



# **ECONOMIC ANALYSIS OF THE SOUTH AUSTRALIAN DOG FENCE**

A Report to the SA Dog Fence Board  
& Primary Industries and Regions SA

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Prepared by

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## EXECUTIVE SUMMARY

Government of SA and the SA Dog Fence Board (the Board) foresee a need to put forward a business case for replacing the aged Dog Fence with a new Dog Fence and seeks a cost benefit analysis of the Dog Fence replacement/upgrade option to support the business case.

Government of SA and the Board are also seeking to understand the regional economic impact of replacing/upgrading the Dog Fence.

Two economic methods were utilised to provide the necessary outputs required for the application. Firstly, cost benefit analysis (CBA) was used to determine the efficient allocations of resources. Secondly, extended input-output (I-O) analysis was employed for estimation of regional economic impacts.

A key objective of this study was to undertake a CBA to determine the net benefit of replacing approximately 1,600 km of the SA Dog Fence that is more than 100 years old. Replacing approximately 1,600 km of aged Dog Fence was compared against an ongoing business-as-usual scenario under four potential wild dog impact scenarios which are described in the report.

The results indicate that according to the three evaluation criteria used, Option 1, under all four wild dog impact scenarios, is a worthwhile investment. The NPV of between \$56.4 million and \$112.9 million indicates that, relative to the Base Case, Option 1 will generate a net benefit to the community of between 56.4 million and \$112.9 million over a 20-year period. The decision rule is that the investment will be worthwhile if the NPV is greater than zero.

The IRR provides a measure for the rate of return to capital invested, here estimated to be between 26 per cent and 45 per cent. The decision rule for the project to be viable is that the IRR be greater than the discount rate which, for this project and projects of this kind is 6 per cent.

Accordingly, the net benefits of investing in the Dog Fence replacement project (Option 1) outweigh the net benefits of not investing in the Dog Fence replacement (Base Case).

This report also presents the economic impacts of the Dog Fence replacement project<sup>1</sup> makes to the SA and regional economies in terms of gross regional product (GRP) and employment.

The aggregated activity includes:

- Fence construction activities in 2018/19 to 2020/21
- Reduced wild dog management activities on-property by pastoralists
- Increased productivity in sheep operations

### *State-wide economic impact*

In the first three years the economic impact is dominated by the Fence construction activities. In the remaining years the main contributor to GSP and employment is sheep operations, which offsets the negative economic impact from reduced wild dog management activities on-property by pastoralists.

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<sup>1</sup> i.e. the contribution the Dog Fence replacement, reduced private wild dog management expenditures and improved productivity of the pastoral sheep industry.



In the first year (2018/19), the expected impact on total GSP is around \$1.8 million, including flow-on effects. This is expected to increase to around \$8.0 million in the third year and \$4.7 million in the twentieth year. In terms of total employment, the expected impact in year 1 is 14 new fte jobs, including flow-on effects. This is expected to increase to 63 fte jobs in the third year and 26 in the twentieth year.

The report also provides details of economic impacts at regional level.

This report does not value the socio-economic impacts of wild dogs on the well-being of livestock producers, nor the economic impacts of wild dogs on the kangaroo or feral goat industries. Both of these industries would likely be severely impacted if wild dog numbers continued to increase inside the Dog Fence. Accordingly, this report is likely to underestimate the extent of the positive economic impacts that would flow from investment in replacing the Dog Fence.

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## ABBREVIATIONS

ABS	Australian Bureau of Statistics
BCR	benefit-cost ratio
CBA	cost-benefit analysis
fte	full time equivalent
GOS	gross operating surplus
GRP	gross regional product
I-O	Input-output
IRR	internal rate of return
LGA	local government area
NPV	net present value
PIA	potential impact area
RISE	Regional Industry Structure and Employment
SA	South Australia

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## 1. INTRODUCTION

### 1.1. Background

In Australia the 5,400 km Dog Fence aims to protect sheep grazing districts from wild dogs (which includes dingoes and hybrid dingoes). It is the longest continuous fence in the world. At 2,150 km long, the South Australian Dog Fence stretches eastwards from the Great Australian Bight to the New South Wales border. The Dog Fence primarily protects sheep graziers and their livestock from wild dogs on the southern side of the Dog Fence.

The South Australian Dog Fence was formed in 1946, when a multitude of cluster fences were joined to more efficiently protect the sheep industry. At the same time, the Dog Fence and the Dog Fence Board were established under the *Dog Fence Act*.

About 1,600 km of the Dog Fence are more than 100 years of age and are starting to fail. Wild dogs are being found south of the Dog Fence and have the potential to establish populations in formerly dog-free areas.

The Government of SA and the SA Dog Fence Board (the Board) foresee a need to put forward a business case for replacing the 1,600 km of Dog Fence that are more than 100 years old Dog Fence with a new fence. The Government of SA and the Board seek a cost benefit analysis of the Dog Fence replacement/upgrade option to support the business case.

The Government of SA and the Board are also seeking to understand the regional economic impact of replacing/upgrading the Dog Fence.

### 1.2. Purpose and Scope of Economic Analysis

The Government of SA and the Board engaged BDO EconSearch to undertake economic analysis to assess:

- whether the investment option is an efficient and appropriate use of government resources (i.e. whether the project provides a positive return to the community) using cost benefit analysis
- the economic impact on the regional economy, using the extended input-output (I-O) RISE model.

The investment option (i.e. investing in replacing and upgrading the SA Dog Fence to achieve functional exclusion of wild dogs) will be compared against a base case. The base case is envisaged as ongoing repair of the Dog Fence within the existing budget leading to increasing breaches in the Dog Fence and the establishment of populations within sheep pastoral districts and southern agricultural districts within SA.

The analysis focussed on the impacts on the livestock industry and their flow-on effects. Analysis of the effect on other industries, e.g. tourism and kangaroo meat industry, was out-of-scope.

### 1.3. Document Structure

An outline of the key characteristics of the CBA and I-O methods employed in this study is provided in Section 2 of the report. The scope of costs and benefits, data sources/assumptions and results of the CBA, including key indicators and sensitivity analysis, are detailed in Section 3. The results of the economic impact analysis are provided in Section 4.

## 2. METHOD OF ANALYSIS AND DATA

### 2.1. Cost Benefit Analysis - Method and Data

#### 2.1.1. Purpose and scope of cost benefit analysis

A key objective of this study was to undertake a CBA to determine the net benefit of replacing approximately 1,600 km of the aged SA Dog Fence. The proposed development (Option 1) was compared against a Base Case scenario under four potential wild dog impact scenarios, as described in Table 2-1. The Base Case and proposed development option are detailed in the following sections.

**Table 2-1 Alternative options for the cost benefit analysis**

Option	Description
Base Case	Business as usual scenario - no major capital works investment in replacing approx. 1,600 km of aged Dog Fence.
Option 1	\$25.1 million investment in replacing approx. 1,600 km of aged Dog Fence.
Impact Scenarios	Description
Scenario 1	Current rate of spread of wild dogs within the Dog Fence is maintained over the next 20 years. 0.56% sheep loss in flocks exposed to wild dogs.
Scenario 2	Current rate of spread of wild dogs within the Dog Fence is maintained over the next 20 years. 1.12% sheep loss in in flocks exposed to wild dogs.
Scenario 3	Increased rate of spread of wild dogs within the Dog Fence over the next 20 years. 0.56% sheep loss in flocks exposed to wild dogs.
Scenario 4	Increased rate of spread of wild dogs within the Dog Fence over the next 20 years. 1.12% sheep loss in in flocks exposed to wild dogs.

#### 2.1.2. Method of analysis

The CBA conducted for this project conforms to South Australian and Commonwealth Government guidelines for conducting evaluations of public sector projects (Department of Treasury and Finance (2008) and Department of Finance and Administration (2006)).

The starting point for the economic analysis was to develop the 'Base Case' scenario, that is, the benchmark against which the options were compared. It is important to note that the base case is not a 'spend nothing' or 'do nothing' scenario, but rather represents the 'business as usual' scenario. Given that costs and benefits were specified in real terms (i.e. constant 2018 dollars), future values were converted to present values by

applying a discount rate of 6 per cent. The choice of discount rate is consistent with the rate commonly used by the South Australian Government in these type of analysis.

The economic analysis was conducted over a 20-year period and results were expressed in terms of net benefits, that is, the incremental benefits and costs of the options relative to those generated by the 'Base Case' scenario. The evaluation criteria employed for this analysis are described below.

- Net present value (NPV) - discounted<sup>2</sup> project benefits less discounted project costs. Under this decision rule an option was considered to be potentially viable if the NPV was greater than zero. The NPV for option *i* has been calculated as an incremental NPV, using the standard formulation:

$$NPV_i = (PV(\text{option}_i \text{ benefits} - \text{'Base Case' benefits}) - (PV(\text{option}_i \text{ costs} - \text{'Base Case' costs}))$$

- Benefit-cost ratio (BCR) - the ratio of the present value of benefits to the present value of costs. Under this decision rule option *i* was considered to be potentially viable if the BCR was greater than one. The ration was expressed as:

$$BCR_i = PV(\text{option}_i \text{ benefits} - \text{'Base Case benefits'}) / PV(\text{option}_i \text{ costs} - \text{'Base Case' costs})$$

- Internal rate of return (IRR) - the discount rate at which the NPV of a project is equal to zero. Under this decision rule an option was considered to be potentially viable if the IRR was greater than the benchmark discount rate (i.e. 6 per cent).

### 2.1.3. Data sources

The costs and benefits of each option were measured using a 'with' and without' project framework, that is, quantification of the incremental changes associated with the option compared to the Base Case scenario. The method, data sources and assumptions used to quantify these values are described below. Consideration was given to those benefits and costs likely to occur over a 25-year period. The major economic costs and benefits of the project are listed in Table 2-2 and Table 2-3, respectively.

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<sup>2</sup> Discounting refers to the process of adjusting future benefits and costs to their equivalent present-day values (Sinden and Thampapillai 1995)

**Table 2-2**      **Costs of the Dog Fence replacement option**

Option	Description of Costs	Bearer of Cost	Valued in \$ Terms	Source of Information
Base Case	Fence maintenance costs	Government and Industry	Yes	The Board
	Area-wide wild dog management costs	Government and Industry	Yes	Government of SA
	Private wild dog management costs	Industry	Yes	Government of SA
	Sheep enterprise operating costs	Industry	Yes	BDO EconSearch analysis
Option	Fence replacement costs	Government and Industry	Yes	Government of SA
	Fence maintenance costs	Government and Industry	Yes	The Board
	Area-wide wild dog management costs	Government and Industry	Yes	Government of SA
	Private wild dog management costs	Industry	Yes	Government of SA
	Sheep enterprise operating costs	Industry	Yes	BDO EconSearch analysis

**Table 2-3 Benefits of the Dog Fence replacement option**

Option	Description of Benefits	Bearer of Benefit	Valued in \$ Terms	Source of Information
Base Case	Meat and wool sales from sheep enterprises	Industry	Yes	BDO EconSearch analysis
Options	Residual value of project capital	The Board	Yes	BDO EconSearch analysis
	Meat and wool sales from sheep enterprises	Industry	Yes	BDO EconSearch analysis

#### 2.1.4. Quantifiable costs

##### Wild dog impact projections - sheep

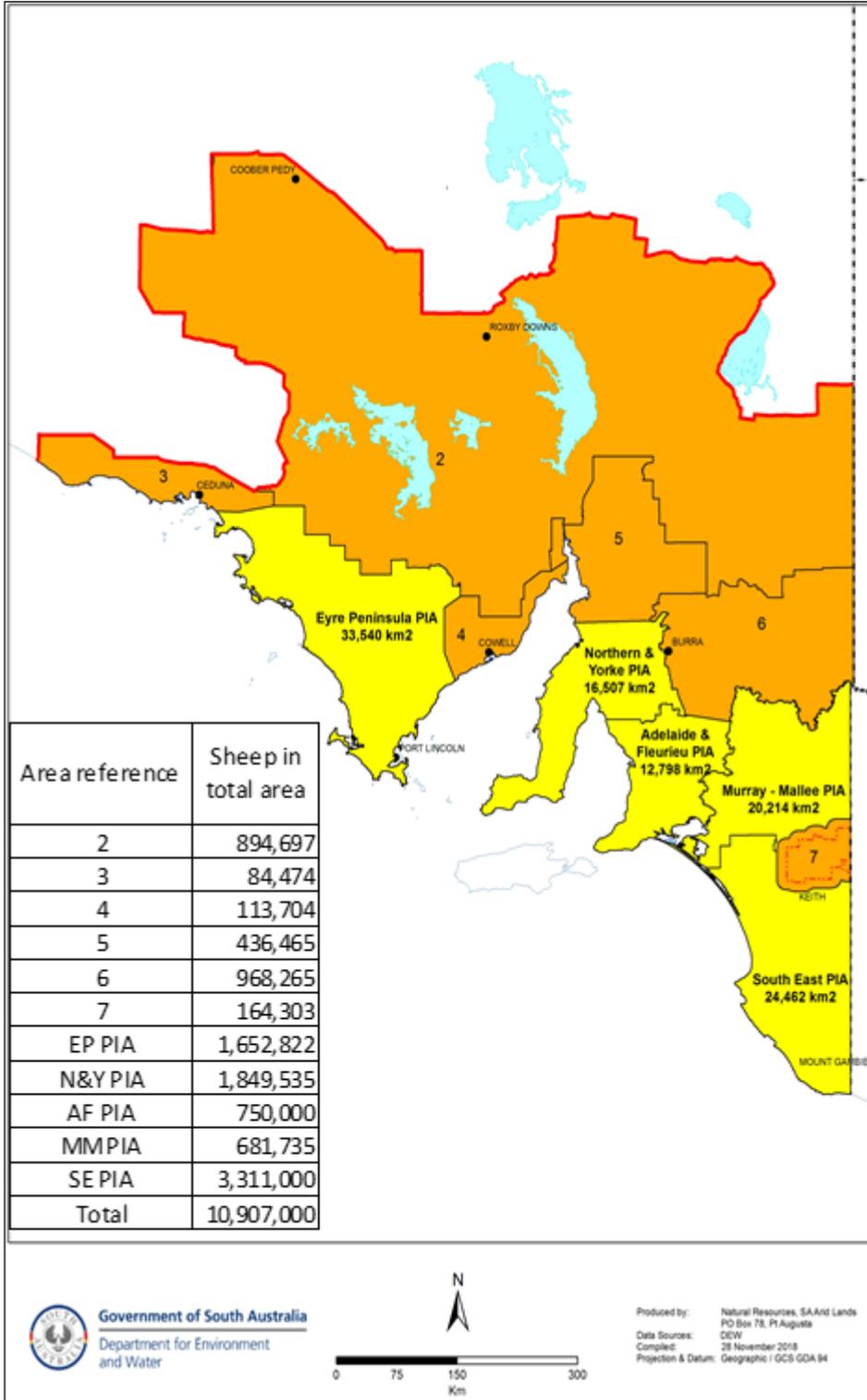
The estimates of sheep numbers and distribution south of the Dog Fence (marked in red in Figure 2-1) as at June 2018, which were provided by Livestock SA and the Government of SA, are provided in Figure 2-1. There are six potential impact areas (PIA, shaded in yellow in Figure 2-1), where sheep may be impacted by wild dogs, and five currently impacted areas (shaded in orange, Figure 2-1).

The Government of SA provided projections of the likely spread of wild dog populations within the Dog Fence at 5, 10 and 20 years under two scenarios:

- Current rate of spread of wild dogs is maintained
- Increased rate of spread of wild dogs.

These estimates are based on ongoing monitoring of wild dog populations in South Australia. The estimates of the area impacted by region (provided in Table 2-4) were used in the analysis.

Figure 2-1 Sheep numbers by region within SA Dog Fence, 2018



Source: Government of SA

**Table 2-4 Area impacted by region, current and increased rate of spread of wild dogs**

Name	Area (Ha)	Area impacted (ha)							
		Current (2018)	Current Rate of Spread			Increased Rate of Spread			
			2023	2028	2038	2023	2028	2038	
2	20,784,876	19,064,904	20,784,876	20,784,876	20,784,876	20,784,876	20,784,876	20,784,876	20,784,876
3	936,288	365,268	928,941	928,941	936,288	928,941	936,288	936,288	936,288
4	591,323	0	270,359	585,315	591,323	585,315	591,323	591,323	591,323
5	1,803,241	683,452	1,703,228	1,803,241	1,803,241	1,803,241	1,803,241	1,803,241	1,803,241
6	2,630,004	1,452,646	2,484,458	2,629,828	2,630,003	2,629,828	2,630,003	2,630,003	2,630,003
7	491,981	491,981	491,981	491,981	491,981	491,981	491,981	491,981	491,981
EP PIA	3,354,040	176,442	1,459,052	2,362,633	3,354,040	2,362,633	3,354,040	3,354,040	3,354,040
N&Y PIA	1,650,745	0	139,857	692,003	1,650,744	692,003	1,650,744	1,650,744	1,650,744
AF PIA	1,279,829	0	0	81,477	1,279,829	81,477	1,279,829	1,279,829	1,279,829
MM PIA	2,021,474	0	0	325,027	2,021,253	325,027	2,021,253	2,021,253	2,021,253
SE PIA	2,446,288	0	0	0	513,035	0	513,035	2,446,034	2,446,034
<b>Total</b>	<b>37,990,089</b>	<b>22,234,693</b>	<b>28,262,752</b>	<b>30,685,322</b>	<b>36,056,613</b>	<b>30,685,322</b>	<b>36,056,613</b>	<b>37,989,612</b>	<b>37,989,612</b>

Source: Government of SA

Based on the average stocking rate of sheep, the number of sheep exposed to wild dogs was estimated (Table 2-5).

**Table 2-5 Number of sheep exposed by region, current and increased rate of spread of wild dogs**

Name	No of Sheep	Sheep exposed							
		Current (2018)	Current Rate of Spread			Increased Rate of Spread			
			2023	2028	2038	2023	2028	2038	
2	894,697	820,660	894,697	894,697	894,697	894,697	894,697	894,697	894,697
3	84,474	32,955	83,811	83,811	84,474	83,811	84,474	84,474	84,474
4	113,704	0	51,987	112,549	113,704	112,549	113,704	113,704	113,704
5	436,465	165,426	412,257	436,465	436,465	436,465	436,465	436,465	436,465
6	968,265	534,808	914,681	968,200	968,265	968,200	968,265	968,265	968,265
7	164,303	164,303	164,303	164,303	164,303	164,303	164,303	164,303	164,303
EP PIA	1,652,822	86,948	719,000	1,164,271	1,652,822	1,164,271	1,652,822	1,652,822	1,652,822
N&Y PIA	1,849,535	0	156,699	775,337	1,849,534	775,337	1,849,534	1,849,534	1,849,534
AF PIA	750,000	0	0	47,747	750,000	47,747	750,000	750,000	750,000
MM PIA	681,735	0	0	109,614	681,660	109,614	681,660	681,660	681,660
SE PIA	3,311,000	0	0	0	694,382	0	694,382	3,310,656	3,310,656
<b>Total</b>	<b>10,907,000</b>	<b>1,805,100</b>	<b>3,397,435</b>	<b>4,756,994</b>	<b>8,290,306</b>	<b>4,756,994</b>	<b>8,290,306</b>	<b>10,906,580</b>	<b>10,906,580</b>

Source: Government of SA

In the SA Arid Lands NRM region, official reports of the number of sheep killed by wild dogs each year over the last 3 years has been between 4,000 and 5,000 head. The official reports are based on a 40 per cent return rate of surveys, which are distributed to land managers in the SA Arid Lands NRM region twice each year. Given the known under-reporting of impacts, staff from the SA Arid Lands NRM region estimate the total number of wild dog impacts at closer to 10,000 sheep per year in recent years.

This estimated annual number of wild dog impacts (5,000 to 10,000 sheep) in the SA Arid Lands NRM region represents between 0.56 and 1.12 per cent of total number of sheep (894,697) in the region in 2018. These percentages were used to predict and estimate the sheep losses from wild dogs by region (Table 2-6 and Table 2-7, respectively).

These estimates were applied to the Base Case.

**Table 2-6 Predicted sheep losses by region at 0.56 per cent of population, current and increased rate of spread of wild dogs**

Name	No of Sheep	Predicted annual sheep losses							
		Current (2018)	Current Rate of Spread			Increased Rate of Spread			
			2023	2028	2038	2023	2028	2038	
<b>2</b>	894,697	5,010	4,596	5,010	5,010	5,010	5,010	5,010	5,010
<b>3</b>	84,474	469	185	469	469	469	473	473	473
<b>4</b>	113,704	291	0	291	630	630	637	637	637
<b>5</b>	436,465	2,309	926	2,309	2,444	2,444	2,444	2,444	2,444
<b>6</b>	968,265	5,122	2,995	5,122	5,422	5,422	5,422	5,422	5,422
<b>7</b>	164,303	920	920	920	920	920	920	920	920
<b>EP PIA</b>	1,652,822	4,026	487	4,026	6,520	6,520	9,256	9,256	9,256
<b>N&amp;Y PIA</b>	1,849,535	878	0	878	4,342	4,342	10,357	10,357	10,357
<b>AF PIA</b>	750,000	0	0	0	267	267	4,200	4,200	4,200
<b>MM PIA</b>	681,735	0	0	0	614	614	3,817	3,817	3,817
<b>SE PIA</b>	3,311,000	0	0	0	0	0	3,889	18,540	18,540
<b>Total</b>	<b>10,907,000</b>	<b>19,026</b>	<b>10,109</b>	<b>19,026</b>	<b>26,639</b>	<b>26,639</b>	<b>46,426</b>	<b>61,077</b>	<b>61,077</b>

<sup>a</sup> applies to impact scenario 1

<sup>b</sup> applies to impact scenario 3.

Source: Government of SA

Under the ‘with Fence replacement’ Option (i.e. Option 1) it was assumed that effective control of wild dogs within the Dog Fence would be achieved over a period of 5 years. It was assumed that the current (2018) sheep losses would decrease in a straight-line over 5 years to nil. This effective control would be achieved with ongoing Dog Fence maintenance and area-wide control investment (i.e. once ‘virtual eradication is achieved, ongoing preventative actions will be needed to maintain effective control).

**Table 2-7 Predicted sheep losses by region at 1.12 per cent of population, current and increased rate of spread of wild dogs**

Name	No of Sheep	Predicted annual sheep losses							
		Current (2018)	Current Rate of Spread			Increased Rate of Spread			
			2023	2028	2038	2023	2028	2038	
2	894,697	9,191	10,021	10,021	10,021	10,021	10,021	10,021	10,021
3	84,474	369	939	939	946	939	946	946	946
4	113,704	0	582	1,261	1,273	1,261	1,273	1,273	1,273
5	436,465	1,853	4,617	4,888	4,888	4,888	4,888	4,888	4,888
6	968,265	5,990	10,244	10,844	10,845	10,844	10,845	10,845	10,845
7	164,303	1,840	1,840	1,840	1,840	1,840	1,840	1,840	1,840
EP PIA	1,652,822	974	8,053	13,040	18,512	13,040	18,512	18,512	18,512
N&Y PIA	1,849,535	0	1,755	8,684	20,715	8,684	20,715	20,715	20,715
AF PIA	750,000	0	0	535	8,400	535	8,400	8,400	8,400
MM PIA	681,735	0	0	1,228	7,635	1,228	7,635	7,635	7,635
SE PIA	3,311,000	0	0	0	7,777	0	7,777	37,079	37,079
<b>Total</b>	<b>10,907,000</b>	<b>20,217</b>	<b>38,051</b>	<b>53,278</b>	<b>92,851</b>	<b>53,278</b>	<b>92,851</b>	<b>122,154</b>	<b>122,154</b>

<sup>a</sup> applies to impact scenario 2

<sup>b</sup> applies to impact scenario 4.

Source: Government of SA

### Fence replacement costs

An estimate of the costs of replacing approximately 1,600 km of the Dog Fence were provided by Government of SA and the timing of the expenditure by the Board (unpublished data).

**Table 2-8 Dog Fence replacement costs**

Itemised costs	2018/19	2019/20	2020/21	Total
Materials & Labour	1,702,000	8,436,000	8,436,000	18,574,000
Remove existing fence	230,000	1,140,000	1,140,000	2,510,000
Earthworks	92,000	456,000	456,000	1,004,000
Baiting	92,000	456,000	456,000	1,004,000
Planning & contract management	184,000	912,000	912,000	2,008,000
<b>Total</b>	<b>2,300,000</b>	<b>11,400,000</b>	<b>11,400,000</b>	<b>25,100,000</b>

Source: Government of SA, SA Dog Fence Board.

These costs apply to the 'with Dog Fence replacement' scenarios (i.e. Option 1).

### Fence maintenance costs

Annual ongoing Dog Fence maintenance costs of \$1.126 million were applied to both the base case and Option 1. In 2018/19, \$563,000 will be raised from industry through the Sheep Transaction Levy and Dog Fence rates levied on rateable properties within the Dog Fence. These funds are matched by the SA Government. This information was provided by Government of SA.

### Area-wide wild dog management costs

Annual ongoing wild dog management costs of \$931,640 were applied to both the base case and Option 1. These funds are raised from the following sources:

#### *Australian Government*

- \$135,000 to part fund both the State Wild Dog Coordinator and the Wild Dog Control Coordinator.

#### *Industry*

- \$148,840 Biteback on-ground wild dog control program in SA Arid Lands region (Sheep Industry Fund).
- \$87,500 annual aerial baiting program in the SA Arid Lands region (Australian Wool Innovation and Sheep Industry Fund).
- \$75,000 toward wild dog trappers. (equally by Sheep Industry Fund and Australian Wool Innovation).

#### *State Government*

- \$225,000 toward wild dog trappers.
- \$120,000 invested through staff supporting state-wide wild dog policy, strategy development, technical advice and implementation in Biosecurity SA.
- \$100,000 investment into the biosecurity program in SA Arid Lands region. SA Arid Lands NRM Board (levy funding).
- \$15,300 Box Flat Dingo Control Committee (SASAG, NRM boards, Councils).
- \$25,000 animal health program from State Government and Eyre Peninsula NRM board.

### Private wild dog management costs

Five land managers, from areas inside the Dog Fence that are currently impacted by wild dogs, were asked to estimate their annual investment (labour and expenditure) into the management of wild dogs on their properties. Across the 5 responses a total of \$330,000 annual investment (including labour) is currently made. The properties run an estimated 258,000 sheep. This gives an estimated cost of \$1.46 per sheep exposed, which was applied to the total number of sheep exposed (Table 2-5). An estimate of the costs under the Base Case and Option 1 is described in Table 2-9.

**Table 2-9 Private wild dog management costs**

	Predicted land manager investment (\$) into wild dog management						
	Current (2018)	Current Rate of Spread <sup>a</sup>			Increased Rate of Spread <sup>b</sup>		
		2023	2028	2038	2023	2028	2038
Base Case	2,308,849	4,345,556	6,084,528	10,603,880	6,084,528	10,603,880	13,950,277
Option 1	2,308,849	300,850	0	0	300,850	0	0

<sup>a</sup> applies to impact scenarios 1 and 2

<sup>b</sup> applies to impact scenarios 3 and 4.

Source: Government of SA.

### Sheep enterprise operating costs

BDO EconSearch has developed whole farm financial models for SA pastoral sheep enterprises which have been updated in 2018<sup>3</sup>. Models for merino and dorper enterprises, assuming an 80:20 ratio of merino to dorper sheep, were used to derive an estimated enterprise variable cost of \$29/head. This was applied to the number of head under the base case and Option 1 for each impact scenario.

Enterprise fixed/overhead costs were not included as they were assumed to be constant under all options and scenarios.

The number of head was estimated as the current (2018) number of head by region less the estimated number of head lost through wild dog impacts

#### 2.1.5. Quantifiable benefits

##### Residual value of project capital

This is the value of capital investment at the end of the project period. It was calculated based on the depreciated value of the investment. Straight-line depreciation was applied. The Fence was assumed to have a useful life of 30 years.

##### Sheep enterprise sales income

Models developed by BDO EconSearch for merino and dorper enterprises (as described in Section 2.1.4), assuming an 80:20 ratio of merino to dorper sheep, were used to derive an estimated enterprise sheep and wool sales of \$71/head. This was applied to the number of head under the base case and Option 1 for each impact scenario.

#### 2.1.6. Unquantified social costs

A number of social costs, which have not been quantified in this analysis, are described below:

##### Threats to livelihoods

###### *Pastoral industry*

The geographical character of the country south of the Dog Fence, as well as other factors including cost, precludes the option of diversifying into cattle for many pastoralists. These sheep graziers have no option but to work to protect their current livelihood (Wicks et al. 2014). This concern was reiterated by one of the pastoralists surveyed for this current analysis. He further added that if people get out of the sheep industry, the sheep industry will be severely compromised as sheep operations within the Dog Fence will have less trading opportunities without excess lambs being produced from pastoralists. Small regional towns will be financially affected to the point where they will become unsustainable.

One pastoralist described the potential 'downward spiral' effect persistent wild dog attacks could have.

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<sup>3</sup> These models are based on 15 years of stock return data and financial return data to account for potential variation in stocking and prices and covers the range in the production cycle from good years to drought years.

*Three years ago we lost 2,000 lambs to dogs. If this were to continue we would employ less people as the profits wouldn't be great which would create a snowballing effect as we would have less labour units available to control the dogs.*

#### *Feral goat and native kangaroo harvesting industries*

Approximately 200,000 feral goats are commercially harvested for meat annually from the SA pastoral areas (Government of SA, pers. comm.). Wild dogs can have a significant impact feral goat numbers. A study (Bell 2015) in Western Australia found an increased distribution and abundance of wild dogs in Western Australia had substantial impacts on the population of feral goats between 2005 (1,000,000 feral goats in the population) and 2011 (150,000 feral goats in the population). The impact on this sector could be significant in South Australia because it is an opportunistic industry where goat numbers are not tracked and wild dog predation not monitored.

A similar impact is expected for the kangaroo harvesting industry.

#### **Wild dog impacts on individuals and families**

In Wicks et al. (2014), pastoralists described spending large amounts of time on purposeful hunting and trapping, but also responding to chance sightings. This sense of needing to be constantly alert meant that pastoralists were vigilant all the time. Holidays and relaxation were compromised. Impacts on family life were also noted with partnerships and parenting often competing for time with long hours of wild dog control.

Pastoralists surveyed for the current study, reflected that considerable time and resources could be given to wild dog management in order to keep on top of the problem. They also reflected the need for constant vigilance. Furthermore, several indicated that they found it emotionally impacting dealing with stock attacked by wild dogs and were generally anxious for their stock's welfare.

## **2.2. Economic Impact - Method and Data**

An important component of the economic analysis task is to undertake an economic impact assessment. The regional economic impact analysis uses an extension of the conventional input-output method. Over the past decade BDO EconSearch has developed an extended input-output model known as the RISE model (Regional Industry Structure and Employment). The RISE model provides a comprehensive economic framework that is extremely useful in the resource planning process, particularly for regional economic impact applications<sup>4</sup>.

The indicators used in impact analysis typically include employment and gross regional product (GRP) which are used in this report.

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<sup>4</sup> RISE models have been constructed for the South Australian Government at both a state and regional level (EconSearch 2017).

### 2.2.1. Economic activity

*Economic activity indicators:* the focus of this report is the generation of economic activity resulting from the Dog Fence replacement project. The key economic activity indicators considered in the analysis are employment and GRP.

*Economic impact:* changes in economic activity are referred to as economic impacts. Generally, changes in *economic activity indicators* results from some stimulus or external shock imposed. In this analysis the concept of economic impact includes the increase in economic contribution from the construction and operations of the project, i.e. the contribution the Dog Fence replacement and improved productivity of the pastoral sheep industry makes to the economy. This *economic impact* is measured in terms of *economic activity indicators* referred to above.

### 2.2.2. Indicators of economic activity

*Employment units:* employment numbers are usually reports in either full-time equivalent (fte) units or total job units defined as follows:

- *FTE:* is a way to measure a worker's involvement in a project or industry activity. An fte of 1.0 means that the person is equivalent to a full-time worker, while an fte of 0.5 signals that the worker is only half-time. Typically, different scales are used to calibrate this number, depending on the type of industry and copy of the analysis but the basic calculation is the total hours worked divided by average annual hours worked in full-time jobs.
- *Jobs:* is used to refer to the number of workers employed in an industry or on a project at any point in time. It typically refers to either:
  - The *maximum* number of workers required at any point over the analytical person or the duration of the project; or
  - The *average* number of workers required over the analytical period/duration of the project. This can be calculated on a daily, weekly, monthly or annual basis.

In this report employment has been reported in terms of fte units on a per annum basis.

*Gross regional product (GRP):* is a measure of the contribution of an activity to the economy. GRP is measured as value of gross output (business revenue) less the cost of goods and services (including imports) used in producing the output. In other words, it can be measured as the sum of household income, gross operating surplus and gross mixed income net of payments to owner managers and taxes less subsidies on products and production. It represents payments to the primary inputs of production (labour, capital and land). Using GRP as a measure of economic impact avoids the problem of double counting that may arise from using value of output for this purpose.

### 2.2.3. Categories of economic activity

A useful way to think about economic activity and economic impact (as measured by employment, GRP, etc.) is using the concept of a 'supply chain'. The supply chain, in the context of an infrastructure project, includes the planning and management of all activities involved in sourcing and procurement, conversion of materials, and all the logistics management activities. It also includes coordination and collaboration with suppliers, intermediaries and third-party service providers.

Broadly speaking there are four categories of employment and GRP along the infrastructure supply chain.

1. *Direct employment and GRP* - this is employment in those firms, businesses and organisations that are directly engaged in providing goods and services to the project.
2. *First round employment and GRP* - refers to employment in firms that supply inputs and services to the 'direct employment' businesses, i.e. those categorised under point 1 above.
3. *Industrial-support employment and GRP* - is the terms applied to 'second and subsequent round' effects as successive waves of output increases occur in the economy to provide industrial support, as a response to the original expenditure. This category excludes any employment associated with increased household consumption.
4. *Consumption-induced employment and GRP* - is the term applied to as those effects induced by increased household income associated with the original expenditure. The expenditure of household income associated with all three categories of employment (direct, first round and industrial-support) will generate economic activity that will itself generate jobs.

*Flow-on (or indirect) economic impact* is the sum of categories 2, 3 and 4. In this analysis *direct* and *flow-on* employment and GRP generated by the supply chain have been reported.

For this project these categories of economic impact will apply to the Dog Fence replacement, changes in private wild dog control activity and to the increased income and expenditures made by sheep enterprises as a result of effective wild dog control.

#### 2.2.4. Economic impact models

Input-output (I-O) models are widely used to assess the economic impacts of existing or changing levels of economic activity<sup>5</sup>, such as regional infrastructure expansion. The RISE I-O models of the regional economies, constructed by BDO EconSearch, are widely used by the Government. I-O models are available at the national, state and regional levels. A RISE models for South Australia and for the Government regions of the Far North, Eyre and Western, Yorke and Mid North, Murray and Mallee and Limestone Coast were used for this assessment. A RISE model was developed for the Adelaide and Fleurieu Region, comprising the four Adelaide metropolitan Government regions, the Barossa, Light and Lower North Government region, the Adelaide Hills Government region and the Fleurieu and Kangaroo Island Government region, which was also used for this assessment.

#### 2.2.5. Data and assumptions

Further details of the data and assumptions used are provided in Section 2.1.4 and 2.1.5.

In addition to the assumptions embodied in the I-O model itself (see Appendix 1), it was necessary to make a number of other general assumptions in estimating the economic impacts:

- The impacts were measured using a model that represents the structure of the regional economy for the year in which the most recent data are available (2016/17). However, over time there are

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<sup>5</sup> Called an 'exogenous shock' in model terminology.

likely to be improvements in primary factor productivity in these economies. To allow for the improvements as an across-the-board (all sectors) labour productivity improvement rate of 1 per cent per annum for subsequent years of the construction and operation phases has been incorporated into the modelling.

- When new jobs are created, it should be determined where the people come from to fill those jobs. In some cases, the jobs will be taken by previously unemployed locals or by someone who is currently employed locally but whose own job is taken by a previously unemployed local. In both cases the impact of the newly created job and associated income is particularly offset by the fact that someone who was previously receiving unemployment benefits for example is no longer doing so. To calculate this effect requires estimates of the parameter  $\rho$  (see Appendix 1), the proportion of new jobs that are likely to be filled by previously unemployed locals. For the construction and operating phases, it was estimated to be 0.8 for SA and 0.6 for the regions.

## 3. COST BENEFIT ANALYSIS RESULTS

### 3.1. Results

The primary focus of the cost benefit analysis in this study was the costs and benefits that accrue as a result of the Dog Fence replacement project (Option 1). That is, the cost benefit analysis was used to assist in the identification, from a range of options (Base Case and Option), the option that maximises the net social benefits.

The results of the economic analysis have been presented in terms of three evaluation criteria: net present value (NPV), benefit-cost ratio (BCR) and internal rate of return (IRR). NPV is a measure of the aggregate, annual net benefits (i.e. benefits - costs) of an option over a 20-year period, discounted (i.e. expressed as a present value<sup>6</sup> using a discount rate of 6 per cent. BCR is the ration of the present value of benefits to the present value of costs. IRR is the discount rate at which the NPV of a project is equal to zero<sup>7</sup>.

While the impact analysis illustrated the economic activity arising from the proposed investment, the CBA shows whether or not the proposed investment represents an efficient use of public money.

The results of the CBA for Option 1 for the four wild dog impact scenarios is described in Table 3-1. These results are based on expected values for key variables, as outlined in Sections 2.1.4 and 2.1.5.

The results indicate that according to the three evaluation criteria used, Option 1, under all four wild dog impact scenarios, is a worthwhile investment. The NPV of between \$56.4 million and \$112.9 million indicates that, relative to the Base Case, Option 1 will generate a net benefit to the community of between 56.4 million and \$112.9 million over a 20-year period. The decision rule is that the investment will be worthwhile if the NPV is greater than zero.

The IRR provides a measure for the rate of return to capital invested, here estimated to be between 26 per cent and 45 per cent. The decision rule for the project to be viable is that the IRR be greater than the discount rate which, for this project and projects of this kind is 6 per cent.

Accordingly, the net benefits of investing in the Dog Fence replacement project (Option 1) outweigh the net benefits of not investing in the Dog Fence replacement (Base Case).

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<sup>6</sup> The present value is the value now of a sum of money arising in the future. Money now is worth more than money in the future because it could be invested now to produce a greater sum in the future. The present value of money in the future is calculated by discounting it at a rate of interest equivalent to the rate at which it could be invested (Bannock et al. 1979). A discount rate of 6 per cent was used in this economic analysis.

<sup>7</sup> For more detailed explanation of each criterion and the method of analysis see Section 2.1.

**Table 3-1 CBA results of the Dog Fence replacement under four wild dog impact scenarios<sup>a</sup>**

	Scenario 1 (\$m <sup>a</sup> )	Scenario 2 (\$m <sup>a</sup> )	Scenario 3 (\$m <sup>a</sup> )	Scenario 4 (\$m <sup>a</sup> )
<b>Net benefits</b>				
Residual value of project capital	3.4	3.4	3.4	3.4
Sheep enterprise sales income	20.1	40.1	30.3	60.5
<i>Total net benefits</i>	<i>23.5</i>	<i>43.6</i>	<i>33.7</i>	<i>64.0</i>
<b>Net costs</b>				
Fence replacement costs	23.2	23.2	23.2	23.2
Fence maintenance costs	0.0	0.0	0.0	0.0
Area-wide wild dog management costs	0.0	0.0	0.0	0.0
Private wild dog management costs	-64.4	-64.4	-97.2	-97.2
Sheep enterprise operating costs	8.3	16.6	12.5	25.1
<i>Total net costs</i>	<i>-32.9</i>	<i>-24.6</i>	<i>-61.5</i>	<i>-48.9</i>
<b>Net Present Value of Dog Fence replacement</b>	<b>56.4</b>	<b>68.2</b>	<b>95.2</b>	<b>112.9</b>
<b>Benefit Cost Ratio</b>	<b>Undefined</b>	<b>Undefined</b>	<b>Undefined</b>	<b>Undefined</b>
<b>Internal Rate of Return</b>	<b>26%</b>	<b>30%</b>	<b>39%</b>	<b>45%</b>

<sup>a</sup> In 2018 dollars.

Source: BDO EconSearch analysis

## 3.2. Sensitivity Analysis

The results of the CBA were re-estimated using values for key variables that reflect the uncertainty of those variables. The sensitivity analysis included the following:

- Discount rates
- Sheep enterprise sales income
- Private wild dog management costs
- Dog Fence replacement costs.

The range of values used for each uncertain variable and detailed results of the sensitivity analysis are set out below with some interpretation of the results. Note that each sensitivity analysis for each variable was undertaken by holding all other variables constant at their 'expected' values. The assumptions and results of the sensitivity analysis are summarised and described in the following sections.

### 3.2.1. Discount rates

Costs and benefits are specified in real terms (i.e. constant 2018 dollars) and future values are converted to present values by applying a discount rate of 6 per cent. A sensitivity analysis was conducted using discount rates of 4 and 8 per cent (Table 3-2).

**Table 3-2 Results of the sensitivity analysis - discount rate**

Discount rate	Scenario 1			Scenario 2			Scenario 3			Scenario 4		
	NPV (\$m <sup>a</sup> )	BCR	IRR	NPV (\$m <sup>a</sup> )	BCR	IRR	NPV (\$m <sup>a</sup> )	BCR	IRR	NPV (\$m <sup>a</sup> )	BCR	IRR
4%	74.7	undef.	26%	89.1	undef.	30%	121.7	undef.	39%	143.5	undef.	45%
6% <sup>b</sup>	56.4	undef.	26%	68.2	undef.	30%	95.2	undef.	39%	112.9	undef.	45%
8%	42.7	undef.	26%	52.4	undef.	30%	74.9	undef.	39%	89.6	undef.	45%

<sup>a</sup> In 2018 dollars.

<sup>b</sup> Expected value.

Source: BDO EconSearch analysis

As expected, the NPV and BCR improve with the lower (4 per cent) discount rate and decrease under the higher discount rate (8 per cent). This occurs because, although the bulk of the project costs are ‘up front’ and are not significantly affected by the discount rate, the benefits accrue over many years and are greater, in present value terms, when the discount rate is lower. Therefore, with 25 percent increase or decrease in discount rates, the positive NPV, BCR that is greater than 1 and IRR that is greater than the discount rate (6 percent) indicate that Options 1, under all wild dog impact scenarios, is still preferable to the Base Case.

Note that the IRR is not affected by the discount rate. In fact, it can be interpreted as the discount rate at which the NPV is equal to zero.

### 3.2.2. Sheep enterprise sales income

Sheep enterprise sales income, whilst based on 15-year average prices, have the potential to vary from current estimates. Accordingly, a sensitivity analysis was undertaken to illustrate the effect of a 25 per cent increase or 25 per cent decrease in meat and wool prices. The results of this analysis are summarised in Table 3-3.

**Table 3-3 Results of the sensitivity analysis - sheep enterprise sales income**

Sheep sales income	Scenario 1			Scenario 2			Scenario 3			Scenario 4		
	NPV (\$m <sup>a</sup> )	BCR	IRR	NPV (\$m <sup>a</sup> )	BCR	IRR	NPV (\$m <sup>a</sup> )	BCR	IRR	NPV (\$m <sup>a</sup> )	BCR	IRR
25% less	51.4	undef.	24%	58.2	undef.	27%	87.6	undef.	36%	97.8	undef.	40%
Expected value	56.4	undef.	26%	68.2	undef.	30%	95.2	undef.	39%	112.9	undef.	45%
25% more	61.4	undef.	28%	78.2	undef.	33%	102.7	undef.	42%	128.0	undef.	51%

<sup>a</sup> In 2018 dollars.

Source: BDO EconSearch analysis.

The results are shown to be moderately sensitive to changes in meat and wool prices. This means that a 25 per cent increase or decrease in meat and wool prices will have a minor impact on the project’s viability (NPV>0, BCR>1 and IRR>discount rate of 6 percent), however all indicators remain substantially positive.

### 3.2.3. Private wild dog management costs

An estimate of the private wild dog management costs of \$1.28 per sheep in areas exposed to wild dogs was derived from a survey of five pastoralists. This estimate has the potential to vary from current estimates. Accordingly, a sensitivity analysis was undertaken to illustrate the effect of a 25 per cent increase or 25 per cent decrease in this value. The results of this analysis are summarised in Table 3-4.

**Table 3-4 Results of the sensitivity analysis - private wild dog management costs<sup>a</sup>**

Private dog mgt costs	Scenario 1			Scenario 2			Scenario 3			Scenario 4		
	NPV (\$m <sup>a</sup> )	BCR	IRR	NPV (\$m <sup>a</sup> )	BCR	IRR	NPV (\$m <sup>a</sup> )	BCR	IRR	NPV (\$m <sup>a</sup> )	BCR	IRR
25% less	40.3	undef.	21%	52.1	undef.	25%	70.9	undef.	31%	88.6	undef.	37%
Expected value	56.4	undef.	26%	68.2	undef.	30%	95.2	undef.	39%	112.9	undef.	45%
25% more	72.5	undef.	31%	84.3	undef.	35%	119.5	undef.	48%	137.2	undef.	55%

<sup>a</sup> In 2018 dollars.

Source: BDO EconSearch analysis.

The results are shown to be moderately sensitive to changes in private wild dog management costs. This means that a 25 per cent increase or decrease in the price will have a minor impact on the project's viability (NPV>0, BCR>1 and IRR>discount rate of 6 percent), however all indicators remain substantially positive.

### 3.2.4. Fence replacement costs

The Dog Fence replacement costs have the potential to vary from current estimates. A sensitivity analysis was undertaken to illustrate the effect of a 25 per cent increase or 25 per cent decrease in this value. The results of this analysis are summarised in Table 3-5.

**Table 3-5 Results of the sensitivity analysis - Dog Fence replacement costs<sup>a</sup>**

Fence replacem't costs	Scenario 1			Scenario 2			Scenario 3			Scenario 4		
	NPV (\$m <sup>a</sup> )	BCR	IRR	NPV (\$m <sup>a</sup> )	BCR	IRR	NPV (\$m <sup>a</sup> )	BCR	IRR	NPV (\$m <sup>a</sup> )	BCR	IRR
25% less	61.4	undef.	34%	73.1	undef.	40%	100.1	undef.	53%	117.8	undef.	64%
Expected value	56.4	undef.	26%	68.2	undef.	30%	95.2	undef.	39%	112.9	undef.	45%
25% more	51.5	undef.	21%	63.2	undef.	24%	90.2	undef.	31%	108.0	undef.	36%

<sup>a</sup> In 2018 dollars.

Source: BDO EconSearch analysis.

The results are shown to be moderately sensitive to changes in Dog Fence replacement costs. This means that a 25 per cent increase or decrease in the price will have a minor impact on the project's viability (NPV>0, BCR>1 and IRR>discount rate of 6 percent), however all indicators remain substantially positive.

## 4. ECONOMIC IMPACT RESULTS

This section presents the economic impacts of the Dog Fence replacement project<sup>8</sup> makes to the SA and regional economies in terms of gross regional product (GRP) and employment. Results are presented for the wild dog impact scenario 1 (assumes current rate of spread of wild dogs is maintained over the next 20 years and the 0.56 per cent of sheep are lost in areas in which wild dogs are present).

Note that the impact measured here is the difference between the income and expenditures of Option 1 (with Fence replacement) and the Base Case (without Fence replacement).

For South Australia, the impacts for the aggregated activities are presented first, followed by disaggregated impacts for Fence construction, ongoing private dog management and sheep enterprise operations. For the regional analyses, the aggregated impacts are presented only.

### 4.1. South Australia

#### 4.1.1. Aggregated impacts

The aggregated activity includes:

- Fence construction activities in 2018/19 to 2020/21
- Reduced wild dog management activities on-property by pastoralists
- Increased productivity in sheep operations.

The aggregated economic impacts of Option 1 (Scenario 1) on the SA economy are presented in terms of GSP and employment in Figure 4-. Detailed economic impacts are presented in terms of GSP and employment (fte) in Table 4-1.

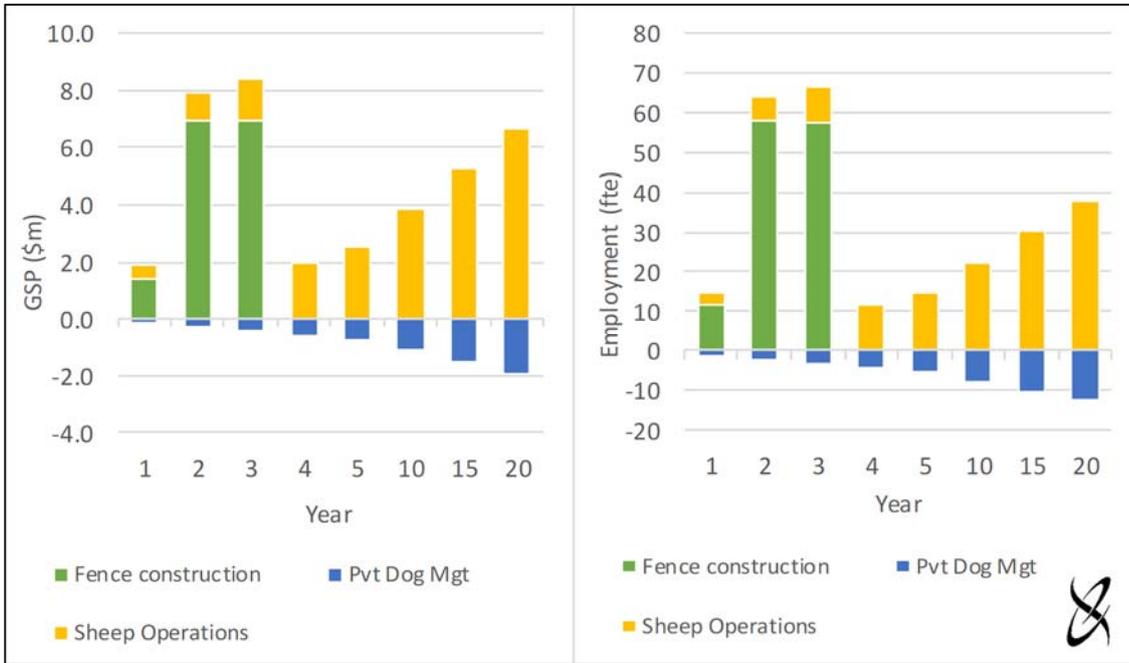
In the first three years the economic impact is dominated by the Fence construction activities. In the remaining years the main contributor to GSP and employment is sheep operations, which offsets the negative economic impact from reduced wild dog management activities on-property by pastoralists.

In the first year (2018/19), the expected impact on total GSP is around \$1.8 million, including flow-on effects. This is expected to increase to around \$8.0 million in the third year and \$4.7 million in the twentieth year. In terms of total employment, the expected impact in year 1 is 14 new fte jobs, including flow-on effects. This is expected to increase to 63 fte jobs in the third year and 26 in the twentieth year.

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<sup>8</sup> i.e. the contribution the Dog Fence replacement, reduced private wild dog management expenditures and improved productivity of the pastoral sheep industry.

**Figure 4-1 Economic Impacts of the Dog Fence replacement project on the SA economy, Scenario 1, GSP and Employment**



Source: EconSearch analysis

**Table 4-1 Annual economic impacts of the Dog Fence replacement project - aggregated activity, GSP and Employment (fte)**

Year	Gross State Product (\$m)				Employment (fte)			
	Direct	Prod. Induced	Cons. Induced	Total	Direct	Prod. Induced	Cons. Induced	Total
1	1.0	0.5	0.3	<b>1.8</b>	8	4	4	<b>14</b>
2	4.0	2.3	1.4	<b>7.6</b>	35	19	19	<b>62</b>
3	4.3	2.3	1.5	<b>8.0</b>	36	19	19	<b>63</b>
4	1.1	0.0	0.3	<b>1.4</b>	5	0	2	<b>8</b>
5	1.4	0.0	0.4	<b>1.8</b>	6	0	3	<b>9</b>
10	2.1	0.0	0.6	<b>2.7</b>	10	0	4	<b>15</b>
15	2.9	0.0	0.8	<b>3.7</b>	14	0	5	<b>20</b>
20	3.7	0.1	1.0	<b>4.7</b>	19	0	6	<b>26</b>

Source: BDO EconSearch

### 4.1.2. Fence construction impacts

The economic impact of the Dog Fence construction activity on the SA economy for Option 1 (Scenario 1) are presented in Table 4-2.

**Table 4-2 Annual economic impact of the Fence construction, SA**

Year	Gross State Product (\$m)				Employment (fte)			
	Direct	Prod. Induced	Cons. Induced	Total	Direct	Prod. Induced	Cons. Induced	Total
1	0.7	0.5	0.2	<b>1.4</b>	7	4	4	<b>12</b>
2	3.5	2.3	1.2	<b>6.9</b>	32	19	18	<b>58</b>
3	3.5	2.3	1.2	<b>6.9</b>	32	19	18	<b>57</b>

Source: BDO EconSearch analysis

The expected impact on GSP from the Dog Fence construction activity, including flow on effects, is approximately \$1.4 million in year 1 (2018/19) and \$6.9 million per year in years 2 and 3 (2019/20 and 2020/21 respectively). In terms of total employment, the expected impact is 12 fte, 58 fte and 57 fte in years 1 to 3 respectively.

#### 4.1.3. Private wild dog management activities

The economic impact of the reduced wild dog management activities on property by pastoralists on the SA economy for Option 1 (Scenario 1) are presented in Table 4-3.

**Table 4-3 Annual economic impact of private wild dog management, SA**

Year	Gross State Product (\$m)				Employment (fte)			
	Direct	Prod. Induced	Cons. Induced	Total	Direct	Prod. Induced	Cons. Induced	Total
1	-0.1	0.0	0.0	<b>-0.1</b>	-1	0	0	<b>-1</b>
2	-0.2	-0.1	0.0	<b>-0.3</b>	-2	-1	0	<b>-2</b>
3	-0.3	-0.1	-0.1	<b>-0.4</b>	-2	-1	0	<b>-3</b>
4	-0.4	-0.2	-0.1	<b>-0.6</b>	-3	-1	0	<b>-4</b>
5	-0.5	-0.2	-0.1	<b>-0.7</b>	-4	-1	0	<b>-5</b>
10	-0.7	-0.3	-0.1	<b>-1.1</b>	-5	-2	-1	<b>-8</b>
15	-1.0	-0.4	-0.2	<b>-1.5</b>	-7	-2	-1	<b>-10</b>
20	-1.2	-0.5	-0.2	<b>-2.0</b>	-8	-3	-1	<b>-12</b>

Source: BDO EconSearch analysis

The negative impacts of reduced wild dog management activities on-property by pastoralists (relative to the Base Case) include reduced expenditures on training, equipment, bait preparation and contractors (wild dog trappers). Station labour was a significant proportion of the costs and was excluded because it was assumed that the station labour released by less wild dog management activities would be used for other activities on the station.

The expected impact on GSP from the private wild dog management activity, including flow on effects, is approximately -\$0.1 million in year 1 (2018/19) decreasing to -\$0.7 million in year 5 and -\$2.0 million by year 20. In terms of total employment, the expected impact is 1 fte, -5 fte and -12 fte in years 1, 5 and 20 respectively.

#### 4.1.4. Sheep enterprise operation

The economic impact of the sheep enterprise operation activity on the SA economy for Option 1 (Scenario 11) are presented in Table 4-4.

**Table 4-4 Annual economic impact of sheep enterprise operation, SA**

Year	Gross State Product (\$m)				Employment (fte)			
	Direct	Prod. Induced	Cons. Induced	Total	Direct	Prod. Induced	Cons. Induced	Total
1	0.4	0.0	0.1	<b>0.5</b>	2	0	1	<b>3</b>
2	0.7	0.1	0.2	<b>1.0</b>	4	1	1	<b>6</b>
3	1.1	0.1	0.3	<b>1.5</b>	6	1	2	<b>9</b>
4	1.5	0.2	0.4	<b>2.0</b>	8	1	3	<b>12</b>
5	1.8	0.2	0.5	<b>2.5</b>	10	1	3	<b>15</b>
10	2.8	0.3	0.7	<b>3.8</b>	16	2	5	<b>22</b>
15	3.8	0.5	1.0	<b>5.3</b>	21	3	6	<b>30</b>
20	4.9	0.6	1.2	<b>6.7</b>	27	3	8	<b>38</b>

Source: BDO EconSearch analysis

The impact of sheep enterprise operations includes the increased sales and expenditure as a result of improved productivity of these operations.

The expected impact on GSP from the sheep enterprise activity, including flow on effects, is approximately \$0.5 million in year 1 (2018/19) increasing to \$2.5 million in year 5 and \$6.7 million by year 20. In terms of total employment, the expected impact is 3 fte, 15 fte and 38 fte in years 1, 5 and 20 respectively.

## 4.2. Far North

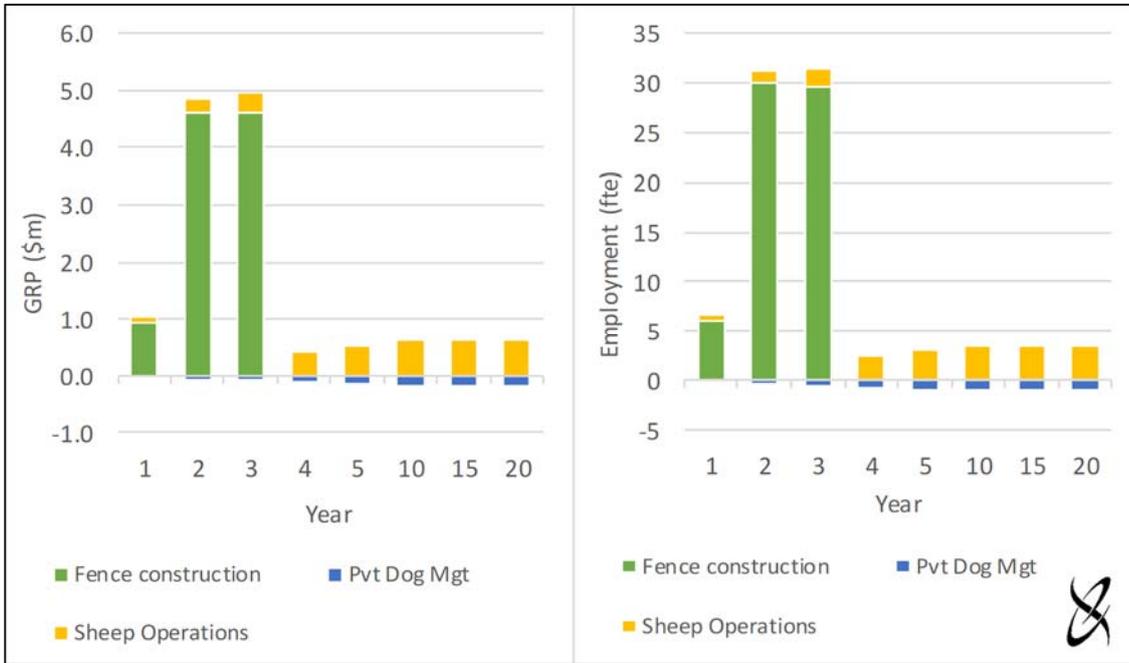
### 4.2.1. Aggregated impacts

The aggregated activity includes:

- Fence construction activities in 2018/19 to 2020/21
- Reduced wild dog management activities on-property by pastoralists
- Increased productivity in sheep operations

The aggregated economic impacts of Option 1 (Scenario 1) on the Far North economy are presented in terms of GRP and employment in Figure 4-2. Detailed economic impacts are presented in terms of GRP and employment (fte) in Table 4-5.

**Figure 4-2 Economic Impacts of the Fence replacement project on the Far North, Scenario 1, GRP and Employment**



Source: EconSearch analysis

In the first three years the economic impact is dominated by the Fence construction activities. In the remaining years the main contributor to GRP and employment is sheep operations, which offsets the negative economic impact from reduced wild dog management activities on-property by pastoralists.

In the first year (2018/19), the expected impact on total GRP is around \$1.0 million, including flow-on effects. This is expected to increase to around \$4.9 million in the third year and \$0.5 million in the twentieth year. In terms of total employment, the expected impact in year 1 is 7 fte jobs, including flow-on effects. This is expected to increase to 31 fte jobs in the third year and 3 fte jobs in the twentieth year.

**Table 4-5 Annual economic impacts of the Dog Fence replacement project, Far North - aggregated activity, GRP and Employment (fte)**

Year	Gross Regional Product (\$m)				Employment (fte)			
	Direct	Prod. Induced	Cons. Induced	Total	Direct	Prod. Induced	Cons. Induced	Total
1	0.7	0.2	0.1	<b>1.0</b>	5	2	0	<b>7</b>
2	3.3	1.1	0.3	<b>4.8</b>	22	8	1	<b>31</b>
3	3.4	1.1	0.3	<b>4.9</b>	22	8	1	<b>31</b>
4	0.3	0.0	0.0	<b>0.3</b>	1	0	0	<b>2</b>
5	0.3	0.0	0.0	<b>0.4</b>	2	0	0	<b>2</b>
10	0.4	0.0	0.1	<b>0.5</b>	2	0	0	<b>2</b>
15	0.4	0.0	0.1	<b>0.5</b>	2	0	0	<b>2</b>
20	0.4	0.0	0.1	<b>0.5</b>	2	0	0	<b>3</b>

Source: BDO EconSearch

### 4.3. Eyre and Western

#### 4.3.1. Aggregated impacts

The aggregated activity includes:

- Reduced wild dog management activities on-property by pastoralists
- Increased productivity in sheep operations.

Detailed economic impacts are presented in terms of GRP and employment (fte) in Table 4-6.

In the Eyre and Western region small negative impacts from reduced expenditures on wild dog management by pastoralists is offset by increased income and expenditure from improved productivity on sheep properties.

Modest positive impacts occur in the first year with the expected impact on total GRP of around \$0.1 million, including flow-on effects. This is expected to increase to around \$0.7 million in the 10<sup>th</sup> year and \$1.0 million in the twentieth year. In terms of total employment, the expected impact in year 1 is less than 1 fte jobs, including flow-on effects. This is expected to increase to 4 fte jobs in the 10<sup>th</sup> year and 5 fte jobs in the twentieth year.

**Table 4-6 Annual economic impacts of the Dog Fence replacement project, Eyre and Western - aggregated activity, GRP and Employment (fte)**

Year	Gross Regional Product (\$m)				Employment (fte)			
	Direct	Prod. Induced	Cons. Induced	Total	Direct	Prod. Induced	Cons. Induced	Total
1	0.1	0.0	0.0	<b>0.1</b>	0	0	0	<b>0</b>
2	0.1	0.0	0.0	<b>0.2</b>	1	0	0	<b>1</b>
3	0.2	0.0	0.0	<b>0.3</b>	1	0	0	<b>1</b>
4	0.3	0.0	0.1	<b>0.4</b>	1	0	0	<b>2</b>
5	0.4	0.0	0.1	<b>0.4</b>	2	0	1	<b>2</b>
10	0.6	0.0	0.1	<b>0.7</b>	3	0	1	<b>4</b>
15	0.7	0.0	0.1	<b>0.8</b>	4	0	1	<b>5</b>
20	0.8	0.0	0.2	<b>1.0</b>	4	0	1	<b>5</b>

Source: BDO EconSearch

### 4.4. Yorke and Mid North

#### 4.4.1. Aggregated impacts

The aggregated activity includes:

- Reduced wild dog management activities on-property by pastoralists
- Increased productivity in sheep operations.

Detailed economic impacts are presented in terms of GRP and employment (fte) in Table 4-7.

In the Yorke and Mid North region small negative impacts from reduced expenditures on wild dog management by pastoralists is offset by increased income and expenditure from improved productivity on sheep properties.

With regard to GRP, modest positive impacts occur in the first year with the expected impact on total GRP of around \$0.1 million, including flow-on effects. This is expected to increase to around \$0.52 million in the 10<sup>th</sup> year and \$1.2 million in the twentieth year. In terms of total employment, the expected impact in year 1 is less than 1 fte jobs, including flow-on effects. This is expected to increase to 3 fte jobs in the 10th year and 6 fte jobs in the twentieth year.

**Table 4-7 Annual economic impacts of the Dog Fence replacement project, Yorke and Mid North - aggregated activity, GRP and Employment (fte)**

Year	Gross Regional Product (\$m)				Employment (fte)			
	Direct	Prod. Induced	Cons. Induced	Total	Direct	Prod. Induced	Cons. Induced	Total
1	0.0	0.0	0.0	<b>0.1</b>	0	0	0	<b>0</b>
2	0.1	0.0	0.0	<b>0.1</b>	0	0	0	<b>1</b>
3	0.1	0.0	0.0	<b>0.2</b>	1	0	0	<b>1</b>
4	0.2	0.0	0.0	<b>0.2</b>	1	0	0	<b>1</b>
5	0.2	0.0	0.0	<b>0.3</b>	1	0	0	<b>1</b>
10	0.5	0.0	0.1	<b>0.6</b>	2	0	1	<b>3</b>
15	0.8	0.0	0.1	<b>0.9</b>	3	0	1	<b>5</b>
20	1.0	0.0	0.2	<b>1.2</b>	5	0	1	<b>6</b>

Source: BDO EconSearch

## 4.5. Murray and Mallee

### 4.5.1. Aggregated impacts

The aggregated activity includes:

- Reduced wild dog management activities on-property by pastoralists
- Increased productivity in sheep operations.

Detailed economic impacts are presented in terms of GRP and employment (fte) in Table 4-8.

In the Murray and Mallee region small negative impacts from reduced expenditures on wild dog management by pastoralists is offset by increased income and expenditure from improved productivity on sheep properties.

With regard to GRP, modest positive impacts occur in the first year with the expected impact on total GRP of around \$0.1 million, including flow-on effects. This is expected to increase to around \$0.5 million in the 10<sup>th</sup> year and \$0.9 million in the twentieth year. In terms of total employment, the expected impact in year 1 is less than 1 fte jobs, including flow-on effects. This is expected to increase to 3 fte jobs in the 10th year and 4 fte jobs in the twentieth year.

**Table 4-8 Annual economic impacts of the Dog Fence replacement project, Murray and Mallee - aggregated activity, GRP and Employment (fte)**

Year	Gross Regional Product (\$m)				Employment (fte)			
	Direct	Prod. Induced	Cons. Induced	Total	Direct	Prod. Induced	Cons. Induced	Total
1	0.1	0.0	0.0	<b>0.1</b>	0	0	0	<b>0</b>
2	0.1	0.0	0.0	<b>0.2</b>	1	0	0	<b>1</b>
3	0.2	0.0	0.0	<b>0.3</b>	1	0	0	<b>1</b>
4	0.3	0.0	0.0	<b>0.3</b>	1	0	0	<b>2</b>
5	0.4	0.0	0.1	<b>0.4</b>	2	0	1	<b>2</b>
10	0.5	0.0	0.1	<b>0.6</b>	2	0	1	<b>3</b>
15	0.6	0.0	0.1	<b>0.7</b>	3	0	1	<b>4</b>
20	0.7	0.0	0.1	<b>0.9</b>	3	0	1	<b>4</b>

Source: BDO EconSearch

## 4.6. Limestone Coast

### 4.6.1. Aggregated impacts

The aggregated activity includes:

- Reduced wild dog management activities on-property by pastoralists
- Increased productivity in sheep operations.

Detailed economic impacts are presented in terms of GRP and employment (fte) in Table 4-9.

In the Yorke and Mid North region small negative impacts from reduced expenditures on wild dog management by pastoralists is offset by increased income and expenditure from improved productivity on sheep properties.

With regard to GRP, modest positive impacts occur in the fourth year with the expected impact on total GRP of around \$0.1 million, including flow-on effects. This is expected to increase to around \$0.1 million in the 10<sup>th</sup> year and \$0.4 million in the twentieth year. In terms of total employment, the expected impact in year 1 is less than 1 fte jobs, including flow-on effects. This is expected to still be less than 1 fte jobs in the 10th year and 2 fte jobs in the twentieth year.

**Table 4-9 Annual economic impacts of the Dog Fence replacement project, Limestone Coast- aggregated activity, GRP and Employment (fte)**

Year	Gross Regional Product (\$m)				Employment (fte)			
	Direct	Prod. Induced	Cons. Induced	Total	Direct	Prod. Induced	Cons. Induced	Total
1	0.0	0.0	0.0	<b>0.0</b>	0	0	0	<b>0</b>
2	0.0	0.0	0.0	<b>0.0</b>	0	0	0	<b>0</b>
3	0.0	0.0	0.0	<b>0.0</b>	0	0	0	<b>0</b>
4	0.0	0.0	0.0	<b>0.1</b>	0	0	0	<b>0</b>
5	0.1	0.0	0.0	<b>0.1</b>	0	0	0	<b>0</b>
10	0.1	0.0	0.0	<b>0.1</b>	0	0	0	<b>0</b>
15	0.2	0.0	0.0	<b>0.3</b>	1	0	0	<b>1</b>
20	0.4	0.0	0.1	<b>0.4</b>	2	0	0	<b>2</b>

Source: BDO EconSearch

## 4.7. Adelaide and Fleurieu

### 4.7.1. Aggregated impacts

The aggregated activity includes:

- Reduced wild dog management activities on-property by pastoralists
- Increased productivity in sheep operations.

Detailed economic impacts are presented in terms of GRP and employment (fte) in Table 4-6.

In the Adelaide and Fleurieu region small negative impacts from reduced expenditures on wild dog management by pastoralists is offset by increased income and expenditure from improved productivity on sheep properties.

**Table 4-10 Annual economic impacts of the Dog Fence replacement project, Adelaide and Fleurieu - aggregated activity, GRP and Employment (fte)**

Year	Gross Regional Product (\$m)				Employment (fte)			
	Direct	Prod. Induced	Cons. Induced	Total	Direct	Prod. Induced	Cons. Induced	Total
1	0.0	0.0	0.0	<b>0.0</b>	0	0	0	<b>0</b>
2	0.0	0.0	0.0	<b>0.0</b>	0	0	0	<b>0</b>
3	0.0	0.0	0.0	<b>0.0</b>	0	0	0	<b>0</b>
4	0.0	0.0	0.0	<b>0.0</b>	0	0	0	<b>0</b>
5	0.0	0.0	0.0	<b>0.0</b>	0	0	0	<b>0</b>
10	0.0	0.0	0.0	<b>0.0</b>	0	0	0	<b>0</b>
15	0.2	0.0	0.0	<b>0.2</b>	1	0	0	<b>1</b>
20	0.3	0.0	0.1	<b>0.4</b>	2	0	0	<b>2</b>

Source: BDO EconSearch



With regard to GRP, modest positive impacts occur by the 15th year with the expected impact on total GRP of around \$0.2 million, including flow-on effects. This is expected to increase to around \$0.4 million in the twentieth year. In terms of total employment, the expected impact in year 1 is less than 1 fte jobs, including flow-on effects. This is expected to still be less than 1 fte jobs in the 10th year and 2 fte jobs in the twentieth year.

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### Disclaimer

The assignment is a consulting engagement as outlined in the 'Framework for Assurance Engagements', issued by the Auditing and Assurances Standards Board, Section 17. Consulting engagements employ an assurance practitioner's technical skills, education, observations, experiences and knowledge of the consulting process. The consulting process is an analytical process that typically involves some combination of activities relating to: objective-setting, fact-finding, definition of problems or opportunities, evaluation of alternatives, development of recommendations including actions, communication of results, and sometimes implementation and follow-up.

The nature and scope of work has been determined by agreement between BDO and the Client. This consulting engagement does not meet the definition of an assurance engagement as defined in the 'Framework for Assurance Engagements', issued by the Auditing and Assurances Standards Board, Section 10.

Except as otherwise noted in this report, we have not performed any testing on the information provided to confirm its completeness and accuracy. Accordingly, we do not express such an audit opinion and readers of the report should draw their own conclusions from the results of the review, based on the scope, agreed-upon procedures carried out and findings.

## APPENDIX 1 AN OVERVIEW OF ECONOMIC IMPACT ANALYSIS USING THE INPUT-OUTPUT METHOD

Economic impact analysis based on an I-O model provides a comprehensive economic framework that is extremely useful in the resource planning process. Broadly, there are two ways in which the I-O method can be used.

First, the I-O model provides a numerical picture of the size and shape of an economy and its essential features. The I-O model can be used to describe some of the important features of an economy, the interrelationships between sectors and the relative importance of the individual sectors.

Second, I-O model is used to calculate industry multipliers that can then be applied to various development or change scenarios.

### The input-output database

I-O analysis, as an accounting system of inter-industry transactions, is based on the notion that no industry exists in isolation. This assumes, within any economy, each firm depends on the existence of other firms to purchase inputs from, or sell products to, for further processing. The firms also depend on final consumers of the product and labour inputs to production. An I-O database is a convenient way to illustrate the purchases and sales of goods and services taking place in an economy at a given point in time.

As noted above, I-O models provide a numerical picture of the size and shape of the economy. Products produced in the economy are aggregated into a number of groups of industries and the transactions between them recorded in the transaction table. The rows and columns of the I-O table can be interpreted in the following way:

- The rows of the I-O table illustrate sales for intermediate usage (i.e. to other firms in the region) and for final demand (e.g. household consumption, exports or capital formation).
- The columns of the I-O table illustrate purchases of intermediate inputs (i.e. from other firms in the region), imported goods and services and purchases of primary inputs (i.e. labour, land and capital).
- Each item is shown as a purchase by one sector and a sale by another, thus constructing two sides of a double accounting schedule.

In summary, the I-O model can be used to describe some of the important features of a state or regional economy, the interrelationships between sectors and the relative importance of the individual sectors. The model is also used for the calculation of sector multipliers and the estimation of economic impacts arising from some change in the economy.

### Using input-output analysis for estimation of economic impacts

The I-O model conceives the economy of the region as being divided up into a number of sectors and this allows the analyst to trace expenditure flows. To illustrate this, consider the example of a vineyard that, in the course of its operation, purchases goods and services from other sectors. These goods and services would include fertiliser, chemicals, transport services, and, of course, labour. The direct employment created by the vineyard is regarded in the model as an expenditure flow into the household sector, which is one of several non-industrial sections recognised in the I-O model.

Upon receiving expenditure by the vineyard, the other sectors in the regional economy engage in their own expenditures. For example, as a consequence of winning a contract for work with vineyard, a spraying contractor buys materials from its suppliers and labour from its own employees. Suppliers and employees in turn engage in further expenditure, and so on. These indirect and induced (or flow-on) effects, as they are called, are part of the impact of the vineyard on the regional economy. They must be added to the direct effects (which are expenditures made in immediate support of the vineyard itself) in order to arrive at a measure of the total impact of the vineyard.

It may be thought that these flow-on effects (or impacts) go on indefinitely and that their amount adds up without limit. The presence of leakages, however, prevents this from occurring. In the context of the impact on a regional economy, an important leakage is expenditure on imports, that is, products or services that originate from outside the region, state or country (e.g. machinery).

Thus, some of the expenditure by the vineyard (i.e. expenditure on imports to the region) is lost to the regional economy. Consequently, the flow-on effects get smaller and smaller in successive expenditure rounds due to this and other leakages. Hence the total expenditure created in the regional economy is limited in amount, and so (in principle) it can be measured.

Using I-O analysis or estimation of regional economy impacts requires a great deal of information. The analyst needs to know the magnitude of various expenditures and where they occur. Also needed is information on how the sectors receiving this expenditure share their expenditures amount the various sectors from whom they buy, and so on, for the further expenditure rounds.

In applying the I-O model to economic impact analysis, the stranded procedure is to determine the direct or first-round expenditure in subsequent expenditures only. No attempt is made to pursue such inquiries on expenditure in subsequent rounds, not even, for example, to trace the effects in the regional economy on household expenditures by vineyard employees on food, clothing, entertainment and so on, as it is impracticable to measure these effects for an individual case, here the vineyard.

The I-O model is instead based on a set of assumptions about constant and uniform proportions of expenditure. If households in general in the regional economy spend, for example, 13.3 per cent of their income on food and non-alcoholic beverages, it is assumed that those working in vineyards do likewise. Indeed, the effects of all expenditure rounds after the first are calculated by using such standard propositions (i.e. multiplier calculations). Once a transaction table has been compiled, simple mathematical procedures can be applied to derive multipliers for each sector in the economy.

### **Input-output multipliers**

I-O multipliers are an indication of the strength of the linkages between a particular sector and the rest of the state or regional economy. As well, they can be used to estimate the impact of a change in that particular sector on the rest of the economy.

Detailed explanations on calculating I-O multipliers, including the underlying assumptions, are provided in any regional economics or I-O analysis textbook (see, for example, Jensen and West 1986)). They are calculated through a routine set of mathematical operations based on coefficients derived from the I-O transactions model, as outlined below.

The transactions table may be represented by a series of equations thus:

$$X_1 = X_{11} + X_{12} + \dots + X_{1n} + Y_1$$

$$X_2 = X_{21} + X_{22} + \dots + X_{2n} + Y_2$$

$$X_n = X_{n1} + X_{n2} + \dots + X_{nn} + Y_n$$

Where:  $X_i$  = total output of intermediate sector  $i$  (row totals);  
 $X_{ij}$  = output of sector  $i$  purchased by sector  $j$  (elements of the intermediate quadrant); and  
 $Y_j$  = total final demand for the output of sector  $i$ .

It is possible, by dividing the elements of the columns of the transactions table by the respective column totals to derive coefficients, which represent more clearly the purchasing pattern of each sector. These coefficients, termed 'direct' or 'I-O' coefficients, are normally denoted as  $a_{ij}$ , and represent the direct or first round requirements from the output of each sector following an increase in output of any sector.

In equation terms the model becomes:

$$X_1 = a_{11}X_1 + a_{12}X_2 + \dots + a_{1n}X_n + Y_1$$

$$X_2 = a_{21}X_1 + a_{22}X_2 + \dots + a_{2n}X_n + Y_2$$

$$X_n = a_{n1}X_1 + a_{n2}X_2 + \dots + a_{nn}X_n + Y_n$$

where  $a_{ij}$  (the direct coefficient) =  $X_{ij}/X_j$ . this may be represented in matrix terms:

$$X = AX + Y$$

where  $A = [a_{ij}]$ , the matrix of direct coefficients.

The previous equation can be extended to:

$$(I-A)X = Y$$

where  $(I-A)$  is termed the Leontief matrix,

$$\text{or } X = (I-A)^{-1}Y$$

where  $(I-A)^{-1}$  is termed the 'general solution', the 'Leontief inverse' or simply the inverse of the open model.

The general solution is often represented by:

$$Z = (I-A)^{-1} = [z_{ij}]$$

The I-O table can be 'closed' with respect to certain elements of the table. Closure involves the transfer of items from the exogenous portions of the table (final demand and primary input quadrants) to the endogenous section of the table (intermediate quadrant). This implies that the analyst considers that the transferred item is related more to the level of local activity than to external influences. Closure of I-O tables with respect to households is common and has been adopted in this project.

The 'closed' direct coefficients matrix may be referred to as  $A^*$ . The inverse of the Leontief matrix formed from  $A^*$  is given by:

$$Z^* = (I - A^*)^{-1} = [z^*_{ij}]$$

$Z^*$  is referred to as the 'closed inverse' matrix.

A multiplier is essentially a measurement of the impact of an economic stimulus. In the case of I-O multipliers the stimulus is normally assumed to be an increase of one dollar in sales to final demand by a

sector. The impact in terms of output, contribution to gross regional product, household income and employment can be identified in the categories discussed below.

- (i) The initial impact: refers to the assumed dollar increase in sales. It is the stimulus or the cause of the impacts. It is the unity base of the output multiplier and provides the identity matrix of the Leontief matrix. Associated directly with this dollar increase in output is an own-sector increase in household income (wages and salaries, drawings by owner operators etc.) used in the production of that dollar. This is the household income coefficient  $h_j$ . Household income, together with other value added (OVA), provide the total gross regional product from the production of that dollar of output. The gross regional product coefficient is denoted  $v_j$ . Associated also will be an own-sector increase in employment, represented by the size of the employment coefficient. This employment coefficient  $e_j$  represents an employment/output ratio and is usually calculated as 'employment per million dollars of output'.
- (ii) The first round impact: refers to the effect of the first round of purchases by the sector providing the additional dollar of output. In the case of the output multiplier this is shown by the direct coefficients matrix  $[a_{ij}]$ . The disaggregated effects are given by individual  $a_{ij}$  coefficients and the total first-round effect by  $\sum a_{ij}$ . First-round household income effects are calculated by multiplying the first-round output effects by the appropriate household income coefficient ( $h_j$ ). Similarly, the first-round gross regional product and employment effects are calculated by multiplying the first-round output effects by the appropriate gross regional product ( $v_j$ ) and employment ( $e_j$ ) coefficients.
- (iii) Industrial-support impacts. This term is applied to 'second and subsequent round' effects as successive waves of output increases occur in the economy to provide industrial support, as a response to the original dollar increase in sales to final demand. The term excludes any increases caused by increased household consumption. Output effects are calculated from the open Z inverse, as a measure of industrial response to the first-round effects. The industrial-support output requirements are calculated as the elements of the columns of the Z inverse, less the initial dollar stimulus and the first-round effects. The industrial support household income, gross regional product and employment effects are defined as the output effects multiplied by the respective household income, gross regional product and employment coefficients. The first-round and industrial-support impacts are together termed the production-induced impacts.
- (iv) Consumption-induced impacts: are defined as those induced by increased household income associated with the original dollar stimulus in output. The consumption-induced output effects are calculated in disaggregated form as the difference between the corresponding elements in the open and closed inverse (i.e.  $z^*_{ij} - z_{ij}$ , and in total as  $\sum(z^*_{ij} - z_{ij})$ ). The consumption-induced household income, gross regional product and employment effects are simply the output effects multiplied by the respective household income, gross regional product and employment coefficients.
- (v) Flow-on impacts: are calculated as total impact less the initial impact. This allows for the separation of cause and effect' factors in the multipliers. The cause of the impact is given by the initial impact (the original dollar increase in sales to final demand), and the effect is represented by the first-round, industrial-support and consumption-induced effects, which together constitute the flow-on effects.

Each of the five impacts are summarised in Appendix Table 1 -. It should be noted that household income, gross regional product and employment multipliers are parallel concepts, differing only by their respective coefficients  $h_j$ ,  $v_j$  and  $e_j$ .

The output multipliers are calculated on a 'per unit of initial effect' basis (i.e. output responses to a one-dollar change in output). Household income, gross regional product and employment multipliers, as described above, refer to changes in household income per initial change in output, changes to gross regional product per initial change in output and changes in employment per initial change in output. These multipliers are conventionally converted to ratios, expressing a 'per unit' measurement, and described as Type I and Type II ratios. For example, with respect to employment:

Type I employment ratio = [initial + first round + industrial support]/initial

and

Type II employment ratio = [initial + production induced + consumption induced]/initial

**Appendix Table 1 -1 The structure of input-output multipliers for sector  $\bar{A}$**

Impacts	General formula
<i>Output multipliers (\$)</i>	
Initial	1
First-round	$\sum_i a_{ij}$
Industrial-support	$\sum_i z_{ij} - 1 - \sum_i a_{ij}$
Consumption-induced	$\sum_i z'_{ij} - \sum_i z_{ij}$
Total	$\sum_i z'_{ij}$
Flow-on	$\sum_i z'_{ij} - 1$
<i>Household Income multipliers (\$)</i>	
Initial	$h_j$
First-round	$\sum_i a_{ij} h_i$
Industrial-support	$\sum_i z_{ij} h_i - h_j - \sum_i a_{ij} h_i$
Consumption-induced	$\sum_i z'_{ij} h_i - \sum_i z_{ij} h_i$
Total	$\sum_i z'_{ij} h_i$
Flow-on	$\sum_i z'_{ij} h_i - h_j$

*Gross regional product multipliers (\$)*

Initial	$V_j$
First-round	$\sum_i a_{ij} V_i$
Industrial-support	$\sum_i Z_{ij} V_i - V_j - \sum_i a_{ij} V_i$
Consumption-induced	$\sum_i Z'_{ij} V_i - \sum_i Z_{ij} V_i$
Total	$\sum_i Z'_{ij} V_i$
Flow-on	$\sum_i Z'_{ij} V_i - V_j$

*Employment multipliers (full time equivalents)*

Initial	$e_j$
First-round	$\sum_i a_{ij} e_i$
Industrial-support	$\sum_i Z_{ij} e_i - e_j - \sum_i a_{ij} e_i$
Consumption-induced	$\sum_i Z'_{ij} e_i - \sum_i Z_{ij} e_i$
Total	$\sum_i Z'_{ij} e_i$
Flow-on	$\sum_i Z'_{ij} e_i - e_j$

<sup>a</sup> In a DECON model,  $Z'$  (the 'closed inverse' matrix), includes a population and an unemployed row and column (see below for details).

**Model assumptions**

There are a number of important assumptions in the I-O model that are relevant in interpreting the analytical results.

- Industries in the model have a linear production function, which implies constant returns to scale and fixed input proportions.
- Another model assumption is that firms within a sector are homogeneous, which implies they produce a fixed set of products that are not produced by any other sector and that the input structure of the firms is the same. Thus it is preferable to have as many sectors as possible specified in the models and the standard models for this study were compiled with 66 sectors (see Appendix 1 for further detail).
- The model is a static model that does not take account of the dynamic processes involved in the adjustment to an external change, such as a permanent change in natural resources management.

## Extending the standard economic impact model as a DECON model

Based on work undertaken by EconSearch (2009 and 2010a) and consistent with Mangan and Phibbs (1989), the I-O model developed for this project was extended as demographic-economic (DECON) model. The two key characteristics of the DECON model, when compared with a standard economic model, are as follows.

1. The introduction of a population 'sector' (or row and column in the model) makes it possible to estimate the impact on local population levels of employment growth or decline.
2. The introduction of an unemployed 'sector' makes it possible to account for the consumption-induced impact of the unemployed in response to economic growth or decline.

### The population 'sector'

The introduction of a population 'sector' to the standard I-O model allows for the calculation of population multipliers. These multipliers measure the flow-on population impact resulting from an initial population change attributable to employment growth or decline in a particular sector of the regional economy.

Calculation of population multipliers is made possible by inclusion of a population row and column in the 'closed' direct coefficients matrix of the I-O model.

Population row: the population coefficient ( $p_j$ ) for sector  $j$  of the DECON model is represented as:

$$P_j = -rho_j * e_j * family\ size_j$$

where  $rho_j$  = the proportion of employees in sector  $j$  who remain in the region after they lose their job (negative employment impact) or the proportion of new jobs in sector  $j$  filled by previously unemployed locals (positive employment impact);

$e_j$  = the employment coefficient for sector  $j$ ; and

$family\ size_j$  = average family size for sector  $j$ .

**Population column:** the population column of the DECON model is designed to account for growth or decline in those sectors of the economy that are primarily population-driven (i.e. influenced by the size of the population) rather than market-driven (i.e. dependent upon monetary transactions). Clearly, many of the services provided by the public sector fit this description and, for the purpose of this analysis, it was assumed that the following intermediate sectors were primarily population-driven:

- public administration and defence;
- education;
- health and community services; and
- cultural and recreational services.

Thus, the non-market coefficient for sector  $j$  of the DECON model is represented as expenditure on that non-market service (by governments) in \$million per head of population.

The population multiplier for sector  $j$  is represented as:  $Z^*_{pj} / p_{pj}$

where  $Z^*_{pj}$  = coefficient of the 'closed inverse' matrix in the population row for sector  $j$ ; and

$p_{pj}$  = coefficient of the direct coefficients matrix in the population row for sector  $j$ .

Sources of local data for the population sector of the DECON models used in this project included the following.

- rho: little or no published data are available to assist with estimation of this variable, particularly at a regional level. The DECON models have been constructed to enable the analyst to estimate this variable on the basis of the availability superior data or assumptions.
- Family size: in order to estimate average family size by industry, relevant data were extracted from the Australian Bureau of Statistics 2006 Census of Population and Housing using the TableBuilder database. These data were modified by the consultants in order to ensure consistency with the specification and conventions of the I-O models.

### The unemployed 'sector'

As outlined above, the introduction of an unemployed 'sector' to the standard I-O model makes it possible to account for the consumption-induced impact of the unemployed in response to economic growth or decline.

Through the inclusion of an unemployed row and column in the 'closed' direct coefficients matrix of the standard I-O model it is possible to calculate Type III multipliers (for output, gross regional product, household income and employment).

The key point to note is that, in the situation where at least some of the unemployed remain in a region after losing their job (negative employment impact) or some of the new jobs in a region are filled by previously unemployed locals (positive employment impact), Type III multipliers will be smaller than the more frequently used Type II multipliers.

**Unemployed row:** the unemployed coefficient ( $u_j$ ) for sector  $j$  of the DECON model is represented as:

$$u_j = -rho_j * (1-ess_j) * e_j$$

where  $rho_j$  = the proportion of employees in sector  $j$  who remain in the region after they lose their job (negative employment impact) or the proportion of new jobs in sector  $j$  filled by previously unemployed locals (positive employment impact);

$ess_j$  = the proportion of employed in sector  $j$  who are not eligible for welfare benefits when they lose their job; and

$e_j$  = the employment coefficient for sector  $j$ .

**Unemployed column:** the unemployed column of the DECON model is an approximation of total consumption expenditure and the consumption pattern of the unemployed. It is represented as dollars per unemployed person rather than \$million for the region as a whole, as is the case for the household expenditure column in a standard I-O model.

Sources of local (i.e. state and regional) data for the unemployed sector of the DECON models used in this study included the following.

- ess: in order to estimate the proportion of employed by industry who are not eligible for welfare benefits when they lose their job, relevant data were extracted from the Australian Bureau of Statistics 2006 Census of Population and Housing using the TableBuilder database. These data were

modified by the consultants in order to ensure consistency with the specification and conventions of the I-O models.

- Unemployed consumption: total consumption expenditure by the unemployed was based on an estimate of the Newstart Allowance whilst the pattern of consumption expenditure was derived from household income quintiles in the 2003/04 Household Expenditure Survey (ABS 2006).

### **Incorporating a tourism demand profile in the I-O model**

Tourism expenditure is a measure of the value of sales of goods and services to visitors to the state or region. The following method and data sources were used to estimate tourism expenditure by industry sector for the region.

- The primary data were sourced from Tourism Research Australia (TRA).
- Base datasets included total tourism expenditure by TRA tourism region and average expenditure profiles, by region, across a range of goods and services (e.g. food and drink, fuel, shopping, etc.).
- Estimates were available for domestic day, domestic overnight and international visitor expenditure.
- The first adjustment to the base data was the development of a concordance between the TRA tourism regions and I-O model regions and the allocation of these base data to the relevant I-O model region. These allocations were based, in turn, on an ABS concordance between TRA tourism regions and SLAs.
- The second adjustment to the base data was the application of a more detailed expenditure breakdown from the ABS Australian National Accounts: Tourism Satellite Account for both domestic and international visitor expenditure (ABS 2010d).
- The third adjustment to the base data was the conversion of tourism expenditure estimates from purchasers to basic prices (i.e. reallocation of net taxes (taxes minus subsidies) and marketing and transport margins) to make the data consistent with accounting conventions used in the national, state and regional I-O models. Purchasers' to basic price ratios for tourism expenditure categories were derived from ABS data.
- The final adjustment to the base data was the allocation of the tourism expenditure data in basic prices to the relevant input-output sectors (intermediate sectors, taxes less subsidies or imports) in which the expenditure occurred, thus compiling a profile of sales to final demand. This process was undertaken for each type of tourism expenditure (domestic day, domestic overnight and international visitor) and the results aggregated to form a single tourism demand profile. Profiles were developed at the state and regional levels.

### **Constructing a RISE v3.0 economic impact model**

In the final model construction stage the data described above were incorporated into a *Microsoft Excel*<sup>®</sup> spreadsheet based economic impact model for the region and state (i.e. *RISE v3.0*)<sup>7</sup>. This model allows for description of the structure of the economy. It can also be used for the estimation of economic impacts over time in response to the introduction of a new industry or a change in the final demand for the output of one or many sectors. Model assumptions can be modified to account for:

- price changes between the model construction year (2009/10) and the base year for the analysis;

- labour productivity changes over time (as above and for the subsequent years);
- the level of regional migration (e.g. for a positive employment impact, the proportion of new jobs filled by previously unemployed locals).



## APPENDIX 2 DETAILED CBA MODEL



Appendix Table 2-1 Detailed CBA model, Scenario 1<sup>a</sup>

	PV	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2032/33	2033/34	2034/35	2035/36	2036/37	2037/38
<b>Base Case (without Fence replacement)</b>																	
<b>Benefits (\$)</b>																	
Sheep enterprise sales income	9,411.5	775.0	774.9	774.8	774.7	774.5	774.4	774.3	774.2	774.1	774.0	773.3	773.1	773.0	772.9	772.7	772.6
<b>Total Benefits (\$)</b>	<b>9,411.5</b>	<b>775.0</b>	<b>774.9</b>	<b>774.8</b>	<b>774.7</b>	<b>774.5</b>	<b>774.4</b>	<b>774.3</b>	<b>774.2</b>	<b>774.1</b>	<b>774.0</b>	<b>773.3</b>	<b>773.1</b>	<b>773.0</b>	<b>772.9</b>	<b>772.7</b>	<b>772.6</b>
<b>Costs (\$)</b>																	
Fence maintenance costs	13.7	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Area-wide wild dog management costs	11.3	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Private wild dog management costs	69.8	2.7	3.1	3.5	3.9	4.3	4.7	5.0	5.4	5.7	6.1	8.3	8.8	9.2	9.7	10.2	10.6
Sheep enterprise operating costs	3,894.5	320.7	320.7	320.6	320.5	320.5	320.5	320.4	320.4	320.3	320.3	320.0	319.9	319.9	319.8	319.7	319.7
<b>Total Costs (\$)</b>	<b>3,989.3</b>	<b>325.5</b>	<b>325.8</b>	<b>326.2</b>	<b>326.5</b>	<b>326.9</b>	<b>327.2</b>	<b>327.5</b>	<b>327.8</b>	<b>328.1</b>	<b>328.4</b>	<b>330.4</b>	<b>330.8</b>	<b>331.2</b>	<b>331.6</b>	<b>332.0</b>	<b>332.4</b>
<b>Option 1 (with Fence replacement)</b>																	
<b>Benefits (\$)</b>																	
Residual value of project capital	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.3
Sheep enterprise sales income	9,431.6	775.3	775.4	775.5	775.6	775.8	775.9	775.9	775.9	775.9	775.9	775.9	775.9	775.9	775.9	775.9	775.9
<b>Total Benefits (\$)</b>	<b>9,435.0</b>	<b>775.3</b>	<b>775.4</b>	<b>775.5</b>	<b>775.6</b>	<b>775.8</b>	<b>775.9</b>	<b>786.2</b>									
<b>Costs (\$)</b>																	
Fence replacement costs	23.2	2.3	11.4	11.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fence maintenance costs	13.7	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Area-wide wild dog management costs	11.3	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Private wild dog management costs	5.4	1.9	1.5	1.2	0.8	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sheep enterprise operating costs	3,902.8	320.8	320.9	320.9	321.0	321.0	321.1	321.1	321.1	321.1	321.1	321.1	321.1	321.1	321.1	321.1	321.1
<b>Total Costs (\$)</b>	<b>3,956.3</b>	<b>327.1</b>	<b>335.9</b>	<b>335.5</b>	<b>323.8</b>	<b>323.5</b>	<b>323.1</b>										
<b>Incremental Benefits (\$)</b>	<b>23.5</b>	<b>0.2</b>	<b>0.5</b>	<b>0.7</b>	<b>1.0</b>	<b>1.2</b>	<b>1.5</b>	<b>1.6</b>	<b>1.7</b>	<b>1.8</b>	<b>1.9</b>	<b>2.6</b>	<b>2.7</b>	<b>2.9</b>	<b>3.0</b>	<b>3.2</b>	<b>13.6</b>
<b>Incremental Costs (\$)</b>	<b>-32.9</b>	<b>1.6</b>	<b>10.0</b>	<b>9.3</b>	<b>-2.8</b>	<b>-3.5</b>	<b>-4.1</b>	<b>-4.4</b>	<b>-4.7</b>	<b>-5.0</b>	<b>-5.3</b>	<b>-7.3</b>	<b>-7.7</b>	<b>-8.1</b>	<b>-8.4</b>	<b>-8.8</b>	<b>-9.2</b>
<b>Net Benefits (NPV) (\$)</b>	<b>56.4</b>	<b>-1.4</b>	<b>-9.5</b>	<b>-8.6</b>	<b>3.7</b>	<b>4.7</b>	<b>5.6</b>	<b>6.0</b>	<b>6.4</b>	<b>6.8</b>	<b>7.2</b>	<b>9.9</b>	<b>10.4</b>	<b>10.9</b>	<b>11.5</b>	<b>12.0</b>	<b>22.9</b>
<b>Benefit Cost Ratio (BCR)</b>	<b>-0.7</b>																
<b>Internal Rate of Return (IRR)</b>	<b>26%</b>																

<sup>a</sup> Years 2025/26 to 2030/31 are hidden for presentational purposes.

Source: BDO EconSearch Analysis



Appendix Table 2-2 Detailed CBA model, Scenario 2<sup>a</sup>

	PV	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2032/33	2033/34	2034/35	2035/36	2036/37	2037/38
<b>Base Case (without Fence replacement)</b>																	
<b>Benefits (\$)</b>																	
Sheep enterprise sales income	9,389.7	774.2	773.9	773.7	773.4	773.2	773.0	772.7	772.5	772.3	772.1	770.7	770.4	770.1	769.8	769.6	769.3
<b>Total Benefits (\$)</b>	<b>9,389.7</b>	<b>774.2</b>	<b>773.9</b>	<b>773.7</b>	<b>773.4</b>	<b>773.2</b>	<b>773.0</b>	<b>772.7</b>	<b>772.5</b>	<b>772.3</b>	<b>772.1</b>	<b>770.7</b>	<b>770.4</b>	<b>770.1</b>	<b>769.8</b>	<b>769.6</b>	<b>769.3</b>
<b>Costs (\$)</b>																	
Fence maintenance costs	13.7	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Area-wide wild dog management costs	11.3	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Private wild dog management costs	69.8	2.7	3.1	3.5	3.9	4.3	4.7	5.0	5.4	5.7	6.1	8.3	8.8	9.2	9.7	10.2	10.6
Sheep enterprise operating costs	3,885.5	320.4	320.3	320.1	320.0	319.9	319.8	319.8	319.7	319.6	319.5	318.9	318.8	318.7	318.6	318.4	318.3
<b>Total Costs (\$)</b>	<b>3,980.3</b>	<b>325.1</b>	<b>325.4</b>	<b>325.7</b>	<b>326.0</b>	<b>326.3</b>	<b>326.6</b>	<b>326.9</b>	<b>327.1</b>	<b>327.4</b>	<b>327.6</b>	<b>329.3</b>	<b>329.6</b>	<b>330.0</b>	<b>330.3</b>	<b>330.7</b>	<b>331.0</b>
<b>Option 1 (with Fence replacement)</b>																	
<b>Benefits (\$)</b>																	
Residual value of project capital	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.3
Sheep enterprise sales income	9,429.9	774.7	774.9	775.2	775.4	775.6	775.9	775.9	775.9	775.9	775.9	775.9	775.9	775.9	775.9	775.9	775.9
<b>Total Benefits (\$)</b>	<b>9,433.3</b>	<b>774.7</b>	<b>774.9</b>	<b>775.2</b>	<b>775.4</b>	<b>775.6</b>	<b>775.9</b>	<b>786.2</b>									
<b>Costs (\$)</b>																	
Fence replacement costs	23.2	2.3	11.4	11.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fence maintenance costs	13.7	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Area-wide wild dog management costs	11.3	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Private wild dog management costs	5.4	1.9	1.5	1.2	0.8	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sheep enterprise operating costs	3,902.1	320.6	320.7	320.8	320.9	321.0	321.1	321.1	321.1	321.1	321.1	321.1	321.1	321.1	321.1	321.1	321.1
<b>Total Costs (\$)</b>	<b>3,955.6</b>	<b>326.8</b>	<b>335.7</b>	<b>335.4</b>	<b>323.7</b>	<b>323.4</b>	<b>323.1</b>										
<b>Incremental Benefits (\$)</b>	<b>43.6</b>	<b>0.5</b>	<b>1.0</b>	<b>1.5</b>	<b>2.0</b>	<b>2.5</b>	<b>2.9</b>	<b>3.1</b>	<b>3.4</b>	<b>3.6</b>	<b>3.8</b>	<b>5.2</b>	<b>5.5</b>	<b>5.8</b>	<b>6.0</b>	<b>6.3</b>	<b>16.9</b>
<b>Incremental Costs (\$)</b>	<b>-24.6</b>	<b>1.7</b>	<b>10.2</b>	<b>9.6</b>	<b>-2.4</b>	<b>-2.9</b>	<b>-3.5</b>	<b>-3.7</b>	<b>-4.0</b>	<b>-4.3</b>	<b>-4.5</b>	<b>-6.2</b>	<b>-6.5</b>	<b>-6.9</b>	<b>-7.2</b>	<b>-7.5</b>	<b>-7.9</b>
<b>Net Benefits (NPV) (\$)</b>	<b>68.2</b>	<b>-1.2</b>	<b>-9.2</b>	<b>-8.2</b>	<b>4.3</b>	<b>5.4</b>	<b>6.4</b>	<b>6.9</b>	<b>7.4</b>	<b>7.8</b>	<b>8.3</b>	<b>11.4</b>	<b>12.0</b>	<b>12.6</b>	<b>13.2</b>	<b>13.9</b>	<b>24.8</b>
<b>Benefit Cost Ratio (BCR)</b>	<b>-1.8</b>																
<b>Internal Rate of Return (IRR)</b>	<b>30%</b>																

<sup>a</sup> Years 2028/29 to 2031/32 are hidden for presentational purposes.

Source: BDO EconSearch Analysis



Appendix Table 2-3 Detailed CBA model, Scenario 3<sup>a</sup>

	PV	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2032/33	2033/34	2034/35	2035/36	2036/37	2037/38
<b>Base Case (without Fence replacement)</b>																	
<b>Benefits (\$)</b>																	
Sheep enterprise sales income	9,401.3	774.9	774.7	774.5	774.2	774.0	773.7	773.4	773.1	772.9	772.6	772.1	772.0	771.8	771.7	771.6	771.5
<b>Total Benefits (\$)</b>	<b>9,401.3</b>	<b>774.9</b>	<b>774.7</b>	<b>774.5</b>	<b>774.2</b>	<b>774.0</b>	<b>773.7</b>	<b>773.4</b>	<b>773.1</b>	<b>772.9</b>	<b>772.6</b>	<b>772.1</b>	<b>772.0</b>	<b>771.8</b>	<b>771.7</b>	<b>771.6</b>	<b>771.5</b>
<b>Costs (\$)</b>																	
Fence maintenance costs	13.7	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Area-wide wild dog management costs	11.3	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Private wild dog management costs	102.5	3.1	3.8	4.6	5.3	6.1	7.0	7.9	8.8	9.7	10.6	12.3	12.6	12.9	13.3	13.6	14.0
Sheep enterprise operating costs	3,890.2	320.7	320.6	320.5	320.4	320.3	320.2	320.0	319.9	319.8	319.7	319.5	319.4	319.4	319.3	319.3	319.3
<b>Total Costs (\$)</b>	<b>4,017.8</b>	<b>325.8</b>	<b>326.4</b>	<b>327.1</b>	<b>327.8</b>	<b>328.4</b>	<b>329.2</b>	<b>330.0</b>	<b>330.8</b>	<b>331.6</b>	<b>332.4</b>	<b>333.8</b>	<b>334.1</b>	<b>334.4</b>	<b>334.7</b>	<b>335.0</b>	<b>335.3</b>
<b>Option 1 (with Fence replacement)</b>																	
<b>Benefits (\$)</b>																	
Residual value of project capital	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.3
Sheep enterprise sales income	9,431.6	775.3	775.4	775.5	775.6	775.8	775.9	775.9	775.9	775.9	775.9	775.9	775.9	775.9	775.9	775.9	775.9
<b>Total Benefits (\$)</b>	<b>9,435.0</b>	<b>775.3</b>	<b>775.4</b>	<b>775.5</b>	<b>775.6</b>	<b>775.8</b>	<b>775.9</b>	<b>786.2</b>									
<b>Costs (\$)</b>																	
Fence replacement costs	23.2	2.3	11.4	11.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fence maintenance costs	13.7	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Area-wide wild dog management costs	11.3	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Private wild dog management costs	5.4	1.9	1.5	1.2	0.8	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sheep enterprise operating costs	3,902.8	320.8	320.9	320.9	321.0	321.0	321.1	321.1	321.1	321.1	321.1	321.1	321.1	321.1	321.1	321.1	321.1
<b>Total Costs (\$)</b>	<b>3,956.3</b>	<b>327.1</b>	<b>335.9</b>	<b>335.5</b>	<b>323.8</b>	<b>323.5</b>	<b>323.1</b>										
<b>Incremental Benefits (\$)</b>	<b>33.7</b>	<b>0.4</b>	<b>0.7</b>	<b>1.1</b>	<b>1.4</b>	<b>1.8</b>	<b>2.2</b>	<b>2.5</b>	<b>2.7</b>	<b>3.0</b>	<b>3.3</b>	<b>3.8</b>	<b>3.9</b>	<b>4.0</b>	<b>4.1</b>	<b>4.2</b>	<b>14.7</b>
<b>Incremental Costs (\$)</b>	<b>-61.5</b>	<b>1.3</b>	<b>9.4</b>	<b>8.4</b>	<b>-4.0</b>	<b>-5.0</b>	<b>-6.1</b>	<b>-6.9</b>	<b>-7.7</b>	<b>-8.4</b>	<b>-9.2</b>	<b>-10.7</b>	<b>-11.0</b>	<b>-11.3</b>	<b>-11.6</b>	<b>-11.9</b>	<b>-12.2</b>
<b>Net Benefits (NPV) (\$)</b>	<b>95.2</b>	<b>-1.0</b>	<b>-8.7</b>	<b>-7.4</b>	<b>5.4</b>	<b>6.7</b>	<b>8.3</b>	<b>9.3</b>	<b>10.4</b>	<b>11.5</b>	<b>12.5</b>	<b>14.5</b>	<b>14.9</b>	<b>15.3</b>	<b>15.7</b>	<b>16.1</b>	<b>26.8</b>
<b>Benefit Cost Ratio (BCR)</b>	<b>-0.5</b>																
<b>Internal Rate of Return (IRR)</b>	<b>39%</b>																

<sup>a</sup> Years 2028/29 to 2031/32 are hidden for presentational purposes.

Source: BDO EconSearch Analysis



Appendix Table 2-4 Detailed CBA model, Scenario 4<sup>a</sup>

	PV	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2032/33	2033/34	2034/35	2035/36	2036/37	2037/38
<b>Base Case (without Fence replacement)</b>																	
<b>Benefits (\$)</b>																	
Sheep enterprise sales income	9,369.3	774.0	773.5	773.0	772.6	772.1	771.5	771.0	770.4	769.8	769.3	768.2	768.0	767.8	767.6	767.4	767.2
<b>Total Benefits (\$)</b>	<b>9,369.3</b>	<b>774.0</b>	<b>773.5</b>	<b>773.0</b>	<b>772.6</b>	<b>772.1</b>	<b>771.5</b>	<b>771.0</b>	<b>770.4</b>	<b>769.8</b>	<b>769.3</b>	<b>768.2</b>	<b>768.0</b>	<b>767.8</b>	<b>767.6</b>	<b>767.4</b>	<b>767.2</b>
<b>Costs (\$)</b>																	
Fence maintenance costs	13.7	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Area-wide wild dog management costs	11.3	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Private wild dog management costs	102.5	3.1	3.8	4.6	5.3	6.1	7.0	7.9	8.8	9.7	10.6	12.3	12.6	12.9	13.3	13.6	14.0
Sheep enterprise operating costs	3,877.0	320.3	320.1	319.9	319.7	319.5	319.3	319.0	318.8	318.6	318.3	317.9	317.8	317.7	317.6	317.5	317.5
<b>Total Costs (\$)</b>	<b>4,004.6</b>	<b>325.4</b>	<b>325.9</b>	<b>326.5</b>	<b>327.1</b>	<b>327.6</b>	<b>328.3</b>	<b>329.0</b>	<b>329.6</b>	<b>330.3</b>	<b>331.0</b>	<b>332.2</b>	<b>332.5</b>	<b>332.7</b>	<b>333.0</b>	<b>333.2</b>	<b>333.5</b>
<b>Option 1 (with Fence replacement)</b>																	
<b>Benefits (\$)</b>																	
Residual value of project capital	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.3
Sheep enterprise sales income	9,429.9	774.7	774.9	775.2	775.4	775.6	775.9	775.9	775.9	775.9	775.9	775.9	775.9	775.9	775.9	775.9	775.9
<b>Total Benefits (\$)</b>	<b>9,433.3</b>	<b>774.7</b>	<b>774.9</b>	<b>775.2</b>	<b>775.4</b>	<b>775.6</b>	<b>775.9</b>	<b>786.2</b>									
<b>Costs (\$)</b>																	
Fence replacement costs	23.2	2.3	11.4	11.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fence maintenance costs	13.7	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Area-wide wild dog management costs	11.3	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Private wild dog management costs	5.4	1.9	1.5	1.2	0.8	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sheep enterprise operating costs	3,902.1	320.6	320.7	320.8	320.9	321.0	321.1	321.1	321.1	321.1	321.1	321.1	321.1	321.1	321.1	321.1	321.1
<b>Total Costs (\$)</b>	<b>3,955.6</b>	<b>326.8</b>	<b>335.7</b>	<b>335.4</b>	<b>323.7</b>	<b>323.4</b>	<b>323.1</b>										
<b>Incremental Benefits (\$)</b>	<b>64.0</b>	<b>0.7</b>	<b>1.4</b>	<b>2.1</b>	<b>2.8</b>	<b>3.6</b>	<b>4.4</b>	<b>4.9</b>	<b>5.5</b>	<b>6.0</b>	<b>6.6</b>	<b>7.6</b>	<b>7.9</b>	<b>8.1</b>	<b>8.3</b>	<b>8.5</b>	<b>19.0</b>
<b>Incremental Costs (\$)</b>	<b>-48.9</b>	<b>1.5</b>	<b>9.7</b>	<b>8.9</b>	<b>-3.4</b>	<b>-4.2</b>	<b>-5.2</b>	<b>-5.9</b>	<b>-6.5</b>	<b>-7.2</b>	<b>-7.9</b>	<b>-9.1</b>	<b>-9.4</b>	<b>-9.6</b>	<b>-9.9</b>	<b>-10.1</b>	<b>-10.4</b>
<b>Net Benefits (NPV) (\$)</b>	<b>112.9</b>	<b>-0.7</b>	<b>-8.3</b>	<b>-6.7</b>	<b>6.2</b>	<b>7.8</b>	<b>9.5</b>	<b>10.8</b>	<b>12.0</b>	<b>13.2</b>	<b>14.5</b>	<b>16.8</b>	<b>17.2</b>	<b>17.7</b>	<b>18.1</b>	<b>18.6</b>	<b>29.4</b>
<b>Benefit Cost Ratio (BCR)</b>	<b>-1.3</b>																
<b>Internal Rate of Return (IRR)</b>	<b>45%</b>																

<sup>a</sup> Years 2028/29 to 2031/32 are hidden for presentational purposes.

Source: BDO EconSearch Analysis



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Via email:

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PIRSA  
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25 January 2019  
Ref: ES\_1841

Dear Mehdi

#### **DOG FENCE ECONOMIC ANALYSIS**

Thank you for your enquiry yesterday regarding the *Economic Analysis of the South Australian Dog Fence* report, which we completed for SA Dog Fence Board and PIRSA in December 2018. As per your request, we have re-run the modelling using pastoral sheep enterprise income and sales data for the past 5 years (rather than the past 15 years as originally modelled). Details of the revised data and assumptions and results are provided in the notes attached to this letter.

Kind regards

Julian Morison  
Director, BDO EconSearch

CC: Heather Bailey

## Notes on revised modelling for the *Economic Analysis of the South Australian Dog Fence*

### Background

In late 2018 the SA Dog Fence Board and PIRSA engaged BDO EconSearch to complete an economic analysis of replacing the ageing Dog Fence with a new Dog Fence. A report, *Economic Analysis of the South Australian Dog Fence*, detailing the analysis was provided to the SA Dog Fence Board and PIRSA on 21 December 2018.

A key objective of the study was to undertake a cost benefit analysis (CBA) to determine the net benefit of replacing approximately 1,600 km of the SA Dog Fence that is more than 100 years old. Replacing approximately 1,600 km of aging Dog Fence was compared against an ongoing business-as-usual scenario under four potential wild dog impact scenarios which are described in the report.

The report also presented the economic impacts of the Dog Fence replacement project would make to the SA and regional economies in terms of gross regional product (GRP) and employment.

Following a request by PIRSA on 24 January 2019, the economic analysis was re-run using pastoral sheep enterprise income and sales data for the past 5 years (rather than the past 15 years as originally modelled). Details of the revised data and assumptions and results are provided in the sections following.

### Revisions to the data and assumptions

Revisions were made to the data for the following costs and benefits:

- Sheep enterprise operating costs
- Sheep enterprise sales income.

BDO EconSearch has developed whole farm financial models for SA pastoral sheep enterprises which have been updated in 2018. These models are based on 15 years of stock return data and financial return data to account for potential variation in stocking and prices and covers the range in the production cycle from good years to drought years. For the revised modelling, the farm financial models were adjusted to reflect the past five years of financial return data.

The following assumptions were revised from the original modelling:

- Enterprise variable cost: \$32, revised from \$29/head
- Enterprise sheep and wool sales: \$82/head, revised from \$71/head
- Enterprise gross margin: \$50/head, revised from \$42/head.

### Revised results - Cost Benefit Analysis

The results of the CBA for Option 1 for the four wild dog impact scenarios is described in Table 1.

The results indicate that according to the three evaluation criteria used, Option 1, under all four wild dog impact scenarios, is a worthwhile investment. The NPV of between \$58.9 million and \$120.3 million indicates that, relative to the Base Case, Option 1 will generate a net benefit to the community of

between 58.9 million and \$120.3 million over a 20-year period. The decision rule is that the investment will be worthwhile if the NPV is greater than zero.

The IRR provides a measure for the rate of return to capital invested, here estimated to be between 27 per cent and 48 per cent. The decision rule for the project to be viable is that the IRR be greater than the discount rate which, for this project and projects of this kind is 6 per cent.

Accordingly, the net benefits of investing in the Dog Fence replacement project (Option 1) outweigh the net benefits of not investing in the Dog Fence replacement (Base Case).

**Table 1 Revised CBA results of the Dog Fence replacement (Option 1) under four wild dog impact scenarios<sup>a</sup>**

	Scenario 1 (\$m <sup>a</sup> )	Scenario 2 (\$m <sup>a</sup> )	Scenario 3 (\$m <sup>a</sup> )	Scenario 4 (\$m <sup>a</sup> )
<b>Net benefits</b>				
Residual value of project capital	3.4	3.4	3.4	3.4
Sheep enterprise sales income	23.1	46.2	34.9	69.7
<i>Total net benefits</i>	<i>26.5</i>	<i>49.7</i>	<i>38.3</i>	<i>73.2</i>
<b>Net costs</b>				
Fence replacement costs	23.2	23.2	23.2	23.2
Fence maintenance costs	0.0	0.0	0.0	0.0
Area-wide wild dog management costs	0.0	0.0	0.0	0.0
Private wild dog management costs	-64.4	-64.4	-97.2	-97.2
Sheep enterprise operating costs	8.9	17.8	13.4	26.9
<i>Total net costs</i>	<i>-32.3</i>	<i>-23.4</i>	<i>-60.5</i>	<i>-47.1</i>
<b>Net Present Value of Dog Fence replacement</b>	<b>58.9</b>	<b>73.1</b>	<b>98.8</b>	<b>120.3</b>
<b>Benefit Cost Ratio</b>	<b>Undefined</b>	<b>Undefined</b>	<b>Undefined</b>	<b>Undefined</b>
<b>Internal Rate of Return</b>	<b>27%</b>	<b>31%</b>	<b>40%</b>	<b>48%</b>

<sup>a</sup> In 2018 dollars.

Source: BDO EconSearch analysis

**Original modelling results:**

- NPV: \$56.4 million - \$112.9 million
- IRR: 26% - 45%.

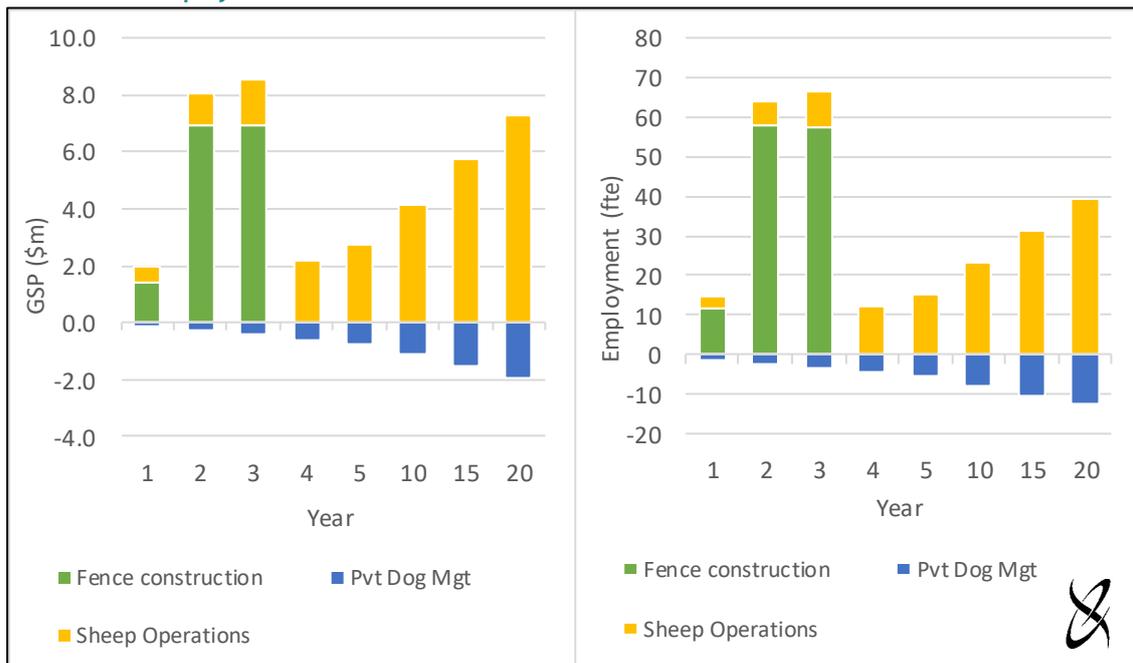
### Revised results - Economic Impact Results

The aggregated economic impacts of Option 1 (Scenario 1) on the SA economy are presented in terms of GSP and employment in Figure 1. Detailed economic impacts are presented in terms of GSP and employment (fte) in Table 2.

In the first three years the economic impact is dominated by the Fence construction activities. In the remaining years the main contributor to GSP and employment is sheep operations, which offsets the negative economic impact from reduced wild dog management activities on-property by pastoralists.

In the first year (2018/19), the expected impact on total GSP is around \$1.8 million, including flow-on effects. This is expected to increase to around \$8.1 million in the third year and \$5.3 million in the twentieth year. In terms of total employment, the expected impact in year 1 is 14 new fte jobs, including flow-on effects. This is expected to increase to 63 fte jobs in the third year and 27 in the twentieth year.

**Figure 1 Economic Impacts of the Dog Fence replacement project on the SA economy, Scenario 1, GSP and Employment**



Source: EconSearch analysis

**Table 2 Annual economic impacts of the Dog Fence replacement project - aggregated activity, GSP and Employment (fte)**

Year	Gross State Product (\$m)				Employment (fte)			
	Direct	Prod. Induced	Cons. Induced	Total	Direct	Prod. Induced	Cons. Induced	Total
1	1.0	0.5	0.3	<b>1.8</b>	8	4	4	<b>14</b>
2	4.1	2.3	1.4	<b>7.7</b>	35	19	19	<b>62</b>
3	4.4	2.3	1.5	<b>8.1</b>	36	19	19	<b>63</b>
4	1.2	0.0	0.3	<b>1.6</b>	5	0	2	<b>8</b>
5	1.5	0.1	0.4	<b>2.0</b>	7	0	3	<b>10</b>
10	2.4	0.1	0.6	<b>3.0</b>	11	1	4	<b>15</b>
15	3.2	0.1	0.8	<b>4.2</b>	15	1	6	<b>21</b>
20	4.1	0.2	1.1	<b>5.3</b>	19	1	7	<b>27</b>

Source: BDO EconSearch

Original modelling results:

- Total GSP: Year 1, \$1.8 million; Year 3, \$8.0 million; Year 20, \$4.7 million
- Total fte employment: Year 1, 14 fte; Year 3, 63 fte; Year 20, 26 fte.