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Investing in the Great Barrier Reef as economic infrastructure

Queensland Farmers' Federation

Queensland Tourism Industry Council

World Wide Fund for Nature Australia

Association of Marine Park Tourism Operators

Final

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Investment in GBR assets

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Project Manager:	Angus MacDonald
Authors:	Kim Hoye and Adrian Volders

Jacobs Australia Pty Limited

32 Cordelia Street
PO Box 3848
South Brisbane QLD 4101 Australia
T +61 7 3026 7100
F +61 7 3026 7300
www.jacobs.com

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Foreword - What is the Great Barrier Reef worth to us?

Tourism operators, farmers and conservationists all have a strong stake in the future of the Great Barrier Reef. That is why our three organisations came together to set out a new way to value the Reef – a business case for Reef investment.

We wanted to answer the question: What is an economically rational, long term level of investment in Reef management needed to secure the jobs and economic growth that rely on a healthy Great Barrier Reef?

We contracted Jacobs, a well-known and respected regulatory economics firm, to apply the same economic tools they use to assess the investment required to maintain major infrastructure. The Great Barrier Reef is an economic asset contributing $7 billion in tourism expenditure to the Australian economy each year. As a minimum, we should be spending the amount of money we invest in roads or dams of similar value.

To develop the business case for Reef investment, Jacobs took a very conservative approach to estimate a Great Barrier Reef asset value of $21 billion. With reasonable changes to assumptions, such as continued tourism growth, this number becomes many billions more. For an infrastructure asset worth $21 billion, Jacobs calculated that there should be:

- $547 million per annum allowance for an operations and maintenance budget
- $283 million per annum allowance for depreciation.

Therefore, an appropriate annual investment in the Great Barrier Reef as economic infrastructure would be around $830 million – an investment of over $8 billion in the next decade. Greater investment would be justified with a less conservative asset valuation.

The current level of government investment, around $200 million per annum, is economically irrational and falls well short of what would normally be spent to ensure an asset continues to function and to deliver jobs and growth.

Recently, the Queensland Government commissioned a consortium of economists and modellers to estimate the cost of actions to deliver the catchment pollution reduction targets set out in the Reef 2050 Long-Term Sustainability Plan. The report, *Costs of achieving the water quality targets for the Great Barrier Reef*, found this would require an investment of least $8.2 billion.

The Jacobs report is a high level business case which draws attention to the likely economic benefits to the tourism industry. More work is needed to fully set out the likely benefits for jobs and growth across multiple sectors from a substantive investment in Reef protection.

We urge the Australian and Queensland Governments to undertake a full business case analysis of different investment scenarios, addressing the economic benefits to tourism, agriculture, fisheries and regional communities.

A comprehensive business case analysis will provide greater understanding of the economic benefits of different investment options. The Jacobs study estimated that an $830 million annual investment would return an amount 5-6 times greater to the economy.

Agriculture and tourism are proven performers for economic growth and employment. In the Great Barrier Reef region, these sectors have combined annual revenues of about $12 billion and directly support over 100,000 jobs. Investment to develop Northern Australia should be focused on making these two industries more secure and more productive.

Governments regularly provide substantial, long term investment for environmental and infrastructure projects which deliver broader economic and public good outcomes. Recent examples include: $13 billion to restore environmental flows to the Murray-Darling Basin; $50 billion to build 12 submarines (over $4 billion a submarine) and over $16 billion a year on roads.

This report provides governments with a new perspective on the level of prudent and efficient annual investment that would generally be appropriate to maintain the Great Barrier Reef. Long term, strategic Reef investment will be required if we are to realise the Reef 2050 Long-Term Sustainability Plan.

The Great Barrier Reef is worth a lot more to us and the broader community than the numbers set out in this report. The Reef is however deserving of at least the annual investment the report recommends if we are to protect it and ensure the economic benefits and broader social values it provides continue.

Travis Tobin

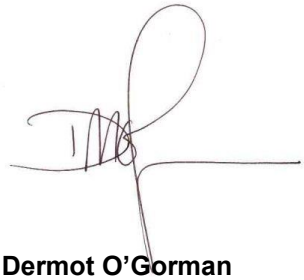
CEO

Queensland Farmers' Federation

Daniel Gschwind

CEO

Queensland Tourism Industry Council



Dermot O'Gorman

CEO

WWF-Australia

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Appendix A. References

Glossary

Abbreviation / Key Term	Explanation
Asset	Used in this report to refer to the Great Barrier Reef asset and its associated water catchment areas on the adjacent coastline.
Discounting	The principle that a dollar tomorrow is worth less than a dollar today, so its value should be reduced when considering what its value would be today.
GVA	Gross Value Added – the measure of how much value an industry adds to the economy. For example, a builder adds value by taking building materials such as wood and bricks, which have a certain value, and building a structure, using tools and labourers, which has a greater value than the component materials.
NPV	Net present value, a measure of what a number of future payments are worth today, using the principle of discounting.
Payments to capital	The payments to owners of tools, machinery, buildings and other capital to recognise the value the capital adds to the outputs of an industry.
Payments to labour	The payments to labourers and staff, such as wages and salaries, to recognise the value labour adds to the outputs of an industry.
RAB	Regulatory Asset Base – the asset value used to determine revenues needed to operate and maintain an asset, usually applied in regulatory economics to assets such as water, energy, rail, ports and so on. The RAB is used to determine a return on (and of) capital to compensate the owner for costs of capital.
WACC	Weighted average cost of capital, a particular discount rate set for a company taking account of the cost of borrowing money or raising money through ownership shares for a benefit in the future.

Executive Summary

Jacobs (we) has been commissioned to assess what level of annual investment Australia's Great Barrier Reef (GBR) would receive if it were treated as an economically regulated piece of essential community infrastructure, in contrast to what funding the GBR actually needs to maintain its health and condition.

We provide a high-level business case which assumes that the GBR is similar to a built asset, such as a dam, that provides commensurate economic benefits. The GBR is a natural World Heritage Site, not a built asset, so arguably it has broader social and economic values than are captured in our analysis. However, our aim is to use a conservative approach, comparing the GBR to other regulated essential community assets (e.g. water supply schemes and energy networks), to highlight the level of funding that such assets do receive.

The Queensland Government commissioned a report, *Costs of achieving the water quality targets for the Great Barrier Reef* (Alluvium 2016), which analysed the funding expected to be required to achieve environmental goals. Our operations and maintenance budget is not set in the same way as Alluvium's report, which approaches the issue of funding as an environmental issue. Rather, we approach funding as a financial and asset management issue.

Constructed assets such as dams, irrigation schemes, roads, railways, ports, and wastewater infrastructure have well-documented replacement, depreciation, maintenance and operating cost budgets. A natural asset such as the GBR does not receive capital and maintenance funding commensurate with its ongoing requirements and the value it generates for users and the broader economy.

Our purpose is to provide a new perspective on the level of prudent and efficient annual investment that would generally be appropriate to maintain such an asset in good working order. Our new perspective aims to bring together key groups who are affected by, or who have an interest in, decisions in this area.

This report draws on over a decade of experience in providing advice, particularly in regulatory economics, for water and energy infrastructure, including in the GBR catchments of Queensland.

Annual revenues, asset value and annual investment

This analysis aims to build on previous valuations of the GBR and to add value by providing an alternative approach through adapting the methods used to determine appropriate management and maintenance costs for built assets.

We have approached this task in three steps:

1) Identification of an annual benefit or revenue which is compatible with the approach we are taking
2) Valuation of the asset using the identified annual benefit
3) Estimation of the appropriate annual investment required to operate and maintain the GBR, as though it was an economically regulated asset.

1) Annual benefits / revenues

Deloitte Access Economics (2013), in a report commissioned by the Australian Government, found that the tourism industry in the GBR catchment area generated:

- $6.4 billion per annum (pa) of direct expenditure
- $5.2 billion pa of gross value added (GVA) in the Australian economy

We have used a similar – but more conservative approach – than Deloitte Access Economics (2013).

Below, we summarise three valuation methods for the reef, including estimates of the annual benefits delivered by the reef to the economy and resulting asset values for the reef under each method. Specifically, Table 1 and Table 2 summarise our estimates of the annual benefits arising from the GBR using the following measures of the tourism industry:

1) Direct tourist expenditure – the final output in terms of total direct expenditure on tourism.

2) GVA – is the sum of the following three major inputs to production:

   a) Payments to labour, wages and salaries. This measure is the contribution of labour to the output of an industry measured in payments, such as wages and salaries, made to employees.

   b) Net taxes on products, such as the goods and services tax (GST), and taxes on production, such as payroll tax.

   c) Payments to capital – is the gross operating surplus. This measure is the contribution of capital, such as boats, vehicles and buildings, towards the output of an industry by measuring the payments to the owners of the capital, such as shareholders or owner operators.

3) Payments to capital only – as per c) above (this value is a sub-set of gross value added, targeting payments to capital only and excluding tax and payments to labour).

Table 1 : Asset value with a WACC of 7.5%

Method	Annual benefit ($ million 2015)	Asset value ($ million 2015)
Direct tourist expenditure	7,169	145,704
Gross value added	4,655	94,613
Payments to capital	1,019	20,717

2) Asset value

Our asset value is not the sum of the annual benefits received every year for the time period we have used (i.e. 100 years). We reflect the idea that getting $100 in one year is worth less to a person than getting $100 today because:

- The person must wait a year to purchase something they would have the opportunity to purchase today if they had $100 (a lost or delayed opportunity – opportunity cost)
- The promise of $100 in one year may not eventuate (cost of risk).

The opportunity cost and the cost of risk are combined into a percentage, the discount rate. The annual benefit is reduced by the discount rate in the first year. The reduced amount is again reduced by the discount rate in the second year, and so on and so forth.

We use the weighted average cost of capital (WACC) as our discount rate. The WACC reflects the discount rate of the financiers of an asset, or capital, purchase for a business, banks and owners of the business. The WACC is weighted by the average amount each financier contributes to the asset. The WACC is used as a discount rate by corporations, such as the state owned corporations running essential community infrastructure.

Our WACC of 7.5% reflects a mid-point degree of uncertainty between our considered 5-10% rates. A 7.5% discount rate is higher than we are seeing, for example, for regulated (water) assets at the moment, where WACCs are typically 5-6%. Accordingly, asset values from a WACC of 7.5% may *understate* the GBR's actual value, but we have adopted this conservative value to ensure that this is a robust, high-level business case.

Table 2 presents asset values from a WACC of 5% which may be closer to a realistic WACC for regulated (e.g. water) assets under current financial market conditions.

Table 2 : Asset value with a WACC of 5.0%

Method	Annual benefit ($ million 2014-15)	Asset value ($ million 2014-15)
Expenditure	7,169	267,514
Gross Value Added	4,655	173,711
Payments to capital	1,019	38,036

A 5% WACC is consistent with regulated WACCs in Australia at present and reflects more certainty than 7.5%. A 5% WACC results in a **$38 billion asset value for the GBR.** This is likely to be reasonable.

Using a 7.5% WACC, based on these three approaches to measuring annual benefits from the GBR above, we estimated asset values for the GBR of about $146 billion, $95 billion and $21 billion, respectively. Our adopted discount rate ensures that the asset values are conservative as 7.5% significantly discounts future benefits, thus reducing our estimate of the GBR's asset value.

We recommend adopting the lowest asset value for the GBR of $20.7 billion derived from payments to capital only. Our recommended approach is intentionally conservative; however, if we treated the GBR more like hard infrastructure or a major constructed asset, the value may be up to $38 billion.

This asset value corresponds to the annual benefit from payments to capital. We consider this to be the most appropriate annual benefit for an asset valuation. The market value of a built asset, or capital, is linked to the future cash flows linked to that asset, or payments to the owners of the capital.

The derived $20.7 billion asset value is adopted as the assumed 'regulatory asset base' (RAB). The RAB for the water and electricity utilities we considered ranged between $800 million and $11 billion per utility.

3) Annual investment

Consistent with the treatment of economically regulated infrastructure (e.g. energy and water supply assets), we consider what other community infrastructure would typically receive in revenue to cover the costs of its long-term functioning. These costs generally consist of:

- Operations and maintenance costs
- A depreciation allowance
- Profit.

On the basis of our asset value, and benchmarking this value against energy and water infrastructure revenue requirements, we find that an annual funding for the GBR of **$830 million would be appropriate.**

Specifically, our benchmarked annual investment of approximately $830 million is comprised of:

- $547 million pa operations and maintenance budget
- $283 million pa depreciation allowance.

This level of investment is consistent with comparable 'operations and maintenance' revenues for other community infrastructure, such as the water and energy assets we have considered.

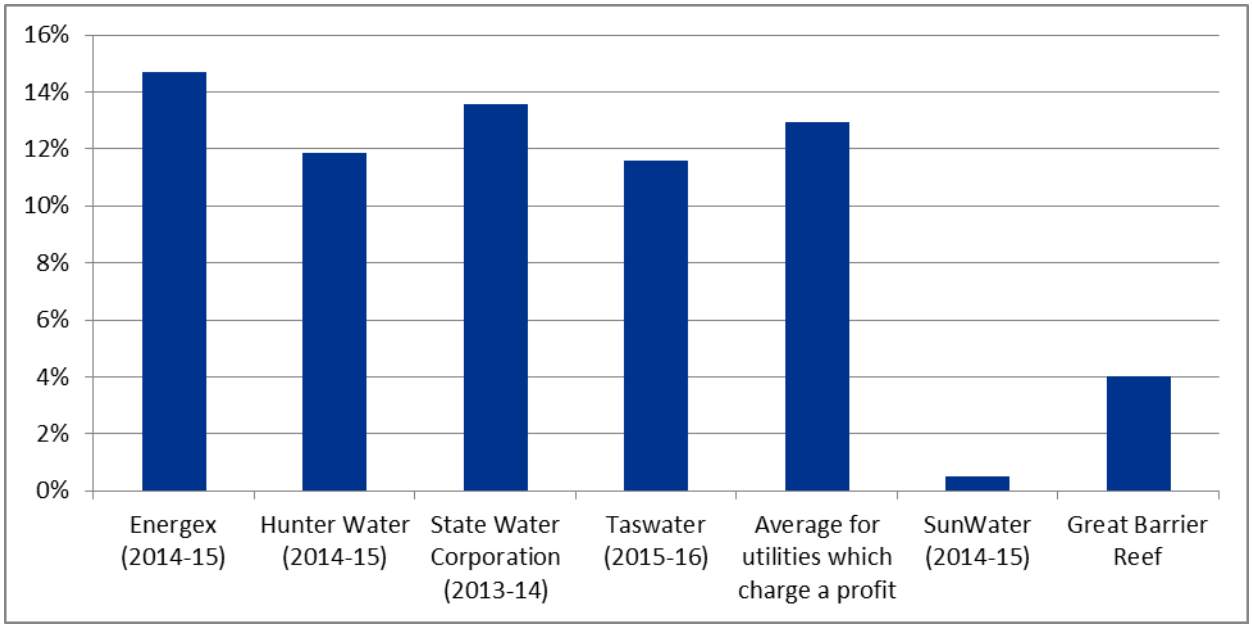
We have excluded a rate of return (or profit) on the asset value. Rather, we have adopted 'break-even' pricing for this asset, so that its efficient cost of operations, maintenance and depreciation only are reflected. This is consistent with Queensland Government irrigation water pricing policy in GBR and other catchments (i.e. no explicit rate of return should be charged on the asset value).

With the regulatory pricing model, wider economic benefits are not factored into pricing. The purpose is to provide sufficient funds for operation and maintenance of assets, and to compensate those who have provided funds for those assets.

Regulated utilities provide benefits to consumers far beyond what they pay for. For example, water tariffs only pay for the costs associated with operating and maintaining the water utility's assets and (in some cases) providing a return on and of those assets, not for the water itself.

It is difficult to estimate the total economic benefit of a regulated utility. However, we can compare the revenue of the regulated utilities we have considered in this report, alongside the proposed $830 million for the GBR assets, as a proportion of each set of asset values. Figure 1 shows this comparison.

Figure 1 : Utility annual revenue as a percentage of the asset value (i.e. investment needed for ongoing asset function)



Based on our proposal, GBR's revenue as a portion of its estimated asset value would be the second lowest. Therefore, our $830 million is a conservative proposal, when compared with other regulated assets providing services to the community. The only exception is SunWater, which in general does not charge an explicit profit margin in irrigation water charges, consistent with Queensland Government policy.

We recognise that the reef is not manmade and as such, returning the initial capital investment, via depreciation may not be justified. We consider that a depreciation allowance is a useful proxy to set aside funds for major rehabilitation of the reef. However, for our most conservative recommendation, we remove the depreciation allowance.

Accordingly, our recommended minimum annual funding for the reef is that **government should invest $547 million pa in the GBR to provide an 'operations and maintenance' budget** needed to ensure long-term viability of assets of similar economic value. This is more investment than is currently occurring.

Sensitivity to assumptions

We note that the estimates of both the asset value and the operations and maintenance budget and depreciation allowance change with changes to our assumptions. Table 3 indicates how our results change with changes to our assumptions.

Table 3 : Change in operations and maintenance plus depreciation allowance pa ($ million 2014-15)

	Asset value ($ m)	Low operation and maintenance (3%) High asset life (73 years)	Medium operation and maintenance (4%) Medium asset life (55 years)	High operation and maintenance (5%) Low asset life (36 years)
No tourism growth rate (0%) Medium WACC (7.5%)	**20,717**	830	1,205	1,611
Medium tourist growth rate (1.5%) Low WACC (5%)	**64,906**	2,602	3,776	5,048

Funding commitments to GBR

Government documents on future funding estimate that $2 billion would be invested in reef management broadly over the next decade or about $200 million annually. This figure includes expenditure by both Australian and Queensland Governments. It includes water quality improvements but also expenditure in areas such as marine safety which don't necessarily maintain the condition of the asset.

Table 4 shows the existing and announced annual funding compared to our minimum funding recommendation for GBR operations and maintenance, assuming an asset value of $20.7 billion.

Table 4 : Annual GBR asset funding

Funding	Amount pa ($ million)
Investment Baseline funding	**215**
Our operations and maintenance allowance	547
Increase from existing funding commitments	**332**
Our operations and maintenance allowance plus depreciation allowance	830
Increase from existing funding commitments	**625**

Table 4 shows that existing funding would need to increase by $332 million, or 154%, to meet our recommended minimum funding requirement for sustainable operations and maintenance of the GBR.

Existing funding for water quality is approximately $85 million pa. Incorporating broader committed GBR funding raises this to approximately $215 million pa (see Table 4). Nevertheless current and new funding commitments are below our recommended minimum $547 million of annual funding needed to operate and maintain the GBR sustainably and further below the $830 million including a depreciation allowance.

Tax revenue and economic benefits

In effect, we have estimated that an annual investment of $830 million is appropriate to maintain or increase the annual contribution by GBR to the Australian Economy of $4.7 billion. In simple terms, if governments agree to this approach, the return would be five to six times their investment.

Tax income to government associated with recent GBR tourism activities ($2014-15) is $836 million, which arguably could be used to fund a low scenario and most of the high scenario requirements presented above. This level of tax revenue to government from the GBR is based on the 2014-15 levels of (lower) funding and tourism activity. GBR tourism has expanded in recent years, and continued expected growth means that the government will receive even greater tax income, provided the asset is well maintained through appropriate investment.

Recommendations and findings

1) We recommend our conservative asset value for the GBR of $21 billion.

2) We note that based on this asset value, an appropriate level of annual funding (including operations, maintenance and depreciation) for the GBR would be $830 million. Depreciation could arguably be excluded as the GBR is not manmade and the capital does not need to be returned to the investor.

3) We recommend a minimum annual funding of $547 million for operation and maintenance of the GBR. That is, to achieve appropriate funding levels for a regulated and essential community asset of comparable value, governments should increase existing funding by $332 million pa (from $215 million pa) to $547 million pa.

4) We note that $830 million of funding to maintain the asset condition supports a contribution to the Australian economy of $4.7 billion, returning between 5 and 6 times the value of the funding.

5) We estimate that tourism businesses and employees contribute $836 million in taxes to the Australian and Queensland governments. We note some of these funds could be used to maintain the GBR asset condition.

6) We also recommend that a detailed business case (including cost-benefit analysis) be completed to support the recommended higher levels of funding needed to sustain GBR assets. This analysis should include the significant economic benefits that would likely occur for agriculture as a key target for investment.

Important note about your report

This section sets out the assumptions and limitations that apply to this report.

The sole purpose of this report is to present Jacobs' (our) illustrative findings in relation to our high-level business case for investment in the Great Barrier Reef (GBR) to be prepared for the World Wide Fund for Nature Australia (WWF), The Association of Marine Park Operators (AMPO), the Queensland Tourism Industry Council (QTIC) and the Queensland Farmers' Federation (QFF).

We have relied upon information in the public domain, where available from credible sources and our estimates derived from the data presented in such sources.

We exclude any warranty or guarantee (expressed or implied) in relation to the data, observations and findings in the report to the extent permitted by law.

This report should be read in full with no excerpts to be used as being representative of our findings.

This report has been prepared exclusively for our client/s and no liability is accepted for any use or reliance on the report by third parties.

1. Introduction

Jacobs has been commissioned to determine a high-level asset value and funding level for the Great Barrier Reef (GBR).

The GBR is the world's largest coral reef, found off the east coast of Queensland, Australia. The GBR benefits many businesses, mainly associated with the tourism industry.

The Australian Bureau of Statistics (ABS 2015b) has developed asset values for a number of Australia's natural assets. The GBR has not been valued in the latest release of the ABS's natural accounts. The ABS is developing a methodology to value the GBR, which does not have a widely accepted asset value.

Other efforts to value the GBR include studies by Deloitte Access Economics (2013) and Oxford Economics (2009).This analysis aims to build on previous work done on valuations of the GBR and to add value by providing an alternative approach through adapting the methodologies used to value and fund built asset management and maintenance.

We will treat the GBR as a built asset, such as a dam, to determine the asset value. The market value of a built asset is based on the return it produces.

Built assets require ongoing spending to remain productive. This spending includes:

- Operation spending – machinery needs spending on people to keep it running
- Maintenance spending – machinery needs regular servicing to run properly
- Replacement spending – machinery needs to be replaced when it is no longer possible to keep it running.

Built assets such as dams, irrigation schemes and electricity networks have well documented operating, maintenance and replacement costs. Our analysis will determine comparative budgeting for operations, maintenance and replacement spending for the GBR by determining the levels of spending for a built asset of the same value.

The GBR is a natural ecosystem, not a built asset. With ideal conditions, the GBR will naturally regenerate and repair damage. Certain human activities, such as increasing nutrient and sediment runoff into the GBR, coastal development and direct uses, impact the GBR's natural regeneration.

Our operating and maintenance spending would reflect activities to manage the effects of human activities and allow the GBR to naturally regenerate. Examples include:

- Operations spending – spending on ongoing activities such as on-water management of the Great Barrier Reef Marine Park Authority.
- Maintenance spending – spending on maintaining conditions where the GBR can effectively regenerate such as monitoring runoff and coral cover, or removing crown of thorns starfish
- Replacement spending – spending on major catchment initiatives to reduce runoff and improve the water quality of the GBR and allow it to naturally regenerate, such as installing irrigation systems which reduce runoffs from crops.

We use Australian Dollars in the financial year 2014-15 in this report, unless otherwise stated (i.e. $2014-15).

2. Previous benefit and asset valuations

There have been many previous attempts to determine a value for the GBR. This section presents the findings of two key reports which influence the methodology of our report. These are:

- A report by Oxford Economics (2009) which found a total value for the GBR of $51.4 billion.
- A report by Deloitte Access Economics (2013) which found the GBR provides annual benefits $5.7 billion.

2.1 Oxford Economics – Total economic value

Oxford Economics (2009) found the value of the reef to be $51.4 billion ($2008-09). Oxford Economics (2009) used the net present value (NPV) of annual benefits over 100 years using a discount rate of 5.15% (assuming long term average inflation of 2.5%) to find this asset value. This represents an annual benefit of $1.47 billion.

Oxford Economics (2009) used a range of benefits, including non-cash benefits such as consumer surplus for tourism. Although this type of benefit is accepted by economists and are widely used in public policy analysis, they are less common in private analysis.

Non-cash benefits may accurately reflect the economic value of the GBR. However, because they are less commonly used by businesses and do not reflect actual transactions, they are not relatable for the general population.

Value estimates of this kind are not ideal for contested negotiations for limited resources due to the limited acceptance by the general public. We will not use valuations of this type as for our purposes, a business case advocating for government investment from limited funds, we require a valuation that can gain wide acceptance.

2.2 Deloitte Access Economics – Gross value added

Deloitte Access Economics (2013) valued the annual benefits of the GBR in 2013 in a report commissioned by the Australian Government.

Deloitte examined the economic benefits of the GBR on industries in the GBR catchment area, including the tourist, recreational, commercial fishing and scientific and management industries.

Deloitte found that the tourism industry in the GBR catchment area generated (in $2010-11):

- $5,677 million of Gross Value Added (GVA) in the entire Australian economy – 91% of the total of the industries in the study
- 68,978 Full Time Equivalent (FTE) jobs – 93% of the total of industries in the study
- $7,041 million of direct expenditure – 90% of the total of industries in the study.

We discuss GVA in more detail in Section 3.

3. Our asset valuation

The ABS (2012) considered including a GBR asset value in the system of national accounts, as part of its natural capital valuations. Estimates of assets such as undiscovered resources in the ground form part of this section of the national accounts.

The ABS (2016) has not finalised a methodology to include the GBR in the most recent Natural Capital section of the national accounts. The ABS (2015a) has undertaken an experimental evaluation of the GBR asset value.

3.1 Economic activity in the region

3.1.1 Agriculture in the GBR catchment

The majority of the GBR Catchment is used for agricultural production, namely rangeland cattle grazing (75% of the area), forestry (5%), dryland cropping (< 2%) and sugarcane (<1%) with irrigated cropping, horticulture, dairy and bananas each covering less than 1% (Waters et al 2014). Table 5 and Figure 2 show the gross value of agriculture production (GVAP) in key regions and for key activities and crops.

Table 5 : 2012-2013 GVAP by region and production sector ($ 2012-13)

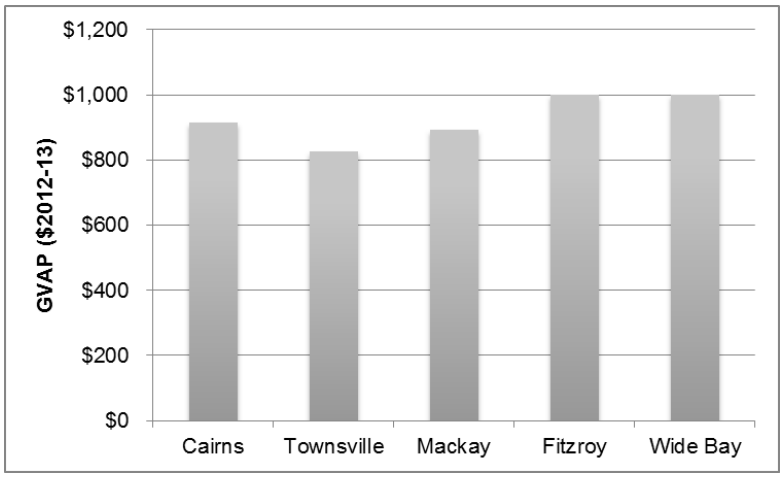
Region	Sugar Cane	Cattle and Calves	Vegetables	Fruit and Nuts	Total GVAP (incl. other activities)
Cairns	175	42	59	525	916
Townsville	433	111	66	27	825
Mackay	304	210	236	20	892
Fitzroy	-	684	-	-	1,000
Wide Bay	140	207	239	226	1,000
Total	**1,052**	**1,254**	**600**	**798**	**4,633**

Source: ABARES 2015

The total GVAP in of agriculture in the GBR catchment area is $4,633 million ($2012-13).

Cattle and calf production has the largest GVAP overall, and particularly in the Fitzroy region. Sugar cane production has the second highest GVAP overall and the largest in the Townsville and Mackay regions. Fruit and nuts production, particularly bananas, is dominant in the Cairns region.

Figure 2 : GVAP of agriculture by region 2012-13



Source: ABARES 2015

We have not included agricultural activity in our study because the agriculture is directly linked to the land in the catchment area and not to the GBR itself. However, any comprehensive study of investments in the maintenance of the GBR asset condition which affect agriculture would need to assess the benefits or costs to agriculture.

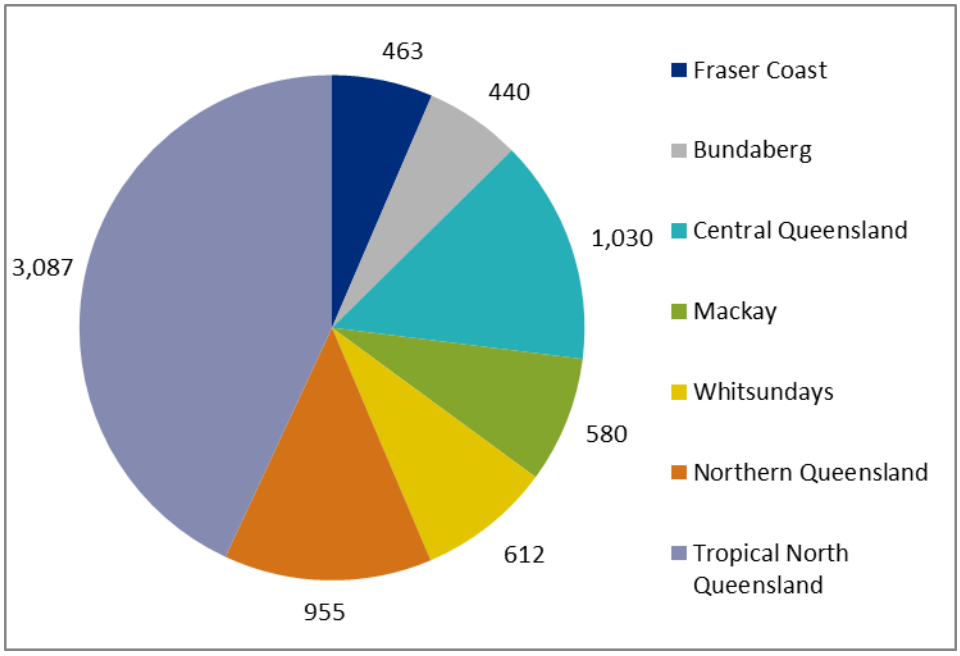
3.1.2 Tourism activity in the GBR region

Our asset valuation relies on the expenditure in the tourist industry as an estimate of the output of that industry. We used the most recent regional expenditures from the regional profiles produced by Tourism Research Australia (TRA 2016), which are for the financial year 2014-15.

Figure 3 shows the tourism expenditure in 2014-15 allocated to the tourism areas defined by TRA.

$7,169 million was the tourist expenditure in the regions adjacent to the GBR.

Figure 3 : Tourist expenditure by region in 2014-15 ($m 2014-15)



Source: TRA 2016

3.2 Economic asset value

Section 2 shows two of the previous approaches to finding a value for the asset, studies by Oxford Economics (2009) and Deloitte Access Economics (2013).

For our valuation of the asset, we will consider the NPV similar to the approach used by Oxford Economics (2009). We use a number of methods for evaluating the annual benefit:

- A full environmental services evaluation, such as that undertaken by Oxford Economics (2009). We have used a recent study by Stoekl (2015) giving an annual value of $15 billion pa
- The expenditure in the region in the tourism industry.

The following three methods of finding the annual benefits by successively removing elements from the expenditure not considered to be benefits. Each method successively removes more elements from expenditure:

- GVA, such as that used by Deloitte Access Economics (2013). Deloitte use GVA because this represents the contribution to gross domestic product (GDP) or gross state product (GSP). The GVA is the sum of:

- Wages and other payments to labour
- The gross operating surplus, which includes payments to capital
- Certain taxes businesses pay to operate, such as payroll taxes.

GVA removes the following elements from expenditure:

- Spending on intermediate inputs. Indirect GVA includes the above three elements of intermediate inputs
- Net imports
- Certain spending on transport delivering items

- Gross operating surplus, a component of GVA, which Oxford Economics (2009) used when calculating their benefits to producers.
- Resource rent, used by the ABS (2015) in their experimental account. The ABS removed an estimate of the payments to other assets owned by producers from the gross operating surplus.

3.2.1 Economic distribution of benefits

We distributed the expenditure into the components of GVA to form an estimate of the benefits from GVA, gross operating surplus and resource rent.

Our distribution of the economic benefits of the assets followed two stages:

- Allocation of the expenditure into component industries
- Allocation of the expenditure in each industry to the components of the GVA.

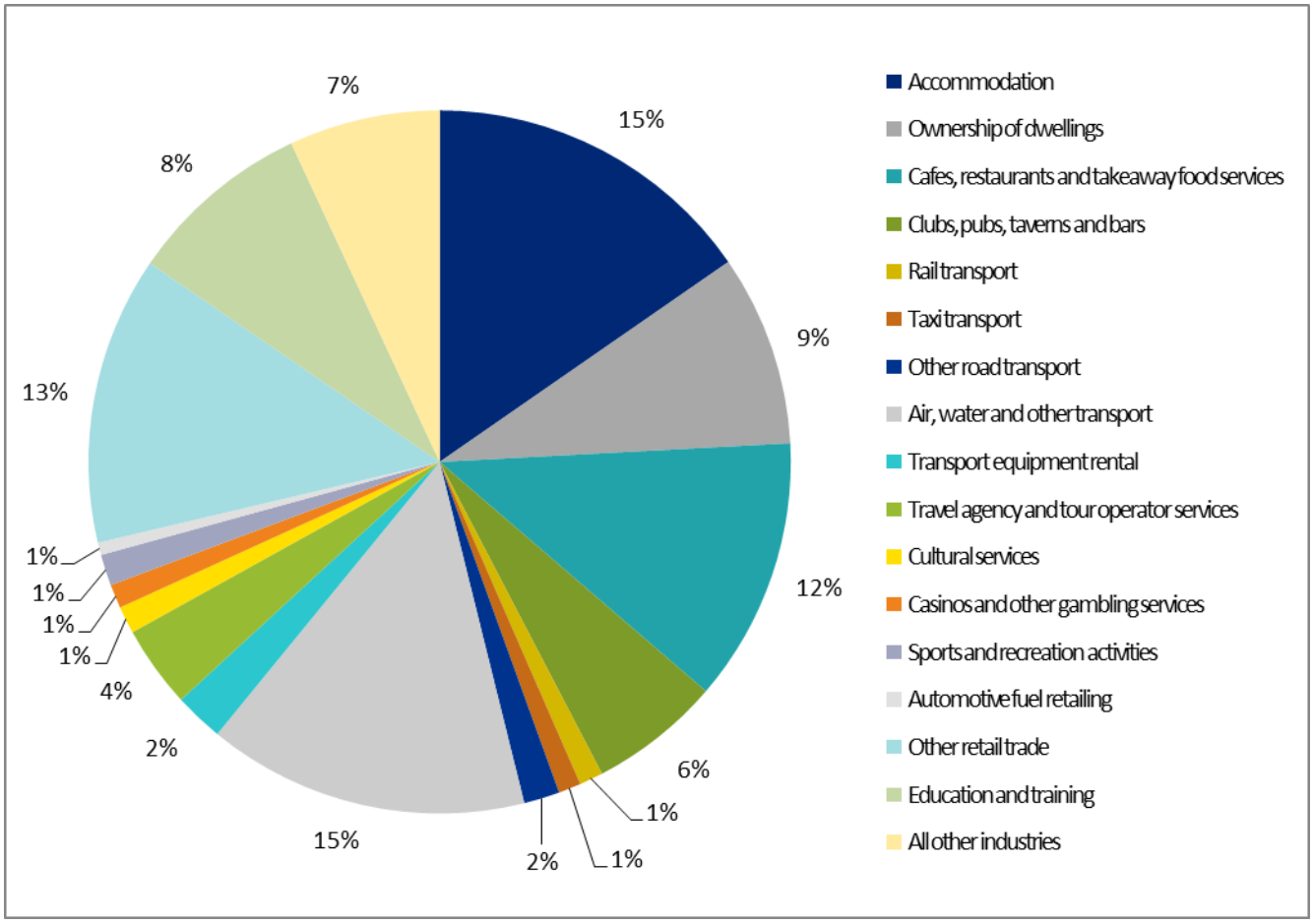
3.2.1.1 Tourism component industries

Tourism is not an industry category in the national accounts produced by the ABS. The economic activity of tourism forms part of the economic activity of other industries classifications.

The ABS estimates how much of the economic activity of other industries in directly attributable to tourism as an accompaniment to the National Accounts, known as the Tourism Satellite Accounts. The satellite accounts show the tourism contribution to the industry classifications shown in Figure 4.

We used the Tourism Satellite Accounts to allocate the total tourism expenditure in the GBR region to the component industries. We used the same proportion as national tourism. Figure 4 shows our allocation.

Figure 4 : Tourist expenditure by industry in 2014-15 ($m 2014-15)



Source: ABS, TRA and Jacobs calculations

3.2.1.2 Contribution of inputs

The ABS analyses what type and the cost of inputs that are required to produce the output in each of its industry categories. For example, a restaurant needs to pay for the following inputs:

- Food (intermediate inputs)
- Cooks and wait staff (payments to labour)
- Profits to the owners of the business and its equipment, or capital (payments to capital)
- Taxes.

The restaurant produces the output of a meal which it sells to customers to generate revenue. The cost of the inputs must balance with the revenue from the output (businesses making a loss will have negative profit). The ABS collects all the information into its input-output tables.

We used input-output tables produced by the ABS to determine the allocation of expenditure in each industry into the components of GVA.

3.2.2 Estimate of economic asset value

We made the following estimates of the GBR asset value using the methods above to assess annual benefit and three values of the weighted average cost of capital (WACC), 10%, 7.5%, 5% and 2.5%. The WACC is the cost of raising the funds to buy a productive asset, through shareholders or loans.

We have assumed the same annual benefits for 100 years and average long term inflation of 2.5%.

Table 6 : Asset value with a WACC of 10.0%

Method	Annual benefit ($ million 2014-15)	Asset value ($ million 2014-15)
Total ecosystem services	15,000	204,824
Expenditure	7,169	97,889
Gross Value Added	4,655	63,564
Payments to capital	1,019	13,918
Tourism rent	510	6,971

This WACC reflects a high degree of uncertainty and is not consistent with regulated asset WACCs in Australia under current financial market conditions. The asset values derived from this WACC are likely too low to reflect the GBR's actual value.

Table 7 : Asset value with a WACC of 7.5%

Method	Annual benefit ($ million 2014-15)	Asset value ($ million 2014-15)
Total ecosystem services	15,000	304,873
Expenditure	7,169	145,704
Gross Value Added	4,655	94,613
Payments to capital	**1,019**	**20,717**
Tourism rent	510	10,376

This WACC reflects a mid-point degree of uncertainty between WACCs of 5% and 10%. This WACC is above regulated asset WACCs in Australia (e.g. for water assets we are seeing 5-6% per annum (pa) under current financial market conditions. The asset values derived from this WACC are likely to understate the GBR's actual value, but we have adopted this conservative valuation to ensure that this is a robust, high-level business case.

The prescribed WACC for business cases for Commonwealth or Queensland Government funding is 7%.

Table 8 : Asset value with a WACC of 5.0%

Method	Annual benefit ($ million 2014-15)	Asset value ($ million 2014-15)
Total ecosystem services	15,000	559,750
Expenditure	7,169	267,514
Gross Value Added	4,655	173,711
Payments to capital	1,019	38,036
Tourism rent	510	19,050

This WACC reflects a lower degree of uncertainty than 7.5% and (at 5%) is consistent with regulated asset WACCs in Australia under current financial market conditions. The asset values derived from this WACC are likely to reasonably reflect the GBR's actual value of up to $38 billion, but we have adopted the more conservative WACC of 7.5% (above) to ensure that this is a robust, high-level business case.

Table 9 : Asset value with a WACC of 2.5% (RBA Risk free rate as discount rate)

Method	Annual benefit ($ million 2014-15)	Asset value ($ million 2014-15)
Total ecosystem services	15,000	1,500,000
Expenditure	7,169	716,874

Method	Annual benefit ($ million 2014-15)	Asset value ($ million 2014-15)
Gross Value Added	4,655	465,505
Payments to capital	1,019	101,928
Tourism rent	510	51,050

A WACC of 2.5% reflects very low uncertainty and is not consistent with regulated asset WACCs in Australia under current financial market conditions. The $102 billion asset values derived from this WACC may overstate GBR's actual value. We did not adopt this valuation as it is insufficiently conservative.

3.2.3 Excluding wider economic benefits from our valuation

We are adopting a regulatory asset approach to the valuation of the GBR assets, so we will not consider or critique economic analysis of the total benefits due to the GBR ecosystem. We have included the ecosystem services as a comparison.

We also do not consider tourist expenditure to be a reliable measure of benefits from the GBR, as the part of the output from ABS's input-output model. This is because comparison of the output of two different industries is not a good measure of the contribution of each industry. An inefficient industry may produce a lot of output from a lot of inputs, or conversely an efficient industry may produce a lot of output from a small amount of inputs.

We consider GVA, or the input into the input-output model, as a more appropriate indicator of the GBR's value. The GVA can be compared to the GDP of the economy, or the GVA of another industry. This makes GVA a useful measure of the value of annual benefit of the assets, as highlighted by Deloitte (2015).

The Deloitte measurement of GVA includes payments to intermediate industries (e.g. if a tourist pays for a meal in a restaurant, we included payments to the owner and labour of the restaurant and to the owners and labour of any capital used to provide the meal, such as the owners and labour of farms used to produce the food).

For our purpose of asset valuation we consider payments to capital as the most appropriate measure of the GBR assets annual value. This is because the market value for a productive asset, or fixed capital, is tied to the returns related to that asset into the future, or the payments to the owners of that capital.

The ABS's tourism rent attempts to remedy some of the distributional issues of the payments to capital, in line with the System of Environmental-Economic Accounting Central Framework (SEEA-CF). Our concerns with the current ABS value are:

- The dependence of tourism assets in the region on natural attractions to draw visitors
- The fixed and built asset base is confidential.

We found an asset value of **$20,717 million** with our preferred payments to capital and a middle range nominal WACC of 7.5%. However, Table 6 to Table 9 show the wide range of asset values resulting from changing the method of finding the annual benefit and changing the WACC.

4. Our operations and maintenance budget

In this section we will consider the operations and maintenance expenditure and allowances for depreciation utility companies use to maintain large assets such as dams and electricity networks. We will use common expenditures to give a high level estimate of the appropriate operations and maintenance allowance for an asset of the same value we have found for the GBR asset.

4.1 Revenue from a regulated asset

4.1.1 Pricing principles

Utilities which run and maintain large assets or systems of assets, such as dams or water and electricity networks, are often the only companies providing such services in an area. Government regulators oversee the operation and maintenance expenditure of such utilities in countries where they have been privatised or corporatized.

Regulated water utilities in Australia are not allowed to sell water. Tariffs which water users pay are for the use of the water utility's dams and water networks. Electricity distribution and network tariffs are also paid for the use of the electricity network. Electricity generation prices are a separate cost for electricity users.

Regulators in Australia and around the world use common principles for determining the revenue that can be gained from productive assets such as dams and water and electricity networks. The revenue is set to match costs of running the asset. These costs are broken into three components, known as building blocks:

- Operating expenditure (opex) – this is the expenditure to operate and maintain the asset
- Return of capital (also referred to as depreciation) – this is intended to return the capital expenditure (capex) spent purchasing, building or otherwise preparing the asset to the advancers of capital, either loans or equity
- Return on capital – this is intended to compensate advancers of capital who must wait for their money to be returned to them.

Regulators allow regulated utilities to recover a maximum revenue from water users, known as upper bound prices including the three building blocks.

We will consider the GBR as a regulated asset. We have used the example of regulated assets because:

- They are large – dams, and water and electricity networks have assets with values of the same scale as the value we have determined for the GBR
- They are typically the only providers of services in an area – although there are other tourist attractions in North Queensland, such as the Daintree Rainforest, the GBR is the most important and the most unique
- Information on revenue and expenditure is publically available – government regulators have set strict rules for how much money can be collected from network users, and the operations and maintenance activities collected revenue can be spent on.

4.1.2 Our sample of utilities

We sampled five electricity and water utilities in Australia to compare operating and maintenance budgets with asset values. Our sample includes the following utilities:

- Ergon Energy – Regional Queensland's electricity network
- Hunter Water Corporation – Water and wastewater network in the Lower Hunter Region around Newcastle, New South Wales (NSW)
- WaterNSW – Water network in NSW
- TasWater – Water and wastewater network in Tasmania

- SunWater – irrigation water supplier in the GBR catchment area.

We will use a comparison with a fixed asset to produce an estimate of the expenditure 'needed' to maintain the GBR assets. In other words, this is the amount that would be spent to maintain infrastructure that provides a similar economic benefit.

SunWater is an ideal analogy for funding the GBR assets because it:

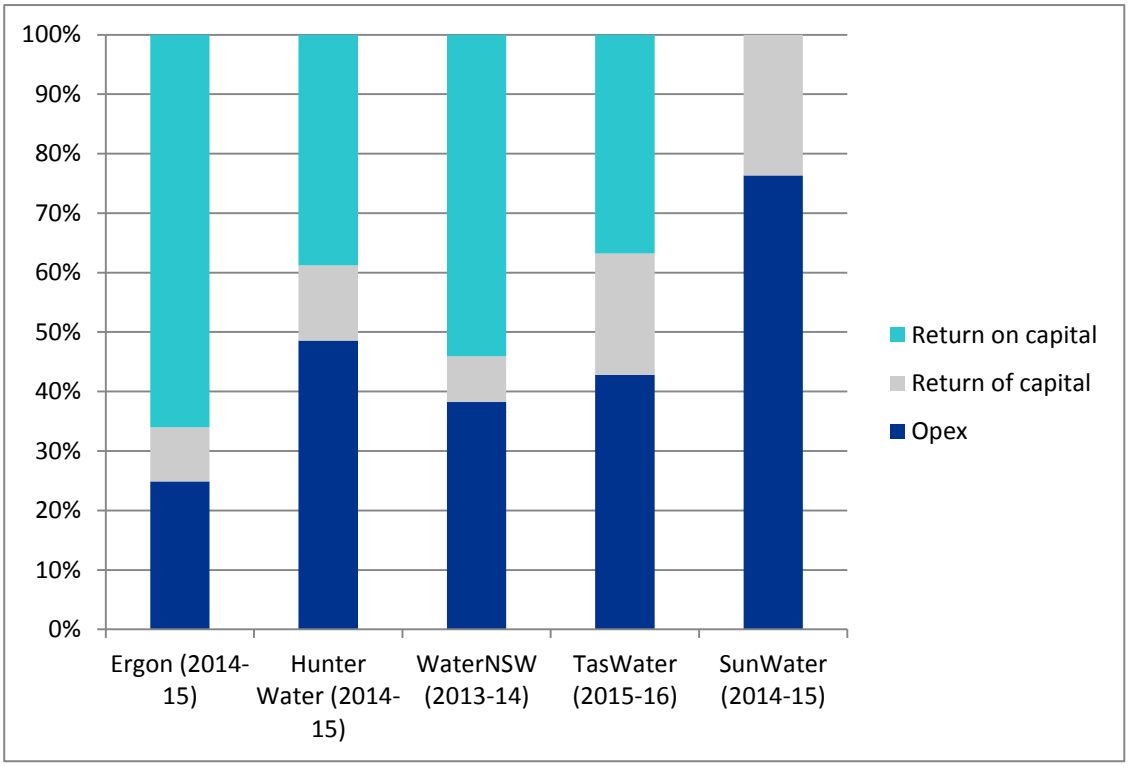
- Operates in the same area
- Does not depreciate its large assets such as dams
- Does not recover a return on capital from irrigators.

As the other utilities in our sample use the return of and on capital building blocks, we have used an average between SunWater and the other utilities.

4.1.3 Allowed revenue of our sample

We have collected the revenue allowance for the regulated utilities in our sample. Figure 5 shows revenue from the regulated assets in our sample divided into the building blocks of costs that form a basis for that revenue.

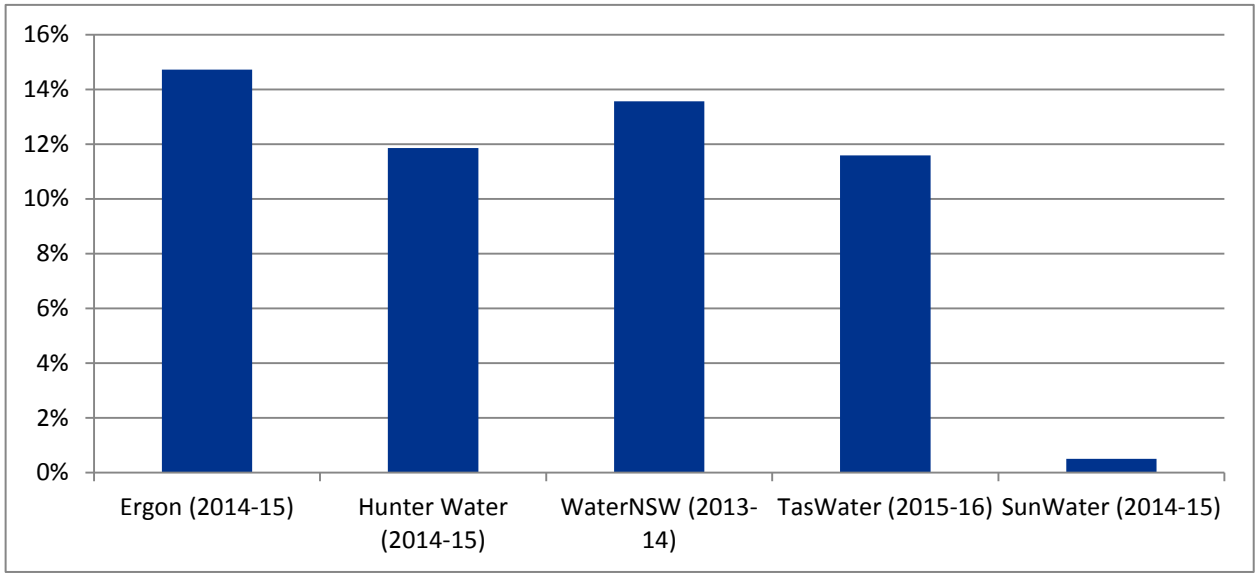
Figure 5 : Building blocks of revenue from regulated assets



Source: AER, IPART, SunWater, Otter

Figure 6 shows the revenue of the regulated utilities as a portion of the value of their regulated asset value (regulated asset base or RAB).

Figure 6 : Revenue as a portion of the regulated asset base



Source: AER, IPART, SunWater, Otter

4.1.4 Opex as part of regulatory revenue

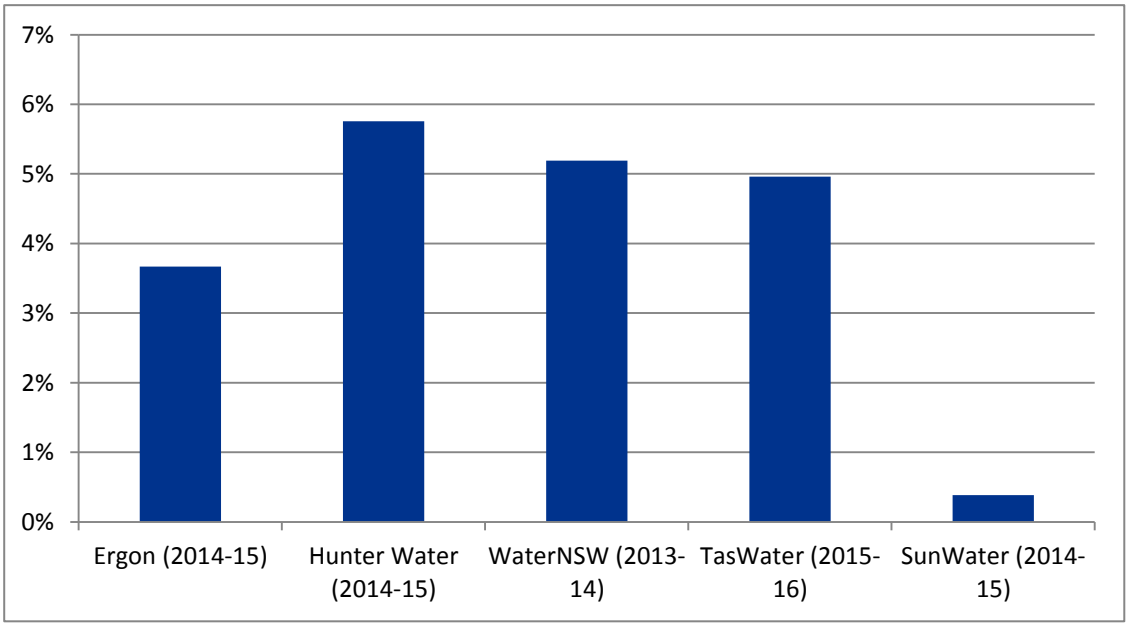
Regulators allow utilities to recover opex, which is the operating and maintenance expenditure used to run the utility's assets. The regulated utility recovers opex in the same year as the expenditure is incurred.

Operating expenditure includes spending on wages and salaries, electricity, water treatment chemicals and similar elements.

Maintenance expenditure includes spending on maintaining assets, such as spare parts.

Figure 7 shows the opex of regulated utilities as a percentage of their regulated asset base.

Figure 7 : Opex as a portion of the regulatory asset base



Source: AER, IPART, SunWater, Otter

The average of the utilities in our sample excluding SunWater is 5%. The midpoint of this average and the percentage of SunWater is 3%.

4.1.5 Depreciation as part of regulatory revenue

From time to time, a utility must replace a large asset, for example a pump or transformer. Large scale maintenance may also need to be undertaken on a larger asset of the utility, such as repairs on the face of a dam.

Utilities often need to make large expenditures in one year followed by one or more years of less expenditure. This is known as lumpy capex, because a bar graph of annual capex will have lumps of high annual expenditure separated by years of smaller expenditure.

Regulated utilities do not charge users for large asset replacements in the year the payments are made. Instead, the funds are recovered over a number of years to smooth the funds needed in each year, so the funds spent in the lumps can be partly recovered in the years with less expenditure.

Regulated utilities in Australia use two methods to smooth capex:

- Return of capital (depreciation allowance) and return on capital
- Renewals annuity.

All the utilities in our sample, except SunWater, use a depreciation allowance with straight line depreciation.

With straight line depreciation, every year an equal amount is removed from the asset value from when the asset is acquired until the asset reaches the end of its useful life. This means that the annual depreciation is the original asset value divided by the expected useful life. The depreciation allowance over the useful life of the asset will be equal to the cost of the asset.

Table 10 shows the useful life for existing assets for utilities which use a depreciation allowance. We have excluded TasWater from the average due to its unusually low asset life.

Table 10 : Useful asset lives for regulated utilities

Utility	Useful asset life (years)
Energex (2014-15)	75
Hunter Water (2014-15)	70
State Water Corporation (2013-14)	75
TasWater (2015-16)	36
Average (excluding TasWater)	**73**

SunWater is a special case because it has a renewals annuity instead of a return of capital (depreciation), and also does not recover costs for a return on capital from irrigators. This is a policy decision of the Queensland Government and is known as lower bound pricing.

SunWater's renewals annuity is a smoothing of the expected asset replacement spending required to maintain its assets in the long term. Spending on items such as pumps is smoothed into the renewals annuity, but replacement of the main asset such as a dam is not.

4.1.6 Return on capital as part of regulatory revenue

Regulated utilities must pay for lumpy capex items all at once, even though the funds are recovered from users over a number of years. To be able to pay for large items, the regulated utility needs to either:

- Commence a loan at a bank

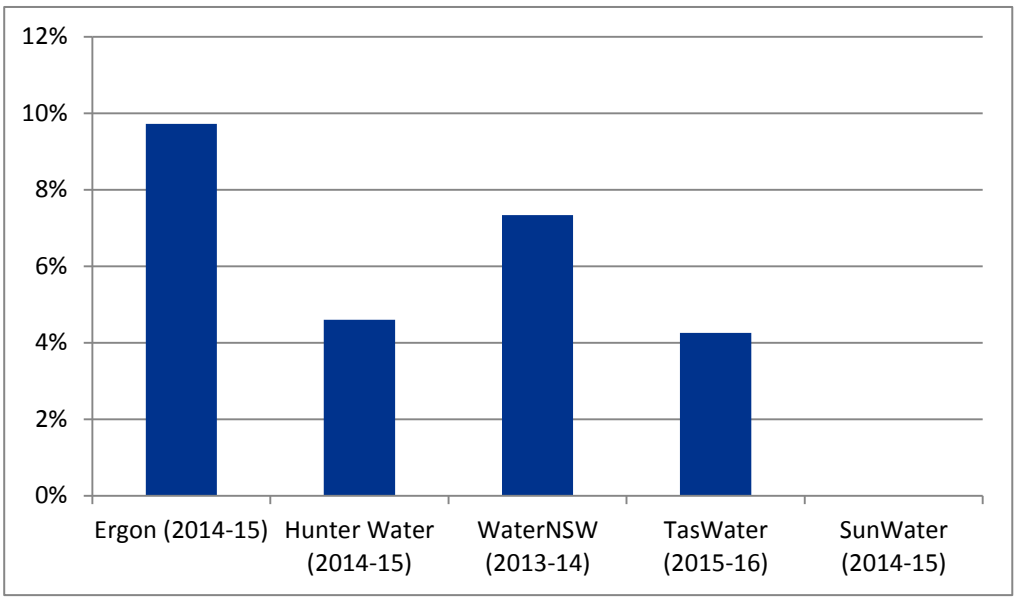
- Raise funds, called equity, from its owners, either the government if the utility is government owned or shareholders.

Banks charge interest on loans which the utility must pay. Owners who provide equity expect a return on the funds they invest in a business.

Regulators allow regulated utilities to charge a return on their assets to users so they are able to pay interest on their loans and a return to their owners.

Figure 8 shows the return on capital of the utilities in our sample as a percentage of their regulated asset base.

Figure 8 : Return on capital as a portion of the regulated asset base



4.2 Maintenance of the GBR asset

We will now apply the common characteristics of the operations and maintenance budget for regulated utilities to the GBR asset.

4.2.1 Opex

We found an average of 4% of the RAB was spent on opex running and maintaining the services related to that RAB for the other assets. Therefore we calculated an opex budget of $547 million for the Great Barrier Reef using a proportion of 4% of our preferred asset value, $20,717 million.

We consider this the minimum annual spending required for the short-term operation and maintenance of a built asset of the same value as the GBR.

4.2.2 Depreciation

The depreciation allowance is tied to the asset life. This can be estimated for a built asset using information from similar assets.

We found a depreciation allowance of $285 million using the average asset life of 73 years from the regulated utilities. We consider the additional spending on the depreciation allowance (potentially) necessary to be set aside for the long term sustainment of a built asset of the same value as the GBR.

With opex and the depreciation allowance together, we estimate an annual expenditure of about $830 million to continue to operate an asset of the same value as the GBR into the long term.

4.2.3 Return on capital

We have not included a return on capital in our recommended annual operations and maintenance budget for the GBR asset. As the GBR was not bought or constructed like a built asset, there are no initial investors to return funds to.

The return on capital would be the payments to capital (i.e. $1,019 million) we have used to determine the asset value.

4.2.4 Revenue as a portion of asset value

Based on our proposal, GBR's revenue as a portion of its estimated asset value would be the second lowest when compared to our sample of utility companies. Therefore, our $830 million is a conservative proposal, when compared with other regulated assets providing services to the community.

The only exception is SunWater, which in general does not charge an explicit profit margin in irrigation water charges, similar to our exclusion of the return on capital from our allowance for the GBR asset. However, of the regulated businesses listed, SunWater is the only one that has not had its asset value independently reviewed by an economic regulator. Accordingly, while SunWater's revenues appear low relative to its asset value, its asset value may be overstated due to a lack of scrutiny of that value.

4.3 Conservative recommendation

We recognise that the reef was not built by human beings and as such, returning the initial capital investment to the 'owners', via depreciation may not be justified.

We consider that a depreciation allowance is a useful proxy to set aside funds for major rehabilitation of the reef. However, for our key conservative recommendation, we remove our depreciation allowance.

We are not setting a position on the level of necessity of major rehabilitation. We do note that setting aside funds for major rehabilitation is more contentious than setting aside an operations and maintenance allowance.

With a regulated utility, each new major project must be evaluated on a case-by-case basis against strict criteria. Although the depreciation allowance is useful to indicate the likely level of funding, we recognise this is a more contentious element of spending.

Accordingly, our recommended annual funding for the reef (based on our benchmarking approach) is that **government should invest $547 million pa as a minimum in the GBR to provide the necessary 'operations and maintenance' budget** needed to ensure the long-term viability of an asset of a similar value.

5. Changes to our assumptions

To produce our asset value and our operations and maintenance budget, we have made a number of assumptions. Due to uncertainties and the limited number of similar studies with a similar scope, we have taken a conservative approach with most assumptions.

This section details how our asset value and our operations and maintenance budget would change with different assumptions.

Assumptions we have made which affect the asset value are:

- Tourism growth rates
- The WACC.

Assumptions we have made which affect the operations and maintenance budget are:

- Opex as a percentage of the RAB
- The asset life.

5.1 Trends in tourism

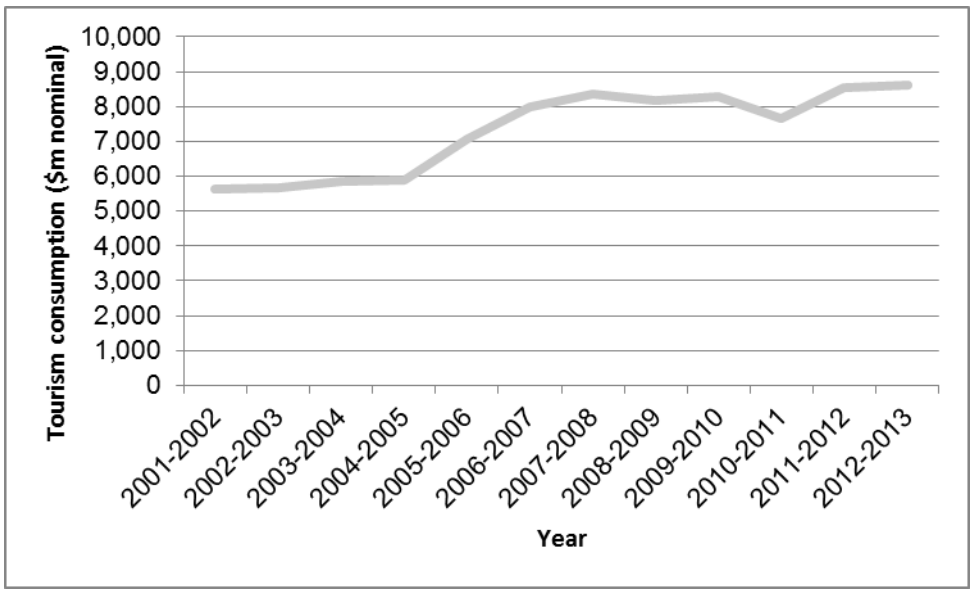
We have used constant tourism expenditure for our asset value. We will consider past trends in tourism and if a positive trend into the future is reasonable.

5.1.1 Likely trends

The purpose of this section is to indicate the likely trends in tourist numbers.

Figure 9 shows the growth of tourism consumption in the GBR region between 2001 and 2013. Figure 9 shows a period of mid-term growth. The mid-term annual growth of tourist consumption is 4.0% averaged over the period 2001-2013. If this trend continues, by 2019-2020, tourism consumption will be $11,360 million, up from expenditure in 2012-13 of $8,634 million.

Figure 9 : Direct tourism consumption in the GBR 2001-2013



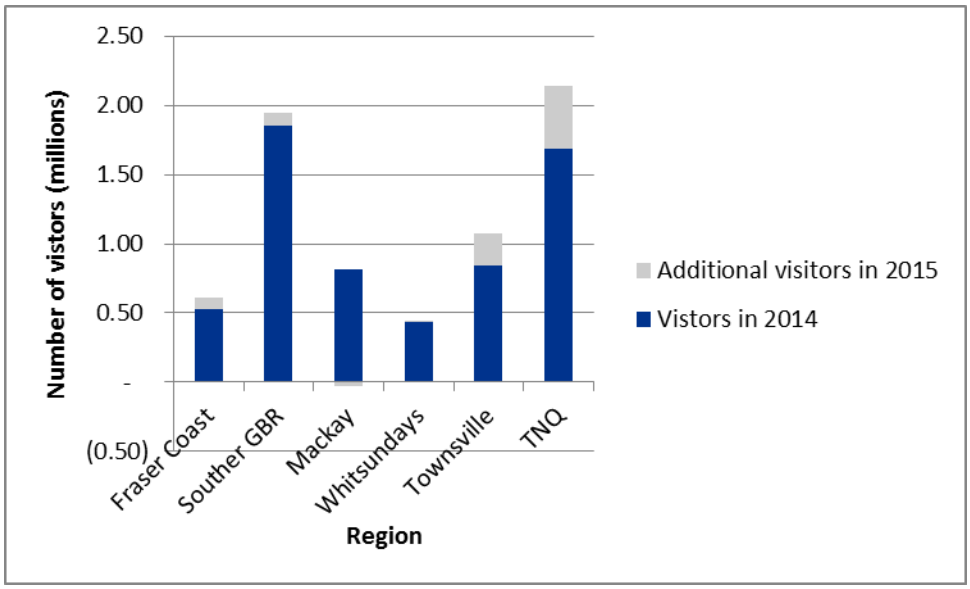
Source: ABS 2015: An Experimental Ecosystem Account for the GBR Region

Figure 9 shows periods of relative increases and declines in tourism expenditure within the general upwards trend. The Deloitte report (2013), which focused on the years 2007 to 2012, explained the drop in expenditure in those years by changes in international tourism expenditure in Australia due largely to a relatively strong Australian dollar during those years, not to changes in general tourist behaviour.

Tourism and Events Queensland (TEQ) finds there has been a significant increase in GBR visitor numbers. Figure 10 shows the percentage increase in visitor numbers by GBR regions. Apart from the Mackay Region, there was a significant increase in overall visitor numbers.

Figure 10 shows that in the Tropical North Queensland (TNQ) Region, which overtook the Southern GBR to have the largest visitor numbers of all the GBR regions between December 2014 and 2015, there was a 20.4% increase in visitors.

Figure 10 : Increase in visitor numbers per region 2014-2015



Source: TEQ 2016

TEQ attributes the increase in international visitors on the decline in value in the Australian dollar. TEQ observes that the increase has occurred despite significant global attention on the health of the GBR.

The ABS's Tourism Satellite Accounts, which detail the economic activity of the tourism industry, show a 5.3% increase in the contribution of the Australian tourist industry towards Australia's GDP between 2013-14 and 2014-15. Growth in visitor numbers in the GBR region suggests regional growth above the national average.

Although an increase in the value of the tourism industry will increase the asset value, forecasts of growth into the future are uncertain. This is particularly the case for the GBR, where tourism is dependent on the condition of the asset. Many key tourist sites remain in good condition and visitors are still willing to travel to see the GBR in increasing numbers. Without appropriate investment, the risk for tourism is that there will be significant deterioration of the asset. This will impact tourist numbers.

5.1.2 Effect of growth or decline of annual benefits on the asset value

The purpose of this section is to show how an increase or a decrease in the annual benefit, in our case the payments to capital, increases or decreases the asset value.

An annual benefit which is expected to grow in the future will increase the value of a productive asset. On the other hand, a declining annual benefit will decrease the annual benefit.

These changes in value sit within our asset valuation concept. If the annual value of an asset is growing, the sum of all of the annual benefits into the future, after discounting, will be more than if the annual benefit is constant. The opposite is true if the annual benefit is declining.

If the annual benefit is expected to grow or decline by approximately the same percentage every year, the growth rate can be incorporated into the discount rate.

This is what happens with inflation. Interest rates normally include inflation. This represents increases in annual benefits, such as revenue, due to increases in prices. However, because inflation is expected to affect all growth rates, this effect will be common to the growth in all annual benefits and will cancel out.

5.1.3 Changes to our assumptions

We have shown that 4.0% is the average mid-term annual growth in tourism from 2001 to 2013.

We can add and subtract growth rates to approximate the combined growth rate. If we subtract mid-term inflation of 2.5% from the tourism growth of 4%, we have growth in the tourism industry relative to the rest of the economy of 1.5%. Increases in tourist numbers support the notion that tourism is growing relative to the rest of the economy.

5.2 Changes to the WACC

We have already shown how our asset values changes with variations in the WACC between 10% and 2.5% in Section 3.2.2.

5.3 Changes to the discount rate

We can consider the combined effect of variations to the WACC and variations to tourism growth rates.

Table 11 shows changes to the discount rate resulting from a range of WACCs and tourism growth rates.

Table 11 : Range of discount rates

Tourism growth	Very low WACC – 2.5%	Low WACC – 5%	Medium WACC – 7.5%	High WACC – 10%
No growth – 0%	2.5%	5%	7.5%	10%
Medium growth – 1.5%	1%	3.5%	6%	8.5%
High growth – 3%	-0.5%	2%	4.5%	7%

Table 11 shows the range of discount rates from various assumptions of the WACC and growth rates is -0.5% to 10%.

To show how our asset value changes with different assumptions for tourism growth and the WACC, we will show the results when a medium growth for tourism of 1.5% above inflation is combined with a low WACC of 5%. This gives a discount rate of approximately 3.5%, compared with the 7.5% we have used for our asset value.

5.4 Changes to opex as a percentage of the RAB

We have used a benchmark for an operations and maintenance budget of 3% of the RAB. The actual operations and maintenance budgets as a portion of the RAB are between 0.4% for SunWater and 6% for Hunter Water.

We will consider a high 5%, medium 4% and low 3% percentage of the RAB to show the variation in the operations and maintenance allowance.

5.5 Changes to the asset life

We have used a benchmark asset life of 73 years to determine our depreciation allowance. Asset lives for the utilities in our sample ranged from 36 years for TasWater to 75 years for Ergon and WaterNSW. We will consider a low asset life of 36 years, a medium asset life of 55 years and a long asset life of 73 years.

5.6 Result variations

Table 12 shows how the asset value and our operations and maintenance budget varies with changes to tourism growth rates, the WACC, the percentage of the RAB which forms operations and maintenance expenditure and the asset life.

Table 12 : Change in operations and maintenance plus depreciation allowance pa ($ million 2014-15)

	Asset value ($ m)	Low operation and maintenance (3%) High asset life (73 years)	Medium operation and maintenance (4%) Medium asset life (55 years)	High operation and maintenance (5%) Low asset life (36 years)
No tourism growth rate (0%) Medium WACC (7.5%)	**20,717**	830	1,205	1,611
Medium tourist growth rate (1.5%) Low WACC (5%)	**64,906**	2,602	3,776	5,048

6. Current funding in the GBR

The purpose of this section is to show the current funding provided to maintain the GBR asset condition. This section also shows tax paid by tourist businesses and employees in the GBR region.

6.1 Funding commitments

The Reef 2050 Investment Baseline completed in 2015 estimated a level of funding allocated to Reef management (e.g. marine park management, biodiversity protection) by the Queensland and Australian Governments in 2014-15 was to be $215 million.

Projections on future funding estimated that $2 billion would be invested in reef management over the next decade or $200 million annually. This figure covers expenditure by both Australian and Queensland Governments and includes water quality improvements investment of $55 million annually. It also includes expenditure on marine safety, which accounts for over a quarter of the total figure. This investment, whilst very important, will not assist the improved condition of the GBR asset.

Table 13 (drawn from the GBR Water Science Taskforce) provides the level of committed funding for GBR water quality protection.

Table 13 : Major Reef funding commitments by Australian and Queensland governments ($ million)

Government body	2009-2013	2014-2018	Average annual funding ($ millions)
Queensland	175	175 over 5 years	35 (55 with additional funding)
Australian Government	200	300 over 6 years	50
Total	**375**	**475 over 6 years**	**85**

Source: GBR Water Science Taskforce Final Report

The discrepancy between the Investment Baseline figure of $55 million of annual funding in water quality and the Taskforce Report is explained in part by additional funding, different categorisation of funds and the fact that portions of the funding covered by the Taskforce go to programs that address management challenges aside from water quality.

The Queensland Government subsequently announced further funding of $100 million over 5 years, which would bring its five year investment to $275 million, assuming maintenance of existing funding ($35 million pa). In the last budget, the Australian Government announced a further $171 million which extended funding to further years but did not increase base funding (and showed a decrease for water quality programs).

A $1 billion Reef Fund was announced by the Australian Government during the 2016 federal election campaign. This is a loan facility drawn from existing money managed by the Clean Energy Finance Corporation. It must be used for clean energy projects and may have optional benefits for GBR water quality. We have not included this funding in our calculations as the extent of the funding which would realise additional benefits for the GBR is unclear.

The above discussion shows it is challenging to set out an accurate forward estimate of GBR funding and the funding amounts that are allocated to each sub-program. We shall use the Investment Baseline which sets out annual funding of $215 million. This is likely an over-estimate of funding in programs which maintain the GBR asset condition due to the inclusion of large investments for maritime safety and uncertainty over ongoing budget commitments.

Table 14 shows the existing and announced annual funding on water quality protection and management, compared with our minimum funding for short-term operations and maintenance.

Table 14 : Annual GBR asset funding

Funding	Amount pa ($ million)
Existing Investment Baseline funding	**215**
Our operations and maintenance allowance	547
Increase from existing funding commitments	**332**
Our operations and maintenance allowance plus depreciation allowance	830
Increase from existing funding commitments	**625**

Table 14 shows existing funding would need to increase by $332 million, or 154%, to meet our estimate of the minimum funding needed for operations and maintenance of an asset with the same value as the GBR.

Regardless of whether the current committed funding is higher or lower than shown above, commitments are still well short of the minimum funding that we consider appropriate to operate and maintain the GBR sustainably, if it were treated as a built regulated asset.

6.2 National benefits and tax collection

6.2.1 Returns to Australia

The GVA of $4,655 billion is the most appropriate measure of the benefit to the national community of the GBR assets. We have not used this figure to value the assets for the reasons outlined above. However, this figure is still relevant to the wider Australian community.

In effect, we are recommending an annual government investment of between $547 million and $830 million to maintain an asset which is supporting a benefit to the community of $4,655 billion and 68,979 FTE jobs. This provides an annual return of between 5.6 and 8.5 times the investment to Australia.

6.2.2 Existing taxation

Australian governments collect a large amount of taxes from the tourist industry in the region which could be used to fund asset operations and maintenance. These include:

- Income tax from employees in the tourism industry
- Company tax from tourist companies
- GST paid by tourists
- Environmental Management Charges (EMCs)
- Other taxes, such as payroll tax.

Two reports by Hassall and Associates (2001 and 2002) made estimates of some of the taxes and charges collected by government from the tourist industry. Hassall and Associates had a strong focus on tourist activities on water. This excludes land-based tourist expenditure, such as accommodation (15%), air travel to destinations (15%), retail trade (13%) and food services (12%), which Figure 4 shows are large contributors to overall tourism expenditure.

We have estimated the amount of each tax collected to compare with our recommended operations and maintenance allowance. Table 15 shows our estimate of the taxes paid by the tourism industry in the GBR asset catchment area.

Table 15 : Taxation of the tourism industry in the region

	Income tax	Company tax	Net taxes on products (including GST)	Other net taxes	EMCs	Total
Estimate of tax ($ million 2014-15)	320	306	87	113	10	**836**

Source: ABS, TRA, QTIC, Jacobs' calculations

We estimate a total tax of $836 million gathered from tourist operators in the GBR asset catchment region. This is similar in magnitude to our estimate of $830 million as the appropriate level of funding for asset operations and maintenance (including depreciation). This means that the tourism industry can support the operations and maintenance of the GBR assets through the targeted use of its tax contributions.

We have used the following methods to estimate each of the taxes.

6.2.2.1 Income tax

We have estimated income tax paid by employees in the tourist industry using the method described by QTIC, which made use of one of the Hassalls and Associates reports (2001):

- We have used $1,599 million as our estimate of employee income. This is derived using ABS input-output tables. Using the multiplier of 0.37 quoted in the QTIC would give $2,653 million, so our estimate is conservative.
- We have applied 20% as the effective tax rate. This was the effective rate applied to $75,000 the average wage in Queensland in May 2015. This is more conservative than the rate of 33% quoted in the QTIC (2004) report.

6.2.2.2 Company tax

We have calculated company tax using the company tax rate of 30% in 2015. We have applied the 30% tax rate to our estimate of the payments to capital of $1,019 million. We note that depreciation and interest are not deducted from the payments to capital, so this method will overestimate the taxation.

QTIC (2004) states Hassalls and Associates (2002) found GBR commercial tourist operators paid $17.7 million ($1999-2000) in company tax from total revenue of $263.3 million, or 6.7% of total revenue. If this proportion was applied to the total tourist expenditure of $7,169 million, the estimate of company tax would be $482 million, so our estimate of $306 million is conservative in comparison.

6.2.2.3 Net taxes on product and other net taxes

The following taxes can be derived from the ABS input-output tables:

- Net taxes on products: this includes taxes such as the GST, less subsidies
- Other net taxes: this is the remaining tax collections, such as payroll tax, less assistance to industries.

6.2.2.4 EMCs

EMCs are collected from tourist operators for the explicit purpose of managing the GBR assets. The Association of Marine Park Operators estimates a collection of $10 million in 2014-15.

6.3 Recommendations

Our report suggests that funding should be dramatically increased to maintain the condition of the GBR asset, commensurate with the value of the asset we have determined.

We recommend a detailed business case (including cost-benefit analysis) is developed to support additional funding to maintain the GBR in a sustainable asset condition.

A future business case, including detailed cost-benefit analysis, would incorporate estimates and techniques we have not used in our analysis including:

- General equilibrium modeling (GEM) of the effect of the decline of the asset condition on the contributions the asset makes to the community
- Improved sensitivity analysis
- Further investigation of the costs and benefits to include in the analysis, in consultation with the stakeholders who are likely to be affected or their representatives, such as farmers, tourism operators and conservation groups.

7. Threats and investment opportunities

The GBR is a natural asset, not a built asset, so the nature of threats to the asset is different. This section will outline the threats to the GBR asset.

Using built assets causes wear and damage. Human activity also cases damage to the GBR asset. Human damage is additional to naturally occurring damage and decline. Unlike a built asset, the GBR asset has a natural rebuilding capacity. However, some human activity reduces the ability of the GBR to naturally regenerate.

While the focus of this report is to determine an appropriate level of investment through comparison with a regulated asset, this section will highlight possible areas where investment will maintain or rehabilitate the asset condition.

7.1 Relationship between asset condition and tourism activity

Findings on the importance between the GBR and tourism in Australia include:

- Tourism Australia (TA) - 42% of international visitors rank the GBR as the most appealing tourist attraction in Australia (Tourism Australia Coastal Factsheet, 2015)

Esparon et al (2015) conducted a major survey of GBR visitors. They found that:

- Water clarity (a clear ocean) was deemed the most important value
- The level of satisfaction with water clarity was low
- Visitors had a stronger negative reaction to the prospect of four different types of environmental degradation (oil spills, reduced water clarity, rubbish, and reduced coral cover) than to a hypothetical 20% increase in local prices.

Esparon et al (2015) found the greatest sensitivity to environmental degradation was in the Cairns/ Port Douglas region.

Stoeckl et al (2014) concluded that changes in the environment in the GBR would have a real impact on people and of the decisions of people that would have a real impact on the economy. They found through a major survey of visitors and residents that:

- Degradation of environmental values is likely to have real impacts in the tourism industry including:
  - Reductions in tourist satisfaction and less repeat visitation
  - Reduced numbers of tourists visiting the region
  - Tourists staying for shorter periods.
- Wages may need to rise in the region due to degradation of the GBR, due to a loss of aesthetic and recreational benefits important in retaining the current workforce with the current wage levels.

Mustika et al (2014) examined the potential implications of environmental deterioration for business and non-business visitor expenditures in the GBR. Their conclusions were:

- Nature-based tourism is an important source of income for the region
- More than 90% of non-business visitors and 67% of business visitors came to the region for at least one nature-related reason
- Substantial environmental degradation could reduce visitor expenditure and thus local tourism income by at least 17%.

Surveys of coral cover since 1985 have shown a decline in coral cover which has not been matched with a decline in tourist numbers. This is due to factors such as key sites being visited by tourist remaining in good

condition. However, there will be a point where the asset deteriorates so markedly that tourism numbers will be impacted.

7.2 Threats to asset condition

The 2014 GBR Outlook Report identified more than 41 threats to the GBR. The four types of threats assessed as very high and high risk are shown in Table 16.

Table 16 : Very high and high risk GBR threats

Climate change	Coastal development	Land-based run-off	Direct use
Sea temperature increase	Clearing and modifying coastal habitats	Nutrients from run-off (including its links to outbreak of crown-of-thorns starfish)	Illegal fishing, collecting and poaching
Altered weather patterns	Artificial barriers to flow	Sediments from run-off	Incidental catch of species of conservation concern
Ocean acidification	Disposal and suspension of dredge material	Pesticides from run-off	Marine debris
Sea level rise		Marine debris	Incompatible uses (assessed for heritage values only)
			Effects on discarded catch; retained take (extraction) of predators
			Disposal and suspension of dredge material
			Retained take (extraction) from unidentified or unprotected spawning aggregations

Outbreaks of disease, both naturally occurring and introduced were also assessed as a high risk. Such outbreaks are likely to be an indicator of overall stress in the natural system from the accumulation of impacts arising from many influencing factors including poor water quality (GBRMPA 2014).

Water clarity has been a particular focus of concern due to increased sedimentation and nutrient loads impacting on the GBR. Poor water quality contributes to the decline in coral biodiversity and fish species composition.

Compared with pre-European conditions, average sediment loads to the GBR have increased by 3.3 to 5.5 fold. Total nitrogen loads have increased 2.0 to 5.7 fold and total phosphorus loads have increased 2.5 to 8.9 fold. Grazing lands contribute the majority of the load in many river systems. The dominant sediment supply is from a combination of gully and stream bank erosion and subsoil erosion from hill slopes. (Kroon et al 2013 Scientific Consensus Statement).

A major investigation into the sources of sediments in the GBR by the CSIRO and Australian Centre for Tropical Freshwater Research found that:

- 70% of the sediment came from just 20% of the total catchment area
- The areas of high contribution are all relatively close to the coast, concentrated in the Mackay Whitsunday catchments, Bowen River sub-catchment of the Burdekin, the Wet Tropics, the south east part of the Normanby River basin, near coastal parts of the Fitzroy and Burnett River basins and the main stem of the Mary River (ACTFR 2011).

The Fitzroy, Burdekin and Wet Tropics contribute over 75% of the total modelled nitrogen load. Sugarcane and other cropping and grazing are the main source of dissolved inorganic nitrogen (DIN). The Scientific Consensus

Statement indicates that, compared with diffuse sources, the relative contribution from point sources, such as intensive animal production, manufacturing and industrial processing, mining, rural and urban residences, waste treatment and disposal, ports and shipping is relatively small but could be locally and over short periods of time highly significant (Kroon et al. 2013).

Excess river sediment, nutrient and pesticide loads to the GBR lagoon are derived from:

- Surface and subsurface erosion, predominantly in rangeland cattle grazing settings
- Fertiliser applications in sugarcane and broad-acre cropping
- Pesticides (particularly photosystem II inhibiting herbicides) primarily applied during sugarcane cultivation (Kroon et al. 2013).

7.3 Investment focus

Cyclones are not able to be mitigated by investment. Climate change issues such as acidification and coral bleaching require global action. However, interventions and investment at a local scale can address matters such as catchment pollution and unsustainable illegal fishing.

The Reef 2050 Long Term Sustainability Plan has developed an ambitious best case scenario. The best case scenario includes targets to reduce fine sediment loads by 20% to 50% by 2025 and DIN loads by 50% to 80% by 2025. The focus of the targets is key catchments, such as the Burdekin for DIN and the Fitzroy for fine sediment. Best management practices in agricultural industries are identified as a key means to achieve the targets.

The GBR Water Science Taskforce concluded that a large increase of current levels of funding would be needed to increase the area of agricultural land using best management farm run-off practices.

To move towards these targets, investment is needed in all agricultural industries to assist with:

- Upfront capital costs associated with acquiring new infrastructure associated with best practice run-off management
- Costs associated with exploring practice changes, accessing support and planning and executing changes (Rolfe & Gregg, 2015).

The infrastructure associated with best practice run-off management has the potential to improve both the short-term profitability and the long-term sustainability of agriculture in the GBR catchment.

7.4 Investment costs

Alluvium (2016) studied funding needed for a number of activities which can improve water quality. Alluvium (2016) found a medium level of funding of $3.86 billion ($2015-16) over 10 years and a high level of funding of $8.2 billion ($2015-16) over 10 years. We found a simple annual medium average of $386 million and high average of $820 million by dividing the total funding by 10.

Table 17 shows the similarity of our recommended high level of annual funding with both the average annual funding to implement Alluvium's (2016) findings and our estimated annual government tax income related to the GBR assets.

Table 17 : Comparison annual values ($ million)

	Medium	High
Our recommended operations and maintenance spending	547	830
10-year average of Alluvium's funding	386	820
Our estimated government tax income related to the GBR	na	836

Source: Jacobs' calculations, Alluvium (2016)

8. Conclusion

This report has set out the level of investment that the GBR should receive if it were treated like a constructed asset of a similar value to maintain its condition the benefits it supplies.

The GBR is a natural asset and so the types of funding which are needed to maintain its condition are different from the funding needed to maintain a built asset. As the GBR can naturally regenerate, funding to maintain its condition is focused on avoiding harm and allowing the GBR to regenerate naturally.

We have used the perspective of appropriate funding for a built asset to suggest a new approach which could determine an appropriate level of funding to maintain the GBR asset condition.

The following section summarises our key recommendations and findings.

8.1 Recommendations and findings

1) We recommend our conservative asset value for the GBR of $21 billion.

2) We note that based on this (including operations, maintenance and depreciation), an appropriate level of annual funding for the GBR would be $830 million. Depreciation could arguably be excluded as the GBR is not manmade and the capital does not need to be returned to the investor.

3) We recommend a minimum annual funding of $547 million for operation and maintenance of the GBR. That is, to achieve appropriate funding levels for a regulated and essential community asset of comparable value, governments should increase funding by $332 million pa (from $215 million pa) to $547 million pa.

4) We note that $830 million of funding to maintain the asset condition supports a contribution to the Australian economy of $4.7 billion, between 5 and 6 times the value of the funding.

5) We estimate that tourism businesses and employees contribute $836 million in taxes to the Australian and Queensland governments. We note that some of these funds could be used to maintain the GBR asset condition.

6) We also recommend that a detailed business case (including cost-benefit analysis) be completed to support the recommended higher levels of funding needed to sustain GBR assets. This analysis should include the significant economic benefits that would likely occur for agriculture as a key target for investment.

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