A CRITIQUE OF THE ECONOMIC VIABILITY OF THE BURNETT RIVER DAM DEVELOPMENT: PREDICTED LEVELS OF FUTURE WATER DEMAND ACCORDING TO IRRIGATORS' ABILITY TO PAY

REPORT TO THE QUEENSLAND CONSERVATION COUNCIL

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Dr. JOHN WARD

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1 EXECUTIVE SUMMARY

The Queensland Government has explored a strategy of increased construction of water infrastructure and impoundments for the Burnett River and surrounding environs. The approved Burnett River Dam water allocation and supply scheme is viewed as a means of stimulating regional economic development and as an extension, increased job creation and wealth. Increased levels of irrigated agricultural crop production resulting from the application of additional water are reported as the primary source of the accruing economic benefits.

As a signatory to the Council of Australian Governments (COAG) Water Reform Framework (COAG 1995), the Queensland Government is obliged to ensure that new rural water schemes are economically viable by achieving positive real rates of return, ecologically sustainable, adopt full cost, consumption based pricing regimes and eliminate direct and cross-subsidies.

Forecasts of the water use specific to water allocation scenarios in the Burnett Basin rely on cane production (and to lesser extent dairy and lucerne hay) as a source of substantial demand for future increased water supplies. The relatively low crop gross margins associated with cane production have been substantially eroded by depressed world sugar prices and exacerbated by a strengthening Australian dollar. Future depressed sugar and cane prices are forecast.

The focus of the analysis has been to:

1. Estimate the opportunity cost of infrastructure provision and the level of water pricing to ensure project compliance with the National Competition Council (NCC) and COAG guidelines for new rural water infrastructure;
2. Determine the ability to pay of users of water supplied at COAG compliant pricing levels, implying imputation of the opportunity costs of capital expended and the loss of habitat and ecosystem services;

3. Comment on the estimated regional social benefits for six water allocation scenarios, resulting from the allocation and use of additional water supplies supplied at full cost pricing.

A benefit cost analysis modelled over a range of internal rates of return, reflective of social time preferences, indicates that the cost of water supplied at COAG compliant water prices is greater than low value gross margins, precluding cane farmers, lucerne producers and, variably, dairy enterprises from purchasing additional water. The disincentive to purchase additional water applies to all water allocation scenarios modelled for 2000 and 2003-4 sugar-cane prices. Based on the results of the analysis, the ability to pay for water in the Burnett Basin supplied at COAG compliant prices is limited to those agricultural producers with gross margins in excess of those currently ascribed to cane producers.

Informed by world commodity prices and Queensland Treasury and Commonwealth performance criteria for publicly funded water infrastructure projects, the economic modelling of future water demand for the allocation scenarios is based on current and forecast cane prices, full water uptake over 10 years, full resource costing and a 7% internal rate of return. Similar results are reported for a 4% internal rate of return.

In all modelled water allocation scenarios the predicted water demand, conditioned by irrigators' ability to pay, is reduced to 42% - 55% of the levels estimated in analyses reported by Alliance Resource Economics (2000) and NECG (2001). The percentage of unaccounted for surplus water relative to the annual water yield remains highest in the 6Z and 7Z water allocation scenarios (58% in both cases). The Burnett River Dam scenario is characterised by a volume of unaccounted for surplus water greater than the predicted demand volume (surplus to yield proportion of 52%). The 5Y, 9X and 10X scenarios are characterised by the lowest surplus to yield proportions of 44%, 49% and 50% respectively.

Internal rates of return were estimated for a 10 year water take up period, the cost of water representing the annualised price of the property right to access water plus the supply cost (estimated at a 7% internal rate of return and accounting for construction and environmental costs) and the volume of available water determined by irrigators' ability to pay. According to the modelling attributes, irrigators must pay an annual supply cost for additional water of $273/ML, realising an internal rate of return of

2.9%. A 2.9% internal rate of return does not meet the performance criteria for the economic viability of publicly funded water infrastructure recommended by Queensland Treasury (1997, 2000) and the NCCOC (1998). In addition, a review of available literature, documentation and information has failed to reveal discussion of forward contracts for property right access and supply costs at pricing levels of this magnitude. Failure to achieve these minimum supply price levels and the water take up times by the water managing authority will result in further internal rate of return reductions.

The Burnett River Dam scenario is characterised by low internal rates of return, relatively high construction costs and volumes of unaccounted for, surplus water greater than estimated demand volumes. As a corollary, the reduced water demand will result in substantial reductions in the forecast regional economic benefits. The reduction in economic benefits remain unquantified. According to the economic performance criteria, proceeding with the Burnett River Dam cannot be supported and the development should be rejected or substantially redesigned. Similar results are reported for the high volume 6Z and 7Z scenarios.

Alternatively, despite relatively large proportions of surplus water, scenarios 9X and 10X are characterised by modelled internal rates of return of 4.0% and 5.9% respectively. Most of the estimated volumes of water demanded by the lower Burnett high value producers in the Burnett River Dam 6Z and 7Z scenarios are met by the surplus water estimated for the 9X and 10X scenarios. Under the modelling prescription and in open, competitive markets, surplus water will be allocated to high value users and the estimated economic benefits previously reported are likely to occur.

The conclusion from this analysis, based on available data, is that there is no reasonable expectation that the economic benefits arising from the low volume 9X and 10X scenarios will be exceeded by the high volume Burnett River Dam project. The conclusion is reinforced by the additional economic costs of construction and increased scale of inundation of the Burnett River Dam.

2 INTRODUCTION

In 1994, the Council of Australian Governments (COAG) endorsed a framework of initiatives for the water industry to run over a seven-year period. The framework covered water pricing reform based on the principles of consumption based pricing and full cost recovery, elimination of cross subsidies and, if occurring, ensuring the transparency of subsidies (COAG 1995). Also covered were issues on water allocation and entitlement, reform of irrigation systems, allocating water for environmental purposes and institutional reform (Industry Commission 1998). The State and Territory Governments are primarily responsible for managing water resources. In ratifying the COAG framework the States and Territories have agreed to stipulated water reform obligations and compliance initiatives, implemented and administered through their respective water authorities.

The recent National Competition Policy Water Reform Assessment Framework reinforces the guidelines articulated in the initial COAG document (NCC 2003). In relation to new rural water schemes, the COAG Water Reform Framework (COAG 1995) states:

> *Governments have agreed that all investments in new rural water schemes or extensions to existing schemes should be undertaken only after appraisal indicates that the scheme/extension is economically viable and ecologically sustainable (clause 3(d)(iii).*

The National Competition Council (2001a) recommends Governments should only provide economic assistance to new rural water schemes if the project has demonstrated a "*standalone*" economic viability. In appraising and determining a project's economic viability, Governments have committed to:

- *[t]he adoption of pricing regimes based an the principles of consumption-based pricing, full cost recovery and desirably the removal of cross subsidies which are not consistent with efficient service, use and provision (clause 3a(1)*;

- *[t]hat where service deliverers are required to provide water services to classes of customer at less than full cost, the cost of this be fully disclosed and ideally paid to the service deliverer as a community service obligation (clause 3a(ii)* and
- *[to] achieve positive real rates of return on the written-down replacement costs of assets in rural water supply by 2001, wherever practicable (clause 3a(iii)* (COAG 1995).

In addition, the National Competition Council (2001a) states that in determining the economic viability of new schemes, a project should demonstrate the ability to:

- Recover all administration, operational and maintenance costs;
- Recover the cost of capital;
- Account for and recover the economic value of environmental damage occurring as externalities.

Externalities will include (but are not limited to) the loss of habitat and ecosystem services as a result of inundation, the costs incurred in river management (at whole-of-catchment and regional scales), initial and on-going environmental monitoring, implementing management initiatives and the cost of allocating sufficient water to meet scientifically determined environmental flow targets.

The National Competition Council monitors and assesses the level of State compliance with the COAG water reform framework. For assessments of economic viability, the Council looks for all relevant economic, social and environmental costs and benefits to be factored into project-specific analysis (NCC 2003). A rigorous benefit cost analysis is relied on as the appropriate methodology for large rural water infrastructure developments and augmentations.

To factor in positive social time preferences, the document detailing the National Competition Council Policy assessment process (NCC 2003, p. 25, footnote 2) states "*viability assessments should discount cash flows using an appropriate rate such as a project specific weighted average cost of capital*".

The Queensland Government has explored a strategy of increased construction of water infrastructure and impoundments for the Burnett River and surrounding environs. The approved water allocation and supply scheme is viewed as a means of stimulating regional economic development and as an extension, increased job creation and wealth. The *Water Resource (Burnett Basin) Plan 2000 (*subordinate legislation to the *Queensland Water Act 2000*) details the management framework of future river and water use in the Burnett Basin. The purposes of the plan (*Water Resource (Burnett Basin) Plan 2000,* S2*,* p.5) are:

a) to define the availability of water in the plan area;

b) to provide a framework for sustainably managing water and the taking of water;

c) to identify priorities and mechanisms for dealing with future water requirements;

d) to provide a framework for establishing water allocations;

e) to provide a framework for reversing, where practicable, degradation that has occurred in natural ecosystems, including for example, stressed rivers**.**

In detailing the proposed future water allocations, made available through infrastructure developments, the Draft Resource Operations Plan for the Burnett Basin (DNRM 2002) prescribes arrangements for:

a) converting existing water entitlements to tradable water allocations;

b) infrastructure operations and water management;

c) reserving water for proposed infrastructure;

d) water and ecosystem monitoring;

e) amending the Resource Operations Plan to make new water entitlements available.

Based on extant scientific knowledge and social values, the prescribed balance of consumptive use and conservation is hoped to achieve a socially optimal outcome. As an economic measure, accruing benefits will outweigh incurred capital and environmental costs.

Initially five supplementary water allocation and supply scenarios for the Burnett Basin were proposed, resulting in variable water yields measured as megalitres (ML) (Alliance Resource Economics 2000). The Draft Resource Operation Plan (DNRM 2002) and NECG (2001) detail a future allocation scheme, now approved by the

Queensland Government, which relies on five major water impoundments including the augmentation of existing infrastructure. The Queensland Government's '*water infrastructure package*' consists of the Burnett River Dam (formerly Paradise Dam), Eidsvold Weir, raising of Ned Churchward Weir (formerly Walla Weir), Barlil Weir and Jones Weir. In the last State Budget the Government allocated $210 million for the dam with an initial $35 million budgeted for expenditure during the 2002-2003 financial year[1]. Dam construction is due to commence in November, 2003[2].

Existing reports of the economic impact of the schemes estimate a substantial flow of economic benefits to the Burnett regional economy (Alliance Resource Economics 2000, NECG 2001). An increase in the level of production of irrigated agricultural crops resulting from the application of increased water supplies are reported as the primary source of the accruing economic benefits.

The analyses reported in the two studies identify lucerne hay, dairy production and sugar cane as crops characterised by relatively low gross margins coupled with large water volume usage. Demand forecasts of future water allocations resulting from the proposed Burnett Basin water allocation schemes rely on cane production (and to a lesser extent dairy and lucerne hay) as a source of substantial demand for future increased water supplies.

Evidence from the Hilderbrand assessment of the sugar industry indicates depressed extant and forecast prices accruing to Australian cane producers, inclusive of those in the Burnett region (Hilderbrand 2002). In light of these findings, cane producers may not be able to pay for the additional irrigation water at prices which ensure project compliance with the COAG agreement. As a corollary, the reduced water demand may result in substantial reductions in the forecast regional economic benefits in addition to large volumes of unallocated surplus water.

The focus of this study is to comment on the estimated regional economic benefits of the water allocation development in the Burnett River Basin outlined in the NECG report (2001) and the Draft Resource Operation Plan (DNRM 2002). The demand

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[1] Queensland Government, State Budget 2002-03 Budget Statement Budget Papers 2 & 4

[2] Hon. T. A. BARTON, Ministerial Statement - Burnett River/Paradise Dam, 11th March 2003; Burnett Water Pty Ltd, Media Release. Also see http://www.sd.qld.gov.au/dsdweb/htdocs/global/content.cfm?id=12536 posted April 3rd 2003, which begins "The Minister for State Development, Tom Barton today announced that three world-class consortia have been selected to progress to the next stage of assessment to deliver the Burnett River Dam project."

estimates for future water are derived by imputing the likely water demand schedule of irrigators who are able to pay for additional water at COAG compliant full cost pricing. In addition, agricultural water demand is estimated for the five water allocation scenarios previously reported by Alliance Resource Economics (2000).

The benefit cost analysis employed to estimate agricultural water demand in the Burnett Basin relies on data compiled in existing studies and research (NECG 2001, Alliance Resource Economics 2000, DNR 2000, DNRM 2003).

This report sets out the methodology and results of an analysis which seeks to:

1. Estimate the opportunity cost of infrastructure provision and the level of water pricing to ensure project compliance with the NCC and COAG guidelines for new rural water infrastructure;
2. Determine the ability to pay of users of water supplied at COAG compliant pricing levels, implying imputation of the opportunity costs of capital expended and the loss of habitat and ecosystem services;
3. Comment on the estimated regional social benefits for the six water allocation scenarios, resulting from the allocation and use of additional water supplies supplied at full cost pricing.

The remainder of the report is set out in four sections. Section Three summarises the hydrological and physical capacities, estimated yields and capital expenditure of the water allocation scenarios reported in Alliance Resource Economics (2000) and the Burnet River Dam reported in NECG (2001). For each water allocation scenario, Tables included in the section detail the infrastructure, capacity, capital cost, water yield reliability and predicted annual water yield, disaggregated according to defined irrigation regions. The analytical framework for estimating annual water yield based on infrastructure yield reliability is also described.

Section Four describes the benefit cost methodology employed in this analysis to estimate the cost of additional water supplied at prices sufficient to comply with the COAG guidelines. Water supply costs are estimated at internal rates of return of 0%, 4%, 7% and 10.6% for each water allocation scenario. A description follows of factors that inform the benefit cost analysis. These are the determination of appropriate sensitivity analysis bounds for the discount rate, the data sources and imputation of estimated economic costs of inundation and the scenario-specific economic benefits (dam revenues from water access property right and annual water sales) and costs (construction and annual operational expenditure). In accordance with the previous water allocation scenario reports and Queensland Treasury (2000) a project time horizon of 30 years is adopted. The economic modelling framework, including the predicted dam budgets for a 10 year demand based and four year supply based water take-up is detailed in the section. Tables summarise the COAG compliant cost of water supply and water access property rights, derived for the four internal rates of return.

Section Five describes the methodology employed to determine the ability of irrigators to pay for access to and the annual supply of water delivered at the estimated COAG compliant supply prices. A decision rule, based on the difference between the compliant cost of additional water and the gross margins of crops in the Burnett Basin is used to establish irrigator's ability to pay. Cane production in the Burnett Basin is characterised by a relatively low crop gross margin and identified as a source of substantial demand for future increased water supplies. The likelihood of cane producers' ability to pay for additional water, conditioned by current and forecast cane prices is discussed. A table details the results of the applied decision rule for the water allocation scenarios.

Tables in Section Six detail the agricultural enterprise for each irrigation region, the predicted demand for water based on users' ability to pay, the crop gross margin and the total margin for agricultural production for the six water allocation scenarios. Comments and discussion of the findings concludes the main body of the report. Samples of net present value worksheets for the water allocation scenarios and the computational methodology are included in the Appendix.

3 WATER ALLOCATION SCENARIOS FOR THE BURNETT RIVER BASIN

Existing reports have analysed and reported on the economic impacts of several water allocation and supply scenarios proposed for the Burnett River Basin, characterised by various combinations of weir and dam construction and subsequent volumes of additional irrigation water. The NECG (2001) report analyses one major water allocation scenario supplying an additional 173,895 ML (167,895 excluding estimated transmission losses) to agriculture. The CARE (2000) report estimates the regional input/output economic impacts of nine scenarios ranging in additional water supplies of 40,000 Ml to 298,000 ML.

The economic analysis of this study evaluates the Burnett River Dam allocation scheme detailed in the NECG report (2001) together with the five water allocation and supply scenarios reported by Alliance Resource Economics (2000) and DNRM (2003). The scenarios include water allocation and supply scenarios of varying scale for the Burnett River basin, inclusive of the Burnett River system, Kolan River system and the Gregory, Isis and Elliott River system.

Table 1 summarises the additional volumes of irrigation water ensuing from the six water allocation scenarios, classified according to the four main irrigation districts of the Burnett River Basin. They are the Northern, Central, Southern and Lower regions. The north Burnett is comprised of Three Moon and Moral Creeks, the Central of the Nogo and Burnett Rivers, the Southern the Boyne and Stuart Rivers and the Lower Burnett is comprised of the Burnett and Kolan Rivers.

Table 1 Regional volumes of additional agricultural water for six water allocation scenarios for the Burnett River Basin

	Water allocation scenario (ML/annum)					
Burnett River Basin Region	*Scenario 9X	*Scenario 10X	*Scenario 5Y	*Scenario 6Z	*Scenario 7Z	#Burnett River Dam
North	6,000	3,000	5,000	5,000	3,000	0
Central	31,300	21,500	37,000	26,300	21,500	28,400
Southern	7,100	7,100	7,100	7,100	7,100	6,000
Lower	28,500	42,000	61,100	131,000	139,000	139,495
Total	72,900	73,600	110,200	169,400	170,600	173,895

(Source: *Alliance Resource Economics 2000 p. 2; #NECG 2001 p.21)

3.1 ESTABLISHING THE WATER YIELD AND RELIABILITY

The reliability of water supply is an important consideration when estimating the economic impacts of irrigated agriculture. NECG (2001, p. 19) reports the percentage of actual yearly allocation compared to nominal allocation in the Burnett River Basin ranges from 30% to 100% in the period 1999/2000. The annual allocation reliability in the Bundaberg region is reported as ranging from 30% to 120% in the period from 1993/1994 to 1999/2000. Transmission losses in the Burnett Basin are reported as 21% (NECG 2001, p. 38). It is assumed in this analysis that allocation reliability and transmission losses have been accurately factored into the available water yields estimated for the six development scenarios.

Table 2 details the storage location, capacity, construction cost and actual yearly water yield imputed in the analysis for the Burnett River Dam water allocation scenario. In Table 2, (C) represents the Central, (S) the Southern and (L) the lower irrigation districts.

Table 2 Location, capacity, construction costs and actual water yield of the approved Burnett River Dam scenario

Scenario Approved Structure (Region)	Additional capacity (Ml/yr)	Capital cost ($'000)	Construction Pattern (year of construction, % of cost)	Yield Reliability (proportion)	Actual Yield (ML/yr)
Eidsvold (C)	10,280	18,600	3 (100%)	N/R	23,800
Jones Weir (C)	2,745	5,900	1 (100%)	N/R	4,600
Barlil Weir (S)	1,100	2,800	1 (100%)	N/R	6,000
Walla Weir (L)	13,875	5,200	1 (100%)	N/R	15,295
Burnett River Dam	300,000	168,000	2 (50%), 3-4 (25%)0	N/R	124,200
Total	328,000	200,500			[a]167,895

N/R: not reported (Source NECG 2001)
[a] Yield is 173,895 ML less 6,000 ML on-farm transmission loss

Alliance Resource Economics (2000) reports the expected water yields for five water allocation scenarios. The water yield reliability is factored into the analysis as either full supply or supply failure per annum. For example, a reliability factor estimated at 50% results in every other year being imputed as a complete failure of supply. A reliability factor of 99% implies one year out of one hundred is characterised by supply failure.

Using the same reported reliability factors of the proposed water allocation scenarios, this analysis adopts a different imputation method. Given the inherent uncertainty of climate, predicting a representative year when failure may occur is necessarily arbitrary and ad hoc. The magnitude of derived net present values will partially be a function of the imputed supply failure year when discounting the future benefits and costs of the scenarios. Thus designating year 1 as a supply failure in a water storage with a reliability factor of 99% will result in a lower net present value compared to imputation of failure in year 99. Additionally, in a 30 year time horizon, the year of supply failure may not enter the net present value calculation. This analysis assumes that water allocation reductions due to yield reliability are equally incurred throughout the project's time horizon of 30 years and factored into the analysis accordingly. Thus a water storage yield of 18,000 ML, with a supply reliability of 50% is imputed as 9,000 ML per annum compared to 18,000 ML and 0 ML in alternate years.

Tables 3-7 detail the storage location, capacity, construction cost and actual yearly water yield imputed in the analysis for each scenario. In the Table, (N) represents the Northern irrigation district, (C) the Central, (S) the Southern and (L) the lower irrigation districts.

Table 3 Location, capacity, construction costs and actual water yield of water allocation scenario 9X

Scenario 9X Structure (Region)	Capacity (Ml/yr)	Capital cost ($'000)	Construction Pattern (year of construction, % of cost)	Yield Reliability (Ml/yr)	Yield Reliability (proportion)	Actual Yield (ML/yr)
W/H North (N)	6,000	6,000	0	6,000	0.50	3,000
Eidsvold (C)	10,280	12,000	1 (100%)	18,500	0.99	18,315
Auburn Weir (C)	7,000	5,500	1 (100%)	5,000	0.99	4,950
Jones Weir (C)	6,400	5,900	1 (100%)	4,800	0.99	4,752
W/H Central (C)	6,000	3,000	0	3,000	0.50	1,500
Barlil Weir (S)	1,100	2,800	1 (100%)	4,100	0.89	3,649
W/H South (S)	6,000	3,000	0	3,000	0.50	1,500
Walla Stage II (L)	10,000	5,200	1 (100%)	10,000	0.99	9,900
Ben Anderson Barrage (L)	3,515	3,500	1 (100%)	5,500	0.99	5,445
W/H (L)	13,000	13,000	0	13,000	0.50	6,500
Total	69,295	59,900		72,900		59,511

Adapted from Alliance Resource Economics (2000)

Table 4 Location, capacity, construction costs and actual water yield of water allocation scenario 10X

Scenario 10X Structure (Region)	Capacity (ML/yr)	Capital cost ($'000)	Construction Pattern (year of construction, % of cost)	Yield Reliability (ML/yr)	Yield Reliability (proportion)	Actual Yield (ML/yr)
W/H North (N)	0	3,000	1 (100%)	3,000	0.50	1,500
Eidsvold (C)	10,280	12,000	1 (100%)	18,500	0.99	18,315
W/H Central (C)	0	3,000	1 (100%)	3,000	0.50	1,500
Barlil Weir (S)	1,100	2,800	1 (100%)	4,100	0.89	3,649
W/H South (S)	0	3,000	1 (100%)	3,000	0.50	1,500
Degilbo Dam (L)	100,000	30,000	1 (40%) and 2 (60%)	32,000	0.99	31,680
Walla Stage II (L)	10,000	5,200	1 (100%)	10,000	0.99	9,900
Total	121,380	59,000		73,600		68,044

Adapted from Alliance Resource Economics (2000)

Table 5 Location, capacity, construction costs and actual water yield of water allocation scenario 5Y

Scenario 5Y Structure (Region)	Capacity (Ml/yr)	Capital cost ($'000)	Construction Pattern (year of construction, % of cost)	Yield Reliability (Ml/yr)	Yield Reliability (proportion)	Actual Yield (ML/yr)
W/H North (N)	5,000	5,000	0	5,000	0.50	2,500
Eidsvold (C)	10,280	12,000	1 (100%)	18,500	0.99	18,315
Cooranga Weir (C)	5,350	12,000	1 (100%)	10,700	0.99	10,593
Jones Weir (C)	6,400	5,900	1 (100%)	4,800	0.99	4,752
W/H Central	3,000	3,000	0	3,000	0.50	1,500
Barlil Weir (S)	1,100	2,800	1 (100%)	4,100	0.89	3,649
W/H South (S)	3,000	3,000	1 (100%)	3,000	0.50	1,500
Degilbo Dam (L)	150,000	35,800	1 (40%) and 2 (60%)	40,600	0.99	40,194
Walla Stage II (L)	10,000	5,200	1 (100%)	10,000	0.99	9,900
Ben Anderson Barrage (L)	3,515	3,500	1 (100%)	5,500	0.99	5,445
W/H (L)	5,000	5,000	1 (100%)	5,000	0.50	2,500
Total	202,645	93,200		110,200		100,848

Adapted from Alliance Resource Economics (2000)

Table 6 Location, capacity, construction costs and actual water yield of water allocation scenario 6Z

Scenario 6Z Structure (Region)	Capacity (Ml/yr)	Capital cost ($'000)	Construction Pattern (year of construction, % of costs)	Yield Reliability (Ml/yr)	Yield Reliability (proportion)	Actual Yield (ML/yr)
W/H North (N)	3,000	3,000	0	5,000	0.50	2,500
Eidsvold (C)	10,280	12,000	1 (100%)	18,500	0.99	18,315
Cooranga/Jones Weir C	6,400	5,900	1 (100%)	4,800	0.99	4,752
W/H C	3,000	3,000	0	3,000	0.50	1,500
Barlil Weir (S)	1,100	2,800	1 (100%)	4,100	0.89	3,649
W/H (S)	3,000	3,000	0	3,000	0.50	1,500
Paradise Dam (L)	300,000	171,700	1 (25%), 2 (50%), 3 (25%)	131,000	0.99	129,690
Total	326,780	201,400		169,400		161,906

Adapted from Alliance Resource Economics (2000)

Table 7 Location, capacity, construction costs and actual water yield of water allocation scenario 7Z

Scenario 7Z Structure (Region)	Capacity (Ml/yr)	Capital cost ($'000)	Construction Pattern (year of construction, % of costs)	Yield Reliability (Ml/yr)	Yield Reliability (proportion)	Actual Yield (ML/yr)
W/H North (N)	3,000	3,000		3,000	0.50	1,500
Eidsvold (C)	10,280	12,000	1	18,500	0.99	18,315
W/H (C)	3,000	3,000		3,000	0.50	1,500
Barlil Weir (S)	1,100	2,800	1	4,100	0.89	3,649
W/H (S)	3,000	3,000		3,000	0.50	1,500
Paradise Dam (L)	300,000	171,700	1 (25%), 2 (50%), 3 (25%)	129,000	0.99	127,710
Walla Stage II (L)	10,000	5,200	3	10,000	0.99	9,900
Total	330,380	200,700		170,600		164,074

Adapted from Alliance Resource Economics (2000)

Table 8 summarises the estimated additional water from the five infrastructure scenarios available to irrigators in the four irrigation regions of the Burnet River Basin. The Total water noted in the table represents the aggregate volume of annual water available to the four regions when the yield reliability loss is factored equally throughout the projects time horizon of 30 years.

Table 8 Summary of annual regional water allocations for six infrastructure proposals in the Burnett River Basin determined according to estimated yield reliability

Scenario	Available water Northern (ML)	Available water Central (ML))	Available water Southern (ML)	Available water Lower (ML)	Total water (ML)
9X	3,000	29,517	5,149	21,845	59,511
10X	1,500	19,815	5,149	41,580	68,044
5Y	2,500	35,160	5,149	58,039	100,848
6Z	2,500	24,567	5,149	129,690	161,906
7Z	1,500	19,815	5,149	137,610	164,074
Burnett River Dam	0	28,400	6,000	140,495	[a]167,895

[a] Yield of 167,895 representing. 173,895 ML less 6,000 ML on-farm transmission loss

4 BENEFIT COST ANALYSIS METHODOLOGY

Benefit cost analysis embodies the notion that economic decisions should be based on weighing up the advantages and disadvantages of a development project. Its principal use is to provide techniques for identifying, quantifying and comparing the factors that must be considered when choosing between alternative actions in the public sector, often characterised by a complex array of resource and social characteristics. Although it is similar in form to private sector capital budgeting, benefit cost analysis differs principally in the broader range of costs and benefits considered, including those costs and benefits associated with the environment. It is concerned with social welfare and uses the social opportunity costs of inputs and the social benefits of outputs.

The objective of a benefit-cost analysis is to assist the decision-making process to determine an outcome which is consistent with the efficient allocation of resources in areas where, for one reason or another, private markets cannot or do not achieve this outcome. Benefit cost analysis attempts to convert a complex array of resource characteristics, specified for a project or resource utilization (including the time constraints), into the common metric of money, enabling meaningful comparison and objective decision-making.

The benefit cost analysis of the six water allocation scenarios aims to:

1. Determine the opportunity cost of infrastructure provision and the subsequent level of water pricing to ensure project compliance with the NCC and COAG guidelines for new rural water infrastructure;
2. Determine the ability to pay of users of water supplied at COAG compliant pricing levels, compensating in full the opportunity costs of publicly funded capital and environmental impact.

4.1 ESTABLISHING THE APPROPRIATE DISCOUNT RATE

To facilitate objective decision making, benefit cost analysis relies on the commonly generated decision criteria of net present value and in this case the internal rate of return. Net present value measures future benefits and costs as a single present-day dollar value. Future benefits and costs are calibrated and weighted to present day values by discounting at a rate which is in accord with the prevailing social time preference[3] (a positive time preference implies that individuals prefer benefits now rather than later). In most cases this value is positive, although for natural resource depletion the choice of an appropriate discount rate remains contentious (Hanley and Spash 1993, Kula 1994). Assuming all benefits and costs over the project's time horizon have been accounted for, a positive net present value indicates the project confers an improvement in social welfare. Project alternatives are ranked according to their net present value. A higher net present value is commensurate with a higher social benefit.

The internal rate of return represents the value of the discount rate such that project benefits equal project costs. A project's internal rate of return that is higher than the prevailing social discount rate is commensurate with a positive social benefit.

Discount rates employed in the analysis represent the range of rates recommended by Queensland State Treasury (Queensland Treasury 1997, 2000), Commonwealth Competitive Neutrality Complaints Office (CCNCO) (1998) and those specified by the then Department of Natural Resources for the Burnett River Project (DNR 2000a).

Queensland State Treasury has produced a set of guidelines for the evaluation of projects involving Government funds and investment in new rural water infrastructure (Queensland Treasury 1997, 2000). The Treasury recommends a test discount rate of 6% with sensitivity bounds of 4% and 8% (*ibid* p. 12).

The Commonwealth Competitive Neutrality Complaints Office, a subsidiary of the Productivity Commission, details the weighted average cost of capital (WACC) method for determining discount rates commensurate with National Competition Council policy for rural water pricing. The WACC method relies on the general commercial practice of setting a business return such that revenues exceed costs,

[3] The discount rate represents the cost to consumers (and their expected level of reward) of abstinence from present day consumption, by postponing that consumption to some future date. Producers, via the opportunity cost of capital, similarly treat the future as less important than the present. The prevailing wisdom is that the appropriate discount rate is the utility discount rate plus the elasticity of the marginal utility of consumption times the consumption growth rate. Countervailing views remain however (see *inter alia* Hanley and Spash 1993, Kula 1994, Stiglitz 1994). As Dasgupta (1982) notes even if there exists a zero pure time preference, future costs and benefits are still discounted if consumption is growing. For comparative purposes, this analysis adopts a conventional approach of selecting sensitivity bounds that attempt to reflect alternate versions of the appropriate scale of the consumer time preference.

including accounting for the costs of variable levels of debt and equity. Ensuring Government enterprises adequately account for the cost of financial capital, with due allowance for appropriate levels of risk, and therefore earning a commercial rate of return on assets, removes any unfair competitive advantage and subsequent market distortions. That is Government enterprises must seek to fund projects with an expected return on capital invested equivalent to those deemed sufficient for private companies investing in the same infrastructure (CCNCO 1998).

The method is detailed by the Commonwealth Competitive Neutrality Complaints Office (1998, p.6). The CCNCO recommends a rate equivalent to the value of the current Commonwealth 10 year bond plus five percentage points for developments associated with medium risk. Development of rural water infrastructure is described by a medium risk factor, *viz*. a beta value of 0.6, (CCNCO 1998, p.10). Employing this method results in a current recommended discount rate of 10.4% (Commonwealth Bond Rate of 5.4% as at 15/4/03).

The Department of Natural Resources (DNR 2000a) has adopted the WACC methodology in recommending a discount rate for economic studies of the Burnett Basin Water Resource Plan of 9.1%. Adherence to the CCNCO guidelines outlined to account for the unreliability of risk assessment[4] would have resulted in a discount rate of approximately 11.24% (bond rate of 6.24%) or 10.4% based on current bond rates of 5.4%.

A recent economic feasibility study of the Meander Dam in Tasmania, used a discount rate of 10.6% by adopting the WACC determination, (Davey and Maynard, Deloitte Touche Tohmatsu, Serve-AG 2002).

[4] CCNCO(1998, p.7) argues that the apparent precision in setting the risk loading inferred in the WACC method is somewhat illusory due the difficulty in reliably establishing risk coefficients. In mitigating this unreliability, CCNCO recommends the use of a generalised risk index, compiled for selected Australian industries (CCNCO 1998, p.10). Hence the applied beta coefficient of 0.6 (medium risk assessment for infrastructure and utilities) and the suggested general formula of the current bond rate plus five percentage points.

This analysis adopts discount rates of 4%, 7% and 10.6%, based on the described government recommendations and contemporary benefit cost analysis of Australian rural water infrastructure proposals[5].

4.2 DETERMINING THE ECONOMIC COST OF ENVIRONMENTAL LOSS

The Draft Water Allocation and Management Plan (DNRM 2003) reports the quantification and estimated economic cost of environmental damage occurring as a result of the proposed water allocation developments. The economic cost of environmental damage for the initial construction phase (Year 1) are calculated as the area of inundation multiplied by a scalar representing the economic value of vegetation classified as high and medium value. High value vegetation loss incurs a loss of $100,000 per hectare, medium value vegetation a loss of $60,000 per hectare (DNRM 2003). The cost of environmental impact statements and initial assessments are included in the Year 1 values. Recurrent yearly costs are project specific, representing the economic costs of implementing an environmental management plan and ongoing monitoring and evaluation. The Draft Burnett Basin Resource Operations Plan (DNRM 2002) specifies the environmental monitoring and assessment regimes and river management performance criteria and metrics.

The environmental costs employed in this analysis only estimate the direct loss of habitat in the inundation zones, excluding downstream environmental impacts. The environmental impact statements contained in the Draft Burnett Basin Water Allocation and Management Plan (DNR 2000) report potential detrimental effects on downstream floral and faunal assemblages and communities. The imputed costs in this analysis are therefore likely to be under-estimates of the aggregate economic cost of environmental damage and subsequent management.

NECG (2001) do not report or include data facilitating estimates of environmental damage due to water allocation development. The scale and location of the

[5] In evaluating the Burnett River water proposals, NECG (2001) propose that the risk free rate of interest is the best basis for determining the social discount rate. This is in accord with Arrow and Lind (1970), who argue the risk adjusted rate for public sector projects should be lower than that of private sector projects. This is due to risk spreading, *viz*. the risk is spread throughout the larger numbers of risk-bearers of society, reducing the level of risk borne by individuals. However, when joint private and public funding of a project is proposed, the choice of an appropriate rate may become further confounded.

infrastructure and the capacities and available water yields are similar to scenario 7Z, in particular the Burnett River Dam (formally the Paradise Dam), the Eidsvold Weir, The Barlil Weir and Ned Churchward Weir (formally Walla Weir). Perforce, the economic cost estimates of inundation for scenario 7Z, as set out in the Draft Burnett Basin Water Allocation and Management Plan (DNRM 2003), are assumed to be commensurate and transferable for the approved Burnett River Dam scenario.

Table 9 summarises the economic evaluation of Year 1 and recurrent costs of environmental damage for each proposal.

Table 9 Summary of estimates of the economic costs of environmental damage for six water allocation scenarios in the Burnett Basin

	Scenario 9X	Scenario 10X	Scenario 5Y	Scenario 6Z	Scenario 7Z	Burnett River Dam
Year 1 ($ '000)	11,630	34,510	38,070	131,350	130,700	130,700
Recurrent costs ($ '000/year)	780	680	1,210	790	840	840

Source: DNRM (2003)

4.3 MODELLED ECONOMIC BENEFITS AND COSTS

Calculation of Benefits

Benefits accruing in Years 1-10 for the demand-based model are calculated as:

$$\mathbf{0.1\ (\mathit{Wy} \times \mathit{Cc}) + 0.1\mathit{t}\ (\mathit{Wy} \times \mathit{Sw})}$$

Benefits accruing in Years 1-4 for the supply-based model are calculated as:

$$\mathbf{0.25\ (\mathit{Wy} \times \mathit{Cc}) + 0.25\mathit{t}\ (\mathit{Wy} \times \mathit{Sw})}$$

Where:

t equals the number of the year of the project

Wy represents the imputed water yield specific for each scenario (ML)

Cc represents the capital cost per ML of the infrastructure ($/ML)

Sw represents the dollar value of water sold, ($/ML) at a baseline opportunity cost of ***Cc* + *Ec***

Where:

Ec equals the estimate of environmental cost at year 1 ($'000)

Benefits accruing in Years 11-30 for the demand-based model and Years 4-30 in the supply-based model are calculated as:

$$\boldsymbol{Wy \times Sw}$$

Calculation of Costs for the 10 year and four year water take up models

Costs incurred in Year 1 in the model are calculated as:

$$\boldsymbol{Cc + Ec}$$

Construction costs (***Cc***) incurred in Years 2-3 are imputed in the model as specified in Tables 2-7

Supply Costs incurred in Years 4-30 in the model are calculated as

$$\boldsymbol{(Wy \times Sc)}$$

Where:

Sc represents the estimate of the supply cost of water ($/ML), in this case $43/ML

This analysis has modelled a water supply framework predicated on the assumption that water allocation scenarios must comply with COAG guidelines for new rural water infrastructures.

The model sets the value of the property right to gain water access as a constant, varying the water price to realise internal rates of returns of 4%, 7% and 10.6% for the project time horizon of 30 years. The water access property right cost per ML is commensurate with the capital expenditure of the scenario-specific infrastructure only, exclusive of environmental cost estimates.

Based on available data (DNRM 2003), the modelled price of water represents full cost accounting, and therefore includes the estimated environmental costs of inundation occurring in Year 1. The NECG report (2001) states that a water supply cost of $43/ML is inclusive of an estimated annual environmental monitoring and assessment cost of $800,000 for the Burnett River Dam water allocation scenario. Therefore, for the economic modelling of the Burnett River Dam scenario, 9X, 10X, 6Z and 7Z, revenue derived from water sales is assumed to be allocated to and compensate for the recurrent costs of environmental monitoring and assessment of Years 2-30. DNRM (2003) estimates the recurrent annual monitoring costs of scenario 5Y at $1.21 m. The approximate difference of $400,000 per annum between the Burnett River Dam monitoring allowance and the DNRM estimate is included in the net present value estimates.

For each internal rate of return, the modelling framework simulates either the mean of market derived water prices or an imposed reserve price, achieved for example through a competitive auction system. The values reported are the minimum thresholds necessary to realize the modelled internal rates of return.

The net present value (NPV) model assumes the irrigator's initial purchase price of the water access property right to each ML of allocated water is constant. Revenue accruing to the managing authority from the sale of water access property rights ($Wy \times Cc$) is assumed to be evenly amortised throughout the water take-up period (10 years and four years respectively for the demand and supply based scenarios). That is the revenue from water access property right sales is 10% (or 25%) of the total capital expenditure for each year of the take-up period, after construction is completed. Revenue accruing from water sales ($Wy \times Sw$) is commensurate with the same take up trajectory. That is water sales revenue from Year 1 equals 10% (or 25%) of the forecast water yield, Year 2 equals 20% (or 50%), Year 3 equals 30% (or 75%) and so on.

The price of water is estimated such that the internal rate of return at year 30 equals, 0%, 4%, 7% and 10.6%, reflecting the bounds of the discount rate sensitivity analysis.

Modelled costs represent the construction and environmental costs specific to each scenario. The value and timing of construction costs are set out in Tables 3-7. Environmental costs are set out in Table 9.

NECG (2001, pp. 23-24) reports a water delivery cost of $43/ML for the Burnett Basin, weighted as an average cost for regional supply in 2004/2005. The $43/ML cost of delivering water in the Burnett Basin is applied for all the water allocation scenarios.

The model assumes that the operational and management costs (*viz*. supply costs of $43ML times the scenario-specific total water yield), are constant after completion of the construction phase, regardless of the demand for water.

In accordance with Alliance Resource Economics, the model assumes that the majority of irrigators will be unable to fund the water access property right purchase from existing cash reserves, necessitating bank finance. 2000-2001 debt levels of sugar cane producers (Hilderbrand 2002, p.12) has increased by $152m from $1,028m at 31st December 1999, to $1,179m at 31st December 2001. Approximately 42% of cane producers were borrowers with an average debt of $428,000. Hilderbrand (2002, p.12) notes that a

> *"…[s]ignificant number of borrowers have moved from being classed as 'considered viable under most/all circumstances' to being classed as 'considered potentially viable in the long term but are experiencing debt servicing difficulties' (170) and 'experiencing debt servicing difficulties and a deteriorating debt situation, but with continuing support from lenders' (474)."*

The documented cane production costs of $30.84/tonne and $35.30/tonne in Central and South Queensland respectively (Hilderbrand 2002) are substantially higher than the current cane price of approximately $21-22/tonne[6]. Forecast downward price trends (see this document, footnote 5) are expected to exacerbate the prevailing cane producers' debt levels.

Finance is imputed at a 7% interest rate compounding weekly, with monthly payments, inclusive of principal, over a loan term of 25 years. The total finance cost of the water access property right for each ML is amortized for the 25 loan year period, generating a value expressed as $/ML/annum. The total cost incurred by user's of future water allocations is comprised of the cost of the water access property right to the allocation ($/ML/year) plus the estimated COAG compliant water price at the modelled internal rates of return ($/ML/year).

4.4 COAG COMPLIANT WATER SUPPLY COSTS

Table 10 summarises for the Burnett River Dam scenario and includes the estimates of the water supply costs of the infrastructure only (A) and infrastructure plus environmental costs (A+B) at internal rates of return of 0%, 4%, 7% and 10.6%. The

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[6] See Queensland Sugar (as at 1/5/03) http://www.queenslandsugar.com.au/ and New York Coffee and Sugar exchange http://www.csce.com/

exclusion of the economic value of environmental costs contravenes the COAG guidelines; it is included in the analysis as a baseline value in recognition of the variability of the economic estimates of non-market values. 0% is also tabled as a baseline value.

Tables 11-15 summarise the cost of property rights, the compliant water supply cost and the aggregate water cost for five water allocation scenarios.

Table 10 COAG compliant water supply prices of the Burnett River Dam scenario at internal rates of return of 4%, 7% and 10.6%

Costs: A $200,500,00 B $130,700,00 Yield: C [c]167,895ML/yr	Burnett River Dam (Govt commitment) Opportunity cost of infrastructure at Year 1[a]: $1194/ML, [b]Loan value $ 2,535/ML, Annual cost $ 101/ML/year			
	10 year demand based water take up		4 year supply based water take up	
Value of IRR	Supply price ($/ML/year)	[d]Total cost ($/ML/year)	Supply price ($/ML/year)	Total cost ($/ML/year)
0% (A+B)	83	194	74	175
4% (A+B)	125	226	98	199
4% (A)	66	167	48	149
7% (A+B)	172	273	122	223
7% (A)	83	194	51	152
10.6% (A+B)	246	247	156	257
10.6% (A)	111	212	55	156

Note: A represents infrastructure costs; B represents environmental costs of Year 1, C equals the annual available yield of the project, subject to reliability constraints noted in Table 2 (source: A, C: NECG 2001; B: DNR 2003)

[a] Opportunity cost of infrastructure only, excluding environmental costs ÷ yield

[b] Loan value equals principal+interest determined at 7% interest rate, monthly payments, compounding weekly over 25 year loan period. Annual cost equals loan value ÷ 25.

[c] Yield 173,895 ML less 6,000ML on farm transmission losses.

[d] Total cost is calculated as the aggregate of the property right costs plus the water supply price

Table 11 COAG compliant water supply prices of scenario 9X at internal rate of returns of 4%, 7% and 10.6%

Costs: A \$59,900,000 B \$11,630,000 Yield: C 59,511 ML/yr	Scenario 9X Opportunity cost of infrastructure at Year 1[a]: \$1006/ML, [b]Loan value \$ 2,136/ML, Annual cost \$ 85/ML/year			
	10 year demand based water take up		4 year supply based water take up	
Value of IRR	Supply price (\$/ML/year)	Total cost (\$/ML/year)	Supply price (\$/ML/year)	Total cost (\$/ML/year)
0% (A+B)	63	148	56	141
4% (A+B)	92	177	71	156
7% (A+B)	128	213	89	174
10.6% (A+B)	187	272	116	201

Note: A represents infrastructure costs; B represents environmental costs of Year 1, C equals the annual available yield of the project, subject to reliability constraints noted in Table 2 (source: A, C: Alliance Resource economics 2001; B: DNR 2003)

[a] Opportunity cost of infrastructure only, excluding environmental costs ÷ yield

[b] Loan value equals principal+interest determined at 7% interest rate, monthly payments, compounding weekly over 25 year loan period. Annual cost equals loan value ÷ 25.

[c] Yield 173,895 ML less 6,000ML on farm transmission losses.

[d] Total cost is calculated as the aggregate of the property right costs plus the water supply price

Notes also apply to Tables 12-15.

Table 12 COAG compliant water supply prices of scenario 10X at internal rate of returns of 4%, 7% and 10.6%

Costs: A \$59,000,000 B \$34,510,000 Yield: C 68,044 ML/yr	Scenario 10X Opportunity cost of infrastructure at Year 1[a]: \$867/ML, [b]Loan value \$ 1842/ML, Annual cost \$ 74/ML/year			
	10 year demand based water take up		4 year supply based water take up	
Value of IRR	Supply price (\$/ML/year)	Total cost (\$/ML/year)	Supply price (\$/ML/year)	Total cost (\$/ML/year)
0% (A+B)	70	144	63	137
4% (A+B)	103	177	81	155
7% (A+B)	143	217	102	176
10.6% (A+B)	204	278	133	207

Table 13 COAG compliant water supply prices of scenario 5Y at internal rate of returns of 4%, 7% and 10.6%

Costs: A $93,200,00 B $38,070,000 Yield:D100,848 ML/yr	Scenario 5Y Opportunity cost of infrastructure at Year 1[a]: $924/ML, [b]Loan value $ 1962/ML, Annual cost $ 78/ML/year			
	10 year demand based water take up		4 year supply based water take up	
Value of IRR	Supply price ($/ML/year)	Total cost ($/ML/year)	Supply price ($/ML/year)	Total cost ($/ML/year)
0% (A+B)	61	139	55	133
4% (A+B)	92	167	71	149
7% (A+B)	126	204	89	167
10.6% (A+B)	184	262	115	193

Table 14 COAG compliant water supply prices of scenario 6Z at internal rate of returns of 4%, 7% and 10.6%

Costs: A $201,000,000 B $131,350,000 Yield C 161906 ML/yr	Scenario 6Z Opportunity cost of infrastructure at Year 1[a]: $1241/ML, [b]Loan value $ 2634/ML, Annual cost $ 105/ML/year			
	10 year demand based water take up		4 year supply based water take up	
Value of IRR	Supply price ($/ML/year)	Total cost ($/ML/year)	Supply price ($/ML/year)	Total cost ($/ML/year)
0% (A+B)	81	186	72	177
4% (A+B)	128	213	99	204
7% (A+B)	180	285	127	232
10.6% (A+B)	265	370	169	274

Table 15 COAG compliant water supply prices of scenario 7Z at internal rate of returns of 4%, 7% and 10.6%

Costs: A $200,700,000 B $130,700,00 Yield:C 164,074 ML/yr	Scenario 7Z Opportunity cost of infrastructure at Year 1[a]: $1223/ML, [b]Loan value $ 2598/ML, Annual cost $ 104/ML/year			
	10 year demand based water take up		4 year supply based water take up	
Value of IRR	Supply price ($/ML/year)	Total cost ($/ML/year)	Supply price ($/ML/year)	Total cost ($/ML/year)
0% (A+B)	80	184	71	175
4% (A+B)	125	229	98	202
7% (A+B)	177	281	125	229
10.6% (A+B)	260	364	166	270

5 DETERMINING IRRIGATORS' ABILITY TO PAY USING CROP GROSS MARGINS

Determining a metric to determine irrigator's ability to pay for supplementary water made available by the six water allocation scenarios relies on estimated gross margins specific for each crop in the Burnett Basin. The CARE report (2000) details the original data, analysis and estimation for crops in the four irrigation districts of the Burnett Region. Gross margins estimate a crop specific dollar value per unit (either spatial or in this case volumetric) where the variable costs of production are subtracted from crop revenues. Variable costs include cultivation, planting, irrigation costs, fertilizer application, weed and pest control, casual labour, harvesting, packing, marketing and freight. Indicative Gross Margins for crops in the Burnett Basin are reported in Table 16. Alliance Resource Economics (2000) and NECG (2001) rely on the same gross margins, derived from the initial estimates by CARE (2000).

Table 16 Gross margins of selected irrigated crops in the Burnett basin

Crop	Water applied ML/ha	Gross margin $/ha	Gross margin $/ML
Beans	1.25	1460	1168
Capsicum (red)	3.5	30580	8737
Rockmelon	2.5	6096	2438
Tomatoes	2.5	26195	10478
Zucchini	1.25	4000	3200
Mandarin	8	19894	2487
Macadamia	4.5	8136	1808
Table grapes	2.5	18709	7480
Lucerne	10	1972	197
Peanuts	6	1992	332
Cotton	6	1823	304
Soybeans	5	598	120

Source NECG (2001), Alliance Resource Economics (2000)

In order to estimate the gross margins resulting from the application of supplementary irrigation water, it is necessary to partition the yield responses from naturally occurring rainfall. In estimating the gross margin of applied irrigation water to sugarcane (expressed as $/ML), this analysis has relied on the description and methodology provided by NECG (2001) and Alliance Resource Economics (2000).

The average ambient yield response for non-irrigated sugar in the Burnett is estimated at 56 tonnes per hectare. Alliance Resource Economics (2000) state that the average yield response to 4-8 MLs of applied water is 8.3 tonnes per ML (using the same data, NECG (2001) employ a value of 8.9 tonnes per MLs). The likely yield response is noted as being marginal and possibly subject to increases due to crop efficiency improvements, although crop productivity gains achieved for non-irrigated cane may erode some of those improvements.

The calculation of the estimated gross margin per ML of applied water is dependent on the prevailing sugar cane price, marginal harvesting costs for additional yields and the cost of water. The two reports impute a cane price of $30.50/ tonne, based on the preceding 10 year average price for the region. Thus the gross return is calculated as $30.50 x 8.3, or $253 per ML. Harvesting and freight costs of $50, in addition to water delivery and application costs of $65 per ML (approximately $43 for delivery charges and $22 for application) are subtracted from the gross returns. The gross margin is therefore $253 - $115 or $138/ML of applied irrigation water.

Current and forecast sugar cane prices diverge substantially from those employed by the previous analyses. As at 1st May, 2003, the New York Coffee and Sugar exchange lists sugar#11 for May 2003 at US 7.30c/lb equating to A$256.90 per tonne (A$=US0.629)[7]. Forward contracts for October 2004 are listed at US 6.56c/lb or an equivalent of A$ 242.34 per tonne (A$=US0.629). According to Hilderbrand (2002) at an industry CCS average of 13.5, the sugar tonnage prices convert to approximately A$22/tonne and A$21/tonne respectively for cane producers.

The values of A$59/ML and A$68/ML are calculated for 2003 and 2004 cane prices respectively, by applying the gross margin per ML formula for $21tonne and $22/tonne. Various longer term forecasts for sugar prices are in accord with a continuing and persistent downward trend (New York Coffee and Sugar Exchange http://www.csce.com 1/5/2003; Hilderbrand 2002). For example Hilderbrand (2002) employed sensitivity bounds of A$=US$ 0.63-0.53 and a sugar price of US 7-8c/lb in estimating a range of A$ 245-333/tonne for Australian cane producers. The forward

[7] See Queensland Sugar (as at 1/5/03) http://www.queenslandsugar.com.au/. US prices are cents/lb; $A prices are /tonne. May-2003 USc7.30 A$256.90 Jul-2003 USc7.20 A$254.84 Oct-2003 USc7.15 A$255.21 Jan-2004 USc7.12 A$256.26 Mar-2004 USc7.10 A$256.98 May-2004 USc6.91 $251.53 Jul-2004 USc6.65 A$243.46 Oct-2004 USc6.56 A$242.34

contract for 2004 breeches the lower bound of the sugar price employed by Hilderbrand (*viz*. US 6.6c/lb *cf* US7.0 c/lb) and the current exchange rate (1st May, 2003) of A$1=US$ 0.629, is approaching Hilderbrand's upper currency exchange threshold. Based on current data and exchange rates, cane prices will need to increase by approximately 39-40% to reach the figure of $30.50 /tonne employed in the Alliance Resource Economics (2000) and NECG (2001) calculation of a gross margin of $138 /ML and $156/ML respectively.

The importance of determining the likely gross margins for cane production rests with the high predicted volumes of supplementary water demanded by cane producers in all of the water allocation scenarios. Failure to realise the predicted level of demand for additional water by cane producers has substantial ramifications on the reliability and magnitude of the calculated economic impacts for the Burnett Basin.

In summary the gross margins for additional water applied to cane production range in value from $59/ML when current and forecast cane prices are imputed, to $138/ML for the 1990-2000 average cane price. In determining irrigator's ability to pay for future water made available from the water allocation scenarios, the analysis considers the upper and lower bounds of the cane price range.

5.1 SETTING A DECISION RULE TO DETERMINE ABILITY TO PAY FOR WATER

The decision rule to establish ability to pay for future water allocations is determined by the crop gross margin per ML being at least 10% less than the aggregate COAG compliant water supply cost, comprised of the cost of the property right to gain allocation access plus the calculated supply cost at 4%, 7% and 10.6% internal rates of return. The gross margins have a variable water cost of $43/ML factored into their calculation, which is therefore subtracted from the aggregate water supply cost. A 10 % margin on water cost is considered the minimum incentive for producers to sufficiently compensate for the risk and volatility of foreign exchange rates and fluctuations in world commodity prices.

Table 17 details the results of applying the decision rule to the gross margin of cane production for the six water allocation scenarios. The values represent the Total Cost of water (Tables 10-15) minus the year 2000 gross margin of cane of $124/ML ($138/ML less 10%) and the year 2003-4 cane gross margin of $59/ML. A positive number indicates the COAG compliant water supply cost is greater than the gross margin for cane. Under those circumstances, demand for supplementary water is excluded from further modelling as the purchase of water confers a financial loss to cane producers.

Table 17 Difference between COAG compliant water cost and 2000, 2004 gross margins for cane producers for six water allocation scenarios: all values are in $/ML

10 year take up: IRR	Burnett River Dam		9X$		10X		5Y		6Z		7Z	
	2000	2004	2000	2004	2000	2004	2000	2004	2000	2004	2000	2004
4% (A+B)	59	124	10	75	10	75	0	59	46	111	62	127
4% (A)	0	65										
7% (A+B)	106	171	46	111	50	115	37	96	118	183	114	179
7% (A)	27	92										
10.6% (A+B)	80	145	105	170	111	176	97	153	203	268	137	202
10.6% (A)	45	110										
4year take up: IRR												
4% (A+B)	32	97	**-11**	54	**-12**	53	**-19**	42	37	102	35	100
4% (A)	**-18**	47										
7% (A+B)	56	121	7	72	9	74	0	60	65	130	62	127
7% (A)	**-15**	50										
10.6% (A+B)	90	155	34	99	40	105	26	87	107	172	103	168
10.6% (A)	**-11**	54										

Note 2000 refers to year 2000 cane gross margin of $138/ML; 2004 refers to forecast gross margin of $59/ML

A refers to infrastructure cost, B refers to environmental cost due to inundation
Figures in bold indicate gross margins are greater than the cost of water

5.2 TEN YEAR DEMAND BASED WATER TAKE-UP

A combination of factors are considered in determining the ability of cane producers and other low marginal value water users' ability to pay for supplementary water from the six water allocation scenarios. They are:

- the internal rate of return deemed sufficient to account for the opportunity cost of publicly provided capital;
- the inclusion of dollar estimates of the environmental costs of inundation and in the case of the Burnett River Dam scenario a baseline analysis excluding environmental costs;
- the value of the gross margin of cane production, dependent, *inter alia*, on the current exchange rate and world sugar price.

The applied decision rule states that the demand for water, contingent on farm revenues associated with crop gross margins, is less than the COAG compliant water supply cost.

Water demand by cane producers in all of the water allocation scenarios, over all sensitivity bounds, is not expected to be realised when applying the decision rule to a demand based water take up period of 10 years. The exclusion from the NPV estimates of the economic value of environmental costs for the Burnett River Dam scenario, the reliance on cane gross margins achieving approximately 40% higher values than current and forecast prices and a low opportunity cost of capital of 4% does not confer an ability to pay for water according to the decision rule. Further modelling and discussion therefore excludes cane producers demand for water (predicted by NECG 2001, Alliance Resource Economics 2000) from the demand based water take up time horizon.

5.3 FOUR YEAR SUPPLY BASED WATER TAKE-UP

Predicted water demand by cane producers in all of the water allocation scenarios, over all sensitivity bounds, is not expected to be realised when applying the decision rule to a supply based water take up time horizon of four years at 2003-4 cane prices.

In accord with the demand based time horizon, at current cane prices, the exclusion from the NPV estimates of the economic costs of inundation and a low opportunity cost of capital of 4% does not confer an ability for cane producers and other low value crops to pay for supplementary water from all water allocation scenarios.

The ability of cane producers to pay for supplementary water is noted for water allocation scenarios 9X, 10X, 5Y and Burnett River Dam when the following confluence of modelling factors occurs.

9X, 10X and 5Y:

- An opportunity cost of 4%
- A supply based take up of water
- A cane price equivalent to $30.50 or 40% higher than current and forecast prices.

Burnett River Dam:

- The economic cost of environmental loss due to inundation is excluded
- An opportunity cost of 4%, 7% and 10.6%
- A supply based take up of water
- A cane price equivalent to $30.50/tonne or 40% higher than current and forecast prices.

The exclusion of the economic value of environmental costs in the Burnett River Dam water allocation scenario is provided as a theoretical lower benchmark figure to account for potential variability in non-market valuation methodologies. The need for accurate accounting for environmental costs are specified in the COAG water reform framework (1995) and reinforced by the National Competition Council (2003, p.25). In accord with those obligations an economic value of environmental cost has been estimated for the Burnett River Dam water allocation scenario to realise a break-even point (water supply costs equal the cane gross margin) for a four year water take-up and cane prices 40% higher than current crop returns.

The break-even point is realised when an environmental cost of $70.867m is introduced into the NPV analysis at Year 1, representing approximately a 47% reduction of the DNRM (2003) estimates. An environmental cost greater than $70.867m would result in water supply costs greater than cane gross margins, precluding future water demand. Based on literature gained insights of non-market valuation methodologies, a reduction of 47% in the estimates falls well outside the traditionally ascribed bounds of sensitivity analysis (see *inter alia* Hanley and Spash 1993). That is, the magnitude of variation traditionally ascribed to the DNRM (2003) estimates would not exceed the 47% limit and an economic cost of inundation of $70.867m would most likely represent a substantial underestimate.

For the water allocation scenarios where the application of the decision rule indicates an ability to pay for additional water, a cautious and rigorous risk appraisal needs to be made to ascertain the likelihood that:

1. current cane prices will increase by 40% and reach those realised in 2000,
2. a 4% internal rate of return is sufficient to compensate for the opportunity cost of publicly allocated capital,
3. there is a rapid (four year) uptake of additional water and
4. the current estimates of the economic cost of environmental damage are not characterised by a reduction of approximately 50%.

Guided by the confluence of factors identified as sufficient to fulfil the decision rule, water authority reliance on levels of water demand predicted in the water allocation scenarios over a four year water take-up period contravenes the prudent, full cost accounting prescription articulated in the COAG Water Reform Framework. Based on the results of this analysis, it seems unlikely the necessary factors will be synchronously realised and the ability to pay for water in the Burnett Basin supplied at COAG compliant prices will be limited to those agricultural producers with gross margins in excess of those currently ascribed to cane producers.

6 THE PREDICTED DEMAND FOR ADDITIONAL WATER IN THE BURNETT BASIN

The following tables detail the agricultural enterprise, the predicted demand for water based on ability to pay for COAG compliant water, the gross margin and the total margin for agricultural production for the six water allocation scenarios. The water demand for the allocation scenarios is estimated at supply prices meeting a 7% internal rate of return, imputed environmental costs and a demand based 10 year time horizon for full water take-up.

Table 18 Water usage and total margins for Burnett River Dam scenario estimated according to users' ability to pay

Region/ enterprise Scenario Burnett River Dam	Distribution of allocation (ML)	Ability to pay reallocation (ML)	Gross margin ($/ML)	Total margin for 83208 ML ($'000)
North				
lucerne hay (25%)	0	0	100	0
dairy cows (75%)	0	0	200	0
subtotal	**0**	**0**		**0**
Central				
vegetables(5%)	1430	1430	2000	2860
citrus (74%)	21164	21164	2200	46561
peanuts (4%)	1144	1144	300	343
fruit and nuts (2%)	572	572	1600	915
table grapes (3%)	858	858	6700	5749
Pigs (2%)	572	572	7000	4004
dairy cows (12%)	2660	0	200	0
subtotal	**28400**	**25740**		**60432**
South				
lucerne hay (10%)	600	0	100	0
vegetables(4%)	240	240	2000	480
peanuts (29%)	1200	1200	300	360
wine grapes (4%)	1500	1500	5000	7500
cotton (8%)	480	480	270	130
Pigs (2%)	180	180	7000	1260
Feedlots (2%)	120	120	7000	840
dairy cows (45%)	1680	0	200	0
subtotal	**6000**	**3720**		**10570**
Lower				
vegetables (26%)	42203	42203	2000	84406
sugar cane (66%)	79747	0	138	0
fruit and nuts (8%)	11545	11545	1600	18472
subtotal	**133495**	**53748**		**102878**
Urban	20200	20200		
	6000	6000		
Total	**173895**	**83208**		**173879**

(adapted from NECG 2001)

Table 19 Water usage and total margins for scenario 9x estimated according to users' ability to pay

Region/ enterprise Scenario 9X	Distribution of allocation (ML)	Yield reliability allocation (ML)	Ability to pay reallocation (ML)	Gross margin ($/ML)	Total margin for 30329 ML ($'000)
North					
lucerne hay (25%)	1500	750	0	100	0
dairy cows (75%)	4500	2250	0	200	0
subtotal	**6000**	**3,000**			**0**
Central					
vegetables(5%)	1565	1476	1476	2000	2952
citrus (74%)	23162	21843	21843	2200	48054
peanuts (4%)	1252	1181	1181	300	354
fruit and nuts (2%)	626	590	590	1600	945
table grapes (3%)	939	886	886	6700	5933
dairy cows (12%)	3756	3542	0	200	0
subtotal	**31300**	**29,517**	**25,975**		**58237**
South					
lucerne hay (10%)	710	515	0	100	0
vegetables(4%)	284	206	206	2000	412
peanuts (29%)	2059	1493	1493	300	448
wine grapes (4%)	284	206	206	5000	1030
cotton (8%)	568	412	412	270	111
dairy cows (45%)	3195	2317	0	200	0
subtotal	**7100**	**5,149**	**2,317**		**2001**
Lower					
vegetables (26%)	7410	5680	5680	2000	11359
sugar cane (66%)	18810	14418	0	138	0
fruit and nuts (8%)	2280	1748	1748	1600	2796
subtotal	**28500**	**21,845**	**7,427**		14156
Urban	7000				
Total	**72900**	**59511**	**30,239**		**74394**

Table 20 Water usage and total margins for scenario 10X estimated according to users' ability to pay

Region/ enterprise Scenario 9X	Distribution of allocation (ML)	Yield reliability allocation (ML)	Ability to pay reallocation (ML)	Gross margin ($/ML)	Total margin for 33891 ML ($'000)
North					
lucerne hay (25%)	750	375	0	100	
dairy cows (75%)	2250	1125	0	200	
subtotal	**3000**	**1,500**	**0**		**0**
Central					
vegetables(5%)	1075	991	991	2000	1982
citrus (74%)	15910	14663	14663	2200	32259
peanuts (4%)	860	793	793	300	238
fruit and nuts (2%)	430	396	396	1600	634
table grapes (3%)	645	594	594	6700	3983
dairy cows (12%)	2580	2378	0	200	0
subtotal	**21500**	**19,815**	**17437**		**39095**
South					
lucerne hay (10%)	710	515	0	100	0
vegetables(4%)	284	206	206	2000	412
peanuts (29%)	2059	1493	1493	300	448
wine grapes (4%)	284	206	206	5000	1030
cotton (8%)	568	412	412	270	111
dairy cows (45%)	3195	2317	0	200	0
subtotal	**7100**	**5,149**	**2317**		**2001**
Lower					
vegetables (26%)	10920	10811	10811	2000	21622
sugar cane (66%)	27720	27443	0	55	0
fruit and nuts (8%)	3360	3326	3326	1600	5322
subtotal	**42000**	**41,580**	**14137**		**26944**
Urban	7000				
Total	**73600**	**68044**	**33891**		**68040**

Table 21 Water usage and total margins for scenario 5Y estimated according to users' ability to pay

Region/ enterprise Scenario 5Y	Distribution of allocation (ML)	Yield reliability allocation (ML)	Ability to pay reallocation (ML)	Gross margin ($/ML)	Total margin for 55823 ML ($'000)
North					
lucerne hay (25%)	1250	625	0	100	0
dairy cows (75%)	3750	1875	0	200	0
subtotal	**5000**	**2,500**	**0**		**0**
Central					
vegetables(5%)	1850	1758	1758	2000	3516
citrus (74%)	27380	26018	26018	2200	57240
peanuts (4%)	1480	1406	1406	300	422
fruit and nuts (2%)	740	703	703	1600	1125
table grapes (3%)	1110	1055	1055	6700	7067
dairy cows (12%)	4440	4219	0	200	0
subtotal	**37000**	**35,160**	**30941**		**69371**
South					
lucerne hay (10%)	710	515	0	100	0
vegetables(4%)	284	206	206	2000	412
peanuts (29%)	2059	1493	1493	300	448
wine grapes (4%)	284	206	206	5000	1030
cotton (8%)	568	412	412	270	111
dairy cows (45%)	3195	2317	0	200	0
subtotal	**7100**	**5,149**	**5149**		**2001**
Lower					
vegetables (26%)	15886	15090	15090	2000	30180
sugar cane (66%)	40326	38306	0	138	0
fruit and nuts (8%)	4888	4643	4643	1600	7429
subtotal	**61100**	**58,039**	**19733**		**37609**
Urban	7000				
Total	**110200**	**100848**	**55823**		**108981**

Table 22 Water usage and total margins for scenario 6Z estimated according to users' ability to pay

Region/ enterprise Scenario 6Z	Distribution of allocation (ML)	Yield reliability allocation (ML)	Ability to pay reallocation (ML)	Gross margin ($/ML)	Total margin for 67460 ML ($'000)
North					
lucerne hay (25%)	1250	625	0	100	0
dairy cows (75%)	3750	1875	0	200	0
subtotal	**5000**	**2,500**	**0**		**0**
Central					
vegetables(5%)	1315	1228	1228	2000	2457
citrus (74%)	19462	18180	18180	2200	39995
peanuts (4%)	1052	983	0	300	0
fruit and nuts (2%)	526	491	491	1600	786
table grapes (3%)	789	737	737	6700	4938
dairy cows (12%)	3156	2948	0	200	0
subtotal	**26300**	**24,567**	**20,636**		**48176**
South					
lucerne hay (10%)	710	515	0	100	0
vegetables(4%)	284	206	206	2000	412
peanuts (29%)	2059	1493	0	300	0
wine grapes (4%)	284	206	206	5000	1030
cotton (8%)	568	412	0	270	0
dairy cows (45%)	3195	2317	2317	200	463
subtotal	**7100**	**5,149**	**2,729**		**1905**
Lower					
vegetables (26%)	34060	33719	33719	2000	67439
sugar cane (66%)	86460	85595	0	138	0
fruit and nuts (8%)	10480	10375	10375	1600	16600
subtotal	**131000**	**129,690**	**44,095**		**84039**
Urban	7000				
Total	**169400**	**161906**	**67460**		**134120**

Table 23 Usage of additional water and total margins for scenario 7Z, estimated according to users' ability to pay

Region/ enterprise Scenario 7Z	Distribution of allocation (ML)	Yield reliability allocation (ML)	Ability to pay reallocation (ML)	Gross margin ($/ML)	Total margin for 68675 ML ($'000)
North					
lucerne hay (25%)	750	375	0	100	0
dairy cows (75%)	2250	1125	0	200	0
subtotal	**3000**	**1,500**	**0**		**0**
Central					
vegetables(5%)	1075	1008	1008	2000	2015
citrus (74%)	15910	14912	14912	2200	32807
peanuts (4%)	860	806	806	300	242
fruit and nuts (2%)	430	403	403	1600	645
table grapes (3%)	573	537	537	6700	3598
dairy cows (12%)	2293	2149	0	200	0
subtotal	**21141**	**19,815**	**17,666**		**39307**
South					
lucerne hay (10%)	710	515	0	100	0
vegetables(4%)	284	206	206	2000	412
peanuts (29%)	2059	1493	1493	300	448
wine grapes (4%)	284	206	206	5000	1030
cotton (8%)	568	412	0	270	0
dairy cows (45%)	3195	2317	2317	200	463
subtotal	**7100**	**5,149**	**4,222**		**2353**
Lower					
vegetables (26%)	36140	35779	35779	2000	71557
sugar cane (66%)	91740	90823	0	138	0
fruit and nuts (8%)	11120	11009	11009	1600	17614
subtotal	**139000**	**137,610**	**46,787**		**89171**
Urban	20000				
Total	**170241**	**164074**	**68675**		**130831**

Table 24 summarises the estimated aggregate demand for water by Burnett Basin irrigators, determined by irrigators' ability to pay for COAG compliant water at a 7% discount rate and a demand based 10 year time horizon for full water take-up. The total cost of water represents the aggregate price of the property right to access water plus the supply cost. The internal rate of return is calculated imputing the noted total cost of water and the volume of water demand determined by ability to pay.

Table 24 Summary of estimated water demand and water surplus for six water allocation scenarios in the Burnett Basin

Scenario	Yield (MLs)	Demand (MLs)	Surplus (MLs)	[a]Surplus / Yield	[b]Total cost of water ($/ML)	[c]Internal rate of return
Burnett River Dam	167,895	83,208	87,687	52%	273	2.9%
9X	59,511	30,239	29,272	49%	213	4.0%
10X	68,044	33,891	34153	50%	217	5.9%
5Y	100,848	55,823	44,972	45%	204	3.8%
6Z	161,906	67,460	94,446	58%	285	2.2%
7Z	164,074	68,675	95,399	58%	281	2.3%

[a] Percentage of surplus relative to yield
[b] Total cost of water equals cost of property right to water access + supply cost
[c] Derived internal rate of return for 30 years, 10 year water takeup, demanded water only at noted total cost of water

7 SUMMARY

The COAG Water Reform Framework (COAG 1995) articulates that new rural water schemes must demonstrate standalone economic viability by achieving positive real rates of return, be ecologically sustainable, adopt full cost, consumption based pricing regimes and eliminate direct and cross-subsidies (or ensure transparency). As a signatory, the Queensland Government is obligated to comply with the COAG guidelines. The National Competition Policy Water Reform Assessment Framework (NCC 2003) reinforces the COAG initiative.

The Queensland Government has explored a strategy of increased construction of water infrastructure and impoundments for the Burnett River and surrounding environs. The approved Burnett River Dam water allocation and supply scheme is viewed as a means of stimulating regional economic development and as an extension, increased job creation and wealth. Increased levels of irrigated agricultural crop production resulting from the application of additional water are reported as the primary source of the accruing economic benefits.

Forecasts of the water use specific to water allocation scenarios in the Burnett Basin rely on cane production (and to lesser extent dairy and lucerne hay) as a source of substantial demand for future increased water supplies. The relatively low crop gross margins associated with cane production have been substantially eroded by depressed world sugar prices and exacerbated by a strengthening Australian dollar. Future sugar prices are forecast to remain volatile and assume a similar depressed price trajectory.

The focus of the analysis has been firstly to estimate the scenario-specific cost of additional water, supplied at prices sufficient to comply with the COAG Water Reform Framework. Secondly the analysis has sought to determine the ability of irrigators to pay, based on crop gross margins, for access to, and the annual supply of, water delivered at the estimated COAG compliant supply prices.

This analysis of available data indicates that for a range of internal rates of return, reflective of possible social time preferences, the cost of water supplied at compliant water prices is greater than low value gross margins, precluding cane farmers, lucerne producers and, variably, dairy enterprises from purchasing additional water. The disincentive for low value crop producers to purchase additional water applies to all water allocation scenarios for a demand based 10 year water take up scenario.

Low value crop gross margins greater than compliant water supply costs, conferring an ability to pay for additional water, are realised in a rapid, supply based, water take-up simulation constrained by the following model attributes:

a) current cane prices will increase by 40% and reach those realised in 2000,

b) a 4% internal rate of return is sufficient to compensate for the opportunity cost of publicly allocated capital,

c) the current estimates of the economic cost of environmental damage are not characterised by a reduction of approximately 50%.

Informed by current and forecast cane prices, Queensland Treasury performance criteria for publicly funded water infrastructure projects and the unlikelihood that the (then) Department of Natural Resources overestimated the economic costs of environmental impact by a factor of two, the synchronous realisation of these factors remains remote. The unlikely confluence of these attributes conditioning water supply cost provides a cogent reason for modelling future water demand for the allocation scenarios based on current and forecast cane prices, full water uptake over 10 years and a 7% internal rate of return.

Based on the results of this analysis, the ability to pay for water in the Burnett Basin supplied at COAG compliant prices is limited to those agricultural producers with gross margins in excess of those currently ascribed to cane producers.

In all modelled water allocation scenarios the predicted water demand, conditioned by irrigators' ability to pay, is reduced to 42% - 55% of the levels estimated in the Alliance Resource Economics (2000) and NECG (2001) reports. The percentage of unaccounted for surplus water relative to the annual yield remains highest in the 6Z and 7Z water allocation scenarios (58% in both cases). The Burnett River Dam scenario is characterised by a volume of unaccounted for surplus water greater than the predicted demand volume (surplus to yield proportion of 52%). The 5Y, 9X and 10X scenarios are characterised by the lowest surplus to yield proportions of 44%, 49% and 50% respectively. Applying a 4% internal rate of return resulted in similar water demand and surplus volumes.

Internal rates of return were estimated for a 10 year water take up period, the cost of water representing the annualised price of the property right to access water plus the supply cost (estimated at a 7% internal rate of return and to account for construction and environmental costs) and the volume of available water determined by irrigators' ability to pay. The modelled internal rates of return (Table 24) calculated for the Burnett River Dam, the 6Z and 7Z water allocation scenarios of 2.9%, 2.2% and 2.3% respectively do not meet the performance criteria for economic viability stipulated by Queensland Treasury (1997, 2000) and the CCNCO (1998). The three water allocation scenarios are characterised by low internal rates of return, relatively high construction costs and volumes of unaccounted for, surplus water greater than estimated demand volumes. According to the performance criteria, the scenarios should be rejected or substantially redesigned.

Annual costs to irrigators for additional water of \$273/ML, \$285/ML and \$281/ML are necessary to realise the internal rates of return for the Burnett River Dam, 6Z and 7Z scenarios respectively. Failure to achieve these minimum supply price levels by the water managing authority will result in further internal rate of return reductions. A review of available literature, documentation and information has failed to reveal discussion of forward contracts for property right access and water supply costs at pricing levels of this magnitude. Failure to address the large volumes of surplus water and to ensure the level of residual demand at COAG compliant pricing levels may leave the Queensland Government exposed to rent-seeking alliances and industry specific lobby groups. Water supplied at subsidised prices, either as direct or as cross subsidies, contravenes the COAG Water Reform Framework (Clause3 (a(i), ii)). Under differential, subsidised water prices, the potential confounding effect on the levels of water demand and the value of purchased water access property rights by producers of high value gross margin remains similarly uncertain.

Despite relatively large proportions of surplus water, scenarios 9X and 10X the internal rates of return are estimated at 4.0% and 5.9% respectively. Most of the estimated volumes of water demanded by high value producers in the lower Burnett in the Burnett River Dam, 6Z and 7Z scenarios are met by the surplus water calculated for the 9X and 10X scenarios. Surplus water is estimated according to the method outlined to determine irrigators' ability to pay. High value producers are estimated to demand approximately 43,000 ML of additional water in the Burnett River Dam scenario and approximately 13,000 ML in the 10X scenario, a difference of approximately 30,000 ML. The surplus water accruing in the 10X scenario, is 34,153 ML, sufficient to meet unmet demand (assuming the possibility of regional water transfers). It remains unclear why the 9X and 10X scenarios estimate the future level of high value demand at substantially less volumes than those of the Burnett River Dam, 6Z and 7Z scenarios. The sale of water at competitive, open auction should ensure that the high value crop producers purchase water in sufficient volumes to meet forecast demand levels.

There is insufficient data to remodel the regional or crop demand, use and uptake of surplus additional water beyond the available modelling data. The modelling assertion that future allocations will be proportional to current regional use (NECG 2001) remains uncertain and improbable given the different market conditions for agricultural producers.

Based on the available data and this analysis, the Burnett River Dam and the 6Z, 7Z scenarios do not meet the COAG Water Reform Framework stipulations of economic viability, if procedures of full cost resource accounting, consumption based pricing regimes, elimination of direct and cross-subsidies and demonstrable positive real rates of return are applied. The conclusion from this analysis is that there is no reasonable expectation that the economic benefits arising from the low volume 9X and 10X scenarios will be exceeded by the high volume Burnett River Dam project. The conclusion is reinforced by the additional economic costs of construction and increased scale of inundation of the Burnett River Dam.

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9 APPENDIX 1

The calculation of the net present value (NPV) of the five water allocation scenarios at a social discount rate of 7% are detailed in Tables A1 to A10.

Tables A1, A3, A5, A7, A9 and A11 detail the estimated NPV of the 10 year demand-based water take up model. Tables A2, A4, A6, A8, A10 and A12 detail the supply-based four year water take up model.

9.1 MODELLED ECONOMIC BENEFITS AND COSTS

Calculation of Benefits

Benefits accruing in Years 1-10 for the demand-based model are calculated as:

$$\mathbf{0.1\,(\mathit{Wy} \times \mathit{Cc}) + 0.1\mathit{t}\,(\mathit{Wy} \times \mathit{Sw})}$$

Benefits accruing in Years 1-4 for the supply-based model are calculated as:

$$\mathbf{0.25\,(\mathit{Wy} \times \mathit{Cc}) + 0.25\mathit{t}\,(\mathit{Wy} \times \mathit{Sw})}$$

Where:

t equals the number of the year of the project

Wy represents the imputed water yield specific for each scenario (ML)

Cc represents the capital cost per ML of the infrastructure (\$/ML)

Sw represents the dollar value of water sold, (\$/ML) at a baseline opportunity cost of ***Cc* + *Ec***

Where:

Ec equals the estimate of environmental cost at year 1 (\$'000)

Benefits accruing in Years 11-30 for the demand-based model and Years 4-30 in the supply-based model are calculated as:

$$\mathbf{\mathit{Wy} \times \mathit{Sw}}$$

Calculation of Costs for the 10 year and four year water take up models

Costs incurred in Year 1 (as specified in Tables 2-7) in the model are calculated as:

$$\mathbf{\mathit{Cc} + \mathit{Ec}}$$

Costs incurred in Year 2-30 in the model are calculated as

$$\mathbf{(\mathit{Wy} \times \mathit{Sc})}$$

Where:

Sc represents the estimate of the supply cost of water ($/ML)

The NPV model assumes the initial purchase price incurred by irrigator's of the property right to each ML of allocated water is constant. The price is proportionally commensurate with the capital expenditure of the project' infrastructure, exclusive of environmental cost estimates and expressed as $/ML. Revenue accruing to the managing authority from the sale of property rights is assumed to be evenly amortised throughout the water take-up period (10 years and four years respectively for the demand and supply based scenarios). That is the revenue from property right sales is 10% (or 25%) of the total capital expenditure for each year of the take-up period, after construction is completed. Revenue accruing from water sales ($Wy \times Sw$) is commensurate with the same take up trajectory. That is water sales revenue from Year 1 equals 10% (or 25%) of the forecast water yield, Year 2 equals 20% (or 50%), Year 3 equals 30% (or 75%) and so on.

Based on available data, the modelled price of water represents full cost accounting, and therefore includes the estimated environmental costs of year 1. The price of water is estimated such that the internal rate of return at year 30 equals, in this example, 7%. Modelling the NPV to comply with COAG guidelines at internal rates return of 4% and 10.6% is facilitated by imputing the sale price of water detailed in the Tables in section 5.

Describing scenario 9X as an example:

- Property right value = $1006/ML or $74/ML/year (determined for a 25 year loan at 7% interest)
- Sale price of water is such that:
  at an internal rate of return of 0% = $63/ML
  at an internal rate of return of 4% = $92/ML
  at an internal rate of return of 7% = $128/ML (imputed in these examples)
  at an internal rate of return of 10.6% = $187/ML

Modelled costs represent the construction and environmental costs specific to each scenario. The value and timing of construction costs are set out in Tables 2-7. Environmental costs are set out in Table 9.

The model assumes that the operational and management costs (*viz*. supply costs of $43/ML times the total water yield) are constant after completion of the construction phase, regardless of the demand for water.

Table A1 NPV of Burnett River Dam, 10 year demand based water take up, at IRR 7%

Year	10 year take up benefits ($ '000)	Capital Costs ($'000)	Environmental Costs ($'000)	Total costs ($'000)	Net Benefits ($'000)	NPV @7% ($'000)
1	0	13,900	130700	144600	-144600	-135,140
2	22938	94,800	0	94800	-71862	-197,907
3	25826	42,500	0	42500	-16674	-211,519
4	28713	42,500	0	42500	-13787	-222,036
5	31601	7,219	0	7219	24382	-204,653
6	34489	7,219	7000	14219	20269	-191,146
7	37377	7,219	7000	14219	23157	-176,725
8	40265	7,219	7000	14219	26045	-161,567
9	43152	7,219	7000	14219	28933	-145,829
10	46040	7,219	0	7219	38821	-126,095
11	48928	7,219	0	7219	41708	-106,279
12	28878	7,219	0	7219	21658	-96,663
13	28878	7,219	0	7219	21658	-87,675
14	28878	7,219	0	7219	21658	-79,276
15	28878	7,219	0	7219	21658	-71,426
16	28878	7,219	0	7219	21658	-64,089
17	28878	7,219	0	7219	21658	-57,233
18	28878	7,219	0	7219	21658	-50,825
19	28878	7,219	0	7219	21658	-44,836
20	28878	7,219	0	7219	21658	-39,239
21	28878	7,219	0	7219	21658	-34,008
22	28878	7,219	0	7219	21658	-29,119
23	28878	7,219	0	7219	21658	-24,551
24	28878	7,219	0	7219	21658	-20,281
25	28878	7,219	0	7219	21658	-16,290
26	28878	7,219	0	7219	21658	-12,561
27	28878	7,219	0	7219	21658	-9,075
28	28878	7,219	0	7219	21658	-5,818
29	28878	7,219	0	7219	21658	-2,773
30	28878	7,219	0	7219	21658	72

Imputed water yield (*Wy*) 167,895 ML, Supply cost (*Sc*) = $43/ML;
Capital cost (*Cc*) of infrastructure $200.5M equates to $1194/ML (*viz.* property right cost);
Environmental cost (*Ec*) at year 1 = $130.7;
Sale price (*Sw*) at baseline opportunity cost of *Cc* + *Ec*=
at internal rate of return of 0% = $63/ML
at internal rate of return of 4% = $92/ML
at internal rate of return of 7% = $128/ML
at internal rate of return of 10.6% = $187/ML

Benefits: **10 year demand based take up**:	**Costs:**
Years 1-10 calculated as 0.1 ($Wy \times Cc$) + 0.1t ($Wy \times Sw$)	Year 1-4= $Cc + Ec$
Year 11-30 calculated as ($Wy \times Sw$)	Year 7-10= $Cc + Ec$ +infrastructure
Where: t equals the number of the year of the project	Year 5-30 = ($Wy \times Sc$)

Table A2 NPV of Burnett River Dam, 4 year demand based water take up, at IRR of 7%

Year	4 year take up benefits ($ '000)	Capital Costs ($'000)	Environmental Costs ($'000)	Total costs ($'000)	Net Benefits ($'000)	NPV @7% ($'000)
1	0	13,900	130700	144600	-144600	-135,140
2	55246	94,800	0	94800	-39554	-169,688
3	60367	42,500	0	42500	17867	-155,104
4	65487	42,500	0	42500	22987	-137,567
5	70608	7,219	0	7219	63389	-92,372
6	20483	7,219	7000	14219	6264	-88,198
7	20483	7,219	7000	14219	6264	-84,297
8	20483	7,219	7000	14219	6264	-80,652
9	20483	7,219	7000	14219	6264	-77,245
10	20483	7,219	0	7219	13264	-70,502
11	20483	7,219	0	7219	13264	-64,201
12	20483	7,219	0	7219	13264	-58,311
13	20483	7,219	0	7219	13264	-52,807
14	20483	7,219	0	7219	13264	-47,663
15	20483	7,219	0	7219	13264	-42,856
16	20483	7,219	0	7219	13264	-38,363
17	20483	7,219	0	7219	13264	-34,164
18	20483	7,219	0	7219	13264	-30,240
19	20483	7,219	0	7219	13264	-26,572
20	20483	7,219	0	7219	13264	-23,145
21	20483	7,219	0	7219	13264	-19,941
22	20483	7,219	0	7219	13264	-16,948
23	20483	7,219	0	7219	13264	-14,150
24	20483	7,219	0	7219	13264	-11,535
25	20483	7,219	0	7219	13264	-9,091
26	20483	7,219	0	7219	13264	-6,807
27	20483	7,219	0	7219	13264	-4,673
28	20483	7,219	0	7219	13264	-2,678
29	20483	7,219	0	7219	13264	-813
30	20483	7,219	0	7219	13264	929

Imputed water yield (*Wy*) 167,895 ML, Supply cost (*Sc*) = $43/ML;
Capital cost (*Cc*) of infrastructure $200.5M equates to $1194/ML (*viz.* property right cost);
Environmental cost (*Ec*) at year 1 = $130.7M;
Sale price (*Sw*) at baseline opportunity cost of *Cc* + *Ec*=:
at internal rate of return of 0% = $66/ML
at internal rate of return of 4% = $85/ML
at internal rate of return of 7% = $104/ML
at internal rate of return of 10.6% = $135/ML

Benefits: **4 year supply base take up**:	**Costs:**
Years 1-4 calculated as 0.25 (*Wy* × *Cc*) + 0.25*t* (*Wy* × *Sw*) Years 5-30 calculated as (*Wy* × *Sw*) Where: *t* equals the number of the year of the project	Year 1-4 = *Cc* + *Ec* Year 7-10= *Cc* + *Ec* +infrastructure Year 5-30 = (*Wy* × *Sc*)

Table A3 NPV of scenario 9X, 10 year demand based water take up, at IRR 7%

Year	10 year take up benefits ($ '000)	Capital Costs ($'000)	Environmental Costs ($'000)	Total costs ($'000)	Net Benefits ($'000)	NPV @7% ($'000)
1	0	65246	11630	76876	-76876	-71,847
2	6752	2,559	0	2559	4193	-68,185
3	7513	2,559	0	2559	4955	-64,140
4	8275	2,559	0	2559	5716	-59,779
5	9037	2,559	0	2559	6478	-55,161
6	9799	2,559	0	2559	7240	-50,336
7	10560	2,559	0	2559	8001	-45,354
8	11322	2,559	0	2559	8763	-40,253
9	12084	2,559	0	2559	9525	-35,072
10	12846	2,559	0	2559	10287	-29,843
11	13607	2,559	0	2559	11048	-24,594
12	7617	2,559	0	2559	5058	-22,348
13	7617	2,559	0	2559	5058	-20,249
14	7617	2,559	0	2559	5058	-18,287
15	7617	2,559	0	2559	5058	-16,454
16	7617	2,559	0	2559	5058	-14,740
17	7617	2,559	0	2559	5058	-13,139
18	7617	2,559	0	2559	5058	-11,642
19	7617	2,559	0	2559	5058	-10,244
20	7617	2,559	0	2559	5058	-8,937
21	7617	2,559	0	2559	5058	-7,715
22	7617	2,559	0	2559	5058	-6,573
23	7617	2,559	0	2559	5058	-5,506
24	7617	2,559	0	2559	5058	-4,509
25	7617	2,559	0	2559	5058	-3,577
26	7617	2,559	0	2559	5058	-2,706
27	7617	2,559	0	2559	5058	-1,892
28	7617	2,559	0	2559	5058	-1,131
29	7617	2,559	0	2559	5058	-420
30	7617	2,559	0	2559	5058	245

Imputed water yield (*Wy*) 59,511 ML, Supply cost (*Sc*) = $43/ML;
Capital cost (*Cc*) of infrastructure $59.9M equates to $1006/ML (*viz.* property right cost);
Environmental cost (*Ec*) at year 1 = $11.63M;
Sale price (*Sw*) at baseline opportunity cost of *Cc* + *Ec*:
at internal rate of return of 0% = $63/ML
at internal rate of return of 4% = $92/ML
at internal rate of return of 7% = $128/ML
at internal rate of return of 10.6% = $187/ML

Benefits: 10 year demand based take up	Costs:
Years 1-10 calculated as 0.1 ($Wy \times Cc$) + 0.1t ($Wy \times Sw$) Year 11-30 calculated as ($Wy \times Sw$) Where: t equals the number of the year of the project	Year 1-3 = $Cc + Ec$ Year 4-30 = ($Wy \times Sc$)

Table A4 NPV of scenario 9X, 4 year demand based water take up, at IRR of 7%

Year	4 year take up benefits ($ '000)	Capital Costs ($'000)	Environmental Costs ($'000)	Total costs ($'000)	Net Benefits ($'000)	NPV @7% ($'000)
1	0	65246	11630	76876	-76876	-71,847
2	16299	2,559	0	2559	13740	-59,846
3	17623	2,559	0	2559	15064	-47,549
4	18947	2,559	0	2559	16388	-35,046
5	20271	2,559	0	2559	17713	-22,417
6	5296	2,559	0	2559	2738	-20,593
7	5296	2,559	0	2559	2738	-18,888
8	5296	2,559	0	2559	2738	-17,295
9	5296	2,559	0	2559	2738	-15,806
10	5296	2,559	0	2559	2738	-14,414
11	5296	2,559	0	2559	2738	-13,114
12	5296	2,559	0	2559	2738	-11,898
13	5296	2,559	0	2559	2738	-10,762
14	5296	2,559	0	2559	2738	-9,701
15	5296	2,559	0	2559	2738	-8,709
16	5296	2,559	0	2559	2738	-7,781
17	5296	2,559	0	2559	2738	-6,915
18	5296	2,559	0	2559	2738	-6,105
19	5296	2,559	0	2559	2738	-5,348
20	5296	2,559	0	2559	2738	-4,640
21	5296	2,559	0	2559	2738	-3,979
22	5296	2,559	0	2559	2738	-3,361
23	5296	2,559	0	2559	2738	-2,784
24	5296	2,559	0	2559	2738	-2,244
25	5296	2,559	0	2559	2738	-1,740
26	5296	2,559	0	2559	2738	-1,268
27	5296	2,559	0	2559	2738	-828
28	5296	2,559	0	2559	2738	-416
29	5296	2,559	0	2559	2738	-31
30	5296	2,559	0	2559	2738	328

Imputed water yield (Wy) 59,511 ML, Supply cost (Sc) = $43/ML;
Capital cost (Cc) of infrastructure $59.9M equates to $1006/ML (*viz.* property right cost);
Environmental cost (Ec) at year 1 = $11.63M;
Sale price (Sw) at baseline opportunity cost of $Cc + Ec$=:
at internal rate of return of 0% = $66/ML
at internal rate of return of 4% = $85/ML
at internal rate of return of 7% = $104/ML
at internal rate of return of 10.6% = $135/ML

Benefits: **4 year supply base take up**:	**Costs:**
Years 1-4 calculated as 0.25 ($Wy \times Cc$) + 0.25t ($Wy \times Sw$) Years 5-30 calculated as ($Wy \times Sw$)	Year 1 = $Cc + Ec$
Where: t equals the number of the year of the project	Year 4-30 = ($Wy \times Sc$)

Table A5 NPV of scenario 10X, 10 year demand based water take up, at IRR 7%

Year	10 year take up benefits $ '000)	Capital Costs ($'000)	Environmental Costs ($'000)	Total costs ($'000)	Net Benefits ($'000)	NPV @7% ($'000)
1	0	41000	34510	75510	-75510	-70,570
2	6873	18000	0	18000	-11127	-80,289
3	7846	2,926	0	2926	4920	-76,272
4	8819	2,926	0	2926	5893	-71,777
5	9792	2,926	0	2926	6866	-66,881
6	10765	2,926	0	2926	7839	-61,657
7	11738	2,926	0	2926	8812	-56,170
8	12711	2,926	0	2926	9785	-50,474
9	13684	2,926	0	2926	10758	-44,623
10	14657	2,926	0	2926	11731	-38,659
11	15630	2,926	0	2926	12704	-32,623
12	9730	2,926	0	2926	6804	-29,602
13	9730	2,926	0	2926	6804	-26,778
14	9730	2,926	0	2926	6804	-24,140
15	9730	2,926	0	2926	6804	-21,673
16	9730	2,926	0	2926	6804	-19,368
17	9730	2,926	0	2926	6804	-17,214
18	9730	2,926	0	2926	6804	-15,201
19	9730	2,926	0	2926	6804	-13,320
20	9730	2,926	0	2926	6804	-11,561
21	9730	2,926	0	2926	6804	-9,918
22	9730	2,926	0	2926	6804	-8,382
23	9730	2,926	0	2926	6804	-6,947
24	9730	2,926	0	2926	6804	-5,605
25	9730	2,926	0	2926	6804	-4,352
26	9730	2,926	0	2926	6804	-3,180
27	9730	2,926	0	2926	6804	-2,085
28	9730	2,926	0	2926	6804	-1,061
29	9730	2,926	0	2926	6804	-105
30	9730	2,926	0	2926	6804	789

Imputed water yield (*Wy*) 68,044 ML, Supply cost (*Sc*) = $43/ML;
Capital cost (*Cc*) of infrastructure $59.0M equates to $867/ML (*viz.* property right cost);
Environmental cost (*Ec*) at year 1 = $34.51M;
Sale price (*Sw*) at baseline opportunity cost of *Cc* + *Ec*=:
at internal rate of return of 0% = $82/ML
at internal rate of return of 4% = $122/ML
at nternal rate of return of 7% = $168/ML
at internal rate of return of 10.6% = $242/ML

Benefits: **10 year demand based take up**:	**Costs:**
Years 1-10 calculated as 0.1 (*Wy* × *Cc*) + 0.1*t* (*Wy* × *Sw*) Year 11-30 calculated as (*Wy* × *Sw*) Where: *t* equals the number of the year of the project	Year 1 = *Cc* + *Ec* Year 4-30 = (*Wy* × *Sc*)

Table A6 NPV of scenario 10X, 4 year demand based water take up, at IRR of 7%

Year	4 year take up benefits $ '000)	Capital Costs ($'000)	Environmental Costs ($'000)	Total costs ($'000)	Net Benefits ($'000)	NPV @7% ($'000)
1	0	41000	34510	75510	-75510	-70,570
2	16485	18000	0	18000	-1515	-71,893
3	18220	2,926	0	2926	15294	-59,408
4	19955	2,926	0	2926	17029	-46,417
5	21690	2,926	0	2926	18765	-33,038
6	6940	2,926	0	2926	4015	-30,363
7	6940	2,926	0	2926	4015	-27,863
8	6940	2,926	0	2926	4015	-25,526
9	6940	2,926	0	2926	4015	-23,343
10	6940	2,926	0	2926	4015	-21,302
11	6940	2,926	0	2926	4015	-19,394
12	6940	2,926	0	2926	4015	-17,612
13	6940	2,926	0	2926	4015	-15,946
14	6940	2,926	0	2926	4015	-14,389
15	6940	2,926	0	2926	4015	-12,934
16	6940	2,926	0	2926	4015	-11,574
17	6940	2,926	0	2926	4015	-10,303
18	6940	2,926	0	2926	4015	-9,115
19	6940	2,926	0	2926	4015	-8,005
20	6940	2,926	0	2926	4015	-6,968
21	6940	2,926	0	2926	4015	-5,998
22	6940	2,926	0	2926	4015	-5,092
23	6940	2,926	0	2926	4015	-4,245
24	6940	2,926	0	2926	4015	-3,454
25	6940	2,926	0	2926	4015	-2,714
26	6940	2,926	0	2926	4015	-2,023
27	6940	2,926	0	2926	4015	-1,377
28	6940	2,926	0	2926	4015	-773
29	6940	2,926	0	2926	4015	-209
30	6940	2,926	0	2926	4015	319

Imputed water yield (*Wy*) 68,044 ML, Supply cost (*Sc*) = $43/ML;
Capital cost (*Cc*) of infrastructure $59.0M equates to $867 /ML (*viz.* property right cost);
Environmental cost (*Ec*) at year 1 = $34.51M;
Sale price (*Sw*) at baseline opportunity cost of *Cc* + *Ec* =:
at internal rate of return of 0% = $73/ML
at internal rate of return of 4% = $98/ML
at internal rate of return of 7% = $123/ML
at internal rate of return of 10.6% = $161/ML

Benefits: **4 year supply base take up**:	**Costs:**
Years 1-4 calculated as 0.25 ($Wy \times Cc$) + 0.25t ($Wy \times Sw$) Years 5-30 calculated as ($Wy \times Sw$) Where: t equals the number of the year of the project	Year 1 = $Cc + Ec$ Year 4-30 = ($Wy \times Sc$)

Table A7 NPV of scenario 5Y, 10 year demand based water take up, at IRR 7%

Year	10 year take up benefits $ '000)	Capital Costs ($'000)	Environmental Costs ($'000)	Total costs ($'000)	Net Benefits ($'000)	NPV @7% ($'000)
1	0	71000	38070	109070	-109070	-101,935
2	10591	22200	400	22600	-12009	-112,424
3	11861	3,631	400	4031	7831	-106,032
4	13132	3,631	400	4031	9102	-99,088
5	14403	3,631	400	4031	10372	-91,693
6	15673	3,631	400	4031	11643	-83,935
7	16944	3,631	400	4031	12914	-75,893
8	18215	3,631	400	4031	14184	-67,637
9	19485	3,631	400	4031	15455	-59,231
10	20756	3,631	400	4031	16726	-50,729
11	22027	3,631	400	4031	17996	-42,179
12	12707	3,631	400	4031	8676	-38,326
13	12707	3,631	400	4031	8676	-34,726
14	12707	3,631	400	4031	8676	-31,361
15	12707	3,631	400	4031	8676	-28,216
16	12707	3,631	400	4031	8676	-25,277
17	12707	3,631	400	4031	8676	-22,531
18	12707	3,631	400	4031	8676	-19,964
19	12707	3,631	400	4031	8676	-17,565
20	12707	3,631	400	4031	8676	-15,322
21	12707	3,631	400	4031	8676	-13,227
22	12707	3,631	400	4031	8676	-11,269
23	12707	3,631	400	4031	8676	-9,438
24	12707	3,631	400	4031	8676	-7,728
25	12707	3,631	400	4031	8676	-6,129
26	12707	3,631	400	4031	8676	-4,635
27	12707	3,631	400	4031	8676	-3,239
28	12707	3,631	400	4031	8676	-1,934
29	12707	3,631	400	4031	8676	-714
30	12707	3,631	400	4031	8676	425

Imputed water yield (*Wy*) 100,848 ML, Supply cost (*Sc*) = $43/ML;
Capital cost (*Cc*) of infrastructure $93.2M equates to $924/ML (*viz.* property right cost);
Environmental cost (*Ec*) at year 1 = $38.07M, recurrent cost (*Erc*) of $0.4M;
Sale price (*Sw*) at baseline opportunity cost of *Cc* + *Ec* + *Erc*:
at internal rate of return of 0% = $81/ML
at internal rate of return of 4% = $119/ML
at nternal rate of return of 7% = $162/ML
at internal rate of return of 10.6% = $233/ML

Benefits: **10 year demand based take up**:	**Costs:**
Years 1-10 calculated as 0.1 ($Wy \times Cc$) + 0.1t ($Wy \times Sw$)	Year 1 = $Cc + Ec$
Year 11-30 calculated as ($Wy \times Sw$)	Year 2-3= $Cc + Ec + Erc$
Where: *t* equals the number of the year of the project	Year 4-30 = ($Wy \times Sc$) + Erc

Table A8 NPV of scenario 5Y, 4 year demand based water take up, at IRR of 7%

Year	4 year take up benefits $ '000)	Capital Costs ($'000)	Environmental Costs ($'000)	Total costs ($'000)	Net Benefits ($'000)	NPV @7% ($'000)
1	0	71000	38070	109070	-109070	-101,935
2	25519	22200	400	22600	2919	-99,385
3	27737	3,631	400	4031	23707	-80,034
4	29956	3,631	400	4031	25925	-60,255
5	32175	3,631	400	4031	28144	-40,189
6	8875	3,631	400	4031	4844	-36,961
7	8875	3,631	400	4031	4844	-33,944
8	8875	3,631	400	4031	4844	-31,125
9	8875	3,631	400	4031	4844	-28,490
10	8875	3,631	400	4031	4844	-26,028
11	8875	3,631	400	4031	4844	-23,726
12	8875	3,631	400	4031	4844	-21,575
13	8875	3,631	400	4031	4844	-19,565
14	8875	3,631	400	4031	4844	-17,687
15	8875	3,631	400	4031	4844	-15,931
16	8875	3,631	400	4031	4844	-14,290
17	8875	3,631	400	4031	4844	-12,757
18	8875	3,631	400	4031	4844	-11,323
19	8875	3,631	400	4031	4844	-9,984
20	8875	3,631	400	4031	4844	-8,732
21	8875	3,631	400	4031	4844	-7,562
22	8875	3,631	400	4031	4844	-6,469
23	8875	3,631	400	4031	4844	-5,447
24	8875	3,631	400	4031	4844	-4,492
25	8875	3,631	400	4031	4844	-3,599
26	8875	3,631	400	4031	4844	-2,765
27	8875	3,631	400	4031	4844	-1,986
28	8875	3,631	400	4031	4844	-1,257
29	8875	3,631	400	4031	4844	-576
30	8875	3,631	400	4031	4844	60

Imputed water yield (*Wy*) 100,848 ML, Supply cost (*Sc*) = $43/ML;
Capital cost (*Cc*) of infrastructure $93.2M equates to $924/ML (*viz.* property right cost);
Environmental cost (*Ec*) at year 1 = $38.07M, recurrent cost (*Erc*) of $0.4M;
Sale price (*Sw*) at baseline opportunity cost of *Cc* + *Ec* + *Erc* =:
internal rate of return of 0% = $72/ML
internal rate of return of 4% = $94/ML
internal rate of return of 7% = $118/ML
internal rate of return of 10.6% = $153/ML

Benefits: **4 year supply base take up**:	**Costs:**
Years 1-4 calculated as 0.25 ($Wy \times Cc$) + 0.25t ($Wy \times Sw$) Years 5-30 calculated as ($Wy \times Sw$) Where: t equals the number of the year of the project	Year 1= $Cc + Ec$ Year 2-3= $Cc + Ec+Erc$ Year 4-30 = ($Wy \times Sc$) + Erc

Table A9 NPV of scenario 6Z, 10 year demand based water take up, at IRR 7%

Year	10 year take up benefits $ '000)	Capital Costs ($'000)	Environmental Costs ($'000)	Total costs ($'000)	Net Benefits ($'000)	NPV @7% ($'000)
1	0	72625	131350	203975	-203975	-190,631
2	23014	85850	0	85850	-62836	-245,514
3	25929	42925	0	42925	-16996	-259,388
4	28843	6,962	0	6962	21881	-242,695
5	31757	6,962	0	6962	24795	-225,017
6	34672	6,962	0	6962	27710	-206,552
7	37586	6,962	0	6962	30624	-187,481
8	40500	6,962	0	6962	33538	-167,962
9	43414	6,962	0	6962	36453	-148,134
10	46329	6,962	0	6962	39367	-128,122
11	49243	6,962	0	6962	42281	-108,035
12	29143	6,962	0	6962	22181	-98,186
13	29143	6,962	0	6962	22181	-88,982
14	29143	6,962	0	6962	22181	-80,379
15	29143	6,962	0	6962	22181	-72,340
16	29143	6,962	0	6962	22181	-64,826
17	29143	6,962	0	6962	22181	-57,804
18	29143	6,962	0	6962	22181	-51,242
19	29143	6,962	0	6962	22181	-45,109
20	29143	6,962	0	6962	22181	-39,376
21	29143	6,962	0	6962	22181	-34,019
22	29143	6,962	0	6962	22181	-29,013
23	29143	6,962	0	6962	22181	-24,334
24	29143	6,962	0	6962	22181	-19,961
25	29143	6,962	0	6962	22181	-15,874
26	29143	6,962	0	6962	22181	-12,055
27	29143	6,962	0	6962	22181	-8,485
28	29143	6,962	0	6962	22181	-5,149
29	29143	6,962	0	6962	22181	-2,031
30	29143	6,962	0	6962	22181	883

Imputed water yield (*Wy*) 161,906 ML, Supply cost (*Sc*) = $43/ML;
Capital cost (*Cc*) of infrastructure $201.0M equates to $1241/ML (*viz.* property right cost);
Environmental cost (*Ec*) at year 1 = $131.35M,
Sale price (*Sw*) at baseline opportunity cost of *Cc* + *Ec*:
at internal rate of return of 0% = $92/ML
at internal rate of return of 4% = $148/ML
at internal rate of return of 7% = $212/ML
at internal rate of return of 10.6% = $315/ML

Benefits: **10 year demand based take up**:	**Costs:**
Years 1-10 calculated as 0.1 ($Wy \times Cc$) + 0.1t ($Wy \times Sw$) Year 11-30 calculated as ($Wy \times Sw$) Where: t equals the number of the year of the project	Year 1-3 = $Cc + Ec$ Year 4-30 = ($Wy \times Sc$)

Table A10 NPV of scenario 6Z, 4 year demand based water take up, at IRR of 7%

Year	4 year take up benefits $ '000)	Capital Costs ($'000)	Environmental Costs ($'000)	Total costs ($'000)	Net Benefits ($'000)	NPV @7% ($'000)
1	0	72625	131350	203975	-203975	-190,631
2	55391	85850	0	85850	-30459	-217,235
3	60531	42925	0	42925	17606	-202,864
4	65672	6,962	0	6962	58710	-158,074
5	70812	6,962	0	6962	63850	-112,550
6	20562	6,962	0	6962	13600	-103,488
7	20562	6,962	0	6962	13600	-95,018
8	20562	6,962	0	6962	13600	-87,103
9	20562	6,962	0	6962	13600	-79,705
10	20562	6,962	0	6962	13600	-72,792
11	20562	6,962	0	6962	13600	-66,330
12	20562	6,962	0	6962	13600	-60,292
13	20562	6,962	0	6962	13600	-54,648
14	20562	6,962	0	6962	13600	-49,374
15	20562	6,962	0	6962	13600	-44,445
16	20562	6,962	0	6962	13600	-39,838
17	20562	6,962	0	6962	13600	-35,532
18	20562	6,962	0	6962	13600	-31,509
19	20562	6,962	0	6962	13600	-27,748
20	20562	6,962	0	6962	13600	-24,233
21	20562	6,962	0	6962	13600	-20,949
22	20562	6,962	0	6962	13600	-17,879
23	20562	6,962	0	6962	13600	-15,010
24	20562	6,962	0	6962	13600	-12,329
25	20562	6,962	0	6962	13600	-9,823
26	20562	6,962	0	6962	13600	-7,481
27	20562	6,962	0	6962	13600	-5,293
28	20562	6,962	0	6962	13600	-3,247
29	20562	6,962	0	6962	13600	-1,336
30	20562	6,962	0	6962	13600	451

Imputed water yield (*Wy*) 161,906 ML, Supply cost (*Sc*) = \$43/ML;
Capital cost (*Cc*) of infrastructure \$201.0M equates to \$1241/ML (*viz.* property right cost);
Environmental cost (*Ec*) at year 1 = \$131.35M,
Sale price (*Sw*) at baseline opportunity cost of *Cc* + *Ec* =:
internal rate of return of 0% = \$66/ML
internal rate of return of 4% = \$85/ML
internal rate of return of 7% = \$104/ML
internal rate of return of 10.6% = \$135/ML

Benefits: **4 year supply base take up**:	**Costs:**
Years 1-4 calculated as 0.25 ($Wy \times Cc$) + 0.25t ($Wy \times Sw$) Years 5-30 calculated as ($Wy \times Sw$) Where: t equals the number of the year of the project	Year 1-3 = $Cc + Ec$ Year 4-30 = ($Wy \times Sc$)

Table A11 NPV of scenario 7Z, 10 year demand based water take up, at IRR 7%

Year	10 year take up benefits $ '000)	Capital Costs ($'000)	Environmental Costs ($'000)	Total costs ($'000)	Net Benefits ($'000)	NPV @7% ($'000)
1	0	71925	130700	202625	-202625	-189,369
2	22974	85850	0	85850	-62876	-244,287
3	25878	42925	0	42925	-17047	-258,203
4	28782	7,055	0	7055	21727	-241,627
5	31686	7,055	0	7055	24631	-224,065
6	34591	7,055	0	7055	27535	-205,717
7	37495	7,055	0	7055	30439	-186,761
8	40399	7,055	0	7055	33344	-167,355
9	43303	7,055	0	7055	36248	-147,639
10	46207	7,055	0	7055	39152	-127,736
11	49111	7,055	0	7055	42056	-107,755
12	29041	7,055	0	7055	21986	-97,993
13	29041	7,055	0	7055	21986	-88,870
14	29041	7,055	0	7055	21986	-80,343
15	29041	7,055	0	7055	21986	-72,375
16	29041	7,055	0	7055	21986	-64,927
17	29041	7,055	0	7055	21986	-57,967
18	29041	7,055	0	7055	21986	-51,462
19	29041	7,055	0	7055	21986	-45,383
20	29041	7,055	0	7055	21986	-39,701
21	29041	7,055	0	7055	21986	-34,392
22	29041	7,055	0	7055	21986	-29,429
23	29041	7,055	0	7055	21986	-24,791
24	29041	7,055	0	7055	21986	-20,457
25	29041	7,055	0	7055	21986	-16,406
26	29041	7,055	0	7055	21986	-12,620
27	29041	7,055	0	7055	21986	-9,082
28	29041	7,055	0	7055	21986	-5,775
29	29041	7,055	0	7055	21986	-2,685
30	29041	7,055	0	7055	21986	204

Imputed water yield (*Wy*) 164,074 ML, Supply cost (*Sc*) = $43/ML;
Capital cost (*Cc*) of infrastructure $200.7M equates to $1223/ML (*viz.* property right cost);
Environmental cost (*Ec*) at year 1 = $130.7M,
Sale price (*Sw*) at baseline opportunity cost of *Cc* + *Ec* =:
at internal rate of return of 0% = $74/ML
at internal rate of return of 4% = $108/ML
at nternal rate of return of 7% = $148/ML
at internal rate of return of 10.6% = $213/ML

Benefits: **10 year demand based take up**:	**Costs:**
Years 1-10 calculated as 0.1 ($Wy \times Cc$) + 0.1t ($Wy \times Sw$) Year 11-30 calculated as ($Wy \times Sw$) Where: *t* equals the number of the year of the project	Year 1-3 = $Cc + Ec$ Year 4-30 = ($Wy \times Sc$)

Table A12 NPV of scenario 7Z, 4 year demand based water take up, at IRR of 7%

Year	4 year take up benefits $ '000)	Capital Costs ($'000)	Environmental Costs ($'000)	Total costs ($'000)	Net Benefits ($'000)	NPV @7% ($'000)
1	0	71925	130700	202625	-202625	-189,369
2	55302	85850	0	85850	-30548	-216,051
3	60430	42925	0	42925	17505	-201,762
4	65557	7,055	0	7055	58502	-157,131
5	70684	7,055	0	7055	63629	-111,764
6	20509	7,055	0	7055	13454	-102,799
7	20509	7,055	0	7055	13454	-94,421
8	20509	7,055	0	7055	13454	-86,590
9	20509	7,055	0	7055	13454	-79,272
10	20509	7,055	0	7055	13454	-72,433
11	20509	7,055	0	7055	13454	-66,041
12	20509	7,055	0	7055	13454	-60,067
13	20509	7,055	0	7055	13454	-54,484
14	20509	7,055	0	7055	13454	-49,267
15	20509	7,055	0	7055	13454	-44,390
16	20509	7,055	0	7055	13454	-39,833
17	20509	7,055	0	7055	13454	-35,574
18	20509	7,055	0	7055	13454	-31,593
19	20509	7,055	0	7055	13454	-27,873
20	20509	7,055	0	7055	13454	-24,396
21	20509	7,055	0	7055	13454	-21,147
22	20509	7,055	0	7055	13454	-18,110
23	20509	7,055	0	7055	13454	-15,272
24	20509	7,055	0	7055	13454	-12,619
25	20509	7,055	0	7055	13454	-10,141
26	20509	7,055	0	7055	13454	-7,824
27	20509	7,055	0	7055	13454	-5,659
28	20509	7,055	0	7055	13454	-3,635
29	20509	7,055	0	7055	13454	-1,744
30	20509	7,055	0	7055	13454	23

Imputed water yield (*Wy*) 164,074 ML, Supply cost (*Sc*) = $43L;

Capital cost (*Cc*) of infrastructure $200.7M equates to $1223/ML (*viz.* property right cost);

Environmental cost (*Ec*) at year 1 = $130.7M,

Sale price (*Sw*) at baseline opportunity cost of *Cc* + *Ec* =:

internal rate of return of 0% = $66/ML

internal rate of return of 4% = $85/ML

internal rate of return of 7% = $104/ML

internal rate of return of 10.6% = $135/ML

Benefits: **4 year supply base take up**:	**Costs:**
Years 1-4 calculated as 0.25 (*Wy* × *Cc*) + 0.25*t* (*Wy* × *Sw*) Years 5-30 calculated as (*Wy* × *Sw*) Where: *t* equals the number of the year of the project	Year 1-3 = *Cc* + *Ec* Year 4-30 = (*Wy* × *Sc*)