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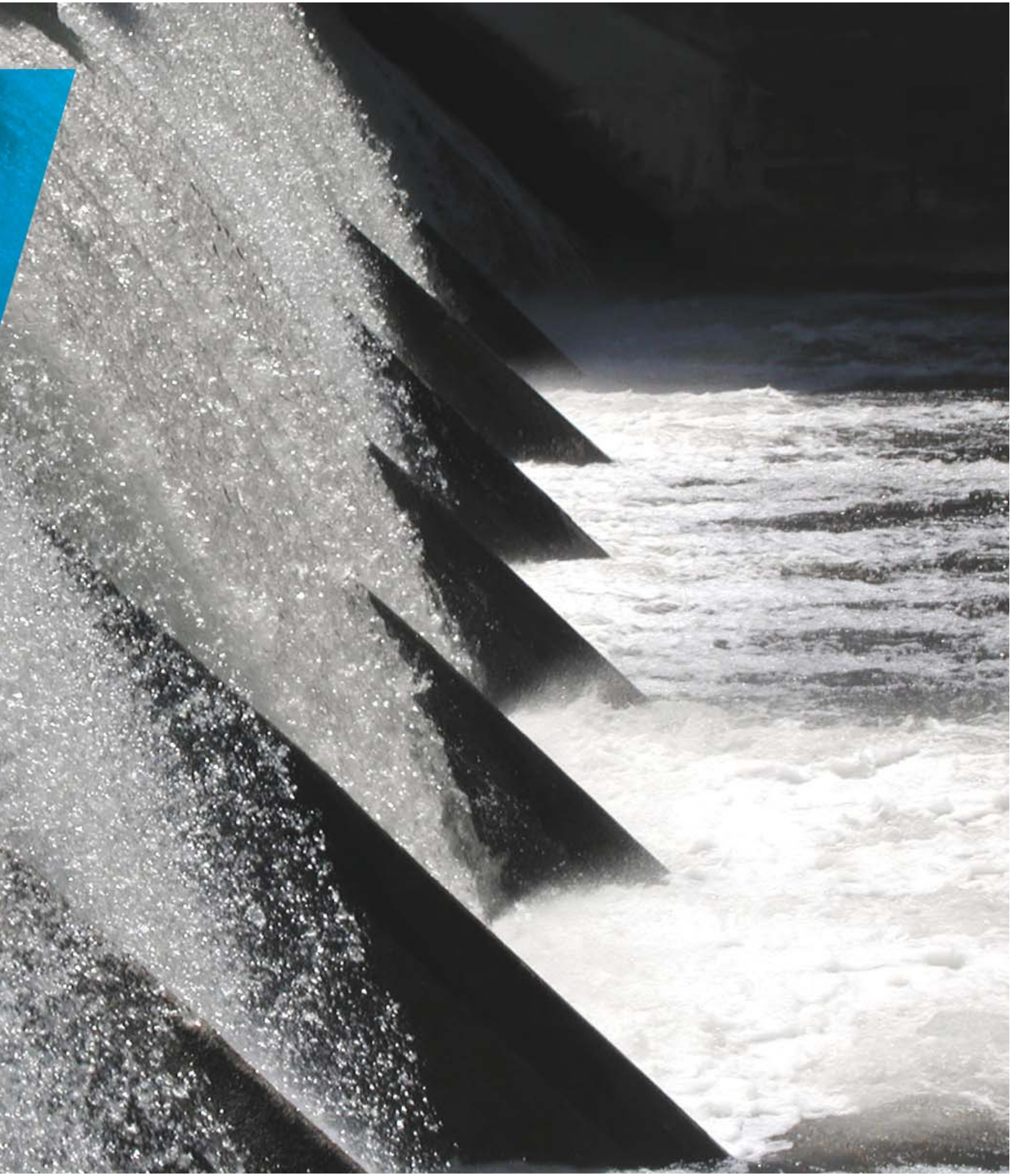
Tamar Lake Economic Impact Update

Tamar Lake Inc

July 2014



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Private and confidential

1 July 2014

Mr Robin Frith
President
Tamar Lake Inc
101 Cameron Street
Launceston TAS 7250

Dear Sir,

Economic Impact Update - Tamar Lake Inc

KPMG is pleased to provide our study into the high level economic impact of Tamar Lake Inc's proposal to construct a barrage on the Tamar River.

In summary, our analysis has found that over the 18 year modelling period:

- During the first 3 years (2019-2021), direct expenditure on barrage construction and irrigation scheme construction would contribute approx $313.51M in net additions to Gross State Product (value added), and support the employment of 856 jobs;
- On an annual basis, for the period 2021-2035, on average, capital works relating to irrigation scheme connections would contribute approx. $2.08M in net additions to GSP p.a., and support the employment of 14 jobs p.a.;
- Combined operations of the barrage and irrigation scheme suppliers would, on average, contribute approx. $3.1M in net additions to GSP p.a., and support the employment of 15 jobs p.a. for the period 2022-2028, increasing to $3.46M p.a. and 17.5 jobs p.a. for the period 2029-2036;
- Operations of the irrigation scheme users would, on average, contribute approx. $5.15M in net additions to GSP p.a., and support the employment of 38 jobs p.a. for the period 2022-2028, increasing to $14.1M p.a. and 96 jobs p.a. for the period 2029-2036; and
- The favourable impact on tourism would more than offset the adverse impact on existing fisheries, and in net terms, would contribute approx. $112.48M in net additions to GSP p.a., and support the employment of 716 jobs p.a.

On the basis of the assumptions, the analysis confirms that the proposed Tamar Lake Inc development would generate positive economic benefits for the region.

Yours faithfully

Martin Rees
(Partner)

David Richardson
(Director)

Important notice

Inherent Limitations

This report has been prepared as outlined in the Scope Section. The services provided in connection with this engagement comprise an advisory engagement which is not subject to assurance and other standards issued by the Australian Auditing and Assurance Standards Board, and consequently no opinions or conclusions intended to convey assurance have been expressed.

No warranty of completeness, accuracy or reliability is given in relation to the statements and representations made by, and the information and documentation provided by Tamar Lake Incorporated's management and personnel / stakeholders consulted as part of the process.

KPMG have indicated within this report the sources of the information provided. We have not sought to independently verify those sources unless otherwise noted within the report.

KPMG is under no obligation in any circumstance to update this report, in either oral or written form, for events occurring after the report has been issued in final form.

The findings in this report have been formed on the above basis.

Third Party Reliance

This report is solely for the purpose set out in the "Scope" section of this report and for Tamar Lake Incorporated's information, and is not to be used for any other purpose or distributed to any other party without KPMG's prior written consent.

This report has been prepared at the request of Tamar Lake Incorporated in accordance with the terms of KPMG's engagement letter dated 9 December 2013. Other than our responsibility to Tamar Lake Incorporated, neither KPMG nor any member or employee of KPMG undertakes responsibility arising in any way from reliance placed by a third party on this report. Any reliance placed is that party's sole responsibility.

Contents

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1. Introduction

Background

KPMG has been engaged to assist TLI determine the high level economic impacts of the proposal to install a barrage on the Tamar River.

This report aims to build on the pre-feasibility study by quantifying the net economic benefits of the project using non-linear input output modelling techniques contained within the Tasmanian Non-Linear Model (TNLM).

Background

The Tamar Estuary in the north of Tasmania is a drowned river valley which stretches 71 kilometres in length. The estuary provides a catchment area for over 20% of Tasmania, which is roughly 11,000 square kilometres. The narrow shape of the estuary causes tidal amplification, and as such the Tamar estuary has the largest tidal range in Tasmania.

With the establishment of Launceston in the 1870s, the channel was dredged to allow a shipping passage. As the original port of Launceston was located in the upper estuary, contamination began to increase due to organic and inorganic waste from industry, mining and domestic sources. The major port was moved to the lower estuary in the1960's.[4]

A barrage over the Tamar estuary has been proposed a number of times over the last 100 years, and has generated much public discussion as well as academic research.

Project Overview

Tamar Lake Incorporated (TLI) is proposing the installation of a barrage on the Tamar River to control the accumulation of silt in the upper reaches. A barrage may be defined as a construction across a watercourse to increase the depth of water to assist navigation or irrigation. It is anticipated that this infrastructure development on the Tamar River would produce economic benefits to Tasmania in general, and specifically to the economy of Northern Tasmania.

Pre-feasibility studies have identified that this economic gain will flow from several sources including additional agricultural output, more available water to be used for various industrial purposes, enhanced residential and commercial property activity, increased tourism activity and reduced and/or avoided costs associated with flooding and sediment build up.

It is however, thought that the proposed barrage may impact negatively upon the operations of fish farms (especially salmon fisheries), by effecting the tidal flows normally required for successful operations of such fisheries. Displacement of migratory birds would also occur, native wetlands which host a variety of species would be threatened, and imported rice grass will die off in the lake environment.

KPMG has been engaged to assist TLI determine the high level economic impacts of the proposal to install a barrage on the Tamar River. This report aims to build on the pre-feasibility study by quantifying the net economic benefits of the project using non-linear input output modeling techniques contained within the Tasmanian Non-Linear Model (TNLM).

1. http://www.aboutcivil.org/barrages-definition-&-components.html
2. See, NERA Economic Consulting (2013)
3. In making these assumptions the data featured in Tasmanian Department of Treasury and Finance (2013) "Structural Change in the Tasmanian Economy" proved useful
4. Ellison, JC and Sheehan, MR, Past, Present and Futures of the Tamar Estuary, Tasmania, Estuaries of Australia in 2050 and Beyond, Springer, E Wolanski (ed), Netherlands, pp. 69-89. ISBN 978-94-007-7018-8 (2014) [Research Book Chapter]

Approach

The engagement has been undertaken using the following approach:

- ***Step 1 - Economic impact data collection***
- ***Step 2 - Economic impact modelling***
- ***Step 3 - Draft and final report***

Approach

The engagement has been undertaken as follows.

Step 1: Economic impact data collection

- Determine the capital expenditure of the proposed new development using data provided by TLI, broken down into its component parts and the timing of those expenditures. This included but was not limited to planning, studies and approvals, site preparation and construction costs, and any other major cost items.
- Quantify the operational expenditure estimates for the period post the development. Data we required included but was not limited to employee numbers, annual expenditure on materials, labour, taxes and other operating costs.

Step 2: Economic impact modelling

- Use data from step 1 to derive the flow-on or multiplied economic benefits of the development, in terms of both construction and operating phases.
- Professor John Mangan from the University of Queensland completed this component of the project using the Tasmanian Non-Linear Model (TNLM).
- The primary economic impact measures that are generated by this modelling are as follows:

  - *Gross Output (regional turnover)* - refers to the gross value of increased production from an additional economic activity. Within this gross value is the value of raw materials that, in most cases, have already been counted as part of gross output from earlier production.

  - *Value Added* - refers to added or net output. It measures the added value placed on intermediate products (raw materials) from the productive process. It is made up of margins, wages, profits and transfers. It is also seen as a good measure of net additions to Gross Regional or State Product.

  - *Factor Income* - relates to the share of value added (and gross output) which is directly paid to individuals or firms in the form of wages and or profits. By definition it is a percentage of value added and cannot exceed value added.

  - *Jobs* - relates (usually) to the amount of labour required for the level of production. Depending upon the type of activity, job numbers measure either the use of existing labour (continuing jobs) or hiring new staff. Full Time Equivalent (FTE) employment refers to the number of full-time person-years of employment generated by a particular project or event. This alleviates the overstating of the level of job growth due to the stimulus.

A complication to the analysis was the fact that the project will not commence until 2019, and the input data used in the model is projected out until 2036. As a consequence, to allow the modelling to proceed, some assumptions have been made concerning the likely behavior of the Tasmanian economy over this extended period, including the behavior of Gross State Product and its distribution across the various industrial sectors in the TNLM .

Step 3: Draft and final report

- Compile the outcomes of the preceding steps into a draft report for initial consideration by you.
- We then resolved any issues in relation to the draft and finalised the report.

Structure of Report

Section 2 provides a summary of the outcomes of the analysis.

Section 3 outlines the key assumptions that underpin the analysis, along with some caveats/qualifications to the analysis.

Section 4 presents the results of the analysis for each of the various capital and operational expenditure components that would be generated by the development.

Section 5 presents the output tables in an aggregated summary form.

2. Executive summary

Headlines

Background	• KPMG has been engaged to assist TLI determine the high level economic impacts of the proposal to install a barrage on the Tamar River. • This report aims to build on the pre-feasibility study by quantifying the net economic benefits of the project using non-linear input output modelling techniques contained within the Tasmanian Non-Linear Model (TNLM). The modelling has been undertaken by Professor John Mangan from the University of Queensland.	Refer to Appendix 1
Assumptions	• A range of assumptions have been adopted to facilitate this economic assessment. These include assumptions around capital costs, operating costs, and revenue projections associated with: – Capital costs of - barrage construction, irrigation scheme construction, and irrigation scheme 'connections' by users; – Operational costs of – the barrage, irrigation scheme suppliers, irrigation scheme users; – Tourism expenditure impacts; and – Fisheries expenditure forgone. • The modelling has some caveats, including the fact the project is being evaluated over 18 years. Over this time there is the issue of economic structural changes, displacement, and capacity constraints.	Refer to pages 12 and 13
Economic impacts	**Capital expenditure – barrage and irrigation scheme suppliers** • During the first 3 years of the 18 year period modelled (2019-2021), combined capital works relating to barrage and irrigation scheme construction will contribute: – $558.9 million in gross additions to Gross State Product; – $313.51 million in net additions to Gross State Product (value added); and – $196.4 million in Factor Income, which supports the employment of 856 jobs.	Refer to pages 16 - 19 and page 29
Economic impacts	**Capital expenditure – irrigation scheme users** • During the 15 year period 2021-2035, on average, capital works relating to irrigation scheme 'connections' by users will contribute: – $3.76 million in gross additions to Gross State Product per annum; – $2.08 million in net additions to Gross State Product (value added) per annum; and – $1.22 million in Factor Income per annum, which supports the employment of 14 jobs per annum.	Refer to pages 20 and 29

Headlines

Economic impacts	Operational expenditure - barrage and irrigation scheme suppliers	Refer to pages 21 - 23 and page 30
	• Over the 7 year period 2022-2028, combined operations of the barrage and irrigation scheme suppliers will contribute: – Approximately $5.49 million in gross additions to Gross State Product per annum; – $3.1 million in net additions to Gross State Product (value added) per annum; – $2.13 million in Factor Income per annum; and – Support the employment of 15 jobs per annum. • Over the 8 year period 2029-2036, combined operations of the barrage and irrigation scheme suppliers will contribute: – Approximately $6.13 million in gross additions to Gross State Product per annum; – $3.46 million in net additions to Gross State Product (value added) per annum; – $2.46 million in Factor Income per annum; and – Support the employment of 17.5 jobs per annum.	
Economic impacts	**Operational expenditure - irrigation scheme users**	Refer to pages 24 - 25 and page 31
	• Over the 7 year period 2022-2028, on average, operations of the irrigation scheme users will contribute: – Approximately $9.77 million in gross additions to Gross State Product per annum; – $5.15 million in net additions to Gross State Product (value added) per annum; – $3.54 million in Factor Income per annum; and – Support the employment of 38 jobs per annum. • Over the 8 year period 2029-2036, on average, operations of the irrigation scheme users will contribute: – Approximately $24.84 million in gross additions to Gross State Product per annum; – $14.1 million in net additions to Gross State Product (value added) per annum; – $8.85 million in Factor Income per annum; and – Support the employment of 96 jobs per annum.	

Headlines

Economic impacts	Expenditure of visitors and loss of fisheries	Refer to pages 26 - 27 and page 32
	• The favourable impact on tourism would more than offset the adverse impact on existing fisheries, and in net terms, will contribute: – Approximately $194.96 million in gross additions to Gross State Product per annum; – $112.48 million in net additions to Gross State Product (value added) per annum; – $83.58 million in Factor Income per annum; and – Support the employment of 716 jobs per annum.	

3. Key assumptions & caveats

Overview

Barrage developments are often associated with controversy regarding their potential for ecological change. Economic impacts typically seen as flowing from these activities include increased agricultural production, flood mitigation and enhanced water based tourism activities.

The economics of barrage construction

The construction of barrages, dams and other devices to alter the level and rate of tidal water flow across rivers and bays is a relatively common practice across the world by those seeking to increase the economic potential of the water resources in question.[5] Economic impacts typically seen as flowing from these activities include increased agricultural production, flood mitigation and enhanced water based tourism activities. In Eastern Australia barrages operate successfully on the Fitzroy[6] and Mary Rivers[7].

The Fitzroy River barrage is the major source of water for the town of Rockhampton and the surrounding areas of Gracemere, The Caves and Nerimbera, in addition to supplying agriculture water to approximately 240 rural users. If water allocations are drawn from the barrage at the maximum approved amounts, the barrage will hold sufficient water to supply the Rockhampton area for nine months. The barrage was constructed with movable gates to keep the upstream river levels as close as practical to full supply level. To prevent the river level rising above its natural flood levels, operation of the gates is carried out automatically. A fish ladder operates at the southern bank of the river when the water level is within 600mm of full supply, and it is estimated well over 500,000 fish successfully negotiate it each year.[8]

Despite the relative frequency of their occurrence, little has been done to formally evaluate the economic impact of the barrages. One of the few studies (2005–06) estimated that the total value of agricultural commodities produced in the Fitzroy Basin was approximately $1 billion, accounting for 13% of Queensland's agricultural commodities produced in that year, with barrage produced irrigation being linked to approximately 50% of that level of production.[9]

Barrage developments are often associated with controversy regarding their potential for ecological change. Among the more famous are the many controversies that have marked the economic development of the Columbia River in the United States. Notable among these have been the division of responsibility between public and private agencies, the effect on the fish life (particularly salmon), and loss of traditional Native American fishing sites. The most ambitious of the barrage projects world-wide, the Severn River barrage proposal, is currently being debated by the UK Government.[10]

5. For example, there are currently five barrages operating in South Australia: along the Murray River; Goolwa Barrage, Mundoo Barrage, Boundary Creek Barrage, Ewe Island and Tauwitchere Barrages. Before the barrages were built, saltwater could reach as far upstream as 250 kilometres from the Murray Mouth, and river levels could fluctuate considerably.
6. Not to be confused with the Fitzroy River Barrage which is a dam type structure built as part of the Camballin Irrigation Scheme in Western Australia
7. See, www.rockhamptonregion.qld.gov.au/files/ *and*
8. See, Fitzroy_River_Barrage http://www.rockhamptonregion.qld.gov.au/Council_Services/Fitzroy_River_Water/Water_and_Sewerage_Infrastructure/
9. For data on the Fitzroy Economy see, http://statistics.oesr.qld.gov.au/profiles/qrp/time-
10. The Severn Barrage refers to a range of ideas for building a barrage from the English coast to the Welsh coast over the Severn tidal estuary. The purpose of such a project has typically been one, or several of: transport links, flood protection, harbour creation, or tidal power generation. Following the Severn Tidal Power Feasibility Study (2008–10), the British government concluded that there was no strategic case for building a barrage but to continue to investigate emerging technologies.

Modelling Assumptions

A range of assumptions have been adopted to facilitate this economic assessment. These include assumptions around capital costs, operating costs, and revenue projections associated with:

- **Capital costs**
  - **Barrage construction**
  - **Irrigation scheme construction**
  - **Irrigation scheme 'connections'**
- **Operating costs**
  - **Barrage**
  - **Irrigation scheme suppliers**
  - **Irrigation scheme users**
- **Tourism expenditure impacts**
- **Fisheries expenditure foregone**

Modelling assumptions

A number of new sources of economic activity in Northern Tasmania will occur as a result of the construction of the barrage. These are connected to the construction and operation of the barrage, and the expansion of agriculture and tourism that will flow from successful barrage construction. This economic assessment takes place under the following assumptions derived by KPMG (Tasmania), in consultation with the proponents of the development, and other independent advisors operating in the agricultural and irrigation industries.

Barrage construction capital costs

- The construction of the barrage is not expected to commence until 2019/20, and will take 3 years to complete
- Cost estimates provided are in nominal terms
- The capital investment (local spend) over that period will be $239.8 million

Barrage operating costs

- Operational expenses have been estimated to average out at $1.5 million ($A2014) per annum, spent mainly on repairs and maintenance

Irrigation scheme suppliers capital costs

- $19 million over a 12 month period, commencing in year 3

Irrigation scheme suppliers operating costs

- An average fixed charge is $66.93/ML, which will be incurred regardless of how many ML's are actually used, and therefore it is constant
- The average variable charge is $114.83/ML, increasing over time to full capacity
- Total local spend (2022-2036) of $11.62 million

Irrigation scheme users capital costs

- $27.3 million over a 15 year period, commencing in year 3

Irrigation scheme user operating costs

- $103.73 million over the period 2022-2036 (increasing monotonically with time)

Tourism

- It is assumed there will be a 10% increase in international visitors, interstate visitors, and intrastate visitors that stay at least 1 night, and that all will stay an additional 1 night in the region
- This will produce additional tourist expenditure of approx $90.5 million ($A2014 prices) per annum in the region

Fisheries

- It is assumed that up to $12 million per annum in local operating expenditure will be lost from disrupted fish farming
- This may be pessimistic following the successful use of fish ladders in other barrage projects in Australia and around the world

Caveats

The modelling has some caveats, including the fact that the project is being evaluated over 18 years. Over this time, there is the issue of economic structural changes, displacement, and capacity constraints.

Caveats to the modelling

The Tamar barrage project is being evaluated over 18 years. This time duration poses a number of problems for accurate modelling. In a project specific sense, estimates of direct spending need to be made in advance, especially operating expenses. More importantly, the project is not occurring in isolation. During this time period the Tasmanian economy will grow and undergo structural change. To allow for successful modelling, the TNLM will need to be recalibrated at least once to allow for these shifts in the Tasmanian economy.

Another potential issue is that of displacement. This occurs where finance for a specific project has been diverted from an alternative use somewhere else in the Tasmanian economy. In such a case the only resultant economic benefit would be from the differential between the chosen project and the substituted project. There is no evidence that this is likely to occur with the Tamar Lake project, and the analysis proceeds on this basis.

Finally, there is the issue of capacity constraints. In a fully engaged economy, projects compete with one another for scarce labour and materials, with the result that some individual projects do not reach their potential economic impact. However, currently and in the foreseeable future the Tasmanian economy is unlikely to be operating at capacity, and so the problem of capacity constraints should not enter the calculations.

Sources of Value

The economic value of a particular activity to an economy is often measured through its value added, or additional contribution to Gross Regional Product (GRP) per Gross State Product (GSP).

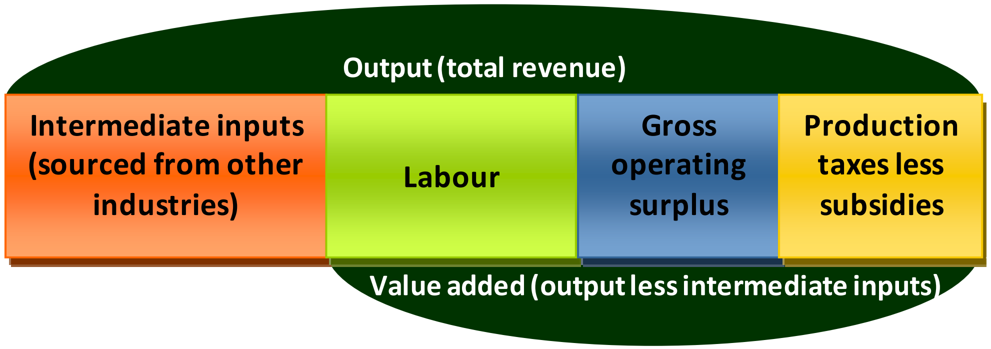
Sources of value from economic activity

Economic models are driven by 'shifts in final demand'. By this it is meant that new expenditure on goods and services represents a genuine stimulus to economic activity rather than simply redistributing a fixed level of spending from one activity to another. If this new expenditure is exogenous (i.e. originates from outside the economy it is spent in, or is local finance that would not have been spent on any alternative project), it is particularly valuable to the local economy because it represents additional new and/or on-going investment. This amount of exogenous expenditure on final demand products is often increased or "multiplied" to provide an estimate of the total impact on the economy, because demand for final demand products also requires a boost in demand for intermediate products used in their production. The higher the percentage of intermediate goods, the higher is this multiplied effect.

This multiplied effect often shows up in significantly expanded Gross Output/Regional Turnover. However, this data is often partially discounted due to concerns over possible double-counting during the estimation process. However, it is still important to take note of Gross Output or Turnover effects because they define the level of activity in an economy, particularly in terms of defining the capacity of an economy to undertake large projects.

Nevertheless, the economic value of a particular activity to an economy is often measured through its value added or additional contribution to Gross Regional Product (GRP) per Gross State Product (GSP). When the Government says the Tasmanian Economy grew by 3% per annum, they mean that the GSP of Tasmania increased by 3%[12], where GSP is the increment added to the sum of the value of intermediate products resulting from the sale of the final demand products. This process is illustrated in Figure 1.1. As can be seen in figure 1.1, Value Added is a sub-component of Gross Output, which in turn may be subdivided into its Labour component (wages and other income such as dividends), Gross Operating Surplus, which includes Company Profits and Production Generated Taxes and Charges.

Figure 1.1: Stylised economic activity accounting framework



Source: Mangan, (2008)

12. Which suggests that turnover increased by 5%-6% but some of this was double counted

4. Economic impact results

Capital Expenditure

The economic impacts of the actual barrage construction are based on approx $240 million in capital works over a three year period (2019-2021).

Capital Expenditure

The capital expenditure to be evaluated takes place (mainly) within the first 3 years of the commencement of the project. The main components are :

- $239.8 million in years 1-3 (2019- 2021) on construction of the barrage; and
- $19 million in year 3 (2021) on construction of the irrigation scheme.

Capital investment also takes place among irrigation scheme users at $27.3 million spread over the 15 year period (2021-2035).

The impact of capital investment has tended to be downplayed in some impact studies because its impacts are seen as project specific and short term, especially for employment. However, Mangan (2002) has shown that one-off capital projects, especially where construction is involved, have more lasting impacts because taken collectively, these types of projects are needed to maintain the jobs of construction workers, who tend to be spatially mobile and move from one project to another.

In this sense an important part of the impact of capital works is in maintaining jobs as well as creating new jobs. In his study of industrial projects in Gladstone, Mangan (2002) estimated that of jobs associated with new capital projects, 40% were newly created, and 60% were supporting those currently in the workforce, but whom may have been between jobs before the commencement of the project. This estimate has subsequently been used in a number of studies.

To evaluate the first two projects, the current TNLM was recalibrated to reflect 2019 GSP[13], the industry structure was modified by using relative growth trends for each industry sector over the ten year period 2003-2013, and constrained to aggregate GSP. The alternative to doing this would have been to take projections of growth by industry, apply this growth rate and then follow the same constraining process. Both methods have strengths and weaknesses, but it was felt that the former had the advantage of observed rather than predicted growth rates.

Table 1: Economic impacts of Barrage Construction - Total 3 year period ($million)

	Final Demand	Industry Effects	Consumption Effects	Total	Flow-on
Gross Output	239.80	58.33	221.82	519.95	280.15
Value Added	122.96	27.92	141.01	291.89	168.93
Factor Income	63.05	13.19	108.01	184.25	121.20
Employment	350	41	320	711	361

Estimated from TNLM (2013) from supplied data

13. Prices were kept constant to fit in the format of the supplied data

Capital Expenditure

The total direct and indirect impacts as a result of barrage construction are estimated to be:

- **A Turnover or Gross Output impact of $519.95 million over the 3 year period**
- **Value Added or net addition to Gross State Product of $291.89 million over the 3 year period**
- **Net additions to Factor Income of $184.25 million over the 3 year period**
- **Total employment impacts (jobs supported) of 711 Full Time Equivalents (FTE's)**

Barrage Construction Capital Expenditure

The model was calibrated to reflect projected 2019 conditions in the Tasmanian economy, and the capital works program was evaluated for the full 3 year period. The alternative would have been to average out over the 3 year period and use annual shocks for calibration. However, these types of programs tend to overlap year to year and for this relatively short period it was considered best to calculate over the 3 year period.

On this basis the total (direct + indirect) impacts are estimated to be:

- A Turnover or Gross Output impact of $519.95 million over the 3 year period
- Value Added or net addition to Gross State Product of $291.89 million over the 3 year period
- Net additions to Factor Income of $184.25 million over the 3 year period
- Total employment impacts (jobs supported) of 711 Full Time Equivalents (FTE's)

By way of interpretation, industry effects (sometimes called supplier effects) represent an increase in purchases from other sectors to generate more output. So in the case of the capital works associated with the construction of the barrage, this would refer to the purchase of more intermediate goods to sustain the increased duration. A proportion of this 'knock-on' effect will benefit suppliers in the local economy, and it is this percentage that is evaluated in Table 2. The ratio of the direct + the industry / the direct produces the type 1 multipliers[14] that are sometimes used in these types of studies where there is a small consumption effect.

However, in this case there is a significant consumption effect.[15] The consumption effect (sometimes referred to as the income effect) relates to the increase in incomes and related spending as a result of the construction of the barrage over a 3 year period. The ratio of the direct + the industry + the consumption effects / the direct effect yields the type 2 multiplier, which is the most widely reported multiplier and the form used in the evaluations in tables 2-9.

14. See, Frontier Economics (2007)
15. The relatively small size of the industry effect in comparison to the consumption effect implies that this sector of the table (though not necessarily this project) tends to import from mainland Australia or overseas the major capital items but the consumption effects of the project are strongly driven by the local spending.

Capital Expenditure

The analysis of the impact of the construction of the barrage suggests that in comparison to other capital works programs these are towards the higher side for regional multipliers, but very close to guidance results for the construction industry issued by the US Department of Commerce.

Barrage Construction Capital Expenditure

The results in Table (1) show that the direct expenditure of $239.8 million, generates an additional $58.33 million in turnover through the Tasmanian economy via direct industrial effects (impacts on customers and clients) and (a large) $221.82 million of additional consumption effects (through employment and income impacts), leading to a total output or turnover impact of $519.95 million over the 3 year period. There is some double counting in these estimates.[16] In net terms there will be $122.96 million over the period in direct additions to GSP or value-adding. This is turn will generate additional flow-on of $27.92 million in industry effects and a larger, $141.01 million in consumption effects, leading to a total value-adding of $291.89 million over the 3 year period, which is normally regarded as the headline figure for economic contribution of these type of projects. Similarly, the value-adding produces factor income; $63.05 million in direct impact and combined flow-on of $121.2 million, leading to a total income impact over the period of $184.25 million.

The employment impacts relate to total jobs supported. It is difficult to predict the exact distribution or time path of employment impacts over the 3 year period. The results suggest (using the default values of the TNLM) a total employment impact (jobs supported in Tasmania) of 711 FTE's from a direct workforce of 350 FTE's. As the large majority of the flow-on jobs are driven by consumption impacts, the more likely scenario is total employment impacts of around 400 in the first year building up to the 711 jobs supported over the 3 year period. Overall, the main flow-on sectors to be positively impacted are Retail and Wholesale Trade (28%), Financial, Insurance and Business Services (14%), Manufacturing (13%), Transport, Postal and Warehousing (9%) Electricity, Gas and Water (5%) and the remaining 31% was spread across the remainder of the sectors.

The results in Table (1) suggest type 2 multipliers of 2.16[17] (output multiplier) and 2.37 (GSP or value added multiplier).[18] In comparison to other capital works programs these are towards the higher side for regional multipliers, but are very close to guideline results for the Construction industry issued by the United States Department of Commerce. [19]

16. For this reason most emphasis in economic impact is placed on value adding although turnover is a useful measure of economic activity generated by a project.
17. Compares with a 2.7 output multiplier for Construction for Australia as a whole, see Australian Bureau of Statistics " Introduction to Input-Output multipliers http://www.ausstats.abs.gov.au/Ausstats
18. Calculated by dividing total value added by the total direct output expenditure
19. See, US Department of Commerce (2007) ; Regional Multipliers A User Handbook for Regional Input Output Model Systemshttp://www.bea.gov/scb/pdf/regional/perinc/meth/rims2

Capital Expenditure

The economic impacts of the irrigation scheme construction (by suppliers) is based on capital expenditure of $19 million over a 12 month period. The economic impacts of this expenditure are estimated to be:

- **A Turnover or Gross Output impact of $38.95 million over the 1 year period**
- **Value added or net addition to Gross State Product of $21.62 million over the 1 year period**
- **Net additions to Factor Income of $12.15 million over the 1 year period**
- **Total employment impacts (jobs supported) of 145 Full Time Equivalents (FTE's)**

Irrigation Scheme Suppliers Capital Expenditure

Table 2 shows the results for the Irrigation Scheme Suppliers capital expenditure. Once again the 2019 calibration of the model was used. The results shown in table 2 relate to an injection of $19 Million over a 12 month period. It is assumed that no crowding out occurred as a result of the overlap of this project with the finalization of the barrage construction project.

Table 2 Economic impacts of Irrigation Scheme Construction (Suppliers) - 1 year ($million)

	Final Demand	Industry Effects	Consumption Effects	Total	Flow-on
Gross Output	19.00	5.32	14.63	38.95	19.95
Value Added	9.78	2.54	9.30	21.62	11.84
Factor Income	3.85	1.17	7.13	12.15	8.30
Employment	72	10	63	145	73

The results indicate;

- A Turnover or Gross Output impact of $38.95 million over the 1 year period [20]
- Value Added or net addition to Gross State Product of $21.62 million over the 1 year period
- Net additions to Factor Income of $12.15 million over the 1 year period
- Total employment impacts (jobs supported) of 145 Full Time Equivalents (FTE's)

Proportionally the modelling results are very similar to those recorded in table 1, but slightly less (output multiplier of 2.06 compared to 2.16) due to the non-linear properties in the model which adjust for scale of development. Once again, as is the pattern in a number of Tasmanian industries, the consumption effect outweighs the industry effect in the composition of the flow-on impacts.

20. It is difficult to fully predict the time path of these economic impacts and when their effects would stop being felt in the economy. However the concept of the 3 year period indicates that the direct injection of investment dollars is program to cease after 3 years.

Capital Expenditure

The economic impacts of irrigation scheme users 'connecting' to the scheme is based on $27.3 million of capital expenditure over a 15 year period (2021-2035). The economic impacts of this expenditure, on average, are estimated to be:

- **A Turnover or Gross Output impact of $3.76 million per annum over the 15 year period**
- **Value Added or net addition to Gross State Product of $2.08 million per annum over the 15 year period**
- **Net additions to Factor Income of $1.22 million per annum over the 15 year period**
- **Total employment impacts (jobs supported) of 14 Full Time Equivalents (FTE's) per annum**

Irrigation Scheme Users Capital Expenditure

Table 3 Economic impacts of Irrigation Scheme 'Connections' (Users) - Annual average over 15 year period ($million)

	Final Demand	Industry Effects	Consumption Effects	Total	Flow-on
Gross Output	1.82	0.51	1.43	3.76	1.94
Value Added	0.93	0.24	0.90	2.08	1.15
Factor Income	0.38	0.14	0.69	1.22	0.83
Employment	7	1	6	14	7.00

Within the construction aspect of the Tamar barrage project, the results in table 3 examine the capital expenses incurred by the irrigation scheme users, estimated by KPMG at $27.3 million in direct spending over a 15 year period. Due to the length of time of this capital works program, the table was reconstituted for 2 periods; 2022-2028 and 2029-2036. An average yearly spend of $1.82 million was used to shock the model and the results from each period were combined and shown in table 3.

Due to the length of the investment program and the regularity of spending, this takes on the characteristic of a quasi-industry (operations) rather than a short period capital works program.

The results in table 3 indicate total average annual economic benefits of:

- A Turnover or Gross Output impact of $3.76 million per annum over the 15 year period
- Value added or net addition to Gross State Product of $2.08 million per annum over the 15 year period
- Net additions to Factor Income of $1.22 million per annum over the 15 year period
- Total employment impacts (jobs supported) of 14 Full Time Equivalents (FTE's) per annum

Operational Expenditure

The economic impacts of barrage operations are based on $1.5 million of operational expenditure per annum. The economic impacts of this expenditure, on average, are estimated to be:

- **A Turnover or Gross Output impact of $3.84 million per annum**
- **Value Added or net addition to Gross State Product of $2.17 million per annum**
- **Net additions to Factor Income of $1.54 million per annum**
- **Total employment impacts (jobs supported) of 11 Full Time Equivalents (FTE's) per annum**

Barrage Operational Expenditure

Operational results differ from those relating to capital works because they represent continuing injections of funds into the economy with on-going impacts. As such it is normal to report annual average impacts only. Table 4 does this for the economic impacts of barrage operations. In this scenario an estimated $1.5 million is injected into the economy on an annual basis. The shock was applied to the model through the Trade, Finance, and Construction and Manufacturing sectors in the proportions 35%; 15%; 25% & 25%.[21]

Table 4 Economic impacts of Barrage Operations - Annual average ($million)

	Final Demand	Industry Effects	Consumption Effects	Total	Flow-on
Gross Output	1.50	0.49	1.85	3.84	2.34
Value Added	0.76	0.24	1.17	2.17	1.41
Factor Income	0.52	0.12	0.90	1.54	1.02
Employment	3	1	7	11	8

The results in table 4 indicate total annual economic benefits of:

- A Turnover or Gross Output impact of $3.84 million per annum
- Value Added or net addition to Gross State Product of $2.17 million per annum
- Net additions to Factor Income of $1.54 million per annum
- Total employment impacts (jobs supported) of 11 Full Time Equivalents (FTE's) per annum

21. Default values from other TNLM projects

Operational Expenditure

The economic impacts of irrigation scheme supplier operations (years 2022-2028) are based on an average annual expenditure of approx $0.65 million. The economic impacts of this expenditure, on average, are estimated to be:

- **A Turnover or Gross Output impact of $1.65 million per annum**
- **Value Added or net addition to Gross State Product of $0.93 million per annum**
- **Net additions to Factor Income of $0.59 million per annum**
- **Total employment impacts (jobs supported) of 4 Full Time Equivalents (FTE's) per annum**
- **The model is then recalibrated with estimates for 2029-2036. The results are shown in 5(b).**

Irrigation Scheme Suppliers Operational Expenditure

The evaluation of the economic impacts of operations of the irrigation scheme suppliers proved problematical, due to the length of time over which it had to be evaluated. KPMG has estimated that the total spending on operational aspects will be $11.62 million over the period (2022-2036). They have also provided yearly expenditures. To estimate the impacts, the period was divided into 2; 2022-2028 and 2029-2036. Annual expenditures in each period were averaged and applied to the model calibrated to reflect conditions for each time period. The results for the first period (2022-2028) are shown in table 5 (a).

Table 5 (a) Economic impacts of Irrigation Scheme Supplier Operations - Annual average 2022-2028 ($million)

	Final Demand	Industry Effects	Consumption Effects	Total	Flow-on
Gross Output	0.65	0.21	0.79	1.65	1.00
Value Added	0.33	0.10	0.50	0.93	0.60
Factor Income	0.23	0.05	0.31	0.59	0.36
Employment	1.5	.5	2	4	2.5

The results in table 5 (a) suggest between 2022 and 2028 the annual economic benefits will be:

- A Turnover or Gross Output impact of $1.65 million per annum
- Value Added or net addition to Gross State Product of $0.93 million per annum
- Net additions to Factor Income of $0.59 million per annum
- Total employment impacts (jobs supported) of 4 Full Time Equivalents (FTE's) per annum
- The model is then recalibrated with estimates for 2029-2036, and the results over this period are shown in table 5 (b)

Operational Expenditure

The economic impacts of irrigation scheme supplier operations (years 2029-2036) are based on annual average expenditure of approx $0.90 million. The economic impacts of this expenditure, on average, are estimated to be:

- **A Turnover or Gross Output impact of $2.29 million per annum**
- **Value Added or net addition to Gross State Product of $1.29 million per annum**
- **Net additions to Factor Income of $0.92 million per annum**
- **Total employment impacts (jobs supported) of 6.5 Full Time Equivalents (FTE's) per annum**

Irrigation Scheme Suppliers Operational Expenditure

Table 5 (b) Economic impacts of Irrigation Scheme Supplier Operations - Annual average 2029-2036 ($million)

	Final Demand	Industry Effects	Consumption Effects	Total	Flow-on
Gross Output	0.90[22]	0.29	1.10	2.29	1.39
Value Added	0.45	0.14	0.70	1.29	0.84
Factor Income	0.31	0.07	0.54	0.92	0.61
Employment	2	0.5	4	6.5	4.5

Over this period the average per annum impacts will be:

- A Turnover or Gross Output impact of $2.29 million per annum
- Value Added or net addition to Gross State Product of $1.29 million per annum
- Net additions to Factor Income of $0.92 million per annum
- Total employment impacts (jobs supported) of 6.5 Full Time Equivalents (FTE's) per annum

22. Average out for the annual figures provided over the period 2029-2036

Operational Expenditure

The economic impacts of irrigation scheme user operations (years 2022-2028) are based on annual average expenditure of approx $3.58 million. The economic impacts of this expenditure, on average, are estimated to be:

- **A Turnover or Gross Output impact of $9.77 million per annum**
- **Value Added or net addition to Gross State Product of $5.15 million per annum**
- **Net additions to Factor Income of $3.54 million per annum**
- **Total employment impacts (jobs supported) of 38 Full Time Equivalents (FTE's) per annum**

Irrigation Scheme Users Operational Expenditure

Table 6 (a) Economic impacts of Irrigation Scheme User Operations - Annual average 2022-2028 ($million)

	Final Demand	Industry Effects	Consumption Effects	Total	Flow-on
Gross Output	3.58	1.92	4.27	9.77	6.19
Value Added	1.84	0.59	2.72	5.15	3.30
Factor Income	1.17	0.29	2.08	3.54	2.37
Employment	16	4	18	38	22

Over this period the average per annum impacts will be:

- A Turnover or Gross Output impact of $9.77 million per annum
- Value Added or net addition to Gross State Product of $5.15 million per annum
- Net additions to Factor Income of $3.54 million per annum
- Total employment impacts (jobs supported) of 38 Full Time Equivalents (FTE's) per annum

Operational Expenditure

The economic impacts of irrigation scheme user operations (years 2029-2036) are based on annual average expenditure of approx $9.83 million. The economic impacts of this expenditure, on average, are estimated to be:

- **A Turnover or Gross Output impact of $24.84 million per annum**
- **Value Added or net addition to Gross State Product of $14.10 million per annum**
- **Net additions to Factor Income of $8.85 million per annum**
- **Total employment impacts (jobs supported) of 96 Full Time Equivalents (FTE's) per annum**

.

Irrigation scheme users operational expenditure

Table 6 (b) Economic impacts of Irrigation Scheme User Operations - Annual average 2029-2036 ($million)

	Final Demand	Industry Effects	Consumption Effects	Total	Flow-on
Gross Output	9.83	3.28	11.73	24.84	15.01
Value Added	5.03	1.61	7.46	14.10	9.07
Factor Income	3.23	0.60	5.02	8.85	5.62
Employment	42	10	44	96	54

Similarly for the period 2029-2036:

- A Turnover or Gross Output impact of $24.84 million per annum
- Value Added or net addition to Gross State Product of $14.1 million per annum
- Net additions to Factor Income of $8.85 million per annum
- Total employment impacts (jobs supported) of 96 Full Time Equivalents (FTE's) per annum

Clearly the strength of the economic impacts increases in the second period quite substantially, due to a greater take-up of the increased agricultural options.

The main industries to be positively impacted are Retail and Wholesale Trade (31%), Public Financial, Insurance and Business Services (19%), Public Administration (12%), Transport, Postal and Warehousing (11%) Electricity, Gas and Water (3%) , Manufacturing (2%) and the remaining 22% was spread across the remainder of the sectors.

Impact on Tourism

The annual impacts of increased tourism visitation and spending are substantial. Based on estimated additional spending of approx $90.49 million per annum, the economic impacts are estimated to be:

- A Turnover or Gross Output impact of $215.75 million per annum
- Value Added or net addition to Gross State Product of $123.29 million per annum
- Net additions to Factor Income of $88.84 million per annum
- Total employment impacts (jobs supported) of 803 Full Time Equivalents (FTE's) per annum

Impact on Tourism

Water–sport related tourism is set to be boosted by an increase of approx $90.49 million in direct spending per annum. Assigning the total economic impact for tourist activities is normally undertaken in one of two ways. The first is to use satellite accounts whereby a tourist industry is artificially compiled and can then be used as a component sector in an economic impact model.[23] The alternative (which, indirectly is quite similar) is to assign tourist designated expenditure to the various sectors of a model that are believed to be tourist intensive. These are Accommodation & Food services; Retail services; Arts & Recreation services, Transport, Postal and Warehousing, and Personal services. In this case the second method was used with expenditure assigned to each category on the basis of proportions previously established by Bureau of Tourism Research.[24] The results appear in table 7 below.

Table 7 Annual Tourism impacts – ($million)

	Final Demand	Industry Effects	Consumption Effects	Total	Flow-on
Gross Output	90.49	28.31	96.95	215.75	125.26
Value Added	47.26	14.04	61.99	123.29	74.03
Factor Income	29.96	6.79	52.09	88.84	58.88
Employment	301	94	408	803	502

The results in table 7 indicate that the total economic impacts from the increased tourism visitation and spending are substantial. Specifically:

- A Turnover or Gross Output impact of $215.75 million per annum
- Value Added or net addition to Gross State Product of $123.29 million per annum
- Net additions to Factor Income of $88.84 million per annum
- Total employment impacts (jobs supported) of 803 Full Time Equivalents (FTE's) per annum

These results suggest a 2A output multiplier of 2.37, and a value added multiplier of 2.5. These are slightly higher than the average suggested by Horvath and Frechtling.[25] in their international study, but within the range established by these authors for a range of countries. REMPLAN (2012) reports in their study of tourism in Western Tasmania, that tourism in Tasmania as a whole has a 2A output multiplier of 2.1, again suggesting the results here are at the higher range of estimates.[26] However, contradicting this is that the TNLM has been shown to have performed well in a number of studies, and is a more recent model than the one used in REMPLAN, which is based on 2008 ABS Australian Tables, and 2010 Tasmanian specific data. Moreover, the employment multiplier obtained (2.54), is at lower end of estimates of the employment impact of tourism. In keeping with the conservative results of non-linear models, the upshot here is we are confident with the results obtained.

23. See Australian Bureau of Statistics Catalogue no. 5249.0 - Australian National Accounts: Tourism Satellite Account, 2012-13
24. See, Bureau of Tourism Research (2012) Tourism and the Australian Economy, http://www.tra.gov.au/publications/tourism-and-the-australian-economy.html\
25. Horvath, E. and Frechtling (1999) " *Estimating the Multiplier Effects of Tourism Expenditures on a Local Economy,* Journal of Travel Research 37 (4) , 324-33
26. REMPLAN (2013) Economic Impact Analysis; Tourism in Tasmania's West report prepared for Tourism Tasmania and the Cradle Coast Authority
Table 9 Tourism annual impacts $M

Impact on Fisheries

There are concerns that the proposed barrage construction will harm fish farms, specifically salmon fisheries located in the region. KPMG estimate that as much as $12 million in the value of production fisheries output might disappear from the Tasmanian economy annually. The multiplied economic impact of this loss is estimated to amount to:

- **A Turnover or Gross Output negative impact of $20.79 million per annum**
- **Value Added or net loss to Gross State Product of $10.81 million per annum**
- **Net losses to Factor Income of $5.26 million per annum**
- **Total employment loss of 87 FTE's**

Impact on Fisheries

There are concerns that the proposed barrage construction will harm fish farms, specifically salmon fisheries located in the region. This is despite the successful use of fish ladders to accompany barrages and dams in a number of places around the world.[27]

Table 8 Negative Impacts on Fisheries – ($million)

	Final Demand	Industry Effects	Consumption Effects	Total	Flow-on
Gross Output	12.00	3.92	4.87	20.79	8.79
Value Added	5.83	1.88	3.10	10.81	4.98
Factor Income	2.19	0.70	2.36	5.26	3.07
Employment	48	13	26	87	39

KPMG estimate that as much as $12 million in the value of production fisheries output might disappear from the Tasmanian economy annually.

The total negative impacts, per annum, were this to occur would be;

- A Turnover or Gross Output negative impact of $20.79 million per annum
- Value Added or net loss to Gross State Product of $10.81 million per annum
- Net losses to Factor Income of $5.26 million per annum
- Total employment loss of 87 FTE's

These total losses are relatively restrained in view of a $12 million direct loss, and imply an output multiplier of 1.73, and a value added multiplier of 1.85[28]. These were obtained by applying the initial shock through the Agricultural, Forestry and Fishing sector, where consumption effects are noticeably less pronounced.

27. Including the Columbia River (USA); Vancouver, Muesa River (Netherlands) and Gullspang (Sweden) which has fish ladders for salmon near a power station.
28. These are at the lower end of multipliers for Agriculture, see WA Department of Agriculture and Food (2012) Multipliers: Western Australian Agriculture and Food Industries; where the output multiplier for Agriculture, forestry and fishing is closer to 2

5. Summary output tables

Summary output tables

Capital Expenditure

During the first 3 years of the 18 year period modelled (2019-2021), combined capital works relating to barrage and irrigation scheme construction will contribute:

- $558.9 million in gross additions to GSP
- $313.51 million in net additions to GSP (value added)
- $196.4 million in Factor Income
- Support the employment of 856 jobs

During the 15 year period 2021-2035, on average, capital works relating to irrigation scheme 'connections' by users will contribute:

- $3.76 million in gross additions to GSP per annum
- $2.08 million in net additions to GSP (value added) per annum
- $1.22 million in Factor Income per annum
- Support the employment of 14 jobs per annum

	Final demand	Industry effect	Consumption effect	Total	Flow on
Barrage construction – one off (2019 – 2021)					
Gross output	239.80	58.33	221.82	519.95	280.15
Value added	122.96	27.92	141.01	291.89	168.93
Factor Income	63.05	13.19	108.01	184.25	121.20
Employment	350.00	41.00	320.00	711.00	361.00
Irrigation scheme construction (suppliers) – one off (2021)					
Gross Output	19.00	5.32	14.63	38.95	19.95
Value Added	9.78	2.54	9.30	21.62	11.84
Factor Income	3.85	1.17	7.13	12.15	8.30
Employment	72.00	10.00	63.00	145.00	73.00
Irrigation scheme construction (users) – average per annum (2021 – 2035)					
Gross Output	1.82	0.51	1.43	3.76	1.94
Value Added	0.93	0.24	0.90	2.08	1.15
Factor Income	0.38	0.14	0.69	1.22	0.83
Employment	7.00	1.00	6.00	14.00	7.00

Summary output tables

Operational Expenditure

Over the 7 year period 2022-2028, combined operations of the barrage and irrigation scheme suppliers will contribute:

- **$5.49 million in gross additions to GSP per annum**
- **$3.1 million in net additions to GSP (value added) per annum**
- **$2.13 million in Factor Income per annum**
- **Support the employment of 15 jobs per annum**

Over the 8 year period 2029-2036, combined operations of the barrage and irrigation scheme suppliers will contribute:

- **$6.13 million in gross additions to GSP per annum**
- **$3.46 million in net additions to GSP (value added) per annum**
- **$2.46 million in Factor Income per annum**
- **Support the employment of 17.5 jobs per annum**

	Final demand	Industry effect	Consumption effect	Total	Flow on
Barrage operations – per annum					
Gross Output	1.50	0.49	1.85	3.84	2.34
Value Added	0.76	0.24	1.17	2.17	1.41
Factor Income	0.52	0.12	0.90	1.54	1.02
Employment	3.00	1.00	7.00	11.00	8.00
Irrigation scheme operations (suppliers) – average per annum (2022-2028)					
Gross Output	0.65	0.21	0.79	1.65	1.00
Value Added	0.33	0.10	0.50	0.93	0.60
Factor Income	0.23	0.05	0.31	0.59	0.36
Employment	1.50	0.5.0	2.00	4.00	2.50
Irrigation scheme operations (suppliers) – average per annum (2029-2036)					
Gross Output	0.90	0.29	1.10	2.29	1.39
Value Added	0.45	0.14	0.70	1.29	0.84
Factor Income	0.31	0.07	0.54	0.92	0.61
Employment	2.00	0.50	4.00	6.50	4.50

Summary output tables

Operational Expenditure

Over the 7 year period 2022-2028, operations of the irrigation scheme users will contribute:

- **$9.77 million in gross additions to GSP per annum**
- **$5.15 million in net additions to GSP (value added) per annum**
- **$3.54 million in Factor Income per annum**
- **Support the employment of 38 jobs per annum**

Over the 8 year period 2029-2036, operations of the irrigation scheme users will contribute:

- **$24.84 million in gross additions to GSP per annum**
- **$14.1 million in net additions to GSP (value added) per annum**
- **$8.85 million in Factor Income per annum**
- **Support the employment of 96 jobs per annum**

	Final demand	Industry effect	Consumption effect	Total	Flow on
Irrigation scheme operations (users) – average per annum (2022-2028)					
Gross Output	3.58	1.92	4.27	9.77	6.19
Value Added	1.84	0.59	2.72	5.15	3.30
Factor Income	1.17	0.29	2.08	3.54	2.37
Employment	16.00	4.00	18.00	38.00	22.00
Irrigation scheme operations (users) – average per annum (2029-2036)					
Gross Output	9.83	3.28	11.73	24.84	15.01
Value Added	5.03	1.61	7.46	14.10	9.07
Factor Income	3.23	0.60	5.02	8.85	5.62
Employment	42.00	10.00	44.00	96.00	54.00

Summary output tables

Operational Expenditure

The favourable impact on tourism would more than offset the adverse impact on existing fisheries, and in net terms, will contribute:

- **$194.96 million in gross additions to GSP per annum**
- **$112.48 million in net additions to GSP (value added) per annum**
- **$83.58 million in Factor Income per annum**
- **Support the employment of 716 jobs per annum**

	Final demand	Industry effect	Consumption effect	Total	Flow on
Impact on Tourism – per annum					
Gross Output	90.49	28.31	96.95	215.75	125.26
Value Added	47.26	14.04	61.99	123.29	74.03
Factor Income	29.96	6.79	52.09	88.84	58.88
Employment	301.00	94.00	408.00	803.00	502.00
Impact on Fisheries (Adverse) – per annum					
Gross Output	12.00	3.92	4.87	20.79	8.79
Value Added	5.83	1.88	3.10	10.81	4.98
Factor Income	2.19	0.70	2.36	5.26	3.07
Employment	48.00	13.00	26.00	87.00	39.00

Appendix 1: Economic impact modelling

Economic Modelling

Economic modelling may proceed from a number of perspectives, with the principal difference being the decision to model industry specific activities (partial equilibrium) or to take a simultaneous approach (general equilibrium); with the latter modelling outcomes as net welfare gains across the economy. However, in most cases the two approaches should be seen as complementary, rather than alternatives. For example, the general approach allows consideration of the net benefit of a range of alternative activities and may be seen as the best means of (ex-ante) resource allocation planning. Conversely, consideration of specific activities, such as the specific operations of a sector of the economy or a specific project are often more suited to partial economic modelling.

In this sense the modeller is not attempting to determine whether an economic activity represents the best possible use of resources but rather to determine its economic value in an absolute rather than a relative sense. For example, in this study we are not concerned whether or not the Tamar River Barrage Project is more or less efficient than other comparable economic activities but rather, in their present form, what economic value it will bring to the contemporary Tasmanian economy? In other words the report relates to industry significance and partial equilibrium impact.

These types of issues are reflected in methodological differences in the construction and interpretation of economic models, ranging from traditional input output (IO), through econometric IO to Computable General Equilibrium models (CGE). Taken to extremes, a general equilibrium approach would only estimate a positive economic value from the operations of an industry or the plant if it represented the most efficient use of these scarce resources in comparison to other potential uses, because such methods seek to allocate resources efficiently across an economy. For this reason, CGE is often the preferred method (used by Government), for making investment decisions designed to maximise economic welfare across the economy as a whole.

By contrast, traditional IO analysis is primarily interested in the impact of each specific project or industry taken separately and after recognising that the initial investment decision is taken as given (exogenous to the analysis). Whilst this may seem a more direct way of attempting to provide economic measurement, the traditional IO method has a number of weaknesses. The principal of these is that, once a decision is made to consider a project in isolation, those factors that operate in the real world (such as the competition among other economic agents for scarce materials) are not considered. For example, constraints on economic activity such as supply imbalances, lack of demand for the product or non-linear features in economic production, are assumed not to exist.

In this sense, the output from a traditional IO analysis gives the best (or maximum) result from an economic activity, on the assumption that there are no barriers in the rest of the economy that may constrain this maximum result from occurring. Whilst for small localised projects, that have no great impact on the economy, this may be a reasonable assumption, for larger projects, or in the evaluation of an industry or sub industry these assumptions can be misleading.

However, modifying traditional IO by the introduction of non-linear assumptions, goes a long way to reducing a number of these constraints, and for specific industry or sub industry evaluation, offers the best way of obtaining an accurate economic evaluation.[29] The other advantage of this method is that it employs the use of marginal coefficients rather than average coefficients. In this sense it approximates the results of CGE modelling where it is used in an impact context. A well-known example of the suitability of non-linear IO modelling to model the economics of economic activity is the study by Gamage and West (2001) of the macro economic effects of tourism in the Victorian Economy. [30]

29. The properties of Non-Linear models are shown in appendix 1, see also, Murphy, T. (2003) “The Economic Significance of the Charles Stuart University”, WRT for a supporting view on the merits of marginal coefficients IO models. The application of marginal coefficients to IO tables provides a more accurate representation of the flow-on effects of tourist related stimuli than would be possible using a linear model. The use of marginal coefficients largely overcomes the overestimation of impacts that can result from using the linear approach”.
30. Gamage, A and West, G (2001) “ Macro Effects of Tourism in Victoria” Journal of Travel Research 40, 101-109

Tasmanian non-linear model

Non-Linear Input Output Models

The Non-Linear Input-Output Model (NLIO) seeks to remove one of the major limitations of standard input-output analysis by removing the assumption of linear coefficients for the household sector and allowing marginal income coefficients adjustment. This is because, as is widely known, the household sector is the dominant component of multiplier effects in an input-output table. As a result using marginal income coefficients for the household sector will provide a more accurate, and empirically more valid, estimate of the multiplier effects, which in turn, provides results closer to those of a computable general equilibrium (CGE) model. The transactions flows in the input-output table can be expressed in matrix equation form as:

$$\mathbf{T}(\hat{\mathbf{X}}^{-1})\mathbf{X} + \mathbf{Y} = \mathbf{X}$$

That is, for each industry, total industry sales equals intermediate sales to other industries for further processing plus sales to final users, where T is the matrix of intermediate transactions, X is the column vector of sector total outputs and Y is the column vector of aggregate final demands. This can be rewritten as:

$$\mathbf{AX + Y = X}$$

Where A is the matrix of direct coefficients which represents the amounts of inputs required from sector i per unit of output of sector j. Thus, for a given direct coefficient matrix, it is possible to solve the set of simultaneous equations to find the new sector production levels X which will be required to satisfy a potential or actual change in the levels of sector final demands Y.

By rearranging and converting to differences, this equation can be rewritten as:

$$\Delta\mathbf{X} = (\mathbf{I} - \mathbf{A})^{-1}\Delta\mathbf{Y}$$

Where $(\mathbf{I} - \mathbf{A})^{-1}$ is termed the total requirements table, Leontief inverse matrix or general solution, and represents the direct and indirect change in the output of each sector in response to a change in the final demand of each sector

T. ΔY can incorporate any element of final demand expenditure, including household expenditure, government expenditure and capital expenditure.

This model is a linear model in which the A matrix represents a (constant) matrix of average input propensities. Normally, the A matrix endogenises the household sector (that is, household income varies with the level of intersectoral activity) so that household consumption induced effects can be measured. This is referred to as the type II model; the alternative type I model is where households are treated as exogenous to local economic activity. Generally speaking, the consumption-induced effects are the largest component of the total multipliers. This is because consumer driven consumption (and income) to a large extent dominates local economic activity. That is, household income varies with the level of intersectoral activity.

Total inputs are equal to intermediate inputs plus primary inputs (labour and capital). In the conventional input-output model, the inputs purchased by each sector are a function only of the level of output of that sector. The input function is assumed linear and homogeneous of degree one, which implies constant, returns to scale and no substitution between inputs. A more reasonable assumption is to allow substitution between primary factors. If there is an expansion in economic activity, say due to a development project, employers will attempt to increase output without corresponding proportional increases in employment numbers, particularly in the short term, e.g. construction projects, where there are economies of scale in getting the existing workforce to work longer hours rather than employ additional persons. This occurs for two reasons. First, there is evidence in Australia that labour productivity (output per employee) is increasing over time. Secondly, as companies strive to reduce costs and satisfy the micro-economic reform processes imposed on all states by the National Competition Policy, there is evidence of a shift in primary factor use from labour to capital. This implies that the conventional input-output model has a tendency to overestimate impacts, in particular the income and employment impacts.

Therefore, a more realistic approach to modelling impacts is to replace the average expenditure propensities for labour income by employers with marginal input propensities. In other words, the household income row in the A matrix, which are average input coefficients, should be replaced by income elasticities of demand. Note that, as in the CGE model, the linear coefficients assumption between intermediate inputs, and also total primary inputs, and total inputs is retained.

One problem associated with this approach is that the solution procedure is now more complex. Now the income impacts will be a function of ΔX but the income coefficients are included in the A matrix which determines ΔX. Therefore the equation set becomes recursive; ΔX depends on A and A depends on ΔX. Solving the input-output equation therefore requires an iterative procedure, a common method being the Gauss-Seidel method.

The income and employment flow-ons from the initial impact also need to be modified. In the conventional input-output model, income and employment flow-ons are calculated as linear functions of the output flow-ons, but in the revised model the parameters relating income to output are no longer constant. The impact on household income needs to be calculated as the difference between the base (i.e. before impact) income levels and the post impact income levels. It can be shown that this is equivalent to using the matrix equation:

$$\Delta \mathbf{Inc} = \hat{\mathbf{X}}_0^{-1}(\Delta\hat{\mathbf{X}})\hat{\mathbf{L}}\mathbf{U}_0$$

where U is a vector of household income flows and L is a vector of sectoral household income elasticities of demand. The zero subscript denotes the base level values and the hat denotes a diagonal matrix formed from the elements of the corresponding vector.

This equation simply states that, for each sector, the change in household income payments equals the proportional change in output times the base level income payments multiplied by the income elasticity of demand. These income elasticities of demand can be shown to be equal to:

$$I_j = \eta_{WX} + \eta_{EX}$$

where ηWX is the elasticity of wage rate with respect to output, and ηEX is the elasticity of labour demand with respect to output; that is, they are made up of two components, the wage price component and the labour productivity component.

Similarly, the change in sectoral employment can be calculated as the change in the sectoral wage bill times the wage rate:

$$\mathbf{\Delta Emp} = \hat{\mathbf{H}}_0^{-1}\hat{\mathbf{P}}_0^{-1}\mathbf{\Delta Inc}$$

where H is a vector of average household income coefficients and P is a vector of coefficients representing average output per employee.

There are several implications arising from the use of this model, compared to the conventional input-output model. Firstly, while the output multipliers and impacts should not be significantly different between the two models, we would expect the income and employment impacts to be smaller in the marginal coefficient model. This is because many industries, especially those which are more capital intensive and can implement further productivity gains, can increase output, particularly in the short run (the term ‘short run’ here does not refer to any specific time period; rather it will vary from industry to industry. It is used here in the conventional economic sense to mean that the full adjustment from any shock has not had time to occur, i.e. the system has not yet returned to full, long run, equilibrium), without corresponding proportional increases in employment and hence income payments.

Secondly, unlike the conventional input-output model in which the multiplier value is the same for all multiples of the initial shock, the multiplier values from the marginal coefficient model vary with the size of the initial impact. Thus larger changes in final demand will tend to be associated with smaller multipliers than small changes in final demand. Therefore, the differential impacts of the marginal coefficient model are not additive, unlike the conventional (linear) Leontief model and CGE model. Overall, within the confines of a static model, the major improvements brought by the non-linear model are to improve the overall accuracy of the factor income and employment impact projections.

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cutting through complexity