Economy-wide Impacts of Proposed Policy Options for the Manuherekia Catchment

Draft Report

April 2021 – Draft

m.e research

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Draft Report

Prepared for

Otago Regional Council

Document reference:

Date of this version: April 2021

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Director approval: Dr Nicola McDonald

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Contents

Executive Summary

Objective

1. This study is designed to estimate the economic impacts associated with probable changes to farm operations due to proposed policy options for water management in the Manuherekia catchment.

Policy Options

2. The current minimum flow status quo of 900 l/s along with four proposed minimum flow policy options (1500 litre/second (l/s), 2000 l/s, 2500 l/s and 3000 l/s) are assessed in this economic impact study.

3. To capture variation in rainfall conditions, three scenarios of rainfall are evaluated for each scenario: a. dry year, b. average year, and c. wet year.

4. Using the above policy and natural environment scenarios, altogether 12 minimum flow and rainfall combination scenarios are evaluated (i.e. 1500 l/s in average/wet/dry year, 2000 l/s in average/wet/dry year, 2500 l/s in average/wet/dry year, and 3000 l/s in average/wet/dry year)

5. All scenarios are analysed against the current status quo (i.e. 900 l/s in average/wet/dry year).

Farm-level and catchment-level impacts for the farming sector and the horticulture sector

6. At the farm level, AbacusBio's enterprise model has provided the impact of minimum flow scenarios on farms.

7. AbacusBio's enterprise model provides a detailed cashflows item information on revenue, expenditure and earnings before interest and tax (EBIT) for each modelled farm under alternative minimum flow policy options.

a. Three farm systems representing Sheep and Beef farms, Dairy farms and Dairy Support farms have been modelled.

b. Generally, expenditure increases and revenue decreases when pasture growth cannot meet the demand of animal feed, which could be a result of the lack of rainfall and/or raised minimum flow[1].

8. Lewis-Tucker co.'s catchment finance model extrapolates AbacusBio's farm-level results across the catchment based on actual land use in the catchment and provides EBIT for farming land use in Manuherekia.

a. Three rainfall scenarios, wet year, dry year, and average year were modelled. The 'wet' year in the model represents the actual sustained 3-year period (2011-2013) where irrigation demand was low; the 'dry' year represent the actual sustained 3-year period (2014-2016) when irrigation demand were high; and the 'average' year represents the average demand in the catchment between 1973 and 2020.

b. The horticulture sector in Manuherekia was not modelled in the same way as the pastoral farms due to its relatively small size and the lack of farm-level financial data. Instead, the assumption of private investment in water storage to sustain economic production was made.

[1] 'Where more extreme seasons are experienced and significantly more feed is required to meet animal demand, feed is purchased at an incrementally increasing price. The range of price reflects the range of value from easily acquired surplus feed to more difficult to access feed or more expensive options such as cereal grains. Where feed deficit is extreme, a high value is placed on the purchased feed reflecting costly impacts difficult to model such as resowing pasture and selling and buying capital stock.' (AbacusBio farm-level report, 2021).

Economy-Wide Flow-On Impacts

9. Market Economics (M.E) has developed a Multi-Regional Input-Output (MRIO) framework which enables comprehensive assessment of the economy-wide (i.e. flow-on) impacts. This framework reports impacts on Manuherekia catchment, rest of Central Otago, rest of Otago and the rest of New Zealand, over the 20-year evaluation period, and by 106 economic industries.

10. Using Input-Output mathematics M.E has calculated the direct, indirect, and induced flow-on impacts associated with farm-level changes to income, expenditure and commodity production.

a. Direct impacts measure the increase/decrease of value added and employment in the directly impacted industries (i.e., sheep and beef, dairy and dairy support industry in this study).

b. Indirect impacts measure both backward (i.e. upstream, the suppliers of the affected industries) and forward (i.e. downstream, the customers of the affected industries) linkage supply chain impacts associated with the direct impacts.

c. Induced impacts measure the changes associated with changes in household income within an economy.

Results

13. Comparison of results - all results are presented in *net* economic terms i.e. net of the 900 l/s minimum flow status quo. The results are also reported separately for each of the three rainfall scenarios (average year, wet year, dry year) assessed.

Table 1. New Zealand Annual Average Value Added and Employment Impacts by Scenario (2025-2040)

		Policy scenario			
		1500 l/s	**2000 l/s**	**2500 l/s**	**3000 l/s**
	Value added ($2020 mil) [1]				
Rainfall scenario	**Average**	*-0.95*	*-2.51*	*-4.55*	*-6.46*
	Wet	*-0.30*	*-0.54*	*-1.28*	*-1.79*
	Dry	*-0.37*	*-2.16*	*-5.64*	*-10.67*
	Employment (MECs) [2]				
Rainfall scenario	**Average**	*-2*	*-7*	*-14*	*-21*
	Wet	*-2*	*-3*	*-6*	*-5*
	Dry	*6*	*6*	*3*	*-15*

Note (1): All results are Type II results from the Input-Output Model and therefore include induced impacts from changes in household income and expenditure in 2020 dollars. (2) MECs are 'Modified Employment Counts'. This measure is based on Statistics New Zealand's Employment Count (EC) statistic but also includes an estimate of the number of working proprietors.

14. Table 1 shows the New Zealand wide annual average value added and employment impacts felt over the period 2025-2040[2]. The results generally suggest that the impact on value add and employment increases as the minimum flow restriction volume increases.

[2] Annual results are available from the model at 5 yearly intervals from 2020-2040 (i.e. 2020, 2025, 2030, 2035, 2040). To provide a more-manageable level of detail for these top level results, we have chosen to produce just an average impact across the period 2025-2040. The years prior to 2025 are not included in this average impact calculation on the basis that the policy is not intended to commence until 2025. A disadvantage of this approach, however, is that it excludes in the calculation some of the construction activities for new water storage that commence prior to 2025.

15. At 1500 l/s minimum flow option level, in a year with average rainfall, the estimated total loss of value added was around 1 million across the whole of New Zealand, with a small job impact of 2 Modified Employment Counts (MECs). If it was a wet year, the loss of value added for the 1500 l/s scenario compared to the status quo is estimated to be smaller at 0.3 million with a similar impact on jobs.

16. It is interesting to note that at 1500 l/s minimum flow option level for the dry year, while there is still a negative impact on value added, the impacts are not as significant as those recorded for the average year.

17. These results appear to stem partly from the changes in commodity production for the pastoral sector derived under the farm systems modelling. For the 1500 l/s scenario, the implementation of the water option has a larger impact on raw milk production for dairy farms during an average rainfall year compared to a dry year. There is also greater production of cattle for sale under the dry year compared to the average year. Thus, overall, the 1500 l/s scenario has lesser impact on supply of commodities from the pastoral sector during a dry year compared to an average year. This direct output also flows through the model causing further forward-linkage effects through the economic system leading to, for example, less impacts in the dry year from the 1500 l/sec scenario on value added produced from dairy product manufacturing.

18. A further reason for the lesser impacts of the 1500 l/s scenario under the dry year compared to the average year stems from the extra demands for inputs such as supplementary feed and support services under the dry year by Manuherekia pastoral farms. While having a negative effect on farm profitability within the catchment (and hence reduces household income and expenditure for the catchment), this also has a stimulating effect (largely outside the catchment) for those responsible for supplying to Manuherekia farms outside of the catchment.

19. Another interesting outcome for the 1500 l/s scenario is that, while for the average and wet years there is small losses of employment estimated across the whole of New Zealand, under the dry year there are small gains in employment estimated compared to the status quo flow scenario. Under each of the average, dry and wet years it is assumed that there will be some gain in employment during the early years of the analysis (2022-2025) associated with construction activities to build new private water storage for horticulture. Furthermore, as discussed in the preceding paragraph, for the dry years there will be gains in employment (generally outside of the catchment) associated with the extra demands for production of animal feed to meet the shortfall in on-farm production.

20. It should nevertheless be noted that one of the limitations of the input-output model is that, apart from the pastoral farms within the catchment which have been studied in detail through the farm systems modelling, it assumed there are no supply constraints for industries. This means that for any economic activities supplying the Manuherekia catchment, it is implied that expansion will occur whenever necessary to meet new increased demands for commodities. However, with environmental constraints also existing outside of the catchment, it may not always be possible to expand production, potentially causing farms to seek alternative mitigation strategies.

21. Similar patterns of results occur for the 2000 l/s minimum flow policy option.

22. At 2500 l/s minimum flow option levels, the rainfall scenarios become more influential to value added and employment. The average annual value added loss is estimated at $1.28 million in a wet year, $4.6 million in an average year and $5.6 million in a dry year. Similarly, job number change is estimated at -6 in a wet year, -14 in an average year and an increase of 3 in a dry year (due to increased purchases of feed and construction of private water storage).

23. Similarly, at 3000 l/s minimum flow option level, rainfall amount becomes even more influential to value added and employment. The total value added loss is estimated at $1.8 million in a wet year, $6.5 million in an average year and $10.7 million in a dry year. Similarly, job number change is estimated at -5 in a wet year, -21 in an average year and -15 in a dry year.

Assumptions and Caveats

The modelling results presented here represent our best understanding of how Manuherekia and New Zealand economies would respond to the proposed policy options under three rainfall settings. They have been developed to help understand the likely scale and magnitude of the impacts associated with the proposed policy options. They are indicative rather than predictive.

Input-output analysis assumes that the relative interrelationships (or interdependencies) between industries remain constant over time. Thus, the way in which industries produce their commodities (i.e. production mix) and generate their revenues (i.e. sales mix), does not change through the analysis[3].

Input-output analysis does not account for factor constraints (e.g. land/labour in other regions) or general equilibrium feedbacks that exist within an economy such as commodity and factor price dynamics, substitution and transformation effects.

All the assumptions made in the AbacusBio and Lewis-Tucker co. reports also apply to the results presented in this study. This includes:

a. Exclusion of future growth aspirations;

b. No allowance is made in the Farm systems modelling for explicit destocking (reducing herd sizes), instead for years where there are shortages of feed increased feed purchases are assumed. There is, nevertheless, a form of de-intensification in implicit in the Farm system modelling in that sometimes farmers choose to sell even when the weight of the animals is not ideal in response to feed availability;

d. There is also no land use changes modelled, i.e. moving away from their current farming practice;

e. For horticulture, it is assumed that operators will build private storage to make up for the loss of water reliability.

[3] In a Statistics NZ study, Tipper (2011) suggested that '(a)t the industry-level, the evidence suggests that a constant elasticity production function with varying elasticities across industries is appropriate (in New Zealand)'.

Definitions

Value added and employment are the key economic aggregates measured. Value added impacts are measured in $$_{2020}$ million, while employment impacts are measures in jobs (or Modified Employee Count (MEC) – see below).

'Value added' is a measure of contribution made by capital and labour when making, or providing, a commodity i.e. the value of output after the cost of bought-in materials and services has been deducted. It includes the National Account categories of 'gross operating surplus', 'compensation of employees', 'other taxes on productions' and 'subsidies'. Value added is equal to Gross Domestic Product (GDP) less taxes on products and import taxes net of subsidies.

Importantly, while value added is related to the EBIT measures typically considered in the Farm Systems modelling, there are important differences. Value added seeks to measure the value of income being generated each year from the resources held in a given geographic area. Resources include capital (e.g. land, farm machinery) as well as labour. Value added thus includes labour income received by farm workers.

Statistics New Zealand reports employment data using the Employee Count (EC) measure. ECs are a head count of all salary and wage earners for a given period. This includes most employees but does not capture all working proprietors (i.e. individuals who pay themselves a salary or wage). M.E. measures employment impacts using a MEC based on ECs which also accounts for working proprietors.

1 Introduction

1.1 Background

The National Policy Statement for Freshwater Management 2020 (NPSFM) requires regional councils engage with communities and thangata whenua when setting environmental outcomes and limits on resource use in regional plans.

Since mid-2019, the Otago Regional Council (ORC) has been working with Kāi Tahu, the Manuherekia Reference Group (MRG) and the community to identify values and outcomes, and to develop options for managing freshwater in the Manuherekia catchment.

The Manuherekia Scenarios document has been developed to provide policy impact assessment and inform decision making. The scenarios for Manuherekia, similar to other natural resource management, strives for a balance between use and protection.

1.2 Policy options and Objective

The policy options are being developed in accordance with various legislative requirements including inter alia the National Policy Statement for Freshwater Management 2020 (NPS-FM). Four minimum flow policy options have been selected for economic impact assessment – 1500 l/s, 2000 l/s, 2500 l/s and 3000 l/s. The objective of this study is to estimate the flow-on economic impacts associated with changes to farm systems because of proposed minimum flow policy options for water management in the Manuherekia catchment.

2 Methodology

2.1 Selection of Appropriate Modelling Framework

Input-Output (IO) analysis has been selected as the core analytical framework for this study. Alternative methodologies for assessing economic impacts do exist; the most notable being the use of Computable General Equilibrium (CGE) modelling. The main author to this study are experts in the application of both input-output and general equilibrium techniques (see, for example, McDonald and Smith (2010, 2013), Yeoman et al. (2009), Zhang et al. (2008), Smith and McDonald (2011, 2014), Fairgray et al. (2014) Smith et al. (2015) and McDonald et al. (2017)). Key water-related studies undertaken by the main author include the 2010 Waikato River Independent Scoping Study Economic Impact Assessment (EIA) (NIWA, 2010, 2010a), the Rotorua Lakes EIA study (Smith and McDonald, 2015; McDonald and Smith, 2011), Waikato Healthy Rivers Wai-Ora study (McDonald and Smith, 2015), Horizon's One Plan (McDonald and Smith, 2015), Environment Southland Economic Project (Smith et al., 2015), Gisborne District Makauri Aquifer Recharge study (Ayers and McDonald, 2017), among many others.

Key reasons for adopting an input-output rather than CGE framework for use in this study are:

• *Disaggregation* – The input-output approach readily produces results that are disaggregated by study regions (in this case the Manuherekia catchment, rest of Central Otago, rest of Otago and rest of New Zealand) and economic industries (altogether 106 economic industries are reported in the model), thus providing important information on the distribution of economic impacts.

• *Paucity of data* – Creation of a multi-regional CGE model that reports down to the level of Manuherekia catchment would necessitate the construction of a Social Accounting Matrix (SAM) for the catchment. There is a lack of information pertaining to interregional investment flows for transfers between economic agents (e.g. from government to households), upon which to complete this task.

• *Full analysis of 'circular flow of income'* – Although based on input-output, a concerted attempt has been made in this study to take full consideration of the 'circular flow of income' within an economy, much like an analysis based on a SAM or CGE. Both backward and forward linkages are considered[4] as well as the opportunity costs of funding water storage options.

• *Timeframe and budget* – While it was feasible to couple a multi-regional input-output based model to the selected farm system models, linking a CGE model to the outputs of the farm system models would involve a substantial body of work, that was considered well beyond the give timeframe and budget.

2.2 An Introduction to Input-Output Analysis

Prior to describing the specifics of the methodology, it is helpful to provide readers, particularly those not familiar with input-output analysis, with a brief introduction to the input-output framework[5]. The remaining sections of the methodology describe the way the different policy options and their rainfall settings are incorporated into an input-output framework, including the major assumptions applied in this analysis.

At the core of any input-output analysis is a set of data that measures the flows of money or goods among various industrial groups within an economy for a given year. These flows are recorded in a matrix or 'input-output table' by arrays that summarise the purchases made by each industry (its inputs) from and the sales of each industry (its outputs) to all other industries. By using the information

[4] Backward linkage effects are those experienced by suppliers, or in other words, organisations situated upstream within the supply chain. This includes, for example, the loss in demand for products of fertiliser manufacturers because of a reduction in farming activities. By contrast, forward linkage effects are experienced by those who purchase goods or are situated 'downstream' within a supply chain. This includes the loss in dairy product manufacturing necessitated by a fall in the supply of raw milk from farms.

[5] Those who wish to learn more about input-output analysis please refer to Miller and Blair (2009).

contained within such a matrix, input-output practitioners may calculate mathematical relationships that describe the interdependencies that exist between the economic industries that comprise the economy under investigation. These relationships describe the interactions between industries – specifically, the way in which each industry's production requirements depend on the supply of goods and services from other industries. With this information it is possible to calculate, given a proposed alteration to a selected industry (i.e. for a given impact or policy-scenario), all the necessary changes in production that are likely to occur throughout supporting industries within the wider economy. For example, if one of the changes anticipated for the Manuherekia catchment were to be a loss in the amount of pastoral farming, the input-output model would calculate all the losses in output that would also occur in industries supporting pastoral farming (e.g. fertiliser production, fencing contractors, farm machinery suppliers), as well as the industries that in turn support these industries.

As with all modelling approaches, input-output analysis relies on certain assumptions for its operation. Among the most important is the assumption that the input structures of industries (i.e. the mix of commodities or industry outputs used in producing output for a specific industry) are fixed[6]. However, in the real world these 'technical coefficients' will change in the long run over time because of new technologies, relative price shifts causing substitutions, and the introduction of new industries. For this reason, input-output analysis is generally regarded as the most suitable for short-run analysis, where economic systems are unlikely to change greatly from the initial snapshot of data used to generate the base input-output tables.

2.3 Overview of Impacts Assessed

Assessment of Direct Farm System Impacts

AbacusBio has developed a detailed set of farm enterprise finances for three farm types (Sheep and beef, Dairy and Dairy support) within the Manuherekia. The model provides detailed line item information on revenue, expenditure and earnings before interest and tax (EBIT) based on rainfall data between 1974 and 2020. Lewis-Tucker used the results of the farm enterprise model and developed a financial model that estimated catchment-wide earnings before interest and tax (EBIT) scenarios under the above policy options and their associated rainfall settings.

The study of economy-wide economic impacts commenced with identifying four major categories of likely economic effects associated with the proposed policy options and their sub-scenarios:

1. *Changes to farming systems within Manuherekia – backward linkage supply chain impacts*. There are operational expenditure changes associated with the pastoral farms in response to new minimum flow requirements. These measures resulted in changes to the purchase patterns of pastoral farms, creating flow-on upstream impacts through economic supply chain linkages.

2. *Changes to farming systems within Manuherekia – forward linkage supply chain impacts*. Changes in pastoral sales also resulted in changes to the overall output of farms. With less output (e.g. meat and milk) produced per hectare, the supply to downstream processors (meat works, food and beverage manufacturers, other food manufacturing etc.) will be reduced, ultimately leading to a reduction in sales by these industries. With less supply of commodities for processing, industries responsible for processing will also downscale operations leading to less demands for goods and services by these industries (further backward-linkages effects resulting from initial forward-linkage effects)

3. *Changes in incomes for landowners*. For each of the policy options there are substantial changes in income for landowners in the form of altered profits. This will cause changes in expenditure patterns of these landowners, hence creating impacts throughout the rest of the economy.

[6] In this analysis the assumption does not apply where there has been specific analysis of changes in industrial production reflecting new regulatory and other situational conditions – i.e. as undertaken for the rural sector.

4 *Changes in demands for water storage, and compensatory changes in demands for other goods and services.* The increased demand for water storage by the horticulture activities will cause a short-term increase in demands for design and construction of these storage facilities. In order to finance this construction, spending must however reduce elsewhere (i.e. from other types of capital investment and normal household consumption).

2.4 Incorporation of the Scenarios within the Modelling Framework

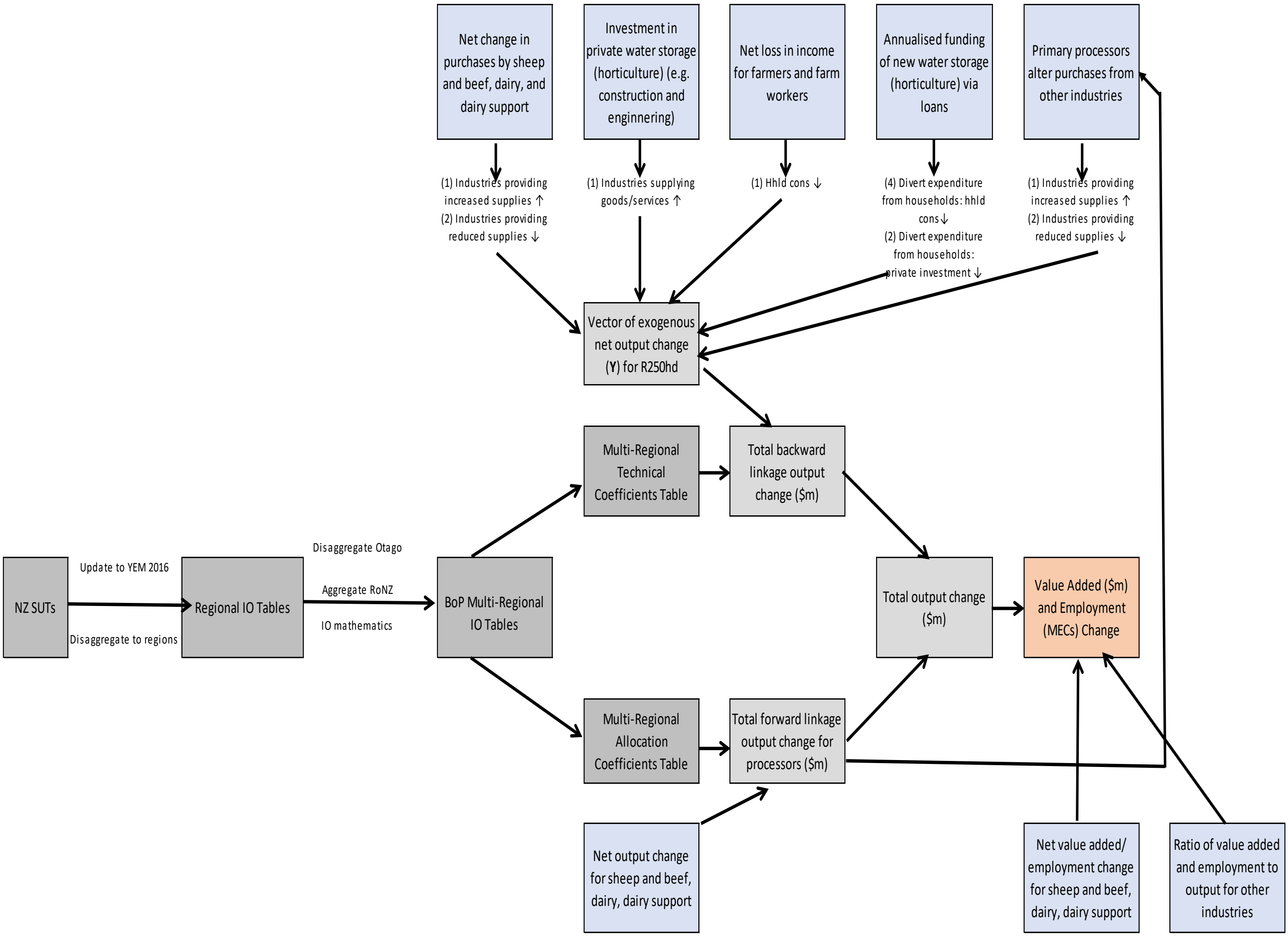

Figure 1. Summary of Modelling Approach

Step 1: Production of multi-regional input–output table

At the core of an IO modelling framework is a matrix recording transactions between different actors within an economy. Each column of the matrix reports the monetary value of an industry's inputs, while each row represents the value of an industry's outputs. Sales by each industry to final demand categories (i.e. households, local and central government, gross fixed capital formation, etc) are also recorded, along with each industry's expenditure on primary inputs (wages and salaries, consumption of fixed capital, gross operating surplus, etc). The data requirements for constructing IO matrices are enormous, and this is part of the reason IO tables are produced in New Zealand on an irregular basis. M.E also only undertakes updates and regionalisation of tables irregularly. The IO tables utilised in this study are for the year ended March 2016. This means that except in the case of the agriculture sectors which are considered in detail through the farm system modelling, the industry production mixes used in this study are based on 2016 information. Changes in technology and/or production techniques that have occurred since 2016 are not considered.

The first major step required for the assessment of economy-wide effects is regionalisation of the national table to produce tables for the following regions or study areas:

1. Manuherekia Catchment,
2. Rest of Central Otago District in Otago,
3. Rest of Otago Region, and
4. Rest of New Zealand.

For each region, 106 different economic industries are defined.

The process adopted to disaggregate a national table from Statistics New Zealand into input-output tables covering New Zealand's 16 regional councils is described in Smith et al (2015)[7]. A modified version of the Generating Regional Input-Output Tables (GRIT) procedure (Jensen *et al*. 1979; West *et al*. 1980) then further disaggregates the regional IO tables to delineate the Central Otago and Manuherekia Catchment regions. The GRIT method consists of a series of mechanical steps that reduce national input-output coefficients to sub-national (or sub-regional) equivalents with reference to available regional data. In this case, reference was made particularly to employment by industry, population and household income data for each of the study areas. A gravity modelling approach, partly based on big-data obtained for EFT-POS and credit card transactions, is also applied to estimate the magnitude of trade between different study areas. The general idea behind a gravity model is that the flow of goods between two locations is a function of the supply or production at the origin location, the demand or consumption at the destination location, and some measure of the impedance factors, usually distance, existing between the two locations.

Importantly, the IO framework used in this study is multi-regional. This means that the model considers not only the relationships between economic actors within any given study area, but also the relationships between economic actors across study areas. This multiregional approach provides a means to evaluate the nation-wide implications.

Step 2: Calculation of technical coefficients and allocation coefficients tables

The multi-regional IO tables created for the study areas are now translated into tables of technical coefficients (i.e. **A** matrices) and tables of allocation coefficients (**B** matrices). The technical coefficients indicate, for each industry, how much input is required to produce one dollar's worth of output and are derived from the base IO tables assuming continuous, linear relationships between inputs and outputs of each industry. Allocation coefficients can also be calculated from input–output tables in a similar manner

[7] To be precise, M.E's regionalisation processes generates multi-regional supply and use tables. These are then translated into the symmetric industry-by-industry input output format utilising the 'Industry Technology' assumption (ITA). For more information on the difference between supply-use and input-output tables and the ITA, refer to Smith and McDonald (2011).

to the calculation of technical coefficients. However, whereas technical coefficients describe the value of inputs purchased from each industry per unit of output, allocation coefficients detail the value of outputs sold to each industry per unit of output.

In this study the allocation coefficients are used solely for the purposes of determining the likely shares of primary commodities produced within the Manuherekia Catchment distributed to key processing activities (e.g. meat processing and dairy product manufacturing).

Step 3: Calculation of output change vectors (Y and M)

The purpose of this Step is to devise a set of industry output change vectors, for which we wish to trace the backward-linkage (i.e. vector **Y**) and forward linkage (i.e. vector **M**) impacts.

The first of these set of output vectors, **Y**, is a summation of:

1. *Net changes in purchases by farming activities within the Manuherekia Catchment*.

These changes in input purchases include changes brought about by the possible shortages of on-farm animal feed. The magnitude of these input changes is derived directly from the results of the farm system modelling (AbacusBio enterprise model). The revenue/expenditure line items from the farm system modelling accounts are matched to the input categories (i.e. different types of commodities/services as well as primary inputs such as wages and salaries) specified in the multi-regional input output table.

2. *Net changes in expenditure resulting from loss or gain in household income within Manuherekia Catchment*. The outputs of the farm system modelling are used to determine the net changes in income for land-owners and employees. It is assumed that any income loss (or gain) will result in a corresponding loss (or gain) in household expenditure. In order to translate income changes into spending changes, average household expenditures shares generated from the National Social Accounting Matrix (see Smith *at al*. 2015) are used. In generating these average household expenditures shares, consideration is given to the proportion of household income that is used to purchase goods and services overseas, and is thus effectively lost from the New Zealand economy.

3. *Net changes in demand for goods and services used as inputs to agriculture processing.* The changes in output produced by agriculture within the catchment will impact the industries directly responsible for processing these commodities (dairy and meat) and, in turn, the industries responsible for supplying goods to these processing sectors. This includes, for example, a loss of demand for electricity, chemicals and other goods as a result of a loss in dairy product manufacturing output. These additional backward linkage effects are also included in vector **Y.**

4. *Net changes in spending resulting from investment in water storage.* The estimated value of additional water storage is assigned to extra demands for industries' outputs based on each industry's contribution to the gross fixed capital formation column of the Otago IO table. It is assumed that this extra temporary spending is counteracted by a loss of spending over time equal to the value of loan payments each year to finance the new storage. It is uncertain exactly how this additional capital investment requirement will impact on regional spending. For the purposes of the modelling, it has simply been assumed that 20% of the annual loan payments will be met by reducing normal Manuherekia household consumption expenditure, and 80% will be met by reducing normal Manuherekia capital expenditure.

Note that as the IO table is expressed entirely in 2016 prices, it is necessary for all values to be translated into 2016 prices prior to input into the model. For these purposes a combination of price index series produced by SNZ are used, i.e. the Farm Expenses Price Index Series, Producers Price Index – Output Series and the Implicit Price Deflator (GDP) Series. The outputs of the input-output model (in value added terms) are then translated back into 2020 terms for presentation in the results tables below.

Finally, the other output vector, **M**, is an estimate of the change in production of pastoral commodities for the Manuherekia Catchment, under each of the scenarios. This information is derived directly from the farm system modelling for outputs of commodities sheep, beef/cattle, wool and milk[8].

Step 3: Calculation of backward–linkage impacts

As previously explained, the direct changes in output occurring in each industry will create indirect economic impacts that flow through the wider New Zealand economy. For example, reductions in electricity use by farmers is a reduction in demand for electricity retailers.

In turn, the industries that supply electricity will experience some loss in demand, and so on. Very simply, the vector of direct and indirect output effects by industry, **X**, is calculated according to the equation,

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

Where **A** is the matrix of technical coefficients (refer to Miller and Blair (2009) for further explanation), **I** is the identity matrix and the vector **Y** is a set of exogenous output changes by industry, the impacts of which are sought to be measured. The inverse matrix $(\mathbf{I} - \mathbf{A})^{-1}$ is termed the 'Leontief Inverse Matrix'.

There is some debate within IO literature and applications of the degree to which an input-output model should be 'closed' with respect to the household sector[9] when calculating the impacts according to Equation (1) above (Miller and Blair, 2009) to capture the relationships between income and consumer spending[10]. This study calculates results for two options, one where the model is open with regards to the household sector, and one where it is closed. The latter includes the so-called 'induced' effects while the former does not.

Step 4: Calculation of forward–linkage impacts

In most examples of regional economic impact analysis, the focus is on estimating backward linkage or demand-side effects. In this study we have endeavoured to also capture the most important supply-side or forward-linkage effects associated with changes in agriculture output under each scenario, such as supply of raw milk to dairy manufacturers. The basic assumption in applying this supply-side approach is that the output distributions within the economic system are stable. This means that if the output of a sector is, say, doubled, sales from that industry to all other industries that purchase from that industry will also be doubled. Although this assumption is unlikely to hold for many economic situations (see, for example, Giarrantani 1980, 1981), it is a reasonable assumption for changes in output for agricultural and forestry industries. This is because the industries that will be primarily affected by the supply-side effects are those that use the agricultural and forestry commodities to manufacture products (i.e. dairy product manufacturing, meat product manufacturing, and textile manufacturing). For these industries a relatively

[8] To avoid double-counting of economic interlinkages, it is necessary to adjust the estimates of output change to account for output changes that are already included as a backward linkage effect.

[9] Under this approach, households are treated in a similar manner to industries in the IO matrix, with a column and row of the matrix recording inputs and outputs of the household 'sector'. Transactions presented along the household row of the matrix record the income generated for households by each industry within the economy in the form of payments for labour, while transactions recorded in the household column of the matrix record the structure of household purchases (i.e. consumption). If it is assumed that the structure of household expenditure among different product types remains constant irrespective of the level of income, it is possible to calculate a vector of technical coefficients for households which can be included in the **A** matrix described above. When the vector of exogenous output changes (**Y**) is multiplied by the Leontief Inverse Matrix (**I** – **A**)-1, the model will calculate the value of outputs from each industry that will be purchased by households. Household incomes are, in turn, also determined by the level of output of each industry.

[10] Often referred to as 'induced' impacts in economic impact assessments.

constant relationship between the availability of commodities for processing and the value of manufactured products produced is likely. It is assumed that a change in supply of an agricultural commodity to a processor will result in a proportional change in processing output. For example, if the supply of raw milk to dairy product manufacturing in Otago reduces by 10 percent, then total output of the dairy product manufacturing industry also reduces by 10 percent.

Additional backward linkage effects associated with the loss of dairy product manufacturing are then included in the calculation of vector **Y** (see above).

Step 5: Capital-related impacts

IO-based modelling is generally not designed to capture changes in capital stocks. The indicators produced by IO analysis, such as changes in value added, are flow-based measures rather than stock-based measures. Nevertheless, the horticulture sector's capital expenditure for water storage building and its implications are addressed in this study.

Lewis-Tucker has estimated the possible cost of private water storage in the Manuherekia catchment for the business to keep the same profit level. In the IO modelling this addition cost to horticulture farms adds to, on the one hand, regional construction spending and, on the hand, diverts funds away from other forms of 'usual' spending (i.e. household consumption expenditure and alternative capital expenditure). Given that it is assumed for all scenarios that the policies are implemented by 2025, it is assumed that construction of water storage commences very soon (i.e. the construction phase is 2022-2025). The financing of the construction is assumed to occur via 25-year loans, with an interest rate of 6 percent per annum. This effectively means that the 'costs' of undertaking the new storage investments will be felt over time and importantly, some six years of the pay-back period for the loans is not captured in the 20-year horizon of the modelling.

Step 6: Translation of output impacts into value added and employment impacts

The final stage of the analysis is to transform estimates of net output change into value added and employment impacts. This occurs by multiplying the output change for each industry by the industry's ratio of (1) value added per unit of output, and (2) employment per unit of output. These ratios are assumed to be constant and are obtained from data for the 2016 financial year, except in the case of the pastoral sector where superior data is available directly from the Farm Systems and Catchment modelling.

2.5 Limitations and Caveats

The regional level economic modelling undertaken in this study represents our best understanding of how the Manuherekia and the wider economies currently operate, and how these economies would respond to the proposed policy options and their sub-scenarios. They have been developed to help us understand the likely scale and magnitude of the impacts associated with the proposed policy options. They are indicative rather than predictive.

As noted above, input-output analysis assumes that the relative interrelationships (or interdependencies) between industries remain constant over time. Furthermore, input-output analysis does not account for factor constraints or general equilibrium feedbacks such as commodity and factor price dynamics and substitution.

The industry-level and multi-regional approach of the input-output modelling provides some assistance in helping to understand the distribution of impacts from a policy intervention. Even with this level of information, impacts can sometimes appear to be negligible as they are 'netted-out' or relatively small compared to the size of an entire region or entire industry within a region. Nevertheless, it is important to keep in mind that the more uneven the distribution of economic impacts, the more significant the impacts will be for those who are affected.

All the assumptions made in the AbacusBio and Lewis-Tucker co. reports also apply to the results presented in this study. This includes:

a. Exclusion of future growth aspirations;

b. No allowance is made in the Farm systems modelling for explicit destocking (selling parts of the herd) as instead feed purchases or feed stock depletion is assumed to occur to cover situations of feed shortage. It can nevertheless be noted that some implicit destocking occurs in the Farm system modelling in that farmers may choose to sell even when the weight of the animals is not ideal in response to feed shortages;

d. There is also no land use changes modelled, i.e. moving away from their current farming practice;

e. For horticulture, it is assumed that operators will build private storage to make up for the loss of water reliability.

3 Results

3.1 Headline Results

All results are presented in *net* economic terms i.e. net of the 900 l/s current status quo level.

Table 1. New Zealand Annual Average Value Added and Employment Impacts by Scenario (2025-2040)

		Policy scenario			
		1500 l/s	2000 l/s	2500 l/s	3000 l/s
	Value added ($2020 mil) [1]				
Rainfall scenario	Average	-0.95	-2.51	-4.55	-6.46
	Wet	-0.30	-0.54	-1.28	-1.79
	Dry	-0.37	-2.16	-5.64	-10.67
	Employment (MECs) [2]				
Rainfall scenario	Average	-2	-7	-14	-21
	Wet	-2	-3	-6	-5
	Dry	6	6	3	-15

Note (1): All results are Type II results from the Input-Output Model and therefore include induced impacts from changes in household income and expenditure in 2020 dollars. (2) MECs are 'Modified Employment Counts'. This measure is based on Statistics New Zealand's Employment Count (EC) statistic but also includes an estimate of the number of working proprietors.

Table 1 shows the New Zealand wide annual average value added and employment impacts felt over the period 2025-2040[11]. The results generally suggest that the impact on value add and employment increases as the minimum flow option volume increases.

At 1500 l/s minimum flow option level, in a year with average rainfall, the estimated total loss of value added was around 1 million across the whole of New Zealand, with a small job impact of 2 Modified Employment Counts (MECs). If it was a wet year, the loss of value added for the 1500 l/s scenario compared to the status quo is estimated to be smaller at 0.3 million with a similar impact on jobs.

It is interesting to note that at 1500 l/s minimum flow option level for the dry year, while there is still a negative impact on value added, the impacts are not as significant as those recorded for the average year.

These results appear to stem partly from the changes in commodity production for the pastoral sector derived under the farm systems modelling. For the 1500 l/s scenario, the implementation of the water option has a larger impact on raw milk production for dairy farms during an average rainfall year compared to a dry year. There is also greater production of cattle for sale under the dry year compared to the average year. Thus, overall, the 1500 l/s scenario has lesser impact on supply of commodities from the pastoral sector during a dry year compared to an average year. This direct output also flows through the model causing further forward-linkage effects through the economic system leading to, for example, less

[11] Annual results are available from the model at 5 yearly intervals from 2020-2040 (i.e. 2020, 2025, 2030, 2035, 2040). To provide a more-manageable level of detail for these top level results, we have chosen to produce just an average impact across the period 2025-2040. The years prior to 2025 are not included in this average impact calculation on the basis that the policy is not intended to commence until 2025. A disadvantage of this approach, however, is that it excludes in the calculation some of the construction activities for new water storage that commence prior to 2025.

impacts in the dry year from the 1500 l/sec scenario on value added produced from dairy product manufacturing.

A further reason for the lesser impacts of the 1500 l/s scenario under the dry year compared to the average year stems from the extra demands for inputs such as supplementary feed and support services under the dry year by Manuherekia pastoral farms. While having a negative effect on farm profitability within the catchment (and hence reduces household income and expenditure for the catchment), this also has a stimulating effect (largely outside the catchment) for those responsible for supplying to Manuherekia farms outside of the catchment.

Another interesting outcome for the 1500 l/s scenario is that, while for the average and wet years, there is small losses of employment estimated across the whole of New Zealand, under the dry year there are small gains in employment estimated compared to the status quo flow scenario. Under each of the average, dry and wet years it is assumed that there will be some gain in employment during the early years of the analysis (2022-2025) associated with construction activities to build new private water storage for horticulture. Furthermore, as discussed in the preceding paragraph, for the dry years there will be gains in employment (generally outside of the catchment) associated with the extra demands for production of animal feed to meet the shortfall in on-farm production.

It should nevertheless be noted that one of the limitations of the input-output model is that, apart from the pastoral farms within the catchment which have been studied in detail through the farm systems modelling, it assumed there are no supply constraints for industries. This means that for any economic activities supplying the Manuherekia catchment, it is implied that expansion will occur whenever necessary to meet new increased demands for commodities. However, with environmental constraints also existing outside of the catchment, it may not always be possible to expand production, potentially causing farms to seek alternative mitigation strategies.

Similar patterns of results occur for the 2000 l/s minimum flow policy option.

At 2500 l/s minimum flow option levels, the rainfall scenarios become more influential to value added and employment. The average annual value added loss is estimated at $1.28 million in a wet year, $4.6 million in an average year and $5.6 million in a dry year. Similarly, job number change is estimated at -6 in a wet year, -14 in an average year and an increase of 3 in a dry year (due to increased purchases of feed and construction of private water storage).

Similarly, at 3000 l/s minimum flow option level, rainfall amount becomes even more influential to value added and employment. The total value added loss is estimated at $1.8 million in a wet year, $6.5 million in an average year and $10.7 million in a dry year. Similarly, job number change is estimated at -5 in a wet year, -21 in an average year and -15 in a dry year.

3.2 Detailed Results

3.2.1 Impacts by Study Area

Table 3.1 provides details on the value added and employment change by study area under the different policy and rainfall combinations.

Table 3.1 New Zealand Annual Average Value Added and Employment Impacts by Scenario by area

				Rainfall scenario					Rainfall scenario		
				Average	**Wet**	**Dry**			**Average**	**Wet**	**Dry**
		Manuherekia		-0.60	-0.11	-0.81			0	0	0
		Rest of Central Otago		0.01	-0.03	0.06			0	0	1
		Rest of Otago		-0.14	-0.04	0.07			-1	0	1
	1500 l/s	**Rest of New Zealand**		-0.21	-0.11	0.32			-1	-1	3
		Manuherekia		-1.38	-0.30	-2.21			0	-1	1
		Rest of Central Otago		0.01	-0.07	0.13			1	-1	3
		Rest of Otago		-0.41	-0.05	-0.15			-2	0	1
Policy scenario	**2000 l/s**	**Rest of New Zealand**	**Value added ($2020mil) [1]**	-0.72	-0.13	0.07		**Employment (MECs) [2]**	-5	-1	2
		Manuherekia		-2.35	-0.68	-4.46			0	-2	2
		Rest of Central Otago		0.02	-0.10	0.27			1	-1	6
		Rest of Otago		-0.80	-0.16	-0.70			-4	-1	-1
	2500 l/s	**Rest of New Zealand**		-1.42	-0.33	-0.74			-10	-2	-4
		Manuherekia		-3.24	-1.25	-6.50			0	-2	3
		Rest of Central Otago		0.00	-0.11	0.34			1	-1	8
		Rest of Otago		-1.16	-0.18	-1.77			-6	-1	-7
	3000 l/s	**Rest of New Zealand**		-2.06	-0.24	-2.73			-15	-1	-19

Note (1): All results are Type II results from the Input-Output Model and therefore include induced impacts from changes in household income and expenditure in 2020 dollars. (2) MECs are 'Modified Employment Counts'. This measure is based on Statistics New Zealand's Employment Count (EC) statistic but also includes an estimate of the number of working proprietors.

At 1500 l/s minimum flow option level, in a year with average rainfall, the estimated total loss of value added is mainly felt within Manuherekia. The slight increase in value added in the rest of Central Otago (almost negligible) is due to small increases in farms' purchasing commodities/services sourced from neighbouring areas. The slight fall in value added in the rest of Otago and New Zealand is due mainly to losses in commodities supplied to processors and income-induced falls in expenditure.

If it was the wetter-than-average year, very little impact is estimated on both value added and employment for the 1500 l/s scenario compared to the status quo flow scenario. For the dryer-than-average year, Manuherekia would bear $0.8mil loss in value added, while part of the loss will be compensated by/transfers to supporting sectors outside of Manuherekia (<0.1mil to rest of Central Otago, <0.1mil to rest of Otago and 0.3mil to rest of New Zealand, respectively). This is due again to the increase demand of farming support external to Manuherekia and demands for design and constructions services for private water storage. Estimated employment changes follow a similar pattern to value added under the 1500 mil/sec scenario; while there is no estimated job loss in Manuherekia, the rest of the region/country is expected to experience very small losses for the average and wet years, and small gains for the dry years.

Similar patterns of results apply to the 2000 l/s minimum flow option across different rainfall scenarios.

At 2500 l/s minimum flow option levels, the losses in value added and employment start to amplify for the rest of Otago and rest of New Zealand, and then generally increase further under the 3000 mil/sec scenario. This is largely due to losses in incomes which spread widely through the economic system. For the rest of New Zealand, in an average rainfall year, job losses under the 3000 l/s scenario are greatest in the service sectors (approximately 80% of total impact), however, the total number of jobs lost in the rest of New Zealand is still relatively small at a national scale (15 in total).

3.2.2 Impacts by Industry for Central Otago District

Table 3.2 below provides details on the value added and employment change by industry sectors under the different policy and rainfall combinations for Central Otago District (i.e. the Manuherekia and rest of Central Otago areas combined).

At 1500 l/s minimum flow option level, in a year with average rainfall, the estimated total loss of value added for the district (0.6 million) is mainly shared amongst the farming industries; while changes in employment are relatively minimal. For the wet year, very little impacts are discernible at the industry level, for both value added and employment. For the dryer than average year, the estimated total loss of value added is slightly greater than the average rainfall year – relating largely to additional losses in profitability for the pastoral sector.

Similar patterns of results apply to the 2000 l/s minimum flow policy options across different rainfall scenarios.

At 2500 l/s and 3000 l/s minimum flow option levels, losses to the services or tertiary sector within the district also start to become more discernible, as the outcomes of reductions in household income flow through the economy. It should, however, be noted that in the first few years or our analysis some additional demands for services are also anticipated due to new investments in water storage for horticulture. These impacts are not easy to see from the average result over 2025-2040 as reported in the table. Some of the construction and design services for new water storage will also be sourced from outside of Central Otago District.

Table summaries of the policy and rainfall scenario combination impact for Manuherekia, rest of Otago and rest of New Zealand can be found in Appendix 1 to Appendix 3 respectively.

Table 3.2 Central Otago District Annual Average Value Added and Employment Impacts by Scenario by Industry (2025-2040)

		Policy scenario											
		1500 l/s			2000 l/s			2500 l/s			3000 l/s		
	Value added ($2020 mil) [1]	Average (rainfall)	Wet (rainfall)	Dry (rainfall)	Average (rainfall)	Wet (rainfall)	Dry (rainfall)	Average (rainfall)	Wet (rainfall)	Dry (rainfall)	Average (rainfall)	Wet (rainfall)	Dry (rainfall)
Industry	Horticulture and fruit growing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Sheep, beef cattle and grain farming	-0.3	0.0	-0.5	-0.7	-0.1	-1.3	-1.2	-0.2	-2.7	-1.6	-0.4	-3.9
	Dairy cattle farming	-0.2	0.0	-0.2	-0.5	-0.1	-0.8	-0.9	-0.3	-1.5	-1.4	-0.6	-2.3
	Other primary	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Agriculture, forestry and fishing support services	0.0	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.3	0.1	0.0	0.4
	Meat and meat product manufacturing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Dairy product manufacturing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Other food manufacturing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Other manufacturing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Utilities, construction, transport	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.2	-0.1	-0.2	-0.2	-0.2	-0.3
	Wholesale and retail trade, hospitality	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Information, finance, insurance, property and business services	0.0	0.0	0.0	-0.1	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
	Government, education, health	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Recreational and personal services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	-0.6	-0.1	-0.8	-1.4	-0.4	-2.1	-2.3	-0.8	-4.2	-3.2	-1.4	-6.2
	Employment (MECs) [2]												
Industry	Horticulture and fruit growing	0	0	0	0	0	0	0	0	1	0	0	1
	Sheep, beef cattle and grain farming	0	0	0	0	0	1	1	0	1	1	0	2
	Dairy cattle farming	0	0	0	0	0	0	0	0	0	0	0	0
	Other primary	0	0	0	0	0	0	0	0	0	0	0	0
	Agriculture, forestry and fishing support services	1	0	1	1	0	3	2	0	6	2	0	9
	Meat and meat product manufacturing	0	0	0	0	0	0	0	0	0	0	0	0
	Dairy product manufacturing	0	0	0	0	0	0	0	0	0	0	0	0
	Other food manufacturing	0	0	0	0	0	0	0	0	0	0	0	0
	Other manufacturing	0	0	0	0	0	0	0	0	0	0	0	0
	Utilities, construction, transport	0	0	0	-1	-1	-1	-2	-2	-2	-2	-2	-2
	Wholesale and retail trade, hospitality	0	0	0	0	0	0	0	0	0	0	0	1
	Information, finance, insurance, property and business services	0	0	0	0	0	1	0	0	1	0	0	1
	Government, education, health	0	0	0	0	0	0	0	0	0	0	0	-1
	Recreational and personal services	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	-1	1	1	-2	4	1	-3	8	1	-3	11

Note (1): All results are Type II results from the Input-Output Model and therefore include induced impacts from changes in household income and expenditure in 2020 dollars. (2) MECs are 'Modified Employment Counts'. This measure is based on Statistics New Zealand's Employment Count (EC) statistic but also includes an estimate of the number of working proprietors.

4 Recommendations

This study represents a first attempt to assess the catchment, district, regional and national level economic consequences associated with the proposed policy options for the Manuherekia catchment. These policy options are being developed in accordance with various legislative requirements including *inter alia* the National Policy Statement for Freshwater Management 2020 (NPS-FM). The work is based on the farm systems work undertaken by AbacusBio and, in turn, summarised into annual catchment wide EBIT for use in this study.

Throughout the course of the study we have noted several possible avenues for further work. These are outlined below:

• *The impacts of alternative farm system and land use change response scenarios*. To date no attempt has been made to model alternative farm system response and land use change scenarios, mainly due to the significant uncertainty of such responses. Instead, it has been simply assumed that farms will largely maintain the same systems of operation and land use will remain static. It should however be noted that should farm system operations significantly change, or land is converted to next best alternatives, different regional and national value added and employment impacts will occur. One avenue for exploring these outcomes is to test a range of feasible land use and system change 'scenarios'.

• *Assessment of wider socio-economic consequences*. It is recommended that the economic costs associated with the catchment level, district level, regional and national level impact assessment be presented alongside the wider societal, environmental and cultural benefits that the policy options provide. Economic impact assessment is usually only a component of a wider assessment of costs and benefits. It is certainly easier for stakeholders to understand what values they may be trading off if they understand the wider economic, social, environmental and cultural consequences.

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6 Appendix

Appendix 1 Manuherekia Annual Average Value Added and Employment Impacts by Scenario by Industry

		Policy scenario (2025-2040)											
		1500 l/s			2000 l/s			2500 l/s			3000 l/s		
	Value added ($2020 mil) [1]	Average (rainfall)	Wet (rainfall)	Dry (rainfall)	Average (rainfall)	Wet (rainfall)	Dry (rainfall)	Average (rainfall)	Wet (rainfall)	Dry (rainfall)	Average (rainfall)	Wet (rainfall)	Dry (rainfall)
Industry	Horticulture and fruit growing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Sheep, beef cattle and grain farming	-0.4	0.0	-0.6	-0.7	-0.1	-1.4	-1.3	-0.3	-2.8	-1.7	-0.4	-4.0
	Dairy cattle farming	-0.2	0.0	-0.2	-0.5	-0.1	-0.8	-0.9	-0.3	-1.5	-1.4	-0.6	-2.3
	Other primary	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Agriculture, forestry and fishing support services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1
	Meat and meat product manufacturing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Dairy product manufacturing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Other food manufacturing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Other manufacturing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Utilities, construction, transport	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
	Wholesale and retail trade, hospitality	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Information, finance, insurance, property and business services	0.0	0.0	0.0	-0.1	0.0	-0.1	-0.1	0.0	-0.1	-0.1	-0.1	-0.2
	Government, education, health	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Recreational and personal services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	-0.6	-0.1	-0.8	-1.4	-0.3	-2.2	-2.4	-0.7	-4.5	-3.2	-1.3	-6.5
	Employment (MECs) [2]												
Industry	Horticulture and fruit growing	0	0	0	0	0	0	0	0	0	0	0	0
	Sheep, beef cattle and grain farming	0	0	0	0	0	0	0	0	0	0	0	0
	Dairy cattle farming	0	0	0	0	0	0	0	0	0	0	0	0
	Other primary	0	0	0	0	0	0	0	0	0	0	0	0
	Agriculture, forestry and fishing support services	0	0	1	1	0	2	1	0	3	1	0	4
	Meat and meat product manufacturing	0	0	0	0	0	0	0	0	0	0	0	0
	Dairy product manufacturing	0	0	0	0	0	0	0	0	0	0	0	0
	Other food manufacturing	0	0	0	0	0	0	0	0	0	0	0	0
	Other manufacturing	0	0	0	0	0	0	0	0	0	0	0	0
	Utilities, construction, transport	0	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1
	Wholesale and retail trade, hospitality	0	0	0	0	0	0	0	0	0	0	0	0
	Information, finance, insurance, property and business services	0	0	0	0	0	0	0	0	0	0	0	0
	Government, education, health	0	0	0	0	0	0	0	0	0	0	0	-1
	Recreational and personal services	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	0	0	0	-1	1	0	-2	2	0	-2	3

Note (1): All results are Type II results from the Input-Output Model and therefore include induced impacts from changes in household income and expenditure in 2020 dollars. (2) MECs are 'Modified Employment Counts'. This measure is based on Statistics New Zealand's Employment Count (EC) statistic but also includes an estimate of the number of working proprietors.

Appendix 2 Rest of Otago Annual Average Value Added and Employment Impacts by Scenario by Industry

		Policy scenario											
		1500 l/s			2000 l/s			2500 l/s			3000 l/s		
	Value added ($2020 mil) [1]	Average (rainfall)	Wet (rainfall)	Dry (rainfall)	Average (rainfall)	Wet (rainfall)	Dry (rainfall)	Average (rainfall)	Wet (rainfall)	Dry (rainfall)	Average (rainfall)	Wet (rainfall)	Dry (rainfall)
Industry	Horticulture and fruit growing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Sheep, beef cattle and grain farming	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.2	0.1	0.1	0.2
	Dairy cattle farming	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Other primary	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Agriculture, forestry and fishing support services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1
	Meat and meat product manufacturing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
	Dairy product manufacturing	-0.1	0.0	0.0	-0.3	0.0	-0.2	-0.5	-0.1	-0.6	-0.7	-0.1	-1.3
	Other food manufacturing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Other manufacturing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Utilities, construction, transport	0.0	0.0	0.0	-0.1	0.0	-0.1	-0.2	0.0	-0.2	-0.2	-0.1	-0.4
	Wholesale and retail trade, hospitality	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Information, finance, insurance, property and business services	0.0	0.0	0.0	-0.1	0.0	0.0	-0.1	-0.1	-0.1	-0.2	-0.1	-0.2
	Government, education, health	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
	Recreational and personal services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
	Total	-0.1	0.0	0.1	-0.4	0.0	-0.1	-0.8	-0.2	-0.7	-1.2	-0.2	-1.8
	Employment (MECs) [2]												
Industry	Horticulture and fruit growing	0	0	0	0	0	0	0	0	0	0	0	0
	Sheep, beef cattle and grain farming	0	0	0	1	0	1	1	0	2	1	1	3
	Dairy cattle farming	0	0	0	0	0	0	0	0	0	0	0	0
	Other primary	0	0	0	0	0	0	0	0	0	0	0	0
	Agriculture, forestry and fishing support services	0	0	0	0	0	1	1	0	1	1	0	2
	Meat and meat product manufacturing	0	0	0	0	0	0	-1	0	-1	-1	0	-1
	Dairy product manufacturing	0	0	0	-1	0	-1	-2	0	-2	-3	0	-5
	Other food manufacturing	0	0	0	0	0	0	0	0	1	0	0	1
	Other manufacturing	0	0	0	0	0	0	0	0	0	0	0	-1
	Utilities, construction, transport	0	0	0	-1	0	-1	-1	0	-1	-2	-1	-3
	Wholesale and retail trade, hospitality	0	0	0	0	0	0	0	0	1	0	0	0
	Information, finance, insurance, property and business services	0	0	0	0	0	0	-1	-1	0	-1	-1	-1
	Government, education, health	0	0	0	0	0	0	0	0	0	-1	0	-1
	Recreational and personal services	0	0	0	0	0	0	0	0	0	-1	0	-1
	Total	-1	0	1	-2	0	1	-4	-1	-1	-6	-1	-7

Note (1): All results are Type II results from the Input-Output Model and therefore include induced impacts from changes in household income and expenditure in 2020 dollars. (2) MECs are 'Modified Employment Counts'. This measure is based on Statistics New Zealand's Employment Count (EC) statistic but also includes an estimate of the number of working proprietors.

Appendix 3 Rest of New Zealand Annual Average Value Added and Employment Impacts by Scenario by Industry

		Policy scenario											
		1500 l/s			2000 l/s			2500 l/s			3000 l/s		
	Value added ($2020 mil) [1]	Average (rainfall)	Wet (rainfall)	Dry (rainfall)	Average (rainfall)	Wet (rainfall)	Dry (rainfall)	Average (rainfall)	Wet (rainfall)	Dry (rainfall)	Average (rainfall)	Wet (rainfall)	Dry (rainfall)
Industry	Horticulture and fruit growing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Sheep, beef cattle and grain farming	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Dairy cattle farming	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	-0.1	-0.1	0.0	-0.2
	Other primary	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Agriculture, forestry and fishing support services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Meat and meat product manufacturing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Dairy product manufacturing	0.0	0.0	0.0	-0.1	0.0	-0.1	-0.2	0.0	-0.3	-0.3	0.0	-0.6
	Other food manufacturing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Other manufacturing	0.0	0.0	0.0	-0.1	0.0	0.0	-0.1	-0.1	-0.1	-0.2	-0.1	-0.3
	Utilities, construction, transport	0.0	0.0	0.0	-0.1	0.0	0.0	-0.2	0.0	-0.2	-0.3	0.0	-0.4
	Wholesale and retail trade, hospitality	0.0	0.0	0.1	-0.1	0.0	0.1	-0.2	-0.1	0.0	-0.2	0.0	-0.2
	Information, finance, insurance, property and business services	-0.1	-0.1	0.1	-0.3	-0.1	0.1	-0.5	-0.2	-0.2	-0.7	-0.1	-0.9
	Government, education, health	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	-0.1
	Recreational and personal services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	-0.1
	Total	-0.2	-0.1	0.3	-0.7	-0.1	0.1	-1.4	-0.3	-0.7	-2.1	-0.2	-2.7
	Employment (MECs) [2]												
Industry	Horticulture and fruit growing	0	0	0	0	0	0	0	0	0	0	0	0
	Sheep, beef cattle and grain farming	0	0	0	0	0	0	0	0	1	0	0	1
	Dairy cattle farming	0	0	0	0	0	0	-1	0	-1	-1	0	-2
	Other primary	0	0	0	0	0	0	0	0	0	0	0	0
	Agriculture, forestry and fishing support services	0	0	0	0	0	0	0	0	0	0	0	0
	Meat and meat product manufacturing	0	0	0	0	0	0	0	0	0	0	0	0
	Dairy product manufacturing	0	0	0	0	0	0	-1	0	-1	-1	0	-2
	Other food manufacturing	0	0	0	0	0	0	0	0	1	0	0	0
	Other manufacturing	0	0	0	-1	0	0	-1	0	-1	-1	0	-2
	Utilities, construction, transport	0	0	0	-1	0	0	-2	0	-1	-2	0	-4
	Wholesale and retail trade, hospitality	0	0	1	-1	0	1	-3	-1	0	-4	0	-4
	Information, finance, insurance, property and business services	0	0	1	-1	0	0	-3	-1	-1	-4	-1	-5
	Government, education, health	0	0	0	0	0	0	-1	0	0	-1	0	-1
	Recreational and personal services	0	0	0	0	0	0	-1	0	0	-1	0	-1
	Total	-1	-1	3	-5	-1	2	-10	-2	-4	-15	-1	-19

Note (1): All results are Type II results from the Input-Output Model and therefore include induced impacts from changes in household income and expenditure in 2020 dollars. (2) MECs are 'Modified Employment Counts'. This measure is based on Statistics New Zealand's Employment Count (EC) statistic but also includes an estimate of the number of working proprietors.