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Economic Impacts of the Healthy Rivers Initiative - Freshwater Management Unit, Regional and National Assessment

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Economic Impacts of the Healthy Rivers Initiative

Freshwater Management Unit, Regional and National Assessment

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Technical Report

Waikato Regional Council

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Contents

Glossary

Computable General Equilibrium (CGE): A class of applied economic models typically used to illustrate an economy's responses to changes in policy, technology or other external shocks.

Households: New Zealand resident individuals and families, and Private Non-Profit Organisation (PNPO) serving households.

Input-Output Model: A quantitative economic technique that represents the interdependencies between different branches (industries or sectors) of a national economy or different regional economies. The technique depends on a matrix of raw economic data collected by companies and governments to study the relationship between suppliers and producers within an economy. Of particular interest is the extent that the outputs of one industry become the inputs to another.

Modified Employment Counts (MECs): Statistics New Zealand typically reports employment data according to the Employee Count (EC) measure. ECs are a head count of all salary and wage earners for a reference period. This includes most employees but does not capture all working proprietors – individuals who pay themselves a salary or wage. The modified employment count or MEC measure is based on ECs but includes an adjustment to incorporate an estimate of the number of working proprietors.

Value Added: The value added to goods and services by the contributions of capital and labour, i.e. the value of output after the cost of bought-in materials and services has been deducted. It includes the national accounts categories 'Gross Operating Surplus', 'Compensation of Employees', 'Taxes on Products' and 'Subsidies'. Value Added is equal to Gross Domestic Product (GDP), excluding Taxes on Products and Import Taxes net of Subsidies. Importantly, as Taxes on Products and Subsidies are only available at the whole economy level, Value Added is used as a proxy for Gross Regional Domestic Product for entities smaller than a whole economy. In New Zealand, Value Added is equal to approximately 88% of Gross Domestic Product.

1 Introduction

To limit the deterioration of the water quality in Waikato River, limit setting initiatives are currently being investigated by Waikato Regional Council under the Wai Ora Healthy Rivers initiative. While no explicit targets have been set, the Healthy Rivers initiative is currently focused on understanding the implications of a range of plausible scenarios. To this end, a technical advisory group has been established.

On the request of that advisory group, Market Economics Ltd has undertaken modelling of the economic impacts of various scenarios, to help inform decision-makers on outcomes of varying policy options. The modelling is, however, critically dependent on inputs derived from independent modelling work undertaken by Prof. Graeme Doole at Waikato University. The work undertaken by Prof. Doole is focused on describing direct impacts, particularly at the farm and forestry-level, while the economic modelling undertaken by Market Economics Ltd is focused on describing the impacts across all industries, at the scale of Freshwater Management Unit (FMU), region, and nation.

2 Background

2.1 Selection of an 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 authors of this report are published 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) and Smith *et al*. (2015)). Key studies undertaken by the authors include the 2010 Waikato Independent Scoping Study Economic Impact Assessment (EIA) (NIWA, 2010, 2010a), the official 1999 and 2003 America's Cup EIAs for the Office of Tourism and Sport/Ministry of Tourism, the EIA of the 2011 Rugby World Cup for the NZRFU, EIAs for Auckland International Airport, Exercise Ruaumoko.

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 individual Freshwater Management Units, the rest of the Waikato region and the rest of New Zealand) and economic sector (altogether 106 economic sectors or '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 Freshwater Management Units would necessitate the construction of a Social Accounting Matrix (SAM) for these local areas. There is a lack of information pertaining to interregional investment flows, particular 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,[1] as well as the 'opportunity costs' of funding alternative policy options. Thus, it is an example of an extensive application of input-output for the purposes of economic impact assessment.
- *Timeframe and budget* – It was feasible to couple an input-output based model to the selected farm system models, so as to produce a picture of district, regional and national economic impacts, while keeping within the timeframe and budget of the project. In comparison, linking a CGE model to the outputs of the farm system models requires a significant amount of work and is beyond the scope of this project.

[1] 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 as a result of a reduction in farming activities. Forward linkage effects, by contrast, 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.

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.[2] The remaining sections of the methodology describe the way the different scenarios are incorporated into an input-output framework, including the major assumptions that are applied.

At the core of any input-output analysis is a set of data that measures, for a given year, the flows of money or goods among various sectors or industrial groups within an economy. These flows are recorded in a matrix or 'input-output table' by arrays that summarise the purchases made by each industry (its inputs) and the sales of each industry (its outputs) from and to all other industries. By using the information 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. a scenario), all of 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 Waikato region were to be a loss in the amount of dairy farming, the input-output model would calculate all of the losses in output that would also occur in industries supporting dairy 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.[3] In the real world, however, these 'technical coefficients' will change over time as a result of new technologies, relative price shifts causing substitutions, and the introduction of new industries. For this reason input-output analysis is generally regarded as 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] Those who wish to learn more about input-output analysis please refer to Miller and Blair (2009).

[3] 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.

3 Method

3.1 Overview of Impacts Assessed

The study of economy-wide economic impacts commenced with identifying nine key categories of likely economic effects associated with the proposed options for nutrient reductions:

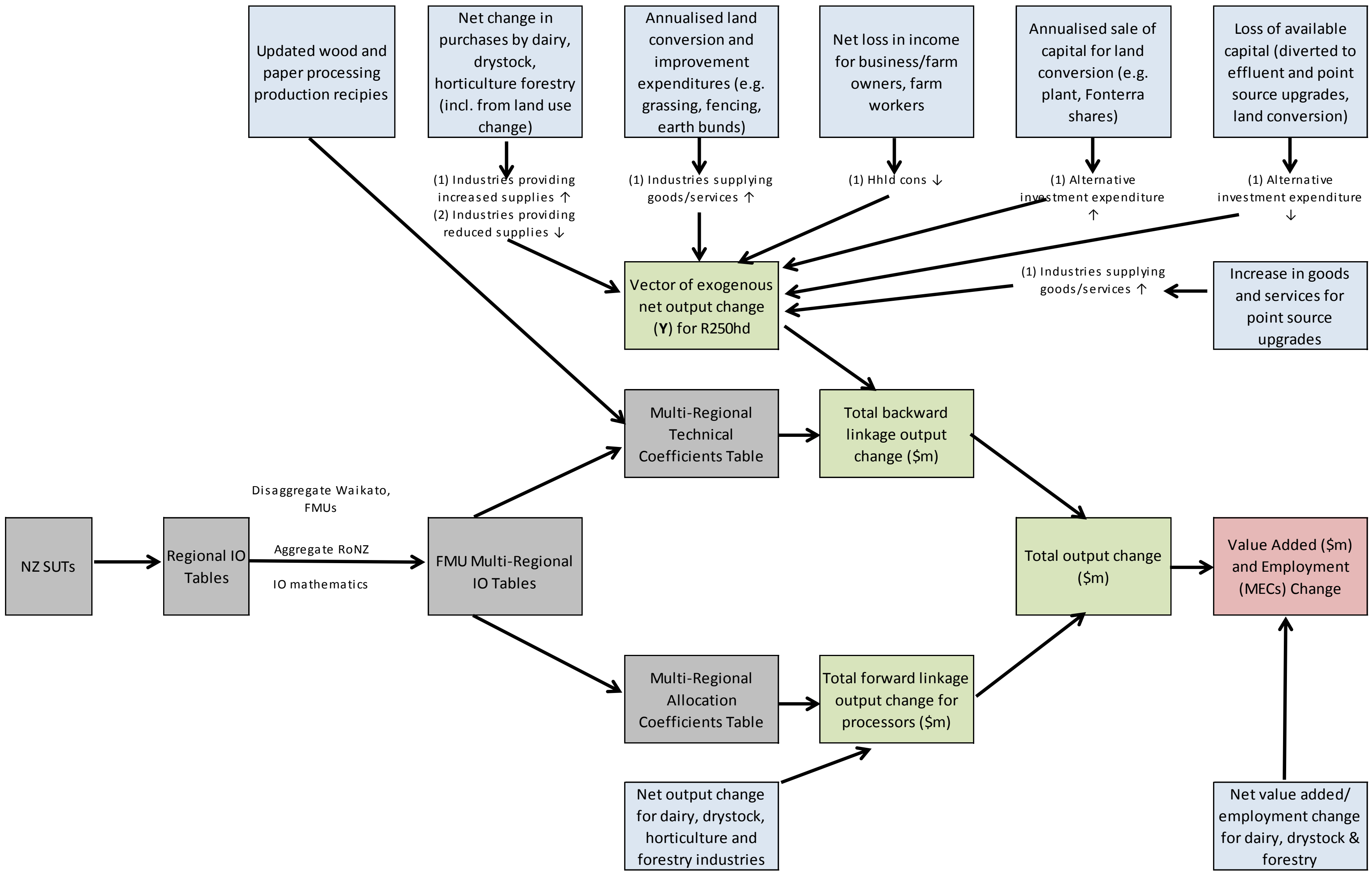
1. *Changes to farming systems within the FMUs– backward linkage supply chain impacts*. Contaminant limits cause changes in land management practices for dairy, drystock and horticulture farms within the various Freshwater Management Units. Examples might include removing summer crops and replacing these with supplements and lowering fertiliser use, reductions in seed and agrichemical purchases by horticulture, and so on. These measures result in changes to the purchase patterns of dairy and drystock farms, creating flow-on upstream impacts through economic supply chain linkages.
2. *Changes to farming systems within the FMUs– forward linkage supply chain impacts*. The changes in farming practices will also result in reductions to the overall output of farms. With less output (e.g. milk, wool, meat, vegetables) produced per hectare, the supply to downstream processes (dairy manufacturers, meat processors, textile manufacturers, food and beverage manufacturers etc.) will be reduced, ultimately leading to a reduction in sales by these industries.
3. *Conversion between land uses – backward supply chain impacts*. In addition to the changes in land management, the alternative limits considered will result in changes in land use across the Freshwater Management Units. This will create additional impacts for industries that would otherwise be involved in supplying goods and services to the existing agricultural industries. Conversely, where there is an increase in land used for a particular activity (e.g. forestry), businesses that are responsible for providing direct inputs to that activity (e.g. pruning contractors, accountants etc.) will be positively impacted by conversion of land.
4. *Conversion between land uses – forward linkage supply chain impacts*. Similar to the forward linkage effects resulting from changes in farming systems (point 2 above), the conversion of land from one use to another will result in changes to the supply of key products to downstream processors (for example, more timber to processors, but less raw milk to dairy product manufacturing).
5. *Changes in incomes for land owners*. For each of the scenarios evaluated, there will be changes in income for landowners in the form of wages/salaries and profits. This will cause changes in expenditure patterns of these land owners, hence creating impacts through the rest of the economy.
6. *Outlays and revenues associated with land conversion*. The conversion of land into different uses is associated with a set of discrete capital investments and other economic transfers. For land owners these can be both outlays (e.g. land improvement costs, planting costs) and revenues (e.g. sale of Fonterra shares, sale of dairy herds). The income and expenditure patterns of land owners will have flow on implications through the district, regional and national economies.

7. *Additional mitigation measures and wetland development.* Included in the outputs from the farm- and forestry-level modelling is a set of annualised costs associated with additional mitigations, for example construction of earth bunds, fencing of riparian margins, implementation of farm plans, and pond upgrades. The outputs further include a set of annualised costs for wetland development. These measures will create additional demand for materials and services (e.g. construction services, specialist farm advice, fencing contractors), but will come at a cost to those responsible for the implementation. Additionally land set aside on farms as part of fencing and wetland schemes will reduce the amount of land under production.
8. *Point source treatment upgrades*. In addition to the farm-and forestry-level modelling, the analysis of direct impacts considered the upgrade of treatment methods for point source discharges. The capital and operational costs associated with these upgrades will, again, create some additional demand for some products and services. However this will also mean a reduction in funds within the economy to spend elsewhere.

3.2 Incorporation of the Scenarios within the Modelling Framework

3.2.1 Overview

A summary of the method used to calculate catchment, district, regional and national economic impacts is provided in Figure 1 below. Information obtained from the farm systems modelling that flows in as inputs to the modelling exercise, is depicted in the circles. The primary components of the input-output framework are depicted in the grey boxes. The final results produced by the model (depicted in pink at the centre of the diagram) are the value added and employment (measured in MECs) impacts associated with each scenario. All results are reported in terms of the net change from the baseline scenario.



Notes: hhld = household, cons = consumption,

Figure 3.1 Summary of Modelling Approach

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

At the core of an input-output 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 (i.e. wages and salaries, consumption of fixed capital, gross operating surplus, etc.). The data requirements for constructing input-output matrices are enormous, and this is part of the reason input-output tables are produced in New Zealand on an irregular basis. The latest available input-output table for the New Zealand economy produced by Statistics New Zealand is based on data for the 2006–07 financial year. This means that except in the case of the agriculture and forestry sectors which are considered in detail through the farm system modelling, the industry production mixes used in this study are based on 2006-07 information. Changes in technology and/or production techniques that have occurred since 2006-07 are not considered. Note, however, that when determining the likely destination of agriculture/forestry output for processing, consideration is given to changes in the distribution of processing employment since 2006-07. Where necessary the allocation coefficients determining the destination of output are adjusted. This is discussed in more detail in the methodology below.

The first major step required for the assessment of economy-wide effects is regionalisation of the national table so as to produce tables for the following regions or study areas (note that study areas 5 and 6 are included to account for changes in the rest of Waikato Region located outside of the Freshwater Management Units, and the rest of New Zealand):

1. Ngaruawahia to Port Waikato (Lower Waikato) Freshwater Management Unit;
2. Waipa River (Waipa) Freshwater Management Unit;
3. Karapiro to Ngaruawahi (Mid Waikato) Freshwater Management Unit;
4. Lake Karapiro to Taupo Gates (Upper Waikato) Freshwater Management Unit;
5. Rest of Waikato Region; and
6. Rest of New Zealand.

For each region or study area, 106 different economic industries are defined (refer to Appendix A). The 106 industries are as per Statistics New Zealand latest release of the national input-output table and are directly reconcilable with the Australian and New Zealand Standard Industrial Classification (ANZSIC) system.

The process adopted to disaggregate the latest available input-output tales from Statistics New Zealand into input-output tables covering New Zealand's 16 regional councils is described in Smith *et al*. (2015).[4] A modified version of the Generating Regional Input-

[4] To be precise, our 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'

Output Tables (GRIT) procedure (Jensen *et al*. 1979; West *et al*. 1980) then further disaggregates the regional input-output tables to delineate the individual Freshwater Management Units from the rest of the Waikato region. 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', usually measured in distance or time terms, that exists between the two locations.

Importantly, the input-output 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 multi-regional approach provides a means to evaluate the nation-wide implications.

3.2.3 Step 2: Adjust input-output tables for superior data

The derived input-output tables are adjusted for superior data obtained as part of the project and then rebalanced.[5] Scion (the New Zealand Forest Research Institute Ltd) provided Market Economics Ltd with industry-level accounts specifically for the wood and paper processing industries within the Waikato region. The data was obtained from a financial feasibility model called WoodScape and was put together in 2012. The Woodscape study was a national-level financial modelling analysis and market review of the forestry sector In New Zealand for the purpose of identifying pathways for export growth and utilised the WoodScape model and available industry data.[6] This information was directly incorporated into the multi-regional input-output table as superior data and, in turn, this table was then rebalanced.

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assumption (ITA). For more information on the difference between supply-use and input-output tables and the ITA, refer to Smith and McDonald (2011).

[5] A balanced table is one in which inputs equal outputs. Only marginal rebalancing was necessary as the inputs and outputs produced by the modified GRIT approach were very close for the industries within each region. Rebalancing was performed using a Quadratic Program which minimised the least squares difference of coefficients in the base table while ensuring that inputs and outputs balanced across all industries and regions.

[6] http://www.woodco.org.nz/index.php/strategic-plans/woodscape

3.2.4 Step 3: Calculation of technical coefficients and allocation coefficients tables

The multi-regional input-output tables created for the regions or study areas were, in turn, translated into tables of technical coefficients (i.e. **A** matrices in input-output terms) 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 multi-regional input-output table 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 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 various Freshwater Management Units distributed to key processing activities (e.g. meat processing, dairy product manufacturing, timber processing and so on). A detailed analysis of employment data was also undertaken to capture changes in processing locations occurring since 2007 (i.e. the base year of the input-output tables).

3.2.5 Step 4: 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 Freshwater Management Units*. These changes in input purchases include changes brought about by contaminant limits causing changes in farming practices (point 1 in Section 3.1 above), switching from one type of farming activity to another (point 3 and 6 in Section 3.1), and undertaking additional mitigation measures (point 7 in Section 3.1). The magnitude of these input changes is derived directly from the results of the farm system modelling. 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. Some adjustments are necessary to account for land lost from production as a result of stream fencing and wetland creation (point 7 in Section 3.1)
2. *Net changes in expenditure resulting from loss or gain in household income within the Freshwater Management Units*. The outputs of the farm system modelling are used to determine the net changes in income for land owners and employees. This includes changes in income resulting from changes to the nature and extent of different types of farm systems within the catchment (point 5 in Section 3.1), as well as revenues and expenditures associated with land conversion (point 6 in Section 3.1). It is further assumed that the outlays required for additional mitigation measures (point 7 in Section 3.1) fall on landowners. Thus if classified as a current expenditure in accounting terms, a

direct adjustment to the value add of the relevant industry is required. The value added (income) loss/gain will also result in a corresponding loss/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. *Point source treatment upgrades.* Additional outlays associated with point source upgrades are classified into two categories: operating and capital. Operating expenditures are added to the expenditure of the relevant industry responsible for each discharge, and hence must be matched by a corresponding reduction in that industry's value added contribution. As described in the preceding paragraph, a loss of income recorded in the value added accounts is also assumed to reduce household expenditure on goods and services. Capital expenditures for point source upgrades are treated the same as other capital expenditures described in the next bullet point.
4. *Change in investment patterns.* Costs that are calculated as capital expenditures (low rate effluent upgrades, capital replacement costs for point source treatment upgrades, and some transition costs) are assumed to divert expenditure away from alternative capital investments. Average investment expenditure patterns from the National Social Accounting Matrix (Smith *et al*., 2015) are used to derive estimates of the ratios of different types of products and services for which expenditure will be reduced.
5. *Additional purchases and sales of goods and services necessary to undertake land conversion* (point 6 in Section 3.1). This information is derived from the forestry and farm-level system modelling and is matched to the input-output categories.
6. *Net changes in demand for goods and services used as inputs to agriculture processing* (an outcome of points 2 and 4 in Section 3.1). The changes in output produced by agriculture and forestry within the catchment will impact the industries directly responsible for processing these commodities (dairy, meat, wood, food processing) 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 – see Section 3.2.6 below. These additional backward linkage effects are also included in vector **Y.**

Note that as the multi-regional input-output table is expressed entirely in 2007 prices, it is necessary for all values to be translated into 2007 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 2015 terms for presentation in the reporting or results tables.

Finally, the other output vector, **M**, is an estimate of the change in production of agricultural/forestry commodities for the Freshwater Management Units, 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.[7,8] Adjustments are necessary to account for the loss of land in production associated with stream/riparian fencing and wetland development. For horticulture commodities, estimates of change in production are derived by triangulating information contained within the input-output accounts with data obtained directly from industry experts (pers. comm. Gareth Wilcox). The distribution of outputs from forestry is obtained directly from the Scion work as explained above.

3.2.6 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 fertiliser use by farmers is a reduction in demand for fertiliser manufacturers. In turn, the industries that supply fertiliser manufacturers 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 the input-output literature 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), so as to capture the relationships between income and consumer spending.[10] This study utilises a model that is 'open' with regards to the household and other final demand sectors. The primary reasons are:

- The method described above already captures some income effects associated with changes in profits and wages/salaries for farming systems within the catchment. These are likely to be the most significant income-related effects.

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[7] 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.

[8] The conversion of dairy and drystock farms to other land uses creates an additional supply of beef and sheep from the FMUs. These sales enter the model as 'annualised' data directly from the farm system modelling.

[9] Under this approach, households are treated in a similar manner to industries in the input-output 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 $(\mathbf{I} - \mathbf{A})^{-1}$, 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.

- The input-output approach can in some cases overestimate impacts, primarily due to the absence of price-related feedback mechanisms that help to regulate economies. The use of the open Leontief Inverse Matrix helps to therefore moderate the economic impact estimates generated by the analysis.

3.2.7 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/forestry output under each scenario, such as supply of raw milk to local 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, wood product manufacturing, meat product manufacturing, and textile manufacturing). For these industries, a relatively constant relationship between the availability of commodities for processing and the value of manufactured products produced is likely. These assumptions can be relaxed in regional modelling applications, but as in this case, the relevant data is typically too poor to support alternative formulations.

It is assumed that a change in supply of an agricultural/forestry 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 Waikato 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**.

3.2.8 Capital-related impacts

Input-output based modelling is generally not designed to capture changes in capital stocks.[11] The indicators produced by input-output analysis, such as changes in value added, are flow-based measures rather than stock-based measures. Nevertheless, some of the implications of changes in capital are addressed in this study:

1. *Sale of Fonterra shares* – Under the farm system modelling, the one-off income derived from sale of Fonterra shares is incorporated into the decision making of farmers by translating the income into an 'annualised income'. In the input-output modelling this

[11] Importantly, input-output models do not capture land value changes. Land is sometimes considered to be a capital input by economists.

addition to farmer annual income adds to regional investment spending (i.e. farmers choose to substitute their sale of capital (ownership in Fonterra) for new capital investments).[12] In theory, there will be purchases of these shares by farmers within the rest of the region or nation. Given that these purchases will experience both positive (right to now supply milk to Fonterra and receive income from milk sales and dividends) and negative (expenditure to purchase shares) impacts associated with the share sale, it is not necessary to undertake any further adjustments to the input-output model.[13]

3.2.9 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.

[12] The value of share sales are not included when deriving value added for the catchment because they are a sale of capital (a stock), rather than income (a flow).

[13] It is beyond the scope of this study to consider the implications of price change for Fonterra shares or greenhouse gas emission rights brought about by changes in the ratio of supply and demand.

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Appendix A: Industry Concordance

Table A.1 Concordance between Input-Output Industries and Reporting Industries

106 Input-Output Industry	Reporting Industry
1 Horticulture and fruit growing	4 Other primary
2 Sheep, beef cattle and grain farming	1 Sheep, beef & grain
3 Dairy cattle farming	2 Dairy farming
4 Poultry, deer and other livestock farming	4 Other primary
5 Forestry and logging	3 Forestry
6 Fishing and aquaculture	4 Other primary
7 Agriculture, forestry and fishing support services	5 Agriculture and forestry support
8 Coal mining	4 Other primary
9 Oil and gas extraction	4 Other primary
10 Metal ore and non-metallic mineral mining and quarrying	4 Other primary
11 Exploration and other mining support services	16 Other services
12 Meat and meat product manufacturing	6 Meat and meat product manufacturing
13 Seafood processing	6 Meat and meat product manufacturing
14 Dairy product manufacturing	7 Dairy product manufacturing
15 Fruit, oil, cereal and other food product manufacturing	9 Other manufacturing
16 Beverage and tobacco product manufacturing	9 Other manufacturing
17 Textile and leather manufacturing	9 Other manufacturing
18 Clothing, knitted products and footwear manufacturing	9 Other manufacturing
19 Wood product manufacturing	8 Wood and paper manufacturing
20 Pulp, paper and converted paper product manufacturing	8 Wood and paper manufacturing
21 Printing	9 Other manufacturing
22 Petroleum and coal product manufacturing	9 Other manufacturing
23 Basic chemical and basic polymer manufacturing	9 Other manufacturing
24 Fertiliser and pesticide manufacturing	9 Other manufacturing
25 Pharmaceutical, cleaning and other chemical manufacturing	9 Other manufacturing
26 Polymer product and rubber product manufacturing	9 Other manufacturing
27 Non-metallic mineral product manufacturing	9 Other manufacturing
28 Primary metal and metal product manufacturing	9 Other manufacturing
29 Fabricated metal product manufacturing	9 Other manufacturing
30 Transport equipment manufacturing	9 Other manufacturing
31 Electronic and electrical equipment manufacturing	9 Other manufacturing
32 Machinery manufacturing	9 Other manufacturing
33 Furniture manufacturing	9 Other manufacturing
34 Other manufacturing	9 Other manufacturing
35 Electricity generation and on-selling	10 Utilities
36 Electricity transmission and distribution	10 Utilities
37 Gas supply	10 Utilities
38 Water supply	10 Utilities
39 Sewerage and drainage services	10 Utilities
40 Waste collection, treatment and disposal services	10 Utilities
41 Residential building construction	11 Construction
42 Non-residential building construction	11 Construction
43 Heavy and civil engineering construction	11 Construction
44 Construction services	11 Construction
45 Basic material wholesaling	12 Wholesale and retail trade
46 Machinery and equipment wholesaling	12 Wholesale and retail trade
47 Motor vehicle and motor vehicle parts wholesaling	12 Wholesale and retail trade
48 Grocery, liquor and tobacco product wholesaling	12 Wholesale and retail trade
49 Other goods and commission based wholesaling	12 Wholesale and retail trade
50 Motor vehicle and parts retailing	12 Wholesale and retail trade
51 Fuel retailing	12 Wholesale and retail trade
52 Supermarket and grocery stores	12 Wholesale and retail trade

Table A.2 (continued) Concordance between Input-Output Industries and Reporting Industries

106 Input-Output Industry	Reporting Industry
53 Specialised food retailing	12 Wholesale and retail trade
54 Furniture, electrical and hardware retailing	12 Wholesale and retail trade
55 Recreational, clothing, footwear and personal accessory retai	12 Wholesale and retail trade
56 Department stores	12 Wholesale and retail trade
57 Other store based retailing; non-store and commission based	12 Wholesale and retail trade
58 Accommodation	16 Other services
59 Food and beverage services	16 Other services
60 Road transport	13 Transport
61 Rail transport	13 Transport
62 Other transport	13 Transport
63 Air and space transport	13 Transport
64 Postal and courier pick up and delivery services	13 Transport
65 Transport support services	13 Transport
66 Warehousing and storage services	16 Other services
67 Publishing (except internet and music publishing)	16 Other services
68 Motion picture and sound recording activities	16 Other services
69 Broadcasting and internet publishing	16 Other services
70 Telecommunications services including internet service provi	16 Other services
71 Library and other information services	16 Other services
72 Banking and financing; financial asset investing	16 Other services
73 Life insurance	16 Other services
74 Health and general insurance	16 Other services
75 Superannuation funds	16 Other services
76 Auxiliary finance and insurance services	16 Other services
77 Rental and hiring services (except real estate); non-financial a	16 Other services
78 Residential property operation	16 Other services
79 Non-residential property operation	16 Other services
80 Real estate services	16 Other services
81 Owner-occupied property operation	16 Other services
82 Scientific, architectural and engineering services	14 Scientific, professional and adminstrative services
83 Legal and accounting services	14 Scientific, professional and adminstrative services
84 Advertising, market research and management services	14 Scientific, professional and adminstrative services
85 Veterinary and other professional services	14 Scientific, professional and adminstrative services
86 Computer system design and related services	14 Scientific, professional and adminstrative services
87 Travel agency and tour arrangement services	14 Scientific, professional and adminstrative services
88 Employment and other administrative services	14 Scientific, professional and adminstrative services
89 Building cleaning, pest control and other support services	14 Scientific, professional and adminstrative services
90 Local government administration	15 Local and central government
91 Central government administration and justice	15 Local and central government
92 Defence	15 Local and central government
93 Public order, safety and regulatory services	15 Local and central government
94 Preschool education	16 Other services
95 School education	16 Other services
96 Tertiary education	16 Other services
97 Adult, community and other education	16 Other services
98 Hospitals	16 Other services
99 Medical and other health care services	16 Other services
100 Residential care services and social assistance	16 Other services
101 Heritage and artistic activities	16 Other services
102 Sport and recreation activities	16 Other services
103 Gambling activities	16 Other services
104 Repair and maintenance	16 Other services
105 Personal services; domestic household staff	16 Other services
106 Religious services; civil, professional and other interest grou	16 Other services