G

Hughenden Irrigation Project - Preliminary Business Case

Economic Analysis Report

Client: HIPCo
Date: 30 January 2020

NineSquared

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NineSquared is a specialist economic consulting and commercial advisory firm focused on helping governments and companies make great decisions and achieve your goals and objectives.

Our principals and staff are experienced, senior level practitioners who have worked in and advised government and private sector clients about a range of commercial and economic issues, primarily relating to transportation. Broadly, our expertise lies in the fields of transport and regulatory economics, policy development and analysis and advising on commercial arrangements between government and the private sector as well as arrangements between companies operating within regulated environments.

Our combined public and private sector experience means that we are well placed to provide our clients with deep understanding of both the public and private sectors and the interface between them.

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30 January 2020

Andrew Vitale
Principal Civil Engineer (RPEQ)
Sector Leader - Water Management
Director

Dear Mr. Vitale

RE: Hughenden Irrigation Project – Economic Analysis

Please find enclosed NineSquared's economics report for the Hughenden Irrigation Project. This report provides an overview of the assumptions, approach and results of the costs benefit analysis conducted by NineSquared.

Our work has been undertaken in accordance with our email dated 19 March 2019. The report may be relied upon by HIPCo and Engeny in describing the estimated economic benefits of the project as of 30 January 2020.

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For all enquires on this report please contact me at tfrost@ninesquared.com.au or 0414 316 656.

Yours sincerely,

T. W. Frost

Tom Frost
Director
NineSquared

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Executive Summary

The Regional Economy

The most recent census counted the population of the town of Hughenden at around 1,100. The Flinders Shire, in which it is located had an estimated population of around 1,500 in 2017. The Shire's population peaked at over 3,000 residents during the 1960s and has declined significantly in the decades since.

In fact, over the last two decades the Flinders Shire has experienced the fourth highest rate of decline across Queensland with a total decline of almost 30% over the period. Further, over the last five years, the Shire has exhibited an average rate of population decline of 3.0% per year, compared to State-wide average increase of 1.6% per year.

Continuation of this decline, in the absence of regional economic growth initiatives, has the Shire population projected to decline to around 1,260 by 2031, a further decrease of approximately 17% from the most recent population estimate.

Similarly, the total number of people employed has declined and across all sections of the local economy. The number of businesses, including farming enterprises, has also declined.

The Flinders Shire economy is mostly comprised of:

- Primary production (farming and to a much lesser extent mining) of which agriculture and, in particular, beef production is dominant;
- Transport-related services;
- Tourism-related services; and
- Support service to primary producers and mines and the broader community, including local government administration, health, education, and hospitality.

Based on the Australian Bureau of Statistics Socio-Economic Indexes for Areas index – which measures socio-economic disadvantage – the Flinders Shire exhibits higher level of disadvantage than more than half of the local government areas in Australia.

While the unemployment rate in the Shire is below the State average, this is driven by population decline, rather than representative of a high level of employment opportunities in the region. Accordingly, the number of people in employment declined by around 12% between 2011 and 2016.

While estimates of the Gross Regional Product (GRP) for the Flinders Shire specifically are not available, the Queensland Government Statistician's Office published data over the period from 2000-01 to 2010-11, showing that the GRP for the North West region of Queensland (which Flinders is a part of) grew at 0.1 per year, well below the State average.

The conclusion is that without significant regional development it is likely that Flinders Shire will experience further decline. This provides an important backdrop to the need for a large-scale regional infrastructure project such as the Hughenden Irrigation Project.

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The Project

Following an options analysis exercise, the project was defined as comprising a suite of bulk water infrastructure (dam, diversion channel and in-stream weir) and distribution infrastructure (pumps and channels) to provide irrigation water to new farming enterprises. Two cropping scenarios are assessed for the project and the subject of this economic analysis:

- **Scenario 1:** a mix of medium and low priority water for diversified cropping, comprising horticulture (avocadoes, mangoes, lemons and mandarins), grains and hay (sorghum, wheat, corn and rhodes grass hay).
- **Scenario 2:** low priority water for grains and hay production.

While improved economic results would be generated by assuming all the production is high-value horticulture, it would be unrealistic to assume the region could immediately go from no high-value horticulture to an entire scheme of horticulture. Instead, for the first scenario it has been assumed that that there is a mix of broad-acre field crops which are less intensive and would not require the same level of experience and expertise.

The primary economic benefit associated with the project is the increase in agricultural production associated with improved availability of water supply. Development of agriculture in the region has previously been constrained due to the variability of water supply.

Total cost of the project is estimated to be around $500 million, with construction costs mostly incurred between 2022 and 2024, with the project's first year of operation in 2025.

The Economic Analysis

The project is assessed using two types of economic modelling:

- Cost-Benefit Analysis (CBA), which assesses the costs and benefits to the community as a whole.
- Economic Contribution Analysis, which also assesses the wider impacts to the community as a result of the project, but through an Input-Output model estimating the impact of the project on Gross Regional Product and employment.

CBA Results

Scenario 1 (diversified cropping) generates higher economic benefits compared to scenario 2 (grains and hay), due to the higher returns from the horticultural production. Capital and ongoing costs are marginally higher for Scenario 2 due to a larger cropping area able to be irrigated. Headline CBA results are a Benefit Cost Ratio of 0.72 for Scenario 1, compared to 0.47 for Scenario 2.

Economic Contribution Analysis Results

The impacts of the project on both employment and Gross Regional Product are summarised below, as estimated on an annual basis over the 50-years of the economic analysis.

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Table 1: Economic Contribution Results

	Employment (FTEs)	GRP ($m)
Scenario 1 – Diversified Cropping		
Construction and Ongoing Maintenance	61	$8.0m
Agriculture	429	$64.9m
Total	**490**	**$72.8m**
Scenario 2 – Grains and Hay		
Construction and Ongoing Maintenance	66	$8.8m
Agriculture	211	$20.9m
Total	**277**	**$29.7m**

Source: Peritus Ag and NineSquared

Conclusion

The economic analysis builds on the earlier conclusion of the need for a significant regional investment project and the suitability of the Hughenden Irrigation Project in this respect. This project has the potential to dramatically reshape the Hughenden and wider Flinders Shire communities. Population and employment have been declining in the region for an extended period, with forecasts showing a continuation of the decline. This project has the potential to not only inject employment into the local community provide a significant regional economic well into the future.

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1. Economic Background

1.1 Project Area

The project is located in the Hughenden region, in the Flinders Shire, Queensland. The Flinders Shire covers a total area of 41,632km^2, with Hughenden being the main business centre, situated on the banks of the Flinders River.

The town of Hughenden has a population of 1,136 as of the 2016 census. There are two schools in the Town – Hughenden State School, which caters for approximately 100 primary and secondary students, and St Francis catholic primary school. Hughenden Hospital provides inpatient, outpatient, 24-hour emergency, and general practice care for the town. For more complex health conditions, the main referring hospital is Townsville Hospital, almost 400km to the east.

While the project is expected to have direct impacts primarily on the town of Hughenden itself, indirect and flow-on impacts to the remainder of the Flinders Shire are to be expected. As such, the Local Government Area (LGA) of Flinders has been adopted as the study area. Figure 1 below shows the positioning of the study area (yellow shaded area).

Figure 1: Study Area – Flinders LGA

Source: Google Maps (2019).

1.2 Economics Overview

The economy of the area is driven by four major elements:

1. Primary production and export, with mining an important secondary industry
2. Services to and associated with transport, for example the Townsville – Mt Isa rail and road transport such as the Flinders Highway
3. Services to holiday and other visitors

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4. Supporting industries to primary producers and mines, as well as supporting services for the wider shire (for example, Local Government administration, health, education, and hospitality).

The area is geared to produce relatively large volumes of primary exports and has some supplementary and outside income coming into it from rail and road servicing and offices and visitors. It has a limited local servicing structure. But otherwise, it imports the bulk of the goods and services it requires from outside its boundaries from the rest of Australia and overseas.

1.3 Industry

1.3.1 Employment

Table 2 outlines industries of employment in 2011 and 2016 within Flinders Shire. Notably, the total number of people employed across all industries decreased over the period by more than 11%. The largest change in share of employment was seen in the transport industry. This percentage share is likely to have declined further since 2016 due to due to Aurizon cutting more than two thirds of its workforce in the Shire since this data was derived. The table also shows that the agriculture, forestry and fishing industry is the largest employer in Flinders Shire, with over one third of the population employed in this industry.

Table 2: Share of employment in Hughenden, by industry.

Industry	2011 (% Share)	2016 (% Share)
Agriculture, Forestry and Fishing	35.3	35.2
Public administration and safety	11.4	12.7
Transport, Postal and Warehousing	11.9	8.2
Retail trade	8	7
Education and training	5.8	5.5
Accommodation and food services	5	4.9
Health care and social assistance	4.1	4.7
Construction	5.9	4.3
Administrative and support services	1.3	2
Electricity, Gas, Water & Waste Services	0.9	1.5
Manufacturing	2.7	1.4
Wholesale trade	0.8	1
Mining	1	0.9
Professional Scientific & Technical Services	0.7	0.9
Financial and insurance services	1	0.6
Rental, Hiring, & Real Estate Services	0.9	0.4
Arts and recreation services	0.3	0.4
Other services	2.1	2.5
Total persons employed (no.)	**898 (total no.)**	**795 (total no.)**

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Source: Australian Bureau of Statistics – Flinders Shire

1.3.2 Agricultural Production

Beef cattle production is the major industry in Flinders Shire, with a gross value of production of $73.5 million[1]. Agriculture is the largest industry within the shire, making up around 35% of employment.

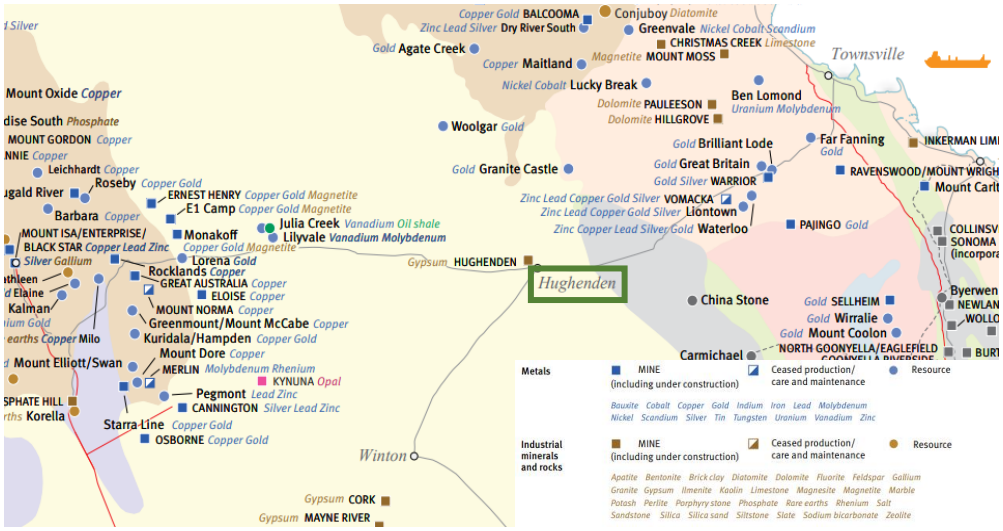
Historically, Flinders Shire also had a major sheep industry. Estimates in 1993 had 443,137 sheep in the shire[2], however the sheep industry has since mostly disappeared.

The sheep industry in Flinders Shire has largely been replaced by cattle. In 1993 the number of cattle in the shire was 227,071, which has now increased to 293,000[3]. The cattle industry is more land-intensive and is likely to have contributed to the decrease in agricultural employment in Flinders Shire, alongside other factors such as the decline in the sheep industry. Investing in alternative crops could yield more employment and increase productivity.

1.3.3 Mining

Mining is not a major industry of direct employment in Flinders Shire, as only 0.9% of residents were classified as employed by the mining industry in 2016. However, due to a significant number of mines located in the area surrounding the Shire (see Figure 2), mining drives employment in supporting industries within Flinders such as transport.

Figure 2: Mining industry in Hughenden and surrounds.



Source: Department of Natural Resources and Mines (2016)[4].

[1] Mount Isa to Townsville Economics Development Zone. (2018). *Flinders Shire.* Retrieved online from http://www.mitez.com.au/ourregion/flinders-shire/

[2] Australian Bureau of Statistics. (1993). *Agriculture statistics – small area data: Queensland*. Retrieved online from http://www.ausstats.abs.gov.au/ausstats/free.nsf/0/83FE12045DC1FD45CA257225000739CB/$File/71203_9293.pdf

[3] Department of agriculture, fisheries and forestry. (2012). Evaluating the viability of a northern outback Queensland meat processing facility. Available from http://www.northbeef.com.au/downloads/NQ_abattoir-study.pdf

[4] Department of Natural Resources and Mines. (2016). Queensland's mining and petroleum industry overview. Available from https://www.dnrm.qld.gov.au/__data/assets/pdf_file/0004/238072/queensland-mining-petroleum-overview.pdf

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1.3.4 Business

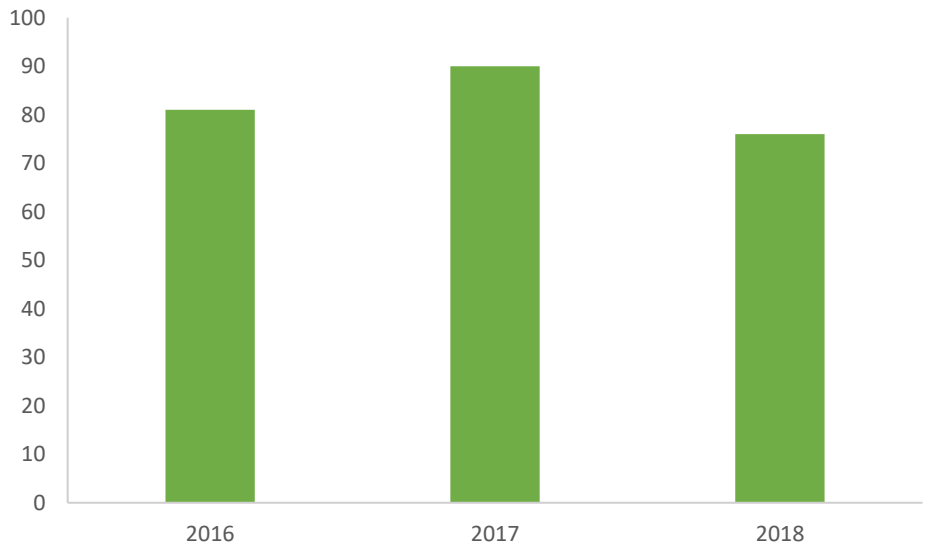
As of June 2018, there were 186 registered businesses in the Flinders Local Government Area. This is down from 199 businesses in June 2017, a reduction of approximately 6.5%.

Of these 186 businesses, approximately 41% were registered as businesses in the Agriculture, Forestry, and Fishing Industry, equating to 76 businesses; the largest out of all business categories.

Figure 3, below, displays how the number of businesses in this category changed over the period 2016 to 2018. As seen in the figure, number of businesses in this sector increased from 2016 to 2017, however fell again by approximately 16% in 2018. Most of these businesses are small non-employing businesses with an annual turnover of less than $200k.

The region has existing potential to sustain high-value agricultural production, with three of the employing agricultural businesses in 2018 reporting annual turnover of between $2 million and $5 million. Hence, it is clear that if investment in the region is able to stimulate productivity and growth in the agricultural sector, allowing the currently non-employing businesses to expand and hire new workers, then there is the potential for businesses in the region to experience large increases in output and economic benefit.

Figure 3: Total businesses in the Agriculture, Forestry, and Fishing category, Flinders LGA, 2016-2018.



Source: Australian Bureau of Statistics, 8165.0 Counts of Australian Businesses, including Entries and Exits, Jun 2014 to Jun 2018.

1.3.5 Services to Transport

Hughenden's location in northern Queensland has made it a large part of the regional freight network. As of 2016, 8.2% of workers in Flinders Shire were part of the transport industry. Hughenden services the Townsville to Mount Isa rail link, which includes the Inlander long distance passenger service as well as freight. Hughenden's location on the cross section of the Flinders Highway and Kennedy Developmental road places it as a major thoroughfare for road freight, having linkages to Cairns, Townsville, Mt Isa and the Northern territory.

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However, since 2016 there has been a further reduction in transport employment in Hughenden. Specifically, Aurizon shed 25 positions in Hughenden in 2017 which led to a corresponding reduction in economic activity[5].

1.4 Local and Visitor Services

Hughenden Aerodrome

Hughenden aerodrome allows residents to be connected to larger regional centres via air travel. REX airlines flies from Townsville to Mount Isa and return, with a stopover in Hughenden, every Monday, Wednesday and Friday.

Schools

Flinders Shire is home to four different schools offering primary education, two of which are located in Hughenden. Secondary education is available at Hughenden State School, which also offers traineeship opportunities, or by distance education. Hughenden is also home to a kindergarten and early childhood centre.

Health

The Hughenden Health Service provides inpatient, outpatient and emergency care services at all times. Visiting services are also provided, giving residents access to dental, mental health, women's health and allied health care (Queensland Health, 2019).

Diggers Entertainment Centre

Diggers entertainment centre functions as a community hall, sporting facility and conference centre in Hughenden. The hall has capacity to easily accommodate 650 guests.

Flinders Discovery Centre

Flinders Discovery Centre is the main visitor information centre located in Hughenden. This facility also houses a dinosaur display and museum that is part of the region's history.

Visitor Accommodation

Visitors to Hughenden have access to a variety of accommodation. Hughenden has one hotel, one hotel/motel, two motels, and one caravan park.

1.5 Relative Disadvantage

According to the Australian Bureau of Statistics *Socio-Economic Indexes for Areas (SEIFA),* in terms of socio-economic disadvantage, the Flinders Shire is in the 43rd percentile of advantage compared to other local government areas in Australia. In Queensland specifically, it ranks marginally higher, being in the 61st percentile; this is due to a relatively larger proportion of disadvantaged areas being located in Queensland.

[5] Queensland Country Life, *Aurizon job losses to hit Hughenden hard*, 7 Dec 2016 https://www.queenslandcountrylife.com.au/story/4340887/a-dark-day-for-hughenden-mayor/

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In other words, Flinders shire exhibits less disadvantage than 61% of Local Government areas in Queensland and 43% of Local Government Areas in Australia. However, this index is a broad measurement of relative socio-economic advantage and disadvantage in terms of "people's access to material and social resources, and their ability to participate in society". It does not provide a complete indication of a region's economic prospects into the future, which has a bearing on future social amenity.

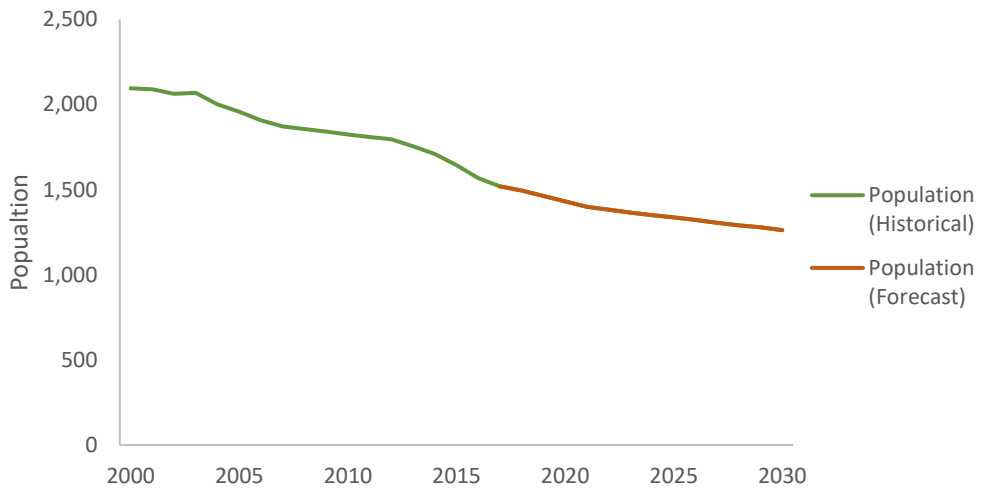
1.6 Future Trends

As is the case in most rural areas, urban drift poses a significant threat to Flinders Shire. Regional development can mitigate some of these effects.

1.6.1 Population and Employment Decline

Since peaking at over 3,000 residents during the 1960s, the population of Flinders Shire has experienced significant decline. In 2000 the population of Flinders Shire was 2,095, which declined to 1,499 residents in 2018. Without regional investment the population of Flinders Shire is projected to decline further to 1,262 residents by 2031, a decrease of approximately 17% (see Figure 4). This decline in population is forecast to continue to 2041 with estimates at 1,149.

Figure 4: Population in Flinders Shire.



Source: Historical Data – ABS, 2019; Forecast Population – QGSO, 2018.

The significance of this decline in the context of the wider Queensland community should not be underestimated. When the 78 LGAs in Queensland are ranked according to their population growth over the 20 years from 1998-2018, Flinders has the fourth highest rate of decline, with a total decline of 29% over the period (see Table 3). Further, over the last five years, Flinders has exhibited an average rate of population decline of 3.0% per year, while wider Queensland has seen an increase in population of 1.6% per year on average.

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Table 3: Queensland Local Government Areas - Top 10 ranked by population decline.

Rank	Local Government Area	% Growth in population, 1998-2018
1	Barcoo	-42.1%
2	Quilpie	-34.2%
3	Bulloo	-32.0%
4	Flinders	-29.1%
5	Paroo	-29.1%
6	Winton	-28.4%
7	Richmond	-27.3%
8	McKinlay	-27.1%
9	Boulia	-23.6%
10	Blackall-Tambo	-23.0%

Source: Queensland Government Statistician's Office, 2018.[6]

Another factor exacerbating the risk to the future of Flinders Shire is the ageing population. In 2017 the median age of the Flinders population was 43.1 years, which is above the Australian average of 37.5 years.

While the unemployment rate within Flinders Shire is relatively low, this is driven by population decline, rather than representative of a high level of employment opportunities in the region. The number of people in employment declined by 11.5% between 2011 and 2016 (equating to approximately 103 jobs), however over the same period the size of the labour force also declined by 11.5%.

As the decline in the labour force seems primarily driven by the decline in population, this may indicate that as people leave their employment in Flinders Shire (either voluntarily or after redundancy), they migrate to an area with better employment prospects, removing them from the Flinders Shire labour force (allowing the unemployment rate to remain relatively low). There is a strong downward trend in the employment prospects in the town, with growth rate of approximately -2% per year (i.e. a decline).

[6] Queensland Government Statistician's Office. 2018. Estimated resident population by local government area (LGA), Queensland, 2008 to 2018p. Available from http://www.qgso.qld.gov.au/products/tables/erp-lga-qld/index.php

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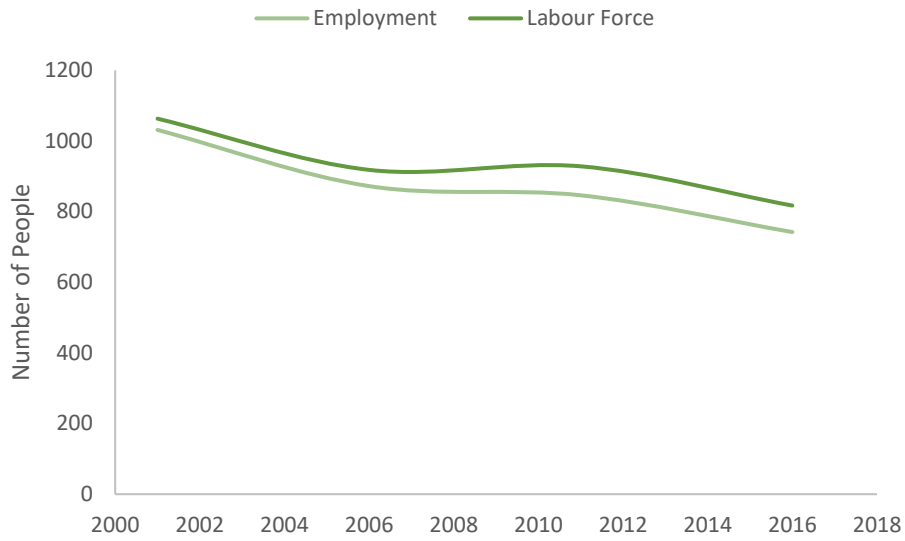
Figure 5: Employment and labour force trends, Flinders Shire.



Source: Australian Bureau of Statistics, Census Data.

Table 4 outlines the occupations of those employed in Flinders Shire as of the 2016 census. It is evident that the majority of employment is within agriculture (predominantly business owners who are classed as 'managers'), labouring and machinery operators and drivers.

Table 4: Occupations of those employed in the Flinders Shire.

Occupation	Percentage
Managers	32.2%
Labourers	18.5%
Machinery operators and drivers	10.2%
Clerical and administrative workers	9.1%
Technicians and trade workers	8.8%
Community and personal service workers	6.9%
Professionals	6.8%
Sales workers	5.0%
Other	1.3%

Source: ABS Data – Flinders Shire

1.6.2 Current/Recent Developments

There are a number of recent and current developments in Flinders Shire that demonstrate the positive effect of investment on boosting opportunities in the region. These have been outlined below.

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It is important to note that the current declining population and employment statistics capture the short term increases in employment in the construction sector that were experienced as a result of these projects. However, once these projects were/will be completed, it is expected that those contractors who relocated to Flinders Shire during the construction of the project will leave the Shire to seek new opportunities, further decreasing the population in the region. Additionally, some projects hired from within the region – for example, Kennedy Energy Park, which provided 30 jobs for locals. Once construction was completed, these locals were left jobless at least for a period. This highlights the importance of investing in projects which provide long-term job opportunities that encourage people to settle in Flinders Shire.

Hughenden Recreational Lake

More than $6 million has been dedicated towards the construction of Hughenden Recreational Lake. The lake will be 900 metres in length, and up to 400 metres wide and will provide opportunities to participate in aquatic activities, as well as a boat ramp, beach and playground area. This project is scheduled for completion by the end of 2019 and will include subcontracting local businesses where possible.

Kennedy Energy Park

Kennedy energy park is a utility-scale hybrid wind, solar and energy storage project, located just outside of Hughenden. This was a $160 million investment, completed in late 2018, that has the capacity to provide 60 MW of clean energy. An estimated 30 local residents were employed as labourers for the construction phase. Additionally, several local businesses were awarded subcontracts to assist in construction[7].

Overland Sun Farm

Completed in 2017, the overland sun farm has the capacity to provide 22.5 MW of clean energy. During construction the project provide employment and subcontracting opportunities.

1.6.3 Gross Regional Product

While estimates of the Gross Regional Product (GRP) for Flinders Shire specifically are not available, the Queensland Government Statistician's Office (QGSO) published data over the period from 2000-01 to 2010-11 which showed that the GRP for the North West region of Queensland (which Flinders is a part of) grew at 0.1 per year. This rate is significantly below the whole-of-Queensland rate, and the slowest growth rate of all regions (aside from the decline seen in the Central West) (see Table 5).

Table 5: Growth in Gross Regional Product, All regions, 2000-01 to 2010-11.

Rank	Region	GRP Growth, 2000-01 to 2010-11
1	Sunshine Coast	5.1%
2	Gold Coast	4.8%
3	Brisbane	4.7%
4	Mackay	4.6%

[7] Windlab. (2018). Kennedy Energy Park – Knowledge Sharing (FinClose report). Available from https://kennedyenergypark.com.au/wp-content/uploads/2018/02/Financial_close_report.pdf

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Rank	Region	GRP Growth, 2000-01 to 2010-11
5	Darling Downs	3.7%
6	Fitzroy	3.5%
7	Wide Bay-Burnett	3%
8	Northern	2.9%
9	West Moreton	2.6%
10	Far North	2.3%
11	South West	0.3%
12	North West	0.1%
13	Central West	-1.9%
	Queensland	**4.1%**

1.6.4 Prospects of Further Decline

Without significant regional development it is likely that Flinders Shire will experience further decline. Ongoing technological change and improvements in efficiency is likely to continue to gradually reduce the demand for labour-based jobs. Furthermore, the future prosperity of the region has a large dependence on local industry remaining in the area. For example, when Aurizon cut 25 jobs in Hughenden due to the loss of a contract it had a huge impact on the local economy. It caused the relocation of many families which is a significant ratio in a small community.

Increasing regional investment and creating more jobs in the area will be the only way to sustain Flinders Shire into the future.

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2. The Project

2.1 Options Analysis

Prior to the Preliminary Business Case being developed, an options analysis was undertaken to evaluate potential dam sites and sizes of dam. A range of dam configurations were reviewed. Engeny undertook an assessment of project's water yield, capital cost and ongoing cost. Financial and economic analyses were undertaken on the three preferred options. While each of the options generated a substantial benefit to the community, the cost of each option exceeded the direct benefits. Further, the financial requirement from either customers (irrigators) and/or the Government would be significant.

As a result of the options analysis process, it was viewed that the sites considered were not suitable due to the comparatively high capital cost compared to yield. This suggested that a different site would need to be identified if a dam of this size was to be built in the Hughenden region. This was the subject of further engineering assessment, which culminated in the Preferred Option, as discussed below.

Another key finding of this part of the study was that the region would be able to support a large irrigation scheme. Specifically, the region has the capacity to grow and there are appropriate conditions in terms of soil and temperature to produce a range of horticulture, grass and hay.

For more detail on the options analysis process, see the associated reporting from Engeny.

2.2 Preferred Option

While a preferred option was not identified during the Options Analysis stage, considerations for what the option should look like were defined. This led to revisions to location, design and scope by Engeny, including consultation with HIPCo.

The preferred option is a large integrated bulk and distribution irrigation project based on harvesting flows from the Flinders River. There are four components of the design:

Bulk infrastructure:

1. In-stream weir in the Flinders River
2. The diversion channel to allow the movement of water from the river into the new Saego Dam
3. The Saego Dam, a large off-stream storage to impound approved water flows from the river. The dam is designed as a rockfill embankment with clay core adjacent to the river, which makes use of the natural topography of surrounding basalt plateau to create a suitable off-stream water storage facility.

Distribution Infrastructure:

4. Distribution infrastructure – comprising pumps and irrigation channels - to divert water from the river downstream of the dam into new irrigation farms.

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Two scenarios of the preferred project have been developed and assessed in this chapter and throughout other parts of the Preliminary Business Case:

- Scenario 1:
  - Comprises each of the four infrastructure components outlined above
  - Designed to provide water for irrigation to 7,770 ha through a mix of medium and low priority water
  - Based on diversified cropping, comprising horticulture (avocadoes, mangoes, lemons and mandarins), grains and hay (sorghum, wheat, corn and rhodes grass hay), with the former requiring the medium priority irrigation water the latter relying on the low priority water
- Scenario 2:
  - Comprises each of the four infrastructure components as per Scenario 1, although the distribution infrastructure is more extensive due to larger areas of irrigated cropping
  - Designed to provide water for irrigation to 11,970 ha via low priority water
  - Based on broadacre cropping comprising grains and hay, specifically sorghum, wheat, corn and rhodes grass hay

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3. Approach

The economic merit of the project is an important consideration for the Preliminary Business Case. It brings together other elements of the Business Case such as the social impact evaluation, environmental analysis and financial analysis and places them in an economic context.

As an outcome of the economic analysis, the project will be assessed to determine whether the project is worthwhile pursuing for society as a whole. This is reviewed using two types of economic modelling:

1. **Cost-Benefit Analysis (CBA):** This assesses the costs and benefits to the community as a whole. This takes into account not just the costs of the project to the entity that builds it, but to all others involved, including the Hughenden community, the wider Flinders community, farmers, downstream communities and the environment. It attempts to quantify broader costs to the community which do not have a market price, such as the environmental impacts. Where these are unable to be quantified or monetised, they are discussed in qualitative terms.
2. **Economic Contribution Analysis:** This assesses the wider impacts to the community as a result of the project. Specifically, an Input-Output (IO) model was used to estimate the impact on Gross Regional Product (GRP) and employment directly and indirectly due to the delivery of the project.

The focus of this chapter and the following three chapters is the cost-benefit analysis. Section 7 covers the approach and results of the economic contribution analysis.

3.1 Key Assumptions

The economic analysis has been undertaken using a CBA. The CBA framework is based on an annual discounted cash flow model with an appraisal period of 50 years from the finalisation of capital investment, as per the Infrastructure Australia guidelines. A sensitivity analysis has been undertaken using a 30-year assessment based on the Building Queensland Guidelines. The analysis was undertaken through the following steps:

- Defining the “base case” against which the “project case” is then compared
- Identifying the costs and benefits that are expected moving from the base case to the project case
- Determining the analysis parameters, such as the base year for prices to calculate present dollar values
- Developing demand and supply changes associated with the move from the base case to the project case, which is informed by water availability forecasts from Engeny and agricultural estimates by Peritus Ag
- Quantifying the costs and benefits over the appraisal period
- Estimating the benefit cost ratio and net present value using discounted cash flow techniques
- Testing the sensitivity of various inputs.

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3.2 Base and project case

CBA compares the costs and benefits of the "project case" with a "do minimum" base case (i.e. the "business as usual" or "keep safe and operational" situation). For the purpose of this study, the base case does not include any water infrastructure being developed within the region. This means irrigation is not possible during the evaluation period.

The project case is defined as a "do something" option that reflects a proposed intervention, as described previously.

3.3 Price Year

The price year is the year in which the monetary values in the CBA are reported. The cost estimates for maintenance and capital costs have been conducted in 2019 dollars. Therefore, the price year for the economic appraisal is 2019. Where appropriate, all unit values were updated to 2019. All benefits and costs are valued in 2019 price terms (i.e. inflated to 2019 values or discounted back to 2019 values) using data sourced from the Australian Bureau of Statistics (ABS)[8]. The latest ABS Consumer Price Index figures are for September 2019.

3.4 Discount rate and appraisal period

Discount rates are the factors applied to future benefits and costs to place them on the same basis as today. The discount rate is used to calculate "present values". For the purpose of this report, a discount rate of 7 percent was used in line with the Infrastructure Australia and Building Queensland guidelines. Sensitivity testing is conducted using the 4 percent and 10 percent discount rate.

3.5 Quality Assurance Review

An internal quality assurance review was conducted on the economic analysis, including a review of the methodology, economic modelling, and outputs. The outcomes of this quality assurance review have been incorporated in this analysis.

3.6 Summary of key assumptions

The key parameters and assumptions used in the analysis are summarised in Table 6.

Table 6: Key assumptions

Item	Parameter / Assumption
Discount rate	The discount rate adopted in the analysis is 7 percent per annum (real) and is used to calculate present values. Sensitivity tests are undertaken at discount rates of 4 percent and 10 percent. These values are in accordance with guidance from Infrastructure Australia (IA). The economic discount rate differs from the discount rate used in the financial analysis. The economic discount rate represents the time value of money while the discount rate in the financial analysis represents the cost of borrowing and the cost of equity.

[8] Australian Bureau of Statistics, 2018, 'Consumer Price Index, Australia' Cat. No. 6401.0

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Item	Parameter / Assumption
Price year and inflation	All costs and benefits in the economic analysis are presented in 2019-real constant prices (i.e. excludes inflation).
Appraisal period	An analysis period of 50 years (operational) was adopted in line with IA Guidelines. A sensitivity test has been undertaken with an analysis period of 30 years (operational) in line with BQ Guidelines.
Timing	
Start year	2019 (price year)
Construction period	2022 - 2024
Opening year	2025
Dam full	2029
Finish year	2073

Source: NineSquared

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4. Benefits

4.1 Agricultural Production

The primary benefit associated with the Hughenden Irrigation Project is the increase in agricultural production associated with improved availability of water supply. Development of agriculture in the region has previously been constrained due to the variability of water supply. As such, the provision of more reliable access to water is expected to increase the potential for agriculture across a wide range of produce.

To help more accurately quantify and monetise the additional agricultural production, two separate pieces of analysis were undertaken. Engeny undertook an assessment on the expected availability of water over time, while Peritus Ag undertook various market assessments to determine which crops were likely to grow, the potential market for these crops and the associated revenues and expenses associated with the production of these crops within the Hughenden production window.

The subsections below detail the process and assumptions which underpin the quantification and monetisation of this benefit. For further details, see the respective reports from Engeny and Peritus Ag.

4.1.1 Water Reliability

The proposed project is expected to increase the availability of water to agriculture and would support both Medium Priority (MP) and Low Priority (LP) allocations. A breakdown of the availability is displayed in the table below.

Table 7: Agricultural water supply assumptions

	Medium Priority (GL)	Low Priority (GL)	Total Allocation (GL)
Mixed Cropping	30	40	70
Grazier Support	-	84	84

Source: Engeny

The availability of MP and LP allocations has been defined by Engeny based on historical rainfall. Specifically, rainfall for 121 years was reviewed to determine how many years water would be available at each priority. Based on their assessment, it was determined that medium reliability water would be available 90% of the time, with low priority water available 70% of the time where two priorities of water allocation exist. In the case of the grazier support option, water is available 80% of the time.

4.1.2 Quantification approach

To quantify and monetise the impact the additional water supply has on the agricultural industry, the gross margin of the additional production has been used. This value is used as an estimate of the value of additional production minus the cost of growing and maintaining the crops.

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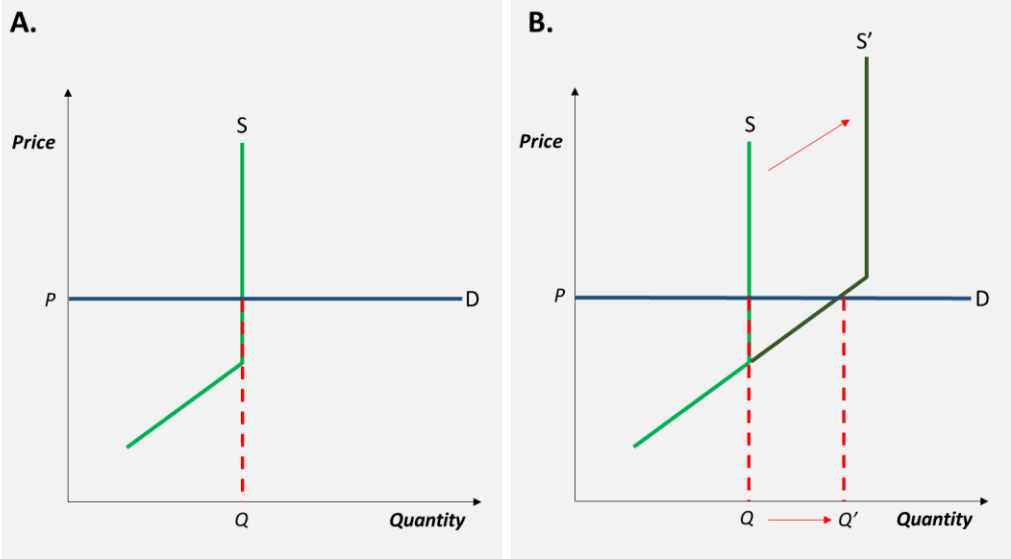
It is assumed that there is a vertical bend in the supply curve in the base case. That is, regardless of price, producers are unable to supply at the market efficient quantities due to the lack of available water. As such, the lack of water is viewed as an inhibiter to production. This is visualised in the figure below as S_1. Once the project is delivered, the barrier presented by a lack of reliable water is removed, shifting the supply curve to S_2. This allows for additional production at the prevailing market price.

Figure 6: Theoretical underpinnings of the economic analysis



Source: NineSquared

4.1.3 Crop Mix

Peritus Ag were engaged to undertake an assessment of which crops would be able to be developed if additional irrigation water was available in the Hughenden region. The purpose of this assessment in an economic context was to determine which crops would be able to be grown on the land associated with the project, the expected cost of production and the price specific to the region and timing of production.

A number of crop types were reviewed as part of the market analysis. After this assessment, two scenarios were reviewed in more detail:

1. Diversified cropping with a mix of horticulture, grains and hay
2. Grains and hay production only.

To inform the economic analysis, four sets of information were required for each scenario:

1. Volume of production
2. Gross margin of each crop, including the revenue and expenditure of production
3. Expected ramp-up
4. Availability of water over time.

The assumptions underpinning these components are detailed in the subsections below.

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4.1.3.1 Volume of Production

Peritus Ag undertook a review of the growing conditions within the region, including factors such as temperatures, soil type and rainfall amongst other factors. In parallel, a market assessment was undertaken to determine which crops would be suitable for production in the region. As a result of this assessment, a variety of crops were determined to be the most suitable for the region. These include:

- Avocado
- Mango
- Lemon
- Mandarin
- Sorghum
- Wheat
- Corn
- Rhodes Grass Hay.

Based on the availability of water, the associated reliability of the allocations, considerations of lot sizes and the conditions of the proposed site, two agricultural scenarios were provided by Peritus Ag. These are summarised in the table below.

Table 8: Volume of production by scenario

Crop Type	Scenario 1 *(Ha)*	Scenario 2 *(Ha)*
Avocado	900	0
Mango	600	0
Lemon	300	0
Mandarin	300	0
Rhodes Grass Hay	3,780	7,980
Sorghum	810	1,710
Corn	810	1,710
Wheat	270	570
Total production (Ha)	**7,770**	**11,970**
Total water required (Ml)	**73,200**	**91,200**

Source: Peritus Ag

Scenario 2 has a larger total area of production due to the lower water requirements of the hay and grain when compared to tree crops. However, these crops are typically of lower value than tree crops so these production scenarios should be considered in the context of their associated gross margins as discussed in the following section.

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4.1.3.2 Gross Margin

An important consideration when reviewing the chosen crop types is the volume of water and the associated priority of water required for production. While the horticulture crops are more profitable, more water is required for production. Further, they require a higher priority water. While the agronomic assessment found that the reliability would be sufficient for production, it is recommended that this is further market-tested as part of the Detailed Business Case.

Improved economic results would be generated by assuming all the production is high-value horticulture, however, it would be unrealistic to assume the region could immediately go from no high-value horticulture to an entire scheme of horticulture. Instead, it has been assumed that that there is a mix of broad-acre field crops which are less intensive and would not require the same level of experience and expertise.

The water requirements are displayed in the table below.

Table 9: Water requirements by crop

Crop Type	Water Required (Ha)	Water Priority
Avocado	16.0	Medium to High
Mango	10.0	Medium to High
Lemon	16.0	Medium to High
Mandarin	16.0	Medium to High
Rhodes Grass Hay	8.0	Low to Medium
Sorghum	7.0	Low to Medium
Corn	7.0	Low to Medium
Wheat	6.0	Low to Medium

Source: Peritus Ag

Market assessments were undertaken on the identified crops to determine the expected gross margins. The inputs to the gross margin analysis include the variable costs, unit outputs and farm gate returns. When combined, total costs per hectare and total revenue per hectare was determined specifically for the climate and production timing associated with the Hughenden region. The table below summaries the total cost per hectare, total revenue per hectare the resulting gross margin by crop type. Adjustments are then made to the gross margin to account for the price of water.

Table 10: Gross margin analysis

Crop Type	Total Cost/Ha ($)	Total Revenue/Ha ($)	Total Gross Margin ($/Ha)
Avocado	$29,848.00	$44,899.92	$15,051.92
Mango	$44,148.40	$50,194.20	$6,045.80
Lemon	$66,600.00	$122,655.00	$56,055.00

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Crop Type	Total Cost/Ha ($)	Total Revenue/Ha ($)	Total Gross Margin ($/Ha)
Mandarin	$51,000.00	$71,730.00	$20,730.00
Sorghum	$897.00	$2,600.00	$1,703.00
Wheat	$856.00	$2,275.00	$1,419.00
Corn	$1,443.00	$4,200.00	$2,757.00
Rhodes Grass Hay	$3,537.00	$5,920.00	$2,383.00

Source: Peritus Ag

Of note, the tree crops deliver larger gross margins when compared to grains and hay. This offsets the lower water requirements associated with hays and grains. While this suggests improved economic results may be generated if the entire water allocation was assigned to tree crops, this is not expected to result in practice. This is due to a number of factors, including:

- **Availability of water:** Based on the water reliability assessment undertaken by Engeny, there would not be sufficient medium priority water available to support 100% tree cropping
- **Diversification of crop type:** New irrigation farmers may not wish to produce a single crop type as this exposes them to production and market risk. To counter this, a diversified portfolio of crop types may be preferred. Hays and grains are able to be grown opportunistically or in periods where there is less water available. As such, it would be expected that at least a portion of the overall crop mix would be hay or grains.
- **Market:** The economic analysis would produce a higher total benefit if the crop with the largest gross margin was adopted in totality. In this case, lemons are assumed to deliver the largest gross margin of the crop types included in this analysis. However, if 100% of the land was allocated to lemons, the rise in supply would have a negative impact on pricing, lowering this gross margin. In extreme cases, it may be the case that the additional produce is unable to be sold due to the shock to supply.
- **Inability to control production:** In practice, the crop types which eventuate as a result of the increased availability of water is driven by the farmers who purchase the land and the associated water allocation. These farmers are then able to produce crops which suit their needs. As such, a diversified approach to crop types is more realistic than assuming a single, high-value crop.

Sensitivity testing has also been undertaken on these variables, primarily related to the potential downsides associated with reduced yield or lower market prices. These values are displayed in the table below. It is noted that reductions in yield are not expected for Mangos or Rhodes Grass Hay as these crops have a proven history of production in the region or in regions with similar conditions. As such, variations in yield are less likely and have not been included in the sensitivity analysis.

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Table 11: Crop value sensitivities

Crop Type	Main Case *(GM, $/Ha)*	10% Increased Costs *(GM, $/Ha)*	10% Increase in Return *(GM, $/Ha)*	10% Less Yield *(GM, $/Ha)*	20% Less Yield *(GM, $/Ha)*	10% Increase in Costs; 10% Less Yield *(GM, $/Ha)*
Avocado	$15,051.92	$12,067.12	$19,541.91	$10,561.93	$6,071.94	$7,577.13
Mango	$6,045.80	$1,630.96	$11,065.22	*N/A*	*N/A*	*N/A*
Lemon	$56,055.00	$49,395.00	$68,320.50	$43,789.50	$31,524.00	$37,129.50
Mandarin	$20,730.00	$15,630.00	$27,903.00	$13,557.00	$6,384.00	$8,457.00
Sorghum	$1,703.00	$1,613.30	$1,963.00	$1,443.00	$1,183.00	$1,353.30
Wheat	$1,419.00	$1,333.40	$1,646.50	$1,191.50	$964.00	$1,105.90
Corn	$2,757.00	$2,612.70	$3,177.00	$2,337.00	$1,917.00	$2,192.70
Rhodes Grass Hay	$2,383.00	$2,029.30	$2,975.00	*N/A*	*N/A*	*N/A*

Source: Peritus Ag

4.1.3.3 Expected Ramp-Up

Crop ramp-up is an important consideration in the economic analysis. Tree crops typically take longer to produce market quality produce, whereas grains and hay are assumed to make a return more readily. To account for this, tree crops have a longer ramp-up period; specifically, no production is realised for the first four years, with production then ramp-up to full production in year 10. Grains and hay are assumed to produce from the first year at 25%, and in full from year 4. This is displayed in the table below.

Table 12: Ramp-up by crop type

Crop Type	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Avocado	0%	0%	0%	0%	17%	33%	50%	67%	83%	100%
Mango	0%	0%	0%	0%	17%	33%	50%	67%	83%	100%
Lemon	0%	0%	0%	0%	17%	33%	50%	67%	83%	100%
Mandarin	0%	0%	0%	0%	17%	33%	50%	67%	83%	100%
Rhodes Grass Hay	25%	50%	75%	100%	100%	100%	100%	100%	100%	100%
Sorghum	25%	50%	75%	100%	100%	100%	100%	100%	100%	100%
Corn	25%	50%	75%	100%	100%	100%	100%	100%	100%	100%

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Crop Type	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Wheat	25%	50%	75%	100%	100%	100%	100%	100%	100%	100%

Source: Peritus Ag

4.1.3.4 Water Availability

While the dam is expected to be able to provide up to 70GL per annum in Scenario 1 and 84 GL per annum in Scenario 2, it is not realistic that this will be available each year. To account for the expected rainfall in the region and the potential for distribution losses, Engeny have estimated how much water will be available each year by water reliability.

Table 13: Water availability by scenario

Crop Type	Scenario 1 *(Ha)*	Scenario 2 *(Ha)*
MP	90%	-
LP	70%	80%

Source: Engeny

4.1.4 First filling of the Dam

Predicting the time it takes for the dam to be full is difficult due to the unpredictable nature of rainfall. To account for this, a conservative assumption has been made that the dam will take four years to fill. During the fill period, production is assumed to align to the proportion that the dam is full. That is, the dam will be 25% full in year 1, increasing to 100% in year four, with the proportions aligning to the grain ramp up.

4.1.5 Incorporation in the CBA

The gross margin of production is combined with the volume of production, the ramp-up period and availability of water over time to determine the expected annual agricultural benefit. This is undertaken for both cropping scenarios using the assumptions detailed in the sub-sections above.

Below is an example of how the information is incorporated in the cost-benefit analysis. The formula to calculate the benefit in a single year is:

$$Benefit_{Year} = Volume_i \times GM_i \times RampUp_i \times Availability_i \times DamFill_i$$

Where:

- $Volume_I$ = The maximum production volume of crop i
- GM_i = The gross margin of crop i
- $RampUp_i$ = The ramp up of crop I in the respective year
- $Availability_i$ = The availability of water of crop I in the respective year
- $DamFill_i$ = The ramp-up period associated with the first filling of the dam (i.e. how full the dam is in each year).

Using avocado production in 2030, the formula is as follows:

$$Benefit_{Avocado,2030} = 900 \times \$15{,}051.92 \times 33\% \times 90\% \times 100\%$$

$$Benefit_{Avocado,2030} = \$4{,}023{,}378.22$$

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4.2 Recreational Impacts

In addition to the value associated with increased water availability, dams have the potential to provide tourism benefits to visitors and the local community. For example, Lake Tinaroo has an estimated 500,000 visitors per year (Carmody & Prideaux, 2011). The potential for tourism induced benefits in Hughenden is heightened due to the potential for a link between this project and the Hughenden Recreational Lake.

To quantify this impact, a literature review was undertaken in place of a detailed tourism study. Since visitor numbers were not estimates as part of this assessment, methods which relied on other variables were preferred. Specifically, the recreational benefit was estimated based on the size of the dam. A study by ACIL Tasmin for the Economic Regulation Authority (ACIL Tasman, 2006) reviewed the recreational value associated with dams. As part of this assessment, the assessment of two dams were reviewed to value their recreational benefit per kilolitre of dam capacity. These values were escalated to 2019 dollars using CPI, with the original and escalated figures presented in the table below.

Table 14: Key assumptions

Dam	Value in 2015 dollars *($ / KL)*	Value in 2019 dollars *($ / KL)*
Logue Brook	0.91	0.98
Waroona Dam	0.98	1.05
Average	**-**	**1.01**

Source: NineSquared

The average value is then combined with the average irrigation supply volume of 84,000 ML provided by Engeny to monetise the economic benefit associated with recreation per annum.

It should be noted that a specific capital allowance for recreational or tourism infrastructure has not been allocated. In practice, there may be additional capital and operating costs which have not been quantified in this analysis. However, when compared to other North Queensland dam and irrigation projects, the absolute value of this benefit is minimal. It is recommended that an assessment of potential tourism and recreation at the dam site be investigated as part of the Detailed Business Case, although it is unlikely to change the conclusion in terms of the relative level of overall economic benefits. Further, the costs associated with delivering and maintaining recreation facilities should be estimated and included in the capital cost allocation.

4.3 Qualitative impacts

There is the potential for other impacts, both positive and negative, to arise as a result of the project which have not been quantified as part of the economic analysis. These include:

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- **Downstream environmental impacts:** Dams result in alterations to the river flow downstream of the site. Such alterations can impact on these downstream ecosystems and farming activities, which have evolved based on historic timings and quantities of water flow. For instance, under certain river flow situations, there may be the potential to impact downstream prawn farming – in reducing the water flow to these farms, the quantity of the prawns that can be grown and sold decreases, potentially resulting in negative impacts to these farming activities.

  While these environmental impacts are potentially material, efforts would be made throughout the design stages to mitigate any negative effects on the environment. Regardless, this is an important factor to be considered in the Detailed Business Case when water allocations are being sought.

- **Upstream environmental impacts:** As well as these downstream environmental impacts, dams can also have upstream impacts. In particular, the dam wall itself acts as a barrier that blocks movement of migratory river animals. This can have large impacts on some species as it effectively separates spawning habitats and rearing habitats. Additionally, dam construction limits the flow upstream of the dam, which has implications for factors such as oxygen levels, temperature, and chemical composition (International Rivers, n.d.).

  Again, while these environmental impacts are potentially material, efforts would be made throughout the design stages to mitigate any negative effects on the environment. Hence, it is considered unlikely that any negative environmental impacts as a result of this scheme would eventuate.

- **Flood Immunity:** There is the potential that this dam could help increase the flood immunity of the local area, by impounding flood waters during times of severe weather, and allowing the water to be stored or diverted for other uses. However, it is considered unlikely that this dam will provide a large degree of flood immunity.

- **Global warming:** Recent scientific studies have indicated that reservoirs, particularly those in hot climates, are a source of greenhouse gas emissions, with as much as 4% of human-caused climate change caused by the methane in dams. This methane comes from the rotting of the vegetation and soils that are flooded when the dam is first filled. However, gaps in the research and a lack of detailed studies which can be used to quantify this impact in the economic analysis means that this has not been included (International Rivers, n.d.).

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5. Costs

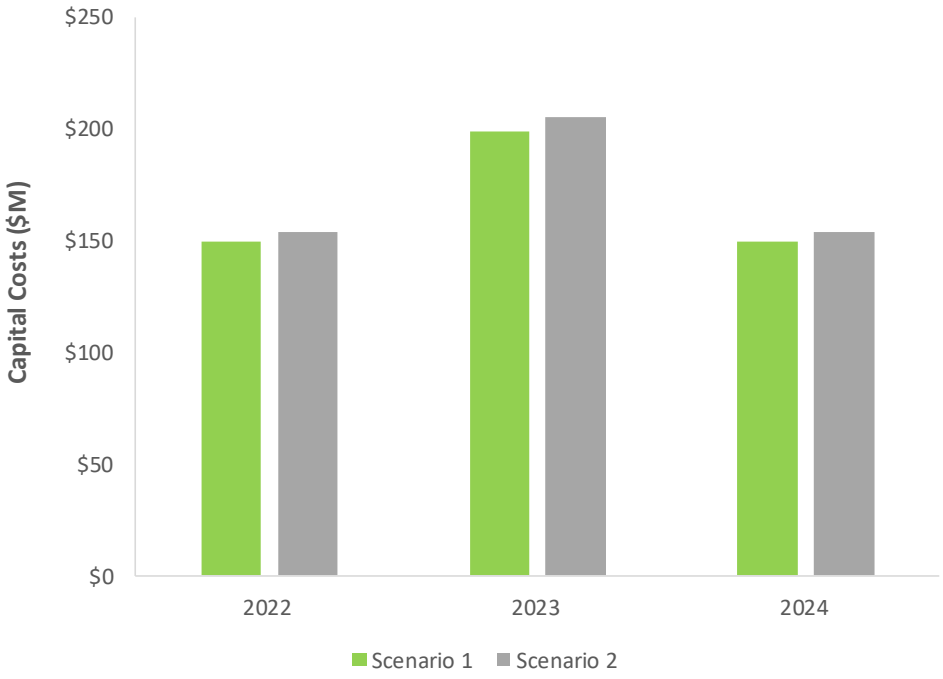
This section provides a summary of the costs included in the CBA. These costs include the capital costs associated with delivering the project along with the ongoing cost requirements such as routine and periodic maintenance. For the purposes of the CBA, all costs are expressed in real 2019 prices, i.e. excluding nominal escalations. Capital and ongoing cost estimates were provided for each of the project options.

5.1 Capital Costs

The direct costs of the project and risk assessment outcomes were provided by Engeny. Total cost of the Scenario 1 is estimated to be $368.2 million (non-risk adjusted, excluding sunk costs) in 2019 prices (excluding the effects of inflation). A deterministic risk adjustment has also been included. The allowance comprises 26 percent of the total project cost for scenario 1 of $498.3 million. For Scenario 2, the total project cost increases to $512.8 million due to the increase in irrigated land included in the project. This means that additional allowances for the distribution network must be made.

The capital spend period of the project starts in 2022 and continues till 2024, with the projects first year of operation being 2025. The figure below illustrates the capital expenditure during this period, with 40 percent of the total capital costs being incurred in 2023 in both scenarios.

Figure 7: Capital cost profile



Source: Engeny

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Table 15 summarises the economic costs that are included in the CBA calculation, noting that scenario 2 costs are higher because the area of irrigated land is larger. This requires additional distribution infrastructure which attracts a higher capital cost. The other cost components, namely the dam structure, the diversion channel and the in-stream weir, require the same level of capital expenditure between each scenario.

Table 15: Capital costs (discounted, undiscounted) – Scenario 1 and 2

Cost types	Undiscounted ($m)	Discounted ($m)
Scenario 1	$498.3m	$380.7m
Scenario 2	$512.8m	$391.8m

Source: Engeny and NineSquared

5.2 Ongoing Costs

On-going costs such as maintenance costs have been provided by Engeny and included in the economic analysis. These include costs which are incurred at various intervals over the evaluation period.

The table below summarises the ongoing costs once the dam is installed. As with the capital costs, Scenario 2 attracts higher ongoing costs due to increased area of irrigated land. Since there is more irrigated land, the cost associated with irrigation channels and the ongoing use of pumps leads to a higher annual ongoing cost.

Table 16: Ongoing Costs

Cost types	Undiscounted ($m)	Discounted ($m)
Scenario 1	$195.5m	$38.5m
Scenario 2	$245.3m	$48.3m

Source: Engeny and NineSquared

5.3 Sustaining Capital

Engeny identified that sustaining capital would be required for the pump stations, including the replacement of mechanical and electrical components, are summarised in the table below in real terms. This cost is expected to be incurred 25 years after the development of the project.

The table below summarises the sustaining capital once the dam is installed.

Table 17: Sustaining Capital

Cost types	Undiscounted ($m)	Discounted ($m)
Scenarios 1 & 2	$3.3m	$0.4m

Source: Engeny and NineSquared

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5.4 On-Farm Costs

It has been assumed that on-farm costs would be incurred by farmers in the first year of operations. For the purpose of this assessment, it has been assumed that the cost is $12,000 per hectare for horticulture only. These costs include:

- Land preparation and levelling
- Irrigation
- Cost of trees landed
- Labour for planting
- Fertiliser and sprays
- Tree guards.

The table below summarises the on-farm costs once the dam is installed.

Table 18: On-Farm Costs

Cost types	Undiscounted ($m)	Discounted ($m)
Scenario 1	$25.2m	$16.8m
Scenario 2	$0.0m	$0.0m

Source: Peritus Ag and NineSquared

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6. Cost Benefit Analysis Results

6.1 Results – Scenario 1

6.1.1 Disaggregated Results

The details of the costs and benefits identified in the CBA for Scenario 1 are summarised in Table 19. The project is assumed to open in 2025 and the benefits will accrue for a 50-year period of operations to 2074. This scenario generates higher economic benefits when compared to scenario 2 due to the gross margin of the horticulture. As the results show, the additional water requirements for the high-value cropping is overcome by the higher gross margin.

As discussed earlier, the economic results would be further improved if a higher share of production was allocated to high-value horticulture rather than grains and hay. However, this would also increase the risk associated with benefit realisation given the unproven nature of these crop types in the Hughenden region.

For the next stage of analysis, the assessment of a program of cropping trials may need to be considered to mitigate the risk that these benefits don't fully eventuate. Further, market testing as to which crops producers would be willing to grow in the region is recommended in the next stage of project assessment.

Table 19: Disaggregated CBA results, undiscounted and 7% discount rate – Scenario 1

CBA results	Undiscounted ($m)	Discounted ($m)	%
Capital costs	$498.3	$380.7	87.2%
Ongoing costs (including on-farm costs, sustaining capital and maintenance)	$224.0	$55.7	12.8%
Total costs	**$722.3**	**$436.3**	
Agricultural Production	$1,993.1	$303.7	96.3%
Leisure Visits	$35.5	$7.0	2.2%
Residual Value	$186.9	$4.5	1.4%
Total benefits	**$2,215.5**	**$315.2**	
BCR		**0.72**	
NPV ($m)		**-$121.2**	

Source: NineSquared

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6.1.2 Sensitivity Analysis

Different outcomes can result from different behavioural response by the community and changes in exogenous issues such as environmental concerns and the state of the economy. Consequently, the robustness of the economic analysis results is assessed through a series of sensitivity tests. A summary of the sensitivity testing results is shown in Table 20.

Table 20: Sensitivity analysis results – Scenario 1

	Sensitivity test	BCR	Change in BCR (%)	NPV ($m)	Change in NPV (%)
	Main Case	**0.72**		**-$121.2**	
1	Discount rate 4%	1.26	74%	134.0	211%
2	Discount rate 6%	0.86	19%	-64.5	47%
3	Discount rate 10%	0.45	-37%	-207.1	-71%
4	Capital costs +20%	0.61	-15%	-197.3	-63%
5	Capital costs -20%	0.87	21%	-45.0	63%
6	Operational costs +20%	0.70	-2%	-132.3	-9%
7	Operational costs -20%	0.74	3%	-110.0	9%
8	Benefits +20%	0.87	20%	-58.1	52%
9	Benefits -20%	0.58	-20%	-184.2	-52%
10	10% increase in farming costs	0.59	-19%	-180.7	-49%
11	10% increase in farm gate return (revenue)	0.93	29%	-30.9	75%
12	10% less yield	0.59	-19%	-180.6	-49%
13	20% less yield	0.45	-38%	-240.0	-98%
14	10% increase in farming costs, 10% less yield	0.50	-30%	-216.9	-79%
15	30-year evaluation	0.68	-6%	-137.8	-14%

Source: NineSquared

6.2 Results – Scenario 2

6.2.1 Disaggregated Results

The details of the costs and benefits identified in the CBA for Scenario 2 are summarised in Table 21. The project is assumed to open in 2025 and the benefits will accrue for a 50-year period of operations to 2074. This scenario generates lower economic benefits when compared to scenario 1 due to the reliance on lower gross-margin production.

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Table 21: Disaggregated CBA results, undiscounted and 7% discount rate – Scenario 2

CBA results	Undiscounted ($m)	Discounted ($m)	%
Capital costs	$512.8	$391.8	89.0%
Ongoing costs (incremental)	$248.5	$48.7	11.0%
Total costs	**$761.3**	**$440.4**	
Agricultural Production	$1,052.3	$192.7	93.6%
Leisure Visits	$42.6	$8.4	4.1%
Residual Value	$196.3	$4.8	2.3%
Total benefits	**$1,291.2**	**$205.9**	
BCR		0.47	
NPV ($m)		-$234.5	

Source: NineSquared

6.2.2 Sensitivity Analysis

Different outcomes can result from different behavioural response by the community and changes in exogenous issues such as environmental concerns and the state of the economy. Consequently, the robustness of the economic analysis results is assessed through a series of sensitivity tests. A summary of the sensitivity testing results is shown in Table 22.

Table 22: Sensitivity analysis results – Scenario 2

	Sensitivity test	BCR	Change in BCR (%)	NPV ($m)	Change in NPV (%)
	Main Case	**0.47**		**-$234.5**	
1	Discount rate 4%	0.75	61%	-130.3	44%
2	Discount rate 6%	0.54	16%	-213.4	9%
3	Discount rate 10%	0.32	-31%	-259.0	-10%
4	Capital costs +20%	0.40	-15%	-312.9	-33%
5	Capital costs -20%	0.57	22%	-156.2	33%
6	Operational costs +20%	0.46	-2%	-244.3	-4%
7	Operational costs -20%	0.48	2%	-224.8	4%
8	Benefits +20%	0.56	20%	-193.4	18%
9	Benefits -20%	0.37	-20%	-275.7	-18%

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	Sensitivity test	BCR	Change in BCR (%)	NPV ($m)	Change in NPV (%)
10	10% increase in farming costs	0.41	-11%	-257.8	-10%
11	10% increase in farm gate return (revenue)	0.56	21%	-191.8	18%
12	10% less yield	0.45	-4%	-243.7	-4%
13	20% less yield	0.43	-9%	-252.9	-8%
14	10% increase in farming costs, 10% less yield	0.44	-6%	-246.9	-5%
15	30-year evaluation	0.48	3%	-226.6	3%

Source: NineSquared

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7. Economic Impact Assessment

7.1 Construction and Ongoing Maintenance

7.1.1 Methodology

To determine the economic impact of the proposed community, an input-output analysis was undertaken. Input-output is a useful economic modelling tool for analysing and reporting the industrial structure of an economy using economic multipliers. Specifically, sectors of the modern economy are interdependent – that relating to the supply of use of projects - and the input-output tool attempts to capture these relationships. This tool is widely used for assessing the impact of policy changes or infrastructure development.

However, there are several limitations associated with input-output modelling, or multiplier analyses in general. The primary limitation with multiplier analyses is that there is the potential to overstate the economic importance of specific sectoral or regional activities. This is due to the likely factor that, if aggregated, they would sum to more than the total for the Australian economy. Further, multiplier analyses fail to consider the opportunity cost of both spending measures and the alternative uses of resources.

Despite these limitations, input-output was viewed as the most appropriate economic tool at this stage of the analysis. While this type of modelling has the potential to overstate the impact of an infrastructure project, there are two primary reasons why the this may not be the case for this specific project:

- **A regional assessment has been undertaken:** Typically input-output analysis is conducted on the state or national level. At this level, impacts have the potential to be overstated as 'crowding out' of investment would occur, particularly for larger projects. Crowding out implies that the increased government involvement in a sector of the market affects the remainder of the market, either on the supply or demand side of the market. Further, the incremental nature of input-output modelling is often debated as this investment may have occurred elsewhere, or another project may utilise the same resources. At a regional level however, the potential for crowding out is diminished due to the lack of alternative investments in the region.
- **Structural changes are not considered:** Input-output analysis makes a simplifying assumption that the structure of the economy does not shift once investment occurs. If industries are not well defined within a region and an investment occurs which leads to a leakage, that leakage will remain once the project is delivered. For small projects in major locations this is appropriate as the project itself is not large enough to shift the underlying structure of an economy. However, in this case there is the potential for industries to shift and the underlying structure of the economy to change as a response to the project. By way of a simple example, the increase in agricultural land may present equipment and machinery providers an opportunity to open a store in the region, which would further improve accessibility for other farmers.

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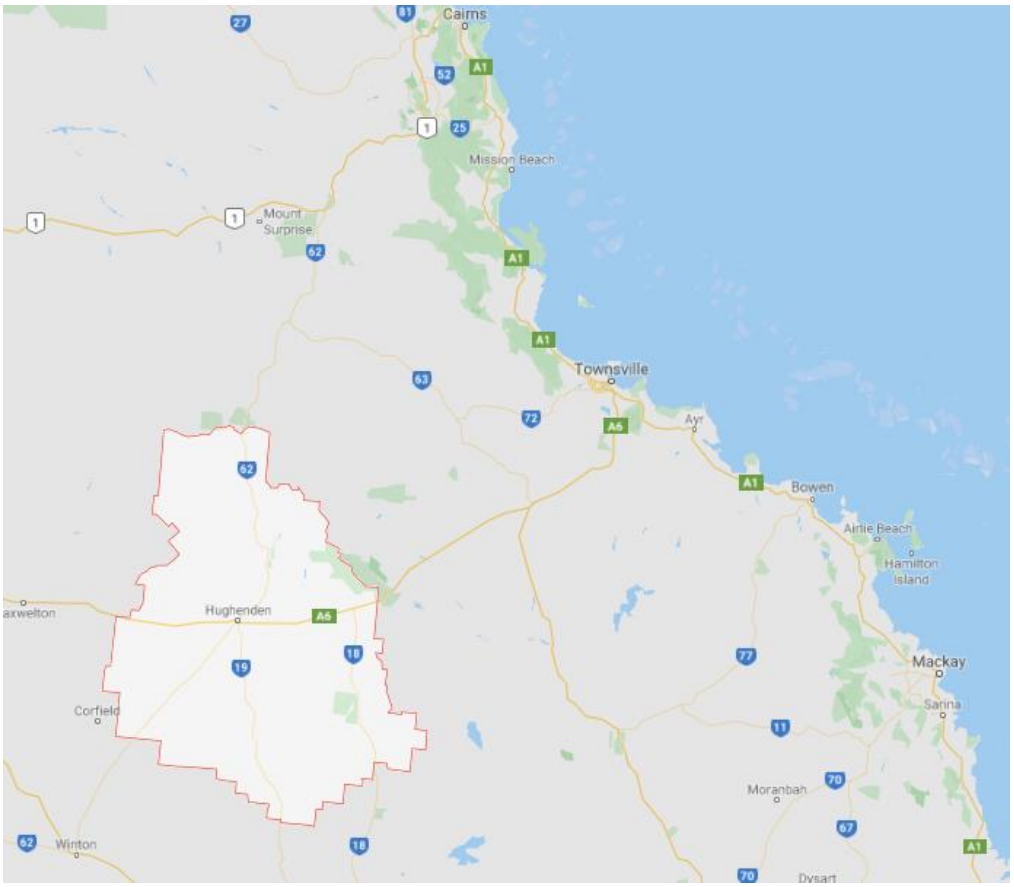
For the Hughenden Irrigation Project, regional multipliers have been adopted from the Economic Impact Analysis Tool (EIAT) produced by the Flinders University as part of the Australian Urban Research Infrastructure Network (AURIN) Workbench. The region used to capture the impacts of employment and Gross Regional Product (GRP) is the Flinders Shire, as shown in the figure below. This means that any impact which is expected to remain within this region is quantified, with any impacts outside of this assumed to be a leakage to other regions.

Figure 8: Study Area – Flinders LGA



Source: Google Maps

7.1.2 Employment

Multipliers for direct and indirect employment were sourced from EIAT. These multipliers were applied to both construction and ongoing costs to determine the total impact on employment. The multipliers used are displayed in the table below. The implied multiplier is a function of the indirect and the direct multiplier. Using the construction multiplier as an example, indirect impacts add an additional 69% to the direct construction impact.

Table 23: Construction sector employment multipliers

	Direct	Indirect	Implied
Construction	2.95	2.05	0.69
Ongoing Costs	1.86	1.82	0.98

Source: EIAT

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The total number of direct full time equivalent (FTE) is calculated by applying the direct multiplier in the preceding table to the total capital spend. Indirect employment is then calculated using the indirect multiplier also from the preceding table. Based on the data from EIAT, 2.95 FTE positions are supported directly for each million dollars of capital investment. This process is repeated for ongoing costs (including sustaining capital) using the associated multipliers. In this case, 1.86 FTE positions are supported directly for each million dollars of ongoing investment. The analysis shows that 2,491 FTE positions are supported during the construction phase of the project in Scenario 1 with 2,563 FTE positions supported in Scenario 2, of which approximately 59% are direct and 41% are indirect.

The table below presents the headline employment results.

Table 24: Construction and ongoing sector employment results

	Direct (FTE)	Indirect (FTE)	Total (FTE)
Scenario 1			
Total *(Over 3 years of construction and 50 years of operations)*	1,839	1,382	3,221
Average	35	26	61
Present Value (7% discount rate)	1,195	850	2,046
Scenario 2			
Total *(Over 3 years of construction and 50 years of operations)*	1,974	1,502	3,476
Average	37	28	66
Present Value (7% discount rate)	1,246	891	2,137

Source: EIAT and Engeny

7.1.3 Gross Regional Product

A similar approach to estimating the direct and indirect Gross Regional Product (GRP) impacts was adopted. To estimate the portion of expenditure which remains within the Flinders Shire, the EIAT multipliers were used. In addition, some of the direct expenditure which remains in the Flinders Shire is reinvested and invested again within the community. This is included as an indirect impact of the expenditure. The table below displays the multipliers from EIAT and the implied relationship between direct and indirect GRP.

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Table 25: Construction and ongoing cost GRP multipliers

	Direct	Indirect	Implied
Construction	0.31	0.25	0.80
Ongoing Costs	0.44	0.28	0.62

Source: EIAT

The table below presents the headline GRP results. While up-to-date Gross Regional Product figures for Hughenden were not available at the time of analysis, the employment figures detailed in the preceding section demonstrate the potential significance of this project on the region. This is discussion further in Section 7.3.

Table 26: Construction and ongoing cost GRP results

	Direct ($m)	Indirect ($m)	Total ($m)
Scenario 1			
Total *(Over 3 years of construction and 50 years of operations)*	243.0	178.6	421.6
Average	4.6	3.4	8.0
Present Value (7% discount rate)	135.8	105.3	241.1
Scenario 2			
Total *(Over 3 years of construction and 50 years of operations)*	269.4	195.9	465.3
Average	5.1	3.7	8.8
Present Value (7% discount rate)	143.6	110.8	254.3

Source: EIAT and Engeny

7.2 Agriculture

7.2.1 Methodology

Rather than using traditional economic contribution multipliers to estimate direct employment, Peritus Ag provided the estimated employment required to develop and maintain the proposed cropping scenarios. Similarly, direct expenditure was estimated by Peritus Ag as part of the ongoing cost process detailed in Section 4.1.3.2.

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Regional multipliers were applied to the direct expenditure to estimate how much of this expenditure would be captured within the region. Similarly, indirect regional multipliers were applied to employment and expenditure to estimate the potential flow-on impacts within the region.

7.2.2 Employment

Direct employment was estimated by Peritus Ag. For the purposes of the assessment, it was assumed that part-time employment is the equivalent of 0.5 full-time equivalent (FTE). The full-time and part-time employment as estimated by Peritus Ag is displayed in the table below, along with the estimated FTE.

Table 27: Agricultural sector employment - direct

Scenario	Full-Time (Positions)	Part-Time (Positions)	Total (Positions)	Total (FTE)
Scenario 1	124	347	471	297.5
Scenario 2	114	57	171	142.5

Source: Peritus Ag

To estimate the indirect employment generated from the project, the multipliers from the EIAT were reviewed. The table below displays the multipliers from EIAT and the implied relationship between direct and indirect employment. This relationship is then used to estimate indirect employment for the Hughenden Irrigation Project.

Table 28: Agricultural sector employment multipliers

	Direct	Indirect	Implied
Employment	4.83	2.56	0.53

Source: EIAT

The table below presents the headline employment results.

Table 29: Agricultural sector employment results

	Direct (FTE)	Indirect (FTE)	Total (FTE)
Scenario 1			
Total *(Over 50 years of operations)*	14,027	7,429	21,455
Average	281	149	429
Present Value (7% discount rate)	2,432	1,288	3,720
Scenario 2			
Total	6,911	3,660	10,572

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	Direct (FTE)	Indirect (FTE)	Total (FTE)
(Over 50 years of operations)			
Average	138	73	211
Present Value (7% discount rate)	1,266	670	1,936

Source: EIAT and NineSquared

7.2.3 Gross Regional Product

Peritus Ag estimated the direct spend within the community to grow and maintain the additional produce. Details of these costs can be found in Section 4.1.3.2. The cost per hectare for each produce time is combined with the total production to estimate the total expenditure associated with production.

Not all of this expenditure remains within the community as some exits the area via a leakage. For example, machinery is unable to be manufactured within the region and seeds may need to be purchased from outside of the area. This expenditure effectively leaves the local community and, as such, is not a direct impact of the project to the Flinders shire.

To estimate the portion of expenditure which remains within the Flinders Shire, the EIAT multipliers were used. In addition, some of the direct expenditure which remains in the Flinders Shire is reinvested and invested again within the community. This is included as an indirect impact of the expenditure. The table below displays the multipliers from EIAT and the implied relationship between direct and indirect GRP.

Table 30: Agricultural sector GRP multipliers

	Direct	Indirect	Implied
Employment	0.44	0.28	0.63

Source: EIAT

The table below presents the headline GRP results.

Table 31: Agricultural sector GRP results

	Direct ($m)	Indirect ($m)	Total ($m)
Scenario 1			
Total *(Over 50 years of operations)*	1,990.9	1,253.2	3,244.1
Average	39.8	25.1	64.9
Present Value (7% discount rate)	298.4	187.8	486.3
Scenario 2			

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	Direct ($m)	Indirect ($m)	Total ($m)
Total *(Over 50 years of operations)*	641.8	404.0	1,045.8
Average	12.8	8.1	20.9
Present Value (7% discount rate)	117.6	74.0	191.6

Source: EIAT and NineSquared

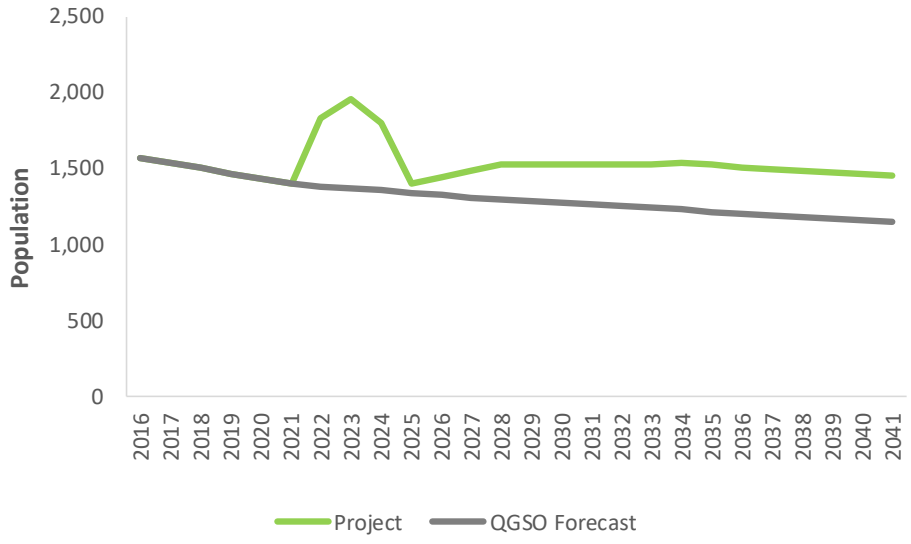
7.3 Economic Impact Assessment Conclusions

Based on the assessment above, the project has the potential to dramatically reshape the Hughenden and wider Flinders community. Population and employment have been declining in the region for an extended period, with forecasts showing a continuation of the decline. This project has the potential to not only inject employment into the local community but help slow the decline in population.

To illustrate the potential impact of this project on the community, the figure below shows the Queensland Government Statistician Office (QGSO) population forecast for the Flinders LGA. As the grey line shows, population is forecast to decline in the region with the compound annual growth rate between 2019 and 2041 being -1.1%. In total, this reduces the total employment in the region to 1,149 positions.

Once this project is delivered, it is expected that there will be an initial spike in employment during construction, as shown by the peak in the green line. This is then supplemented by ongoing and lasting employment and, by extension, population through the production of agriculture.

Figure 9: Population growth with and without the project



Source: Queensland Government Statistician Office, EIAT and NineSquared

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Underpinning this figure are a number of assumptions. Where these assumptions are not matched in reality, different outcomes would be expected. These assumptions include:

- It has been assumed that each of these positions are in addition to the QGSO forecast. Since the forecast does not include the development of a dam, it is expected that a vast majority of employment in the region would be in addition to the baseline forecast. However, where local employment simply shifts industries rather than additional labour being generated, the gap between the forecast and project impacted estimate may be smaller.
- It has been assumed that employment only brings one person to the region. In practice, some of those who move into the region would be expected to bring a family which would lead to more significant population growth. The average household size in Flinders is 2.3 as per the Australian Bureau of Statistics census, indicating that the impact of increases in employment on population may be more significant.
- This assessment only considers the direct and indirect impact of the project on the community. In the longer term, this project may spark a shift in the local economy's composition, leading to a more self-contained region. Specifically, the increase in population, employment and regional activity may make the Flinders LGA a more attractive area for businesses or families. Where more businesses and families move to the region, the region becomes more attractive again leading to further rounds of growth. As such, this project is not simply about limiting or stopping the decline in population and employment but may also be an opportunity for growth.

All else being equal, this project has the potential to make a sizable impact on the local community, both in terms of employment and regional productivity. Without an investment of this scale or another economic boost to the regional economy, forecasts of employment and population would be expected to decline. If this decline continues, it may be the case that industries are unable to be sustained leading to further economic decline.

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