy requirement for desalination plants is also expected to decline over time, as reverse osmosis technology improves thus reducing exposure to risks associated with energy–cost increases. In contrast, technology for constructing dams is relatively stable' ((MJA 2007a, p. 39).

- The analysis focuses on the financial costs associated with the projects and excludes key impacts such as the cost of restrictions, the environmental and social impacts which could differ between the alternative portfolios. It is likely that the desalination plant will result in less time in restrictions compared with an equivalent average supply from a dam.
- The analysis appears to assume that the capital expenditure profile of the TCD and the desalination plant are broadly equivalent. It is not clear whether this is a reasonable assumption. Typically, one would expect that the construction of a dam would be required to commence well in advance of other infrastructure because in addition to the construction time some buffer also needs to be incorporated for 'fill-time'. The exact lead time would need to be tested further as it is likely to differ on a case-by-case basis.

We also believe that the sensitivity analysis undertaken as part of the BCA is also limited. For example:

- the treatment of climate change is simplistic and does not take account of the fact that climate change could significantly change the variability of inflows into storages (not just the average). Therefore, the potential impacts under the climate change scenario, the community could be faced with significantly longer periods of water shortages (resulting in more time in restrictions); and
- it does not consider combinations of scenarios such as removing requirement to provide 88 000 ML of additional supply by 2012 as well as changing the discount rate. It is likely that the combination effects will change the ranking of the projects;

The BCA only considers a limited range of portfolios and does not consider other options such as trigger rules for restrictions and the operation of the Gold Coast desalination, in combination with new projects that might deliver a lower cost outcome than the TCD portfolio. The BCA also does not consider portfolios with additional demand management programs and combined with other measures. It is also important that all options are not disregarded, given that technological advancements into the future can reduce the cost of these measures.

6 Conclusions

In reaching its decision to support the construction of Stage 1 of the TCD project, the proponent, QWI Pty Ltd, has undertaken a substantial degree of economic analysis. The economic analysis has covered a wide range of issues which has been used to support the decision. As the BCA notes:

> TCD is the only major water supply infrastructure development in Australia where such a rigorous process has been applied to facilitate transparent and rigorous comparison of the economic cost of a wide range of water supply options. Thus, there is a very high degree of confidence in the results of the economic modelling undertaken by Marsden Jacob for this study.

In our view there is significant room for improvement in the economic analysis undertaken in the EIS documentation. The economic analysis has been undertaken in a piecemeal approach and does not bring together the findings in regards to the indirect economic, social and environmental impacts in a way that enables a systematic comparison of the TCD option against the alternatives.[64] It is possible that incorporating the indirect impacts into the BCA in a systematic way will change the ranking of the portfolios such that the TCD is no longer the preferred option. This would depend on the magnitude of the indirect impacts and how they differ amongst the alternative options.

The conclusions reached in the EIS in regards to the ranking of alternative options is heavily influenced by the assumptions adopted such as the requirement imposed in the analysis that the alternatives considered need to deliver an additional supply of 88 000 ML per annum. This is likely to result in a high cost outcome for the community and (if average conditions prevail into the future) significant excess capacity. Given the current storage levels in SEQ which are over 70 per cent of capacity and the recent commencement of the Gold Coast desalination plant the imposition of this requirement in the analysis requires further justification.

The conclusion reached in the EIS is also significantly influenced by the assumed discount rate of 4 per cent. Additional sensitivity testing is required to determine whether the choice of the discount rate changes the ranking of the alternative options

64 The need for a systematic framework to incorporate the economic, social and environmental impacts is recognized by MJA, the authors of the BCA. In a supplementary report for the QWI MJA noted that 'the Government must apply a triple bottom line performance of major infrastructure projects and there is no single decision support tool that can act as a substitute for this process' (MJA 2008, p. 8).

considered. If it does change the ranking of the options then this would indicate that there is less robustness around the findings of the BCA. This would also place more emphasis on the indirect impacts, such as the social and environmental impacts, to determine whether the TCD is the preferred option.

There are a range of other assumptions adopted in the BCA that require further explanation. These include the timing of capital expenditure for all the options and the percentage of time the desalination plants included in any portfolio are operating.

Based on the information provided in the EIS documentation we believe that the economic analysis is not sufficiently robust to support the finding that the TCD is the best option to meet the SEQ water needs. In our view, there is sufficient likelihood that once some of the shortcomings are addressed that an alternative combination of measures, such as an additional desalination plant, could deliver similar (or higher) economic benefits to the community than the TCD. There is also a reasonable likelihood that the economic analysis may not provide a clear ranking of options. For example, the TCD may be the preferred option under some assumptions while a desalination plant portfolio may be preferred under other assumptions. Given this, the assessment of environmental and social impacts of the TCD is likely to play an important role in determining whether the TCD is the preferred option compared to other alternatives.

References

ACIL Tasman 2007a, *Scoping economic futures – Traveston Crossing Region: Future economic and business development scenarios,* Report for the Queensland Government, Department of State Development and Trade, February, Brisbane.

—— 2007b, *Commercial Water Use in South East Queensland: Three studies of the impact of reduced water supply,* Confidential report prepared for Queensland Water Infrastructure Pty Ltd, May, Brisbane.

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 (2007), *The Economic Impacts of Traveston Crossing Dam in South-east Queensland*, Report prepared for Queensland Water Infrastructure, Melbourne.

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

Department of Natural Resources, Mines and Water (2006), *Water for South East Queensland – A long term solution,* Brisbane.

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

Energy Edge (2008), *Comparative Cost of Energy: Traveston Dam and Sunshine Coast Desalinator*, Final Report for QWI Pty Ltd, Appendix C19 of the EIS Supplementary Report.

GHD Fichtner (2005), *Planning for Desalination,* Report for Sydney Water Corporation, July.

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, no. 256, March 2006, pp. 56-66.

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

Marsden Jacob Associates (MJA) 2007a, *An economic evaluation of the proposed Traveston Crossing Dam in South East Queensland*', Final Report prepared for the Queensland Water Infrastructure, September, Brisbane.

—— 2007b, 'The cost–effectiveness of rainwater tanks in urban Australia', *Waterlines,* a series of works commissioned by the National Water Commission on key water issues, March, Commonwealth of Australia, Canberra.

—— and MWH Australia Pty Ltd 2007, *Evaluation of ISF/Cardno report: 'Review of Water Supply-Demand Options for South East Queensland'*, Final Report prepared for the Queensland Water Commission, April, Brisbane.

MWA Environmental 2008, *Review of Traveston Crossing Dam Submission,* prepared for the Council of Mary Rivers Mayors, Brisbane.

PricewaterhouseCoopers 2007, *Economic Development Strategy: Traveston Crossing/Mary Valley Area,* Final Report prepared for the Queensland Department of State Development, April.

Queensland Department of Primary Industries and Fisheries (2007), *Food and Fibres Futures: Opportunities for stimulating agricultural development in the region of the proposed Traveston Crossing Dam,* Brisbane.

SKM and Queensland Water Infrastructure Pty Ltd 2007, *Traveston Crossing Dam Environmental Impact Statement*, October.

Synergies Economic Consulting 2007, *Traveston Crossing Dam: Social and Economic Impact*, March.

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

Water Services Association of Australia 2009, *WSAA Report Card 2008-09: Performance of the Australian Urban Water Industry and projections for the future,* August.

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