IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of the proposed Variation 2 to the Proposed Canterbury Land and Water Regional Plan - Section 13 Ashburton

STATEMENT OF PRIMARY EVIDENCE OF JAMES DOUGLAS MARSHALL FAIRGRAY FOR FONTERRA CO-OPERATIVE GROUP LIMITED AND DAIRYNZ LIMITED

15 MAY 2015

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1. INTRODUCTION

1.1 My full name is James Douglas Marshall Fairgray. I have a PhD in geography from the University of Auckland, and I am a Principal of Market Economics Limited ("**MEL**"), an independent research consultancy.

Qualifications and experience

1.2 I have over 35 years' consulting and project experience, working for commercial and public sector clients. I specialise in policy and strategy analysis, the role of major infrastructure in the economy, assessment of demand and markets, the form and function of urban and rural economies, the preparation of forecasts, and evaluation of outcomes and effects. I have applied these specialties in over 900 studies throughout New Zealand, across most sectors of the economy – notably infrastructure, transport, retail, services, leisure, housing, travel, aquaculture, agriculture, local government and commercial property.

1.3 I have expertise in assessing economic growth and change, including employment growth, and how economies develop in relation to policy changes. I have examined how growth in key sectors of an economy flows on through to more general economic and employment growth, and how changes in government policies can affect the range of activities, and employment.

1.4 I have studied New Zealand's regional economies and the national economy, including growth patterns, trends and change, and the interrelationships among regions. I have researched policy and economic change in urban and rural areas. I have examined the interactions among different sectors of the economy, with a general focus on outcomes that enhance efficiency and effective management of growth.

1.5 I have applied these studies for assessment of effects in evidence to council hearings, the Environment Court and the High Court.

1.6 I have had a particular focus on the evaluation of outcomes, including the development and application of comprehensive evaluation frameworks, to help to understand the implications of policies and initiatives. This work is based on assessment of outcomes for societal wellbeing in the Resource

Management Act 1991 ("**RMA**") and Local Government Act 2002 ("**LGA**") contexts.

Background

1.7 My involvement in the proposed Variation 2 to the CWLP - Section 13 Ashburton ("**Variation 2**") commenced in December 2014. Recently, I have also analysed the economic implications relating to other catchment plans, including Selwyn-Waihora (Variation 1) and Manawatu-Wanganui (Horizons One Plan).

1.8 I have reviewed the economic rationale for Variation 2 presented by Environment Canterbury ("**ECan**") as shown in the section 32 Report and the supporting documents on behalf of DairyNZ ("**DNZ**"). I have also undertaken an independent assessment of the economic effects of Variation 2, based on the three scenarios developed by Dr Bell and Mr Neal.

1.9 I am familiar with the provisions of Variation 2 to which these proceedings relate. In preparing my evidence I have reviewed the relevant parts of the section 32 Report, the section 42A Report and relevant supporting material in relation to economic value of Variation 2 including:

(a) Landcare, Daigneault, A.J. (2014) NZFARM Analysis of Environment Canterbury's Hinds Catchment Allocation Options, Report No. R14/81.

(b) MacFarlane Rural Business (2013) Hinds Catchment Nutrient and On-Farm Economic Modelling, Report N. R13/109.

(c) AgResearch, Paragahawewa, U.H. (2014) Economic Impact Assessments of the Hinds Water Quantity and Quality Limit Setting Process, Report No. R14/82.

(d) AgResearch, Paragahawewa, U.H. (2014) Memorandum Catchment and Regional Level Economic Impacts Estimations Based on the MRB Re-Estimated Farm Level Financial Data.

(e) Golder Associates (2014) Hinds/Hekeao Plains Subregional Catchment, Managed Aquifer Recharge (MAR) as a tool for managing water quality and quantity issues, Report No. R14/80.

1.10 I have also read the evidence of Mr Neal, Dr Bell, Ms Hayward, Dr Brown and Mr Willis.

Code of Conduct

1.11 I have read the Code of Conduct for expert witnesses contained in the Environment Court's Practice Note as updated in 2014 and agree to comply with it. In that regard, I confirm that this evidence is within my area of expertise, except where I state that I am relying on the evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed in this evidence.

2. SCOPE OF EVIDENCE

2.1 In my evidence I have provided an assessment of the economic effects of Variation 2 on the district and the region. I have assessed the effects on economic activity at both a district and regional level, as well as associated effects on employment. I have also considered the potential impacts on specific towns, including townships in and around the Hinds catchment.

2.2 For this, I have considered three possible solutions to the intent of Variation 2:

(a) An 'ECan Amended Variation 2', as discussed in evidence of by Mr Neal. Due to his concerns about the assumptions used in the ECan modelling, Mr Neal has assessed Variation 2 and substituted new assumptions which he considers are more appropriate due to:[1]

(i) current land use, as provided by the evidence of Dr Brown; and

(ii) on farm economic modelling and changes to existing land use as provided by the evidence of Mr Neal and Dr Bell.

[1] Paragraph 3.3 of the evidence of Mr Neal.

(b) Two Fonterra and DairyNZ proposed alternative solutions (DNZ/Fonterra – 3 Stage,[2] and DNZ/Fonterra – 4 Stage), as described by DairyNZ experts (paragraph 4.3 (a) of Dr Bell evidence and Mr Neal evidence at paragraphs 5.24 to 5.32).

2.3 The three solutions have been assessed by Dr Bell and Mr Neal to establish farm level cash flows that are expected to occur as a result of the ECan Amended Variation 2 solution package,[3] and the two DNZ/Fonterra solution packages.

2.4 I have assessed the economic and employment effects for each of the possible solutions, and the implications for towns and townships. I also address ECan's original economic modelling.

2.5 From an economic perspective, the key issues relate to the effects on dairy farming of the required reductions in nitrogen leaching in the Hinds catchment, in combination with the on-going growth in dairy farming. For individual farmers, the required reductions in nitrogen leaching are expected to see decreases in farm output. At the catchment level, the likely further increase in the land area used for dairy farming is expected to see higher output from dairy farms in total. Both of these components of change are important, and need to be considered *per se*, and in combination. Key questions relate to the extent of the change for farmers on land which is already in dairy farming, and to the likely increase in the total dairy farming area in Hinds.

2.6 The implications for the economy, which I address in this statement, flow directly from the effects on established dairy farms, and from how much additional dairy farming land will be developed in the Hinds catchment.

2.7 My evidence is structured as follows:

(a) Executive Summary;

(b) Context and issues;

(c) Variation 2 and DNZ/Fonterra Alternative Solutions

(d) Economic Methods;

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2 As set out in the proposed amendments to the rules in Appendix 2 of the evidence of Mr Willis.

3 The ECan Amended Variation 2 solution is as discussed by Mr Neal in paragraph 3.3 and section 4 of his evidence.

(e) Economic Implications; and

(f) Environment Canterbury's economic rationale for Variation 2.

3. EXECUTIVE SUMMARY

3.1 The dairy industry is the largest generator of employment and economic activity in the Hinds catchment, and accounts for around one-third of economic activity in Ashburton District. A substantial proportion of the community is reliant on this sector of the economy, in terms of jobs and income.

3.2 The solution packages suggested by the parties will all affect the operation of the dairy industry, both in terms of existing farmers' and future farmers' activities. The major role of dairying in the economy highlights the importance of close consideration of the potential solution packages.

3.3 I have conducted an economic assessment of three potential solution packages which have been presented by DNZ/Fonterra. I consider that all three of the packages will have negative implications in terms of economic activity and jobs within the Ashburton District.

3.4 I also consider that there will be some negative implications for local towns and townships, with most of the effects accruing to Ashburton town.

3.5 I have also assessed the economic rationale presented by ECan in support of the proposed Variation 2 solution package. I consider that while the AgResearch assessment applies appropriate methods, it relies on base information, and future land use outcomes, which are challenged by DNZ/Fonterra experts.

3.6 In my view, the DNZ/Fonterra – 3 stage implementation solution package would have the lowest negative effects on economic activity in the District. This is because it would be implemented later, and would place more of the mitigation requirement over all high emitters which contribute more to the District economy on a per ha basis.

4. CONTEXT AND ISSUES

4.1 In this section, I describe the economic context, which provides the basis for my economic assessment of ECan Amended Variation 2, and the proposed DNZ/Fonterra alternatives. I examine the scale of the dairy farming industry in the Hinds catchment, the structure of the district economy, the network of local centres in and around the Hinds catchment, and the community.

Hinds Catchment Dairy Farming

4.2 The dairy farming industry in the Hinds catchment has grown rapidly over the last two decades. As can be seen in Dr Brown's evidence (Figure 1), the level of dairy farming activity in the Hinds catchment did not start to grow significantly until after 2000, but as of 2015 the land used for dairy farming is more than 5 times the size it was in 2000.

4.3 The growth seen in the industry is expected to exhibit a sigmoidal pattern, commonly referred to as S-shaped growth. This is a common pattern seen in nature, technology adoption and industry growth.

4.4 This S-shape is characterised by slow growth in the early years with a small number of 'innovators and early adopters' entering and proving that a type of activity is profitable. This slow initial growth is often followed by more rapid growth, as many new operators copy the early adopters. Generally, the very rapid early growth phase tapers off as the industry starts to approach constraints (such as land supply), and as there are progressively fewer remaining non-adopters.

4.5 This pattern is evident in dairy farming in Hinds. Between 2000 and 2005 dairy farming activity in the Hinds catchment grew substantially, by around 13,000 ha. This was a compounding growth rate of 20% per annum. A similar area of dairy farming land was added in the 2005-2010 period (16,000 ha), although the annual growth rate was around 11% in this period. The increase in dairy land continued (similar in land area though at a lower annual growth rate of 6%), and in 2014 an estimated 49,000 ha is occupied by dairy farming[4]. The total conversion of land to dairy farming amounted to some 40,000 ha over the 2000-2014 period.

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[4] I have adopted the land use figures provided by Dr Brown (Table 1 of his evidence).

4.6 However, the past rates of increase are not likely to continue, with the Hinds catchment expected to reach constraints including limits on the availability of land (a matter which is explored in Section 5 of Dr Brown's evidence on land use), and / or other factors such as the marginal viability of the remaining land for dairy farming activity (see Mr Neal's evidence at Table 1) where earlier adopters utilise the most productive land for dairy farming, which means that later entrants are faced with less productive land.[5]

4.7 The ECan estimate allows for a further 13,000 ha for dairy farming itself (from another 30,000 ha of irrigated land)[6], which would take total area in dairy farming area to 62,000 ha. The DNZ/Fonterra estimate[7] allows for a further 5,000 ha for dairy farming (from a further 15,000 ha of irrigated land), which would take the total area in dairy farming to 54,000 ha. Figure 1 shows the past growth in dairy farming land[8], together with the ECan future and the DNZ/Fonterra future. The ECan future suggests that dairy farming in the Hinds catchment is now at 80% of its maximum, while the DNZ/Fonterra future suggest dairying is now at 91% of the maximum.

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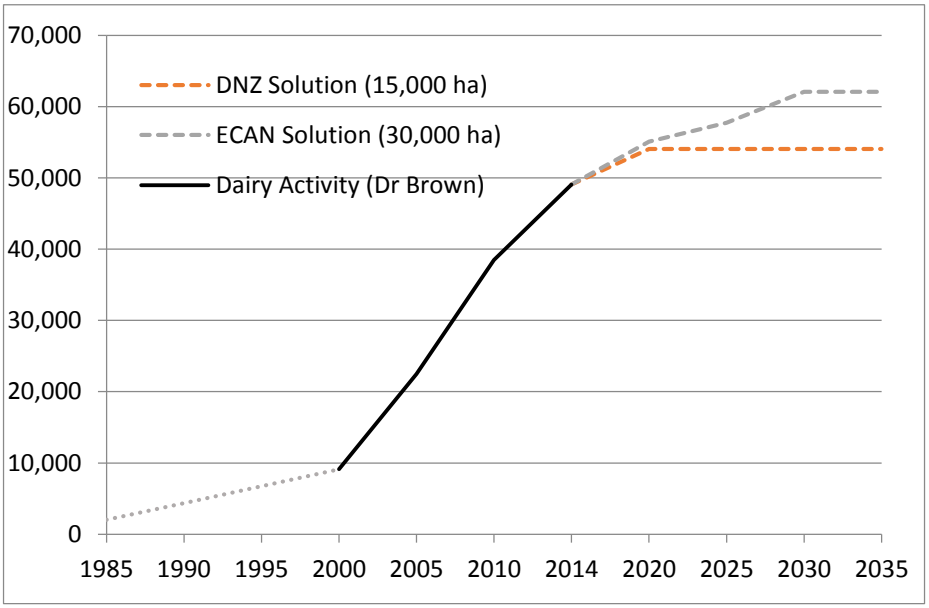
5 As suggested by Dr Bell productivities for the conversions relative to the existing farmers at paragraph 5.2 of his evidence

6 The ECan solution is equivalent to around 2% per annum until 2025 and then decreasing to 1% per annum until 2030 (see Table 1 of AgResearch, Paragahawewa, U.H. (2014) with up to 13,000 ha more of dairy conversions in total (see Landcare, Daigneault, A.J. (2014) , Table 7).

7 DNZ/Fonterra solution is equivalent to 2% per annum out to 2020, with conversions of 1,000 hectares per annum (see paragraph 4.3(e) of Dr Bell's evidence).

8 Sourced from Dr Brown's evidence, Figure 1.

Figure 1: Hinds catchment dairy farming area, ECan and DNZ/Fonterra Solutions



Note: for demonstrate purposes I have assumed very little dairy activity before 1985 (black dotted line).

4.8 This shows that the dairy industry in the catchment has grown following an S-shaped curve, which is consistent with a future where more dairy farming is likely to be constrained, and expectations of the industry's future growth should reflect this.

Economic Structure

4.9 In today's context, dairy farming and dairy support is the most important activity in the Hinds catchment, and is important within the wider Ashburton District economy. It generates $585 million in value added, with more than 1,140 persons engaged on-farm[9] in the catchment and around 1,000 jobs at processing sites in the adjacent Timaru District and Selwyn District[10]. This highlights the importance of understanding how policies that impact on the dairy farming industry are likely to have direct and consequent impacts on the district's and region's economy.

4.10 Economic activity in the Hinds catchment is dominated by farming, forestry and fishing, which accounted for over 75% of employment there in 2014. Other sectors are important components of the local economy, but are small relative to the land-based activities. This is mainly because

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9 See Table 1.

10 Statistics New Zealand Business Directory 2014 and Market Economics distribution of LEED Working Proprietors.

the townships in the catchment are small, and many rural support activities locate in rural service towns, especially Ashburton.

4.11 The Hinds catchment has seen a near 20% increase in employment since the year 2000, with an additional 387 persons employed, and currently there are more than 2,500 jobs in the area.[11] Much of the growth in employment in the area has been in dairy cattle farming (a gain of +810), with associated gains in the wholesale trade (+48), manufacturing (+56), construction (+50), transport, postal and warehousing (+42), and retail (+35) (see Table 1).

4.12 The agriculture, forestry and fishing sector (excluding dairy cattle farming) has seen a substantial loss of employment (-580), which is directly related to the land use change that has occurred in the catchment.

Table 1: Hinds Catchment Employment (MEC[12]) by Industry, 2000-14

Industry	2000	2010	2011	2012	2013	2014
Agriculture, Forestry and Fishing (excl dairy cattle)	1,383	849	871	877	819	802
Dairy cattle farming	333	735	851	915	1,008	1,144
Mining	-	-	1	1	1	1
Manufacturing	22	92	70	46	56	78
Electricity, Gas, Water and Waste Services	2	1	2	2	2	1
Construction	33	103	88	102	63	83
Wholesale Trade	16	42	36	42	71	64
Retail Trade	12	63	70	64	67	47
Accommodation and Food Services	21	11	8	5	11	12
Transport, Postal and Warehousing	26	80	70	68	75	68
Information Media and Telecommunications	1	9	5	5	5	8
Financial and Insurance Services	-	3	6	3	2	1
Rental, Hiring and Real Estate Services	71	75	77	99	79	84
Professional, Scientific and Technical Services	3	28	12	42	9	15
Administrative and Support Services	21	1	5	12	13	24
Public Administration and Safety	-	-	-	-	-	-
Education and Training	58	79	75	66	75	72
Health Care and Social Assistance	-	-	3	3	8	8
Arts and Recreation Services	11	8	18	30	15	12
Other Services	3	19	18	15	24	24
Total	2,016	2,198	2,286	2,397	2,403	2,548

Source: Statistics New Zealand Business Directory 2014 and Market Economics distribution of LEED Working Proprietors

4.13 The numbers of dairy farms in the catchment has grown rapidly over the last 14 years, from 103 in 2000 to nearly 250 in 2014 (see Table 2). This

11 See Appendix 1 for details on Hinds Catchment definition, which is based on Statistics New Zealand 2013 Meshblocks.

12 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 out of business earnings, rather than a salary or wage. The modified employment count or MEC measure is based on ECs but includes an adjustment to incorporate the estimated number of working proprietors from LEED.

growth is equivalent to 10 new dairy farms every year. There is no upstream dairy activity in the catchment over this period.

Table 2: Hinds Catchment Dairy Industry Business Count, 2000-14

Industry	2000	2010	2011	2012	2013	2014
Dairy Cattle Farming	103	195	203	230	233	249

Source: Statistics New Zealand Business Directory 2014 - GU

4.14 It is not possible to provide information on the local Hinds catchment economy in terms Value Added or GDP. The economic models that I have employed in my evidence do not provide information below the district level. However, in Table 3 I present some Ashburton District level Value Added measures to describe the relative importance of each industry.

4.15 This is important, because while some industries employ relatively few people, they nevertheless add significant value to the economy because of the nature of the industry. This is common when there is a highly skilled work force in one industry.

4.16 The direct dairy farming activity in the Ashburton District accounts for around one third ($585 million) of the total Value Added generated by all industries in the area. The Manufacturing industry is the second largest (16%) with the rest of agriculture in the district producing 12%.

4.17 Approximately half of the District's dairy activity is located in the Hinds catchment, so I consider that the dairy activity in the Hinds catchment would account for around 15% of the total district economy.

Table 3: Ashburton Economy 2014 - Value Added by Industry ($ million 2013)

Ashburton District Economy by Industry	Employment 2014 (MEC)	Value Added 2014 (2013 $ mil)	% Value Added
Agriculture, Forestry and Fishing (exl Dairy cattle)	2,776	$ 218	12%
Dairy cattle farming	2,233	$ 585	32%
Mining	16	$ 7	0%
Manufacturing	2,961	$ 304	16%
Electricity, Gas, Water and Waste Services	133	$ 56	3%
Construction	1,635	$ 91	5%
Wholesale Trade	853	$ 80	4%
Retail Trade	1,735	$ 70	4%
Accommodation and Food Services	952	$ 29	2%
Transport, Postal and Warehousing	504	$ 33	2%
Information Media and Telecommunications	255	$ 13	1%
Financial and Insurance Services	236	$ 44	2%
Rental, Hiring and Real Estate Services	380	$ 92	5%
Professional, Scientific and Technical Services	596	$ 17	1%
Administrative and Support Services	547	$ 49	3%
Public Administration and Safety	295	$ 21	1%
Education and Training	772	$ 40	2%
Health Care and Social Assistance	1,082	$ 62	3%
Arts and Recreation Services	287	$ 11	1%
Other Services	402	$ 21	1%
Total	**18,650**	**$ 1,843**	**100%**

Source: Market Economics

4.18 This economic context shows the scale of the dairy industry, compared to other industries in the Ashburton District economy.

Town Economies

4.19 The economy model captures the district level effects of changes in the dairy industry. In order to understand how those changes will have local effects as well as district-level effects, it is necessary to understand the roles and activity levels in the district's towns and the townships which directly serve the farms and the community in the Hinds catchment.

4.20 The focus here is on the retail and service roles of these towns and townships, since these roles are affected most directly by changes in the spending levels of dairy farms and dairy farming households.

4.21 The towns in Ashburton are small compared to Christchurch to the north and Timaru to the south. Ashburton is the largest, with townships at

Methven and Rakaia. The Hinds catchment has two small townships, at Hinds itself (on SH 1, 18 km from Ashburton), and Mayfield (on SH 72, 35 km from Ashburton).[13]

4.22 Table 4 shows the retail and hospitality sector within the district. Ashburton dominates, with some 84% of the sector in the town. Methven accounts for 8.0%, and Rakaia 2.4%. The sector is small in the Hinds catchment (2.2%), and the rest of the district (3.6%).

4.23 However, the retail and hospitality sector has grown in the 2000-2014 period. Ashburton town has seen the largest growth in employment, from 1,753 persons engaged in 2000 to over 2,252 jobs by 2013 (29% gain). The Methven township and the Hinds catchment have also shown growth, with sector employment increasing by around half over the period. Rakaia also recorded strong growth, almost doubling in size over the period, though from a small base. The other areas in the district have remained relatively stable.

4.24 Unlike many rural areas in New Zealand, the townships in the Hinds catchment have shown growth. While this has been relatively small compared with the increase in employment on the land, it is nevertheless likely to have been driven by the additional economic activity from the land use change to dairy farming. However, the level of activity overall in the townships remains small, because the proximity of Ashburton (and to a lesser degree Geraldine) means that the catchment population has fairly convenient access to the goods and services outlets in the larger centres.

Table 4: Ashburton District Retail and Hospitality Employment (MEC) by Town Centres, 2000-14

Retail and Hospitality	2000	2010	2011	2012	2013	2014
Hinds Catchment	33	75	78	69	78	59
Ashburton	1,753	2,058	2,041	2,125	2,174	2,252
Methven	141	217	199	206	192	213
Rakaia	34	56	57	63	60	66
Rest of District	88	68	76	70	90	96
Ashbuton District	**2,049**	**2,473**	**2,450**	**2,534**	**2,595**	**2,687**

Source: Statistics New Zealand Business Directory 2014 and Market Economics distribution of LEED Working Propietors

Community

4.25 The growth in activity in the local towns and townships is further reflected in the growth in population and numbers of households (Table 5). Growth

13 See Figure 3 for spatial definitions of the Town Centres in Table 4.

in Ashburton District has been steady (1.6% pa over the 2001-13 period). Interestingly, the rate of increase in the District as a whole has been faster than that for Ashburton town (1.1%), with the rural areas and townships, and the small townships together accounting for over 60% of total growth.

4.26 The Hinds catchment recorded the highest overall growth rate, with household numbers increasing by 2.8% pa over the period. The number of households living in the Hinds catchment grew by 450, from 1,140 in 2001 to 1,590 in 2013 (see Table 5).

4.27 The rural areas in the rest of the District have also experienced rapid growth in household numbers, of 2.0% per annum, well ahead of the rate seen for Ashburton town.

Table 5: Ashburton and Hinds Community, Households 2001-13 and projected 2031

	2001	2006	2013	2031	2013-2031
Hinds Catchment	1,140	1,260	1,590	2,035	445
Ashburton	6,081	6,402	6,909	7,308	399
Methven	486	552	678	887	209
Rakaia	354	399	483	506	23
Rest of District	2,046	2,238	2,604	3,664	1,060
Ashbuton District	**10,107**	**10,851**	**12,264**	**14,400**	**2,136**

Source: SNZ Census 2013 and SNZ Household Projections, 2006(base)-2031 - Medium

4.28 In my view, this growth in the household numbers living in rural areas is consistent with the level of conversions from other farming types to dairy farming and dairy support activity, and the associated increase in farming intensity.

4.29 It is important to note the number of households in the Hinds catchment relative to the numbers of dairy jobs. The dairy industry currently employees over 1,140 people in the Hinds catchment, which compares to household numbers of 1,590. Although a number of workers will travel from outside the catchment and some of the people in the Hinds catchment will travel out of the catchment for work, I consider that the majority of households in the Hinds catchment are likely to have a household member who is employed **directly** in the dairy industry or **indirectly** in support industries.

5. VARIATION 2 AND DNZ/FONTERRA ALTERNATIVE SOLUTIONS

Variation 2

5.1 In this context, I now consider proposed Variation 2 (the ECan Amended Variation 2, as per Mr Neal's assessment), and the two DNZ/Fonterra proposed alternative solutions.

5.2 Variation 2 is expected to directly affect the operation of dairy farms and dairy support operations in the Hinds catchment. It will require these operations to modify their current methods of farming, in order to reduce the environmental externalities associated with dairy production (mainly with regards to nitrogen (N) leaching).

5.3 Variation 2 also allows for the development of new irrigated areas and conversion from lower productive uses to new dairy or dairy support activities.

5.4 In summary both ECan and DNZ/Fonterra experts agree that Variation 2 will have the following effects:

(a) **Existing Dairy and Dairy Support Farmers**: will be negatively affected by Variation 2, because the reductions in farming activity required to conform to nitrogen standards will mean that farm level profits of existing dairy farmers will reduce, as will those of dairy support farmers. Overall, the level of production on existing farms will decrease, and the costs of production will increase. This reduction in farm output and profitability will have adverse effects on the economic activity in the area, including farm and farmer spend in local retail and service outlets. However it is important to highlight that ECan experts consider that the existing farms can undertake mitigation at little cost, while the DNZ experts consider the costs are likely to be significant (see Table 1 and paragraphs 4.1 to 4.10 of Mr Neals' evidence for a discussion of the differences).

(b) **New Dairy and Dairy Support Farmers**: To offset the impacts of Variation 2, the policy includes the provision for development of new irrigation capacity, which potentially means new dairy farms can establish, along with associated dairy support activities. The additional dairy farming will produce positive

economic activity in the area, including spending in local retail and service outlets.

5.5 A key issue is whether these two effects of the Variation 2 ECan solution will result in a positive or negative impact on the District economy, and for local towns. The ECan evidence suggests that Variation 2 will result in overall positive impacts,[14] with the reduction in existing farmers' economic activity being outweighed by the growth in activity from the new farmers.

5.6 Broadly, the reports that support the ECan Variation 2 (see paragraph 1.9 above for a list of the reports) suggest that existing dairy farmers can reduce nitrogen at little cost, both in terms of on-farm expenditure and levels of production (see paragraph 4.1 to 4.10 of Mr Neals' evidence).

5.7 However, the evidence of the experts on behalf of DNZ/Fonterra (Dr Bell and Mr Neal) is that the cost of mitigation at the farm level is considerably higher than indicated by the experts for ECan.

5.8 The reports prepared in relation to ECan Variation 2 suggest that an additional 30,000 hectares of land could be irrigated, and all could be converted to dairy or dairy support. Those reports find that these new farmers would generate significant levels of positive economic activity in the catchment.

5.9 The DNZ/Fonterra experts consider that the estimates of additional area which can be converted to dairy farming are overly optimistic. This is mainly driven by four key issues:

(a) **Land Constraint:** first, the assessment by Dr Brown indicates that there physically is not enough land in the catchment to allow 30,000 ha of new development. Dr Brown estimates that "*at most 19,000 ha (±5,500) of new irrigation could occur*" (paragraph 4.5);

(b) **Productivity of New Farms:** second, the assessments by Dr Bell[15] and Mr Neal[16] both indicate that the productivity of new dairy farms is likely to be lower than that on existing farms, and lower than that shown in the ECan studies. This would mean

14 MacFarlane Rural Business (2013) Hinds Catchment Nutrient and On-Farm Economic Modelling, Report N. R13/109

15 As suggested by Dr Bell productivities for the conversions relative to the existing farmers at paragraph 5.2 of his evidence

16 See Table 1 of Mr Neals' evidence.

that the overall economic activity that is sustained by the new dairy farms would be lower than what is identified in the ECan reports;

(c) **Viability of New Farms:** third, the Variation 2 provisions enable '**capacity**' for development. This enablement of capacity does not in itself mean that the development will be taken up. The capacity would only be developed by farmers if the irrigated land is viable for dairy farming activity or dairy support. The evidence of Mr Neal[17] indicates that the viability of the new dairy developments would be marginal.

(d) **Effects on Nitrogen Levels:** Ms Hayward (paragraph 5.4) considers that converting all of this land would result in the total nitrogen levels exceeding the ECan targets, and that according intensification on the full 30,000 ha would not be feasible.

5.10 Because of the different opinions of the experts for ECan and DNZ/Fonterra, in my view it is important to understand the economic implications of a higher level of impact on existing dairy farms, and a lower level of offset for the dairy industry overall from the availability of more irrigated land.

DNZ/Fonterra Alternative Solutions

5.11 DNZ/Fonterra has also modelled two 'alternative solutions' which are intended to reduce the level of impact on existing dairy farms, and change the time period over which the changes would be implemented. The DNZ/Fonterra 4-stage solution would see the reductions in nitrogen phased in over the same timeframe as the ECan solution and completed by 2035. The DNZ/Fonterra 4-stage approach assumed MGM applied from 2017, followed by a 9% reduction by 2020, 18% by 2025, 27% by 2030, ending at 36% at 2035.

5.12 The DNZ/Fonterra 3-stage solution would see the reductions in nitrogen phased in later, commencing in 2020-21 (rather than 2017-18) and completed by 2035.[18] The DNZ/Fonterra 4 stage approach assumed MGM applied from 2017, followed by a 9% reduction by 2020, 18% by 2025, 27% by 2030, ending at 36% at 2035.

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17 See Table 1 of Mr Neals' evidence.

18 See Mr Willis' evidence at paras 13.1 to 13.9.

6. ECONOMIC METHODS

6.1 In this section, I examine the implications of Variation 2 and the DNZ/Fonterra alternative solution, for both the district economy, and for the district's towns. I have applied economic impact analysis ("**EIA**") for the effects on the economy, and a retail assessment for effects on the towns.

6.2 The implications for the economy arise mainly from the effects on dairy farming activity, and I draw on the farm level data provided by Dr Bell to identify effects on farming activity and farmer expenditure. I also take into account an additional 5,000 ha of dairy farming and 10,000 ha of mixed farming intensified with dairy support activities (15,000ha in total), where I draw on the information provided by Dr Brown. The evidence of Dr Brown and Dr Bell indicates that it is not physically or financially feasible or likely that 30,000 ha of development would occur.

6.3 This means that my assessment of Variation 2 applies both greater levels of on-farm impact, and a smaller area of additional dairy farming land, than those which are identified and applied by experts for ECan.

6.4 My focus is on the differences between Variation 2 and the DNZ/Fonterra alternative, on the basis that either solution would apply to existing dairy farms, and to new farms on the additional 5,000 ha of dairy farming. I have not examined a future where 30,000 ha of additional land would be used for dairying (the ECan scenario). That would affect the magnitude of effects, although it would not alter the relative results of the Variation 2 vs the DNZ/Fonterra alternative outcomes.

Use of Scenarios

6.5 To consider the outcomes, I have applied a scenario approach, where I compare one pattern of implementation of Variation 2 (a smoothed transition) as against the same pattern, over the same time frame, for the DNZ/Fonterra alternatives which include 3 stages and 4 stages of nitrogen loss reductions.

6.6 A common step in modelling a policy change is to define a base case situation - usually a no change or "business as usual" future - and use that to compare the range of potential solutions. For my assessment, the base case is where all existing dairy farmers adhere to Good

Management Practice ("**GMP**"), without need for Variation 2, and no additional land is converted to dairy farming or dairy support.

6.7 I have defined three scenarios to compare with the base case smoothed transition for both ECan solution and the DNZ/Fonterra 4 stage solution and DNZ/Fonterra 3 stage solution, over the period 2015 to 2035:

(a) **Base vs Smoothed ECan Amended Variation 2:** which is the GMP base case for dairy farming land together with existing farming activity on unirrigated land, compared with the ECan Amended Variation 2 where transition by existing dairy farmers is smoothed over four stages with the first effects evident from 2018 and being fully implemented by 2035. There is new dairy farming (5,000 ha) and more intensive sheep/beef dairy support mixed farm (10,000 ha);

(b) **Base vs Smoothed DNZ/Fonterra - 4 Stage:** which is the GMP base case for dairy farming land together with existing farming activity on unirrigated land, compared with the DNZ/Fonterra solution where transition by existing farms is smoothed over four stages (as above), and there is new dairy farming (5,000 ha) and more intensive sheep/beef dairy support mixed farm (10,000 ha);

(c) **Base vs Smoothed DNZ/Fonterra - 3 Stage:** which is the GMP base case for dairy farming land together with existing farming activity on unirrigated land, compared with the DNZ/Fonterra solution where transition by existing farms is smoothed over three stages, and there is new dairy farming (5,000 ha) and more intensive sheep/beef dairy support mixed farm (10,000 ha).

6.8 All of these apply the farm level revenues and expenditures as estimated by Dr Bell (see paragraph 5.1 to 6.3 of his evidence)[19].

6.9 In the scenarios, as well as the total of an additional 15,000 ha irrigated, it is important to note:

(a) That all of the solution options include a Flexibility Cap on non-dairy activity in the catchment. This addition to the solution

[19] See Appendix 2 of my evidence for brief summary of data.

package has the same impact under all the scenarios and would (marginally) increase revenue and economic activity associated with each of the options.

(b) The ECan solution package that is currently used in Variation 2 includes the Managed Aquifer Recharge (MAR) tool. The potential costs of financing this tool or the benefits associated with potential reliability improvements have not been included in my analysis.

6.10 I am not able to quantify the effects of these two parts of the solution package, and I have not included them in the scenarios. I consider it likely that the Flexibility Cap will provide a small improvement in the economic activity in the catchment. The Flexibility Cap is expected to cause a marginal increase in revenue on arable land, from $39m to $41m (about $2m). However it is important to note that the Flexibility Cap is included in all of the solution packages (ECan Amended Variation 2, DNZ/Fonterra - 4 stage and DNZ/Fonterra - 3 stage) and as such has no material effect on my assessment.

6.11 The costs and benefits associated with the MAR are largely a water and farm level production issue, which lies outside my area of expertise.

Economic Impact Assessment

6.12 For the EIA I have used a district level Input-Output model for Ashburton District, which is of a similar type to the model used by AgResearch for the ECan study for the Hinds catchment. Since both ECan and I have utilised a similar method, I consider that it is of limited benefit to provide of detailed explanation of the model, and I provide a summary narrative of the model used.

6.13 I have applied a multi-regional input-output (IO) model that identifies the economic impacts at the district, regional and national levels. One of the core strengths of IO analysis is that it captures the complex interactions and interdependencies which take place between different sectors within an economy. This means that it is possible to consider a vast number of the indirect or flow-on effects that occur throughout an economy as a result of any type of economic change. IO analysis also enables economic impacts to be evaluated at the level of individual sectors or

industries, thus providing a disaggregated picture of the nature of economic impacts.

6.14 At the core of any IO 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 'IO table' by arrays that summarize 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, mathematical relationships are calculated for the economy in question.

6.15 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 then possible to calculate, given a proposed alteration to a selected industry (a scenario), all of the changes in production that are likely to occur throughout supporting industries within the wider economy. The technical details of the IO modelling are explained further in Appendix 3.

Retail Centres Assessment

6.16 The second assessment that I have undertaken covers the potential implications of ECan Amended Variation 2 and the DNZ/Fonterra alternative solutions for towns in the District. I consider that this type of analysis is important because the viability of rural towns is important to societal and community wellbeing.

6.17 The approach is to develop detailed spatial information about both demand (customers) and supply (retailers) in an area. This shows the roles of centres in meeting consumer needs, and how customers utilise those centres, including the catchments from which retail and service outlets draw their custom. Changes in expenditure by farms and farmers in those catchments – as affected by policy changes which impact on farm income and spending – may then be tracked through to identify which towns and townships are likely to be directly affected, and to what degree. This method complements the economic impact modelling, by placing one important component of changes in economic activity 'on the ground' in the localities affected. A more detailed explanation of the steps undertaken is contained in Appendix 4.

6.18 The potential impacts arise as follows:

(a) **Income Effects:** identify the likely (farm) location and the quantum of change in household income as a result of the solution packages. This was done by using the changes in farm profits, wages and management wages (for each scenario), and applying these to the location of farms and farm employment within the catchment[20].

(b) **Spend Effects:** assess the potential change in retail spend by (farming) households. The income effects were converted to spend by each retail type, assuming that the major share of the income change for each household results in changes in their retail spend[21].

(c) **Spend Patterns:** assess the spatial pattern of spend, in terms of origin (household) and destination (retailers or towns). For this analysis I have used detailed BNZ Market View data which records the origin and destination of spend, and provides suitable spatial data for understanding both the roles of centres and how households from different locations utilise these centres. I have assumed that the effects on farmer spending apply *pro rata* according to the current spending patterns among centres.

(d) **Retail Environment:** the fourth step was to understand the current and future retail environment, in terms of turnover by retail type location and by town centre in the wider area. The information and data used in the analysis is drawn from the Market Economics Limited (MEL) Retail Supply & Demand Model (RSDM), which provides estimates of the current situation and future projections of demand ($000 pa) in each catchment location for each retail and service store type. This data is important as it provides detail about the quantum of supply that exists in the local town centres.

(e) **Retail Demand and Supply Comparison:** the final step in the retail assessment is to compare the spend data from step 3 to

[20] As measured by Statistics New Zealand Business Directory 2013.
[21] I have assumed 80% of income would have been spent by households in retail. I have undertaken sensitivity analysis on this assumption and the broad results do not vary significantly.

the retail supply data in step 4 to establish the potential net impact of the ECan Amended Variation 2 policy, and the DNZ/Fonterra alternative solutions.

6.19 The results from this assessment only record the initial effects of the solution packages on households that are directly employed by the dairy industry. There will be other retail impacts related to other households that work in industries that indirectly support the dairy activity. For this reason, it is expected that the retail impact assessment may slightly underestimate the actual impacts on towns and townships in the area.

7. ECONOMIC IMPLICATIONS

Nature of Effects

7.1 It is important to understand the range of different effects associated with ECan Amended Variation 2, and the DNZ/Fonterra alternatives. It is especially relevant because different groups in society may bear the costs of a policy, while other groups may gain in terms of the benefits. The distribution of the costs and benefits across society can have important implications for policy makers, and may not be apparent if a policy is assessed only for its aggregate, district level outcomes.

7.2 The proposed reductions in nitrogen leaching would have two key effects on the economy. First, existing dairy and dairy support farmers in the area will need to change their operations to meet the specified levels of nitrogen output.

7.3 This would have multiple effects on existing farm activity, including reductions in revenue[22] and expenditure[23] with a resulting decrease profit[24]. These changes in operation have important effects on suppliers of the industry (backward linkages), on households in terms of income (induced), and on milk processors or wholesalers (forward linkages).

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22 Dr Bell's farm level data shows revenue produced by existing farmers would decrease by between $74.7 million (DNZ/Fonterra 3 stage and DNZ/Fonterra 4 stage) and $84.8 million (ECan Amended Variation 2) by 2034/35.

23 Dr Bell's farm level data shows expenditure by existing farmers would decrease by between $36.7 million (DNZ/Fonterra 3 stage and DNZ/Fonterra 4 stage) and $42.3 million (ECan Amended Variation 2) by 2034/3.

24 Dr Bell's farm level data shows operating profit produce by existing farmers would decrease by between $37.9 million (DNZ/Fonterra 3 stage and DNZ/Fonterra 4 stage) and $42.5 million (ECan Amended Variation 2) by 2034/35.

7.4 The second key effect on the economy relates to the additional dairy and dairy support farming activity that is enabled by the allowance for new irrigation in the catchment.

7.5 Variation 2 will also have multiple effects on this new farm activity, including increases in revenue[25] and expenditure[26] with a resulting increase in profit[27] (because dairying generates more revenue and costs than other pastoral farming, and generates higher profit levels). The additional farming will have effects through backward linkages and forward linkages in the economy, as well as on households. These changes will be net of any reductions in economic activity stemming from the reduced land areas in sheep and beef and other farming which is replaced by dairy farming.

7.6 In my modelling, I have established the impacts relating to each group. This provides an understanding of how the two distinct impacts cause economic activity to change in the district.

7.7 In this evidence, I present only aggregate GDP (value added) impacts. The model does provide detail on the particular industries and how they are each affected and employment. However, in my view the aggregate results provide sufficient information from which to assess the effects of reduced nitrogen runoff, as represented by the three scenarios.

Effects of ECan Amended Variation 2 and DNZ/Fonterra Alternative Solutions

7.8 Currently, dairy farming contributes $585m[28] to the Ashburton District economy. There is no substantial dairy processing in Ashburton District, with milk transported to processing plants in adjacent Selwyn and Timaru Districts.

7.9 Figure 2 shows the effects on the economy in 2013 GDP $ million terms, and the timing of those effects, from the changes for the existing dairy farmers, and the output from new dairy farmers. The effect on existing dairy farmers is shown by the orange and blue dotted line, while the net

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25 Dr Bell's farm level data shows revenue produced by new farmers would reach $43.3 million by 2034/35.

26 Dr Bell's farm level data shows expenditure by new farmers would reach $33.0 million by 2034/3.

27 Dr Bell's farm level data shows operating profit produce by new farmers would reach $10.4 million by 2034/35.

28 Table 3, above for 2014 Value Added.

effect from the additional land converted to dairying is shown by the green dotted line.

7.10 The analysis shows that under all of the scenarios that economic activity produced by existing dairy and dairy support farmers will reduce significantly, because farm output will reduce:

(a) **Base vs Smoothed ECan Amended Variation 2 (existing farmers):** the reduction in economic activity under this scenario starts to be felt in 2017/18, and amounts to -$12.3 million in that year. The impacts increase over the following period, to -$59.2 million by 2024/25, -$90.0 million by 2029/30, and finally to -$110.9 million by 2034/35 (the orange dotted line in Figure 2);

(b) **Base vs Smoothed DNZ/Fonterra – 4 Stage (existing farmers):** the reduction in economic activity under the smoothed DNZ/Fonterra – 4 Stage scenario follows a similar pattern to the smoothed ECan Amended Variation 2 scenario. The reduction amounts to -$23.5 million in 2019/20, to -$46.2 million by 2024/25, -$71.2 million by 2029/30 and finally to -$97.7 million by 2034/35. This trend is shown in the blue dotted line in the graph in Figure 2.

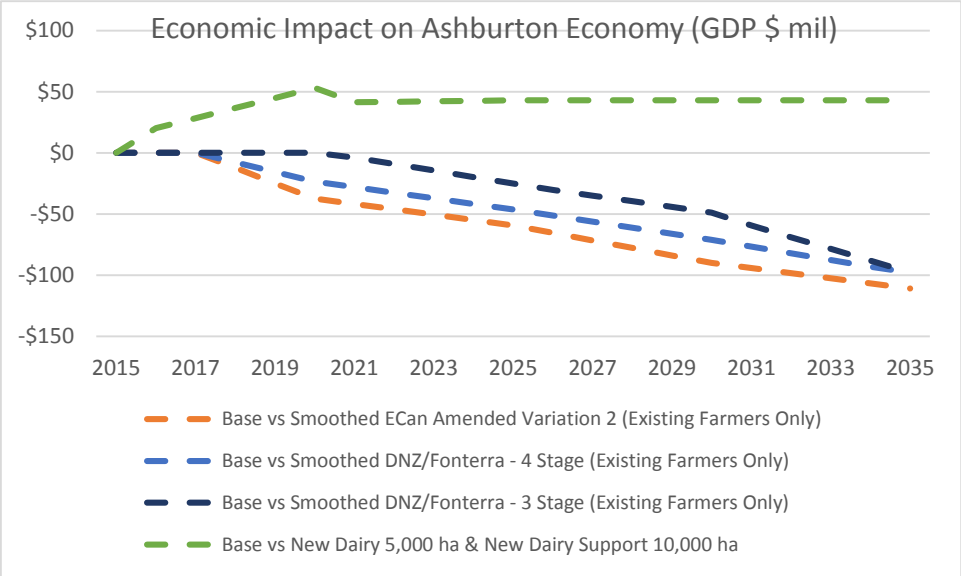
(c) **Base vs Smoothed DNZ/Fonterra – 3 Stage (existing farmers):** the reduction in economic activity under the smoothed DNZ/Fonterra – 3 Stage scenario, has a much later effect on existing farmers as this scenario allows a longer timeframe for achieving the nitrogen rules. The reduction amounts to -$3.7 million in 2020/21, increasing to -$25.0 million by 2024/25, -$48.8 million by 2029/30 and finally to -$97.7 million by 2035. This trend is shown in the dark blue dotted line in the graph in Figure 2.

7.11 In parallel with the reductions on existing dairy farms, there would be additional activity on new farms. The activity generated by the new dairy farming and dairy support that is enabled by each of the solution packages is expected to reach $53.2 million by 2020/21 (see green dotted line in Figure 2). The bulk of the growth is expected to occur between 2015 and 2020, during which time the 5,000 hectares of new dairy are assumed to be developed. The peak in the economic activity is

driven by the additional capital expenditure required for the conversion. The increasing dairy support is expected to add little to the economic activity in the area, net of the reduction in sheep and beef farming and other activity on the land.

7.12 The results suggest that much of the cost associated with each of the solution packages will be borne by existing farmers and those that they employ. The main benefits of the policy will accrue to new farmers who are able to convert to dairy farming. The DNZ/Fonterra 3 stage solution has the least impact on existing farmers as it delays the implementation of the nitrogen mitigation.

Figure 2: Solution Packages' effects on Existing and New Farmers – Economic Impact 2015 -2035



Note: value in graph are base year dollars and no discounting has been applied

Effects on the Ashburton District Economy

7.13 The graphs in Figure 2 above show the gross negative effects from reductions in dairy farm output, and the gross positive effects from the additional land in dairy farming[29]. In this section, I examine the net effects on the Ashburton District economy, together with the estimated effects on Ashburton towns and townships. These results indicate the overall economic impacts of the solution packages, and also compare the relative impacts of the ECan Amended Variation 2 solution package and the DNZ/Fonterra solution packages.

29 Though net of any loss in sheep and beef farming activity.

7.14 In terms of GDP in the Ashburton economy, the results for each scenario are as follows:

(a) **Base vs Smoothed ECan Amended Variation 2:** initially the economic activity under this scenario is net positive, as a result of the new farmers generating more economic activity than is lost from reductions in activity by existing farmers to meet the conditions set by this solution package. The net increase reaches $19.9 million by 2018/19.

This initial positive impact is then offset over time, with the change in dairying economic activity becoming net negative in 2020/21 (-$0.2 million), then further declining to 2024/25 (-$16.2 million), and -$47.0 million by 2029/30 and -$67.9 million by 2034/35 (see orange line in Figure 3).

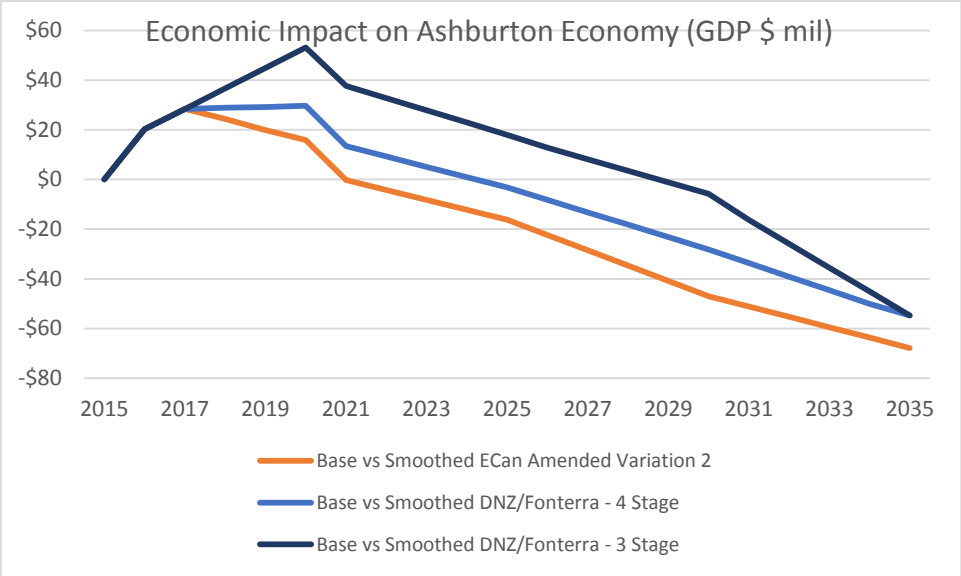
(b) **Base vs Smoothed DNZ/Fonterra – 4 Stage:** the change in economic activity under the DNZ/Fonterra – 4 Stage scenario follows a similar pattern over time as the ECan Amended Variation 2 scenario. However the overall negative impacts from this scenario arrive later, and are smaller. By 2029/30 the economic impact amounts to -$28.2 million and reaches -$54.8 million by 2034/35 (see blue line in Figure 3).

(c) **Base vs Smoothed DNZ/Fonterra – 3 Stage:** the change in economic activity under the DNZ/Fonterra scenario has a much later effect on economic activity than either of the other scenarios.

Initially the economic activity under this scenario is net positive, as a result of the new farmers generating more economic activity than is lost from reductions in activity by existing farmers to meet the conditions set in in the 3 Stages. The net increase reaches $53.2 million by 2019/20.

This initial positive impact is then offset over time, with the change in dairying economic activity becoming net negative in 2028/29 (-$1.1 million), then further declining to 2030/31 (-$16.3 million), and -$54.8 million by 2024/35 (see dark blue line in Figure 3).

Figure 3: Solution Packages' – Economic Impact 2015 -2035



7.15 It is useful to understand the relative scale of this impact compared to the Ashburton economy. In Figure 4 I have presented the impacts in terms of percentage of the Ashburton district economy, with main results for each scenarios as follows:

(a) **Base vs Smoothed ECan Amended Variation 2:** the initial positive impact amounts to around +1.0% in 2018/19, but then changes once the reductions in existing farms' output start to take effect, for a smaller positive impact of +0.7% until 2019/20. After 2019/20, the impact shifts to a negative, reaching –0.7% by 2024/25, and finally amounting to nearly -2.5% of the economy from 2034/35 (see orange line in Figure 4);

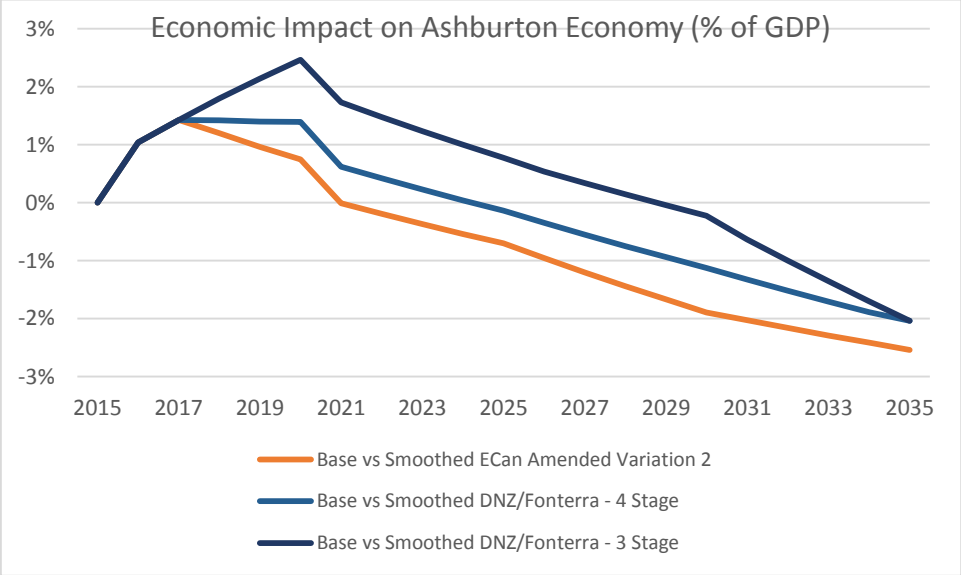
(b) **Base vs Smoothed DNZ/Fonterra – 4 Stage:** the changes in economic activity under the DNZ/Fonterra – 4 Stage scenario follow a similar pattern to the previous ECan Amended Variation 2 scenario, with a positive impact initially, then a transition to a negative effect in the medium and long term. However the overall negative impacts under the DNZ/Fonterra alternative arrive later and are smaller. By 2024/25, the negative impact equates to –0.1%, and from 2034/35 the economic impact amounts to -2.0% of the economy (see blue line in Figure 4);

(c) **Base vs Smoothed DNZ/Fonterra – 3 Stage:** the changes in economic activity under the DNZ/Fonterra – 3 Stage scenario,

has a much larger positive impact initially, then a slower transition to a negative effect in the long term.

The initial positive impact amounts to around +2.5% in 2019/20, but then changes once the reductions in existing farms' output start to take effect, for a smaller positive impact of +0.8% until 2024/25. After 2029/30, the impact shifts to a negative, reaching –0.6% by 2030/31, and finally amounting to nearly -2.0% of the economy from 2034/35.

Figure 4: Solution Packages' effects – % Impact 2015 -2035



7.16 The three scenarios that I have assessed – ECan Amended Variation 2 and the two DNZ/Fonterra alternatives - give consistent and broadly similar results. They all show that there would be positive gains in the early years of the policy, but that these would be offset and then followed by negative effects.

7.17 This outcome is driven by the difference in the timing of the mitigation that is required under each of the three scenarios. Broadly, the mitigation required on existing dairy farms is delayed in the DNZ/Fonterra - 3 Stage, and this improves (delays the reduction in) the overall economic activity generated in the catchment and the District.

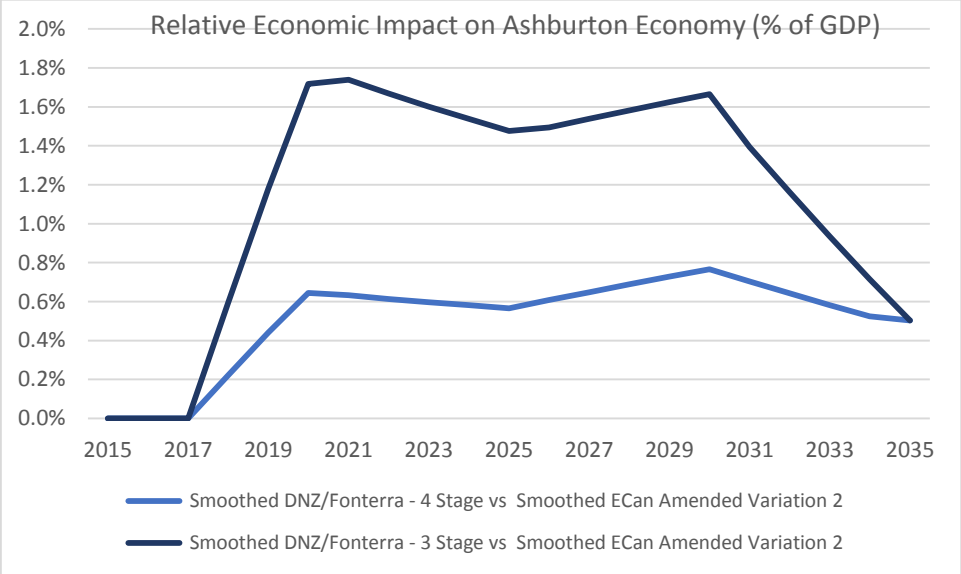
7.18 Nevertheless, while the profiles are similar, the three solutions differ in the scale and timing of impact on the District economy. I have compared the results of the two DNZ/Fonterra solution packages to the ECan Amended Variation 2 solution.

7.19 The smoothed DNZ/Fonterra – 4 Stage solution would see less of a reduction in the district economy (less negative economic impact) than the ECan Amended Variation 2 solution, by approximately 0.8% of the economy at the peak, and by 0.5% from 2024/35 onwards (see blue line in Figure 6).

7.20 The smoothed DNZ/Fonterra – 3 Stage solution would see less of a reduction in the district economy (less negative economic impact) than the ECan Amended Variation 2 solution, by approximately 1.7% of the economy at the peak, and by 0.5% from 2024/35 onwards (see dark blue line in Figure 6).

7.21 This would be because the share of the nitrogen reduction would be less for existing dairy farms – which generate higher value added per hectare - but more for dairy support farms - which generate lower value added per hectare than the dairy farms themselves.

Figure 6: DNZ/Fonterra *Solutions Compared with ECan Amended Variation 2 - % Impact on Economy 2015 -2035*



7.22 These results indicate that both of the DNZ/Fonterra solution packages would result in a better outcome in terms of District-level economic activity compared to the ECan Amended Variation 2 solution. Table 6 shows the Net Present Value (NPV) of the different scenarios, using the discount rates of 8%, 5% and 2%. The NPV adds all of the costs and benefits over each year to establish a total present value of each scenario.

7.23 The data shows that the NPV of the two DNZ/Fonterra solutions are better than (that is, negative impacts are less than) the ECan Amended Variation 2 solution, for all discount rates:

(a) applying a discount rate of 2%, we would expect the DNZ/Fonterra – 4 Stage solution to generate about three-quarters the negative impact of the ECan Amended Variation 2 solution (-$1,915m *cf* -$2,553m) and the DNZ/Fonterra – 3 Stage solution to generate about 65% of the negative impact of the ECan Amended Variation 2 solution (-$1,663m *cf* -$2,553m);

(b) if the discount rate is 5%, we would expect the DNZ/Fonterra – 4 Stage solution to generate 50% less negative impact than the ECan Amended Variation 2 solution (-$415m *cf* -$650m) and the DNZ/Fonterra – 3 Stage solution to generate 36% less negative than the ECan solution (-$232m *cf* -$650m);

(c) if the discount rate is 8%, we would expect the DNZ/Fonterra –4 Stage solution to generate less than half the negative impact of the ECan Amended Variation 2 solution (-$113m *cf* -$246m). While the DNZ/Fonterra – 3 Stage solution is expected to generate positive economic impacts of $24m.

Table 6: Solution Packages' effects – Net Present Value

Net Present Value ($ million)	8%	5%	2%
Base vs Smoothed ECan Amended Variation 2	-$ 246	-$ 650	-$ 2,553
Base vs Smoothed DNZ - 4 Stage	-$ 113	-$ 415	-$ 1,915
Base vs Smoothed DNZ - 3 Stage	$ 24	-$ 232	-$ 1,663

Effects of 30,000 ha Conversion

7.24 I note that while I have assessed only the option of 15,000 hectares of new irrigated land, I consider that my findings would be similar in the case that 30,000 hectares were feasible, in regard to the relative impacts of the DNZ/Fonterra solution compared to the ECan Amended Variation 2 solution.

7.25 However, if the 30,000ha were feasible to irrigate, and were converted to dairy farming and/or dairy support farming, then the reductions in production from existing farms would be more than offset by the increase in dairying output from the additional land area. This may result in the

situation where the overall impacts of Variation 2 on the economy are positive.

Retail Centres Assessment

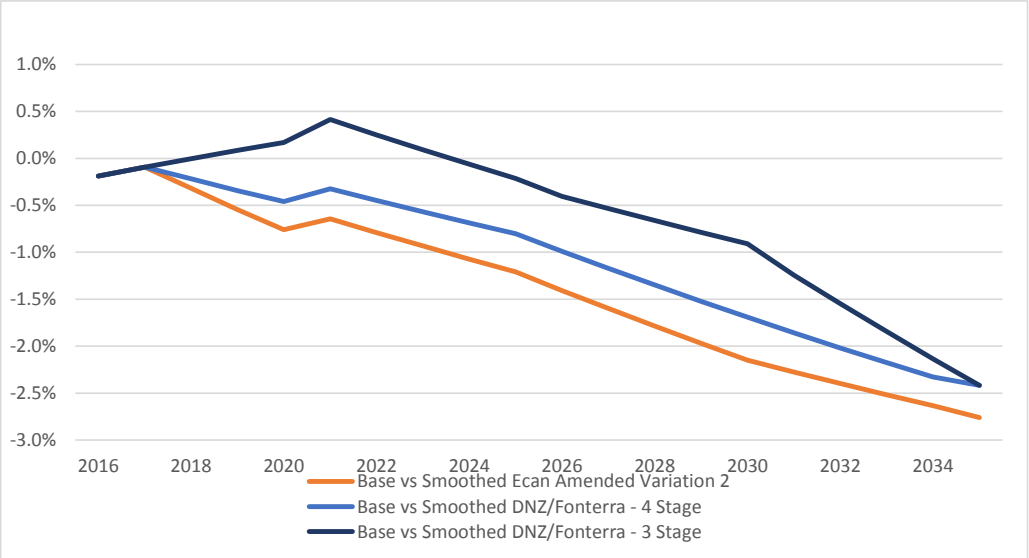
7.26 Finally, I have assessed the changes in dairy farmer incomes and the wages that are paid to dairy workers as a result of the solution packages. Broadly, the findings of this analysis show potential impacts on two centres, Ashburton town and Rakaia township. The other towns and townships in Ashburton District (and the rest of Canterbury region) are expected to receive minor impacts of less than 1% and therefore are not considered further in this evidence.

7.27 The main impacts will accrue to Ashburton, since the town dominates retail and service activity in the District. Ashburton is expected to see small positive gains in demand flowing from the Hinds catchment over the early period of the implementation of any of the solution packages (less than 1%). The expected growth in spend occurs under all scenarios (see Figure 7).

7.28 In the later part of the period the impacts become negative with the final impact ranging from -2.8% for the ECan Amended Variation 2 scenario, to -2.4% for the DNZ/Fonterra scenarios. While this impact is relatively small it helps to describe the impact in terms of employment. A 2.8% reduction in retail activity in the town of Ashburton, as seen in the ECan Amended Variation 2 solution, would be similar to a reduction of retail employment in the order of 85 persons.

7.29 The transition path of DNZ/Fonterra – 3 Stage has the least impact on Ashburton town.

Figure 7: Variation 2 Impacts on Ashburton Centre – % Impact 2015 -2035



7.30 The township of Rakaia would see similar small positive gains in demand over the early period of the implementation of the solution packages (less than +1%), under all scenarios. In the later part of the period the impacts become negative with the final impact ranging from -3.6% for the ECan Amended Variation 2 scenario to -3.1% for the DNZ/Fonterra scenarios. However, the very small size of the retail and service capacity in Rakaia suggests minor change, in the order of 1-2 persons employed.

7.31 I consider that the effects of either ECan Amended Variation 2 solution or the DNZ/Fonterra solution on townships are unlikely to be significant, especially because most of the impact will accrue to Ashburton town. Within the Hinds catchment itself, there are only two townships (Hinds and Mayfield) with very low levels of retail and service activity.

7.32 The impacts on Ashburton town would be material (85 persons employed) under ECan Amended Variation 2, and the impacts would be less under the DNZ/Fonterra solution, although still negative.

8. ENVIRONMENT CANTERBURY'S ECONOMIC RATIONALE FOR VARIATION 2

8.1 As noted at the outset of my evidence, from my review of the reports that support the ECan solution package, I consider there are some flaws in the methods and findings. In addition, some of the results shown in the

reports appear to be inconsistent and I am unable to replicate them from the data and evidence provided in the reports.

8.2 The AgResearch study analyses a solution package that has

> "*three primary actions which are*
>
> (i) *On-farm mitigations to reduce nitrogen leaching for water quality*
>
> (ii) *Groundwater replenishment using the tools of Managed Aquifer Recharge (MAR) for both water quality and quantity in groundwater and surface water bodies*
>
> (iii) *30,000 ha of new irrigation conversions for community and regional economic benefits.*
>
> *These activities are those that are required to be implemented in order for limit setting process to be effective*"[30]

8.3 The first issue is the extent to which existing farmers are impacted by the on-farm mitigation rules. AgResearch has relied on farm level analysis conducted by MacFarlane Rural Business (MRB). I note the considerable difference between the MRB report and Mr Neals' evidence, which shows substantially higher farm level costs of the mitigation (see table 1 of Mr Neals' evidence). The MRB data provides a fundamental basis for the AgResearch analysis. These estimates flow through to the economic assessment, which means that different cost estimates result in different results in terms of economic impact.

8.4 The second issue with the solution package is that it assumes that 30,000 hectares of new land can be irrigated and that this land would be converted to dairy and dairy support. This is a key assumption, which underpins the estimates of positive effects associated with the ECan solution. The economic impacts are heavily influenced by the assumptions about how much additional land in the catchment could be feasibly brought into dairying.

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30 Page 5 of AgResearch, Paragahawewa, U.H. (2014) Economic Impact Assessments of the Hinds Water Quantity and Quality Limit Setting Process, Report No. R14/82.

8.5 As can be seen in the table below, these two differences have a substantial impact on the overall results. In Table 7 I have shown the relative impacts on turnover (Earnings before interest and tax, "EBIT") in the catchment, as predicted by MRB for the ECan Variation 2, and the three solutions as estimated by Mr Neal/Dr Bell. The ECan reports estimate a positive benefit of $584 million in EBIT from Variation 2, while DairyNZ experts consider that the ECan Amended Variation 2 solution will be a negative impact of -$136 million[31].

8.6 I have also presented the related figures for the DNZ/Fonterra solution packages, which show impacts on farm EBIT ranging from -$114m (4 stage transition) to -$62 million (3 stage transition).

Table 7: Solution Packages Farm level EBIT – Net Present Value

NPV - EBIT ($ million and 8% discount rate) excludes capital expenditure on dairy farm conversions	ECan Variation 2 (MRB*)	Mr Neal and Dr Bell		
		ECan Amended Variation 2	DNZ/Fonterra (4 Stage)	DNZ/Fonterra (3 Stage)
Baseline - GMP	$ 2,764	$ 2,668	$ 2,668	$ 2,668
Solutions package	$ 3,348	$ 2,532	$ 2,555	$ 2,607
Effects of Variation 2	$ 584	-$ 136	-$ 114	-$ 62

**Sourced from AgResearch Report table 6*

8.7 This is a substantial difference in the base estimates, and it explains much of the difference between the AgResearch findings and my own.

8.8 Finally, the MAR is an important part of the solution package that has been presented by ECan. A key finding of the economic case (AgResearch) is that the "*The value of managed aquifer recharge is estimated to be very high indicating a benefit cost ratio of at least 4.*"[32]

8.9 The main cause of this finding is that benefits of the MAR are relatively large, at $536.4 million, compared to the cost of implementation (at most $134.6 million). I have attempted to replicate the AgResearch analysis of the MAR. However from the information in the AgResearch report I have not been able to ascertain exactly how the benefit was estimated.

8.10 I also note that the costs of implementing the MAR have not been incorporated into either the MRB analysis[33] or the analysis of the Mr Neal

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31 See sections 5 and 6 of Dr Bell's evidence, I have EBIT which does not include **capital expenditure** on farm conversions or the **interest cost** of financing those conversions. Both of these costs are included in my economic analysis.

32 Page 41.

and Dr Bell. How the cost of implementation of the MAR is spread between existing farmers, future farmers and the community (i.e. who pays, and how much) may be important in terms of farm level profitability, and/or local government budgets.

8.11 The paucity of information provided in the AgResearch report, and with no other evidence provided by the other DairyNZ experts, I am not able to either confirm or disagree with the assertion that the MAR will have significant benefits. However, the scale of its costs, and benefits, suggests it is an important matter.

8.12 Finally I have noted some minor issues in the methods used by AgResearch. These relate to the economic value of wetlands, the issue of drinking water for those who are pregnant or breastfeeding, and the economic value of water improvements in rivers and streams in the Hinds. I have detailed these in Appendix 5.

9. CONCLUSION

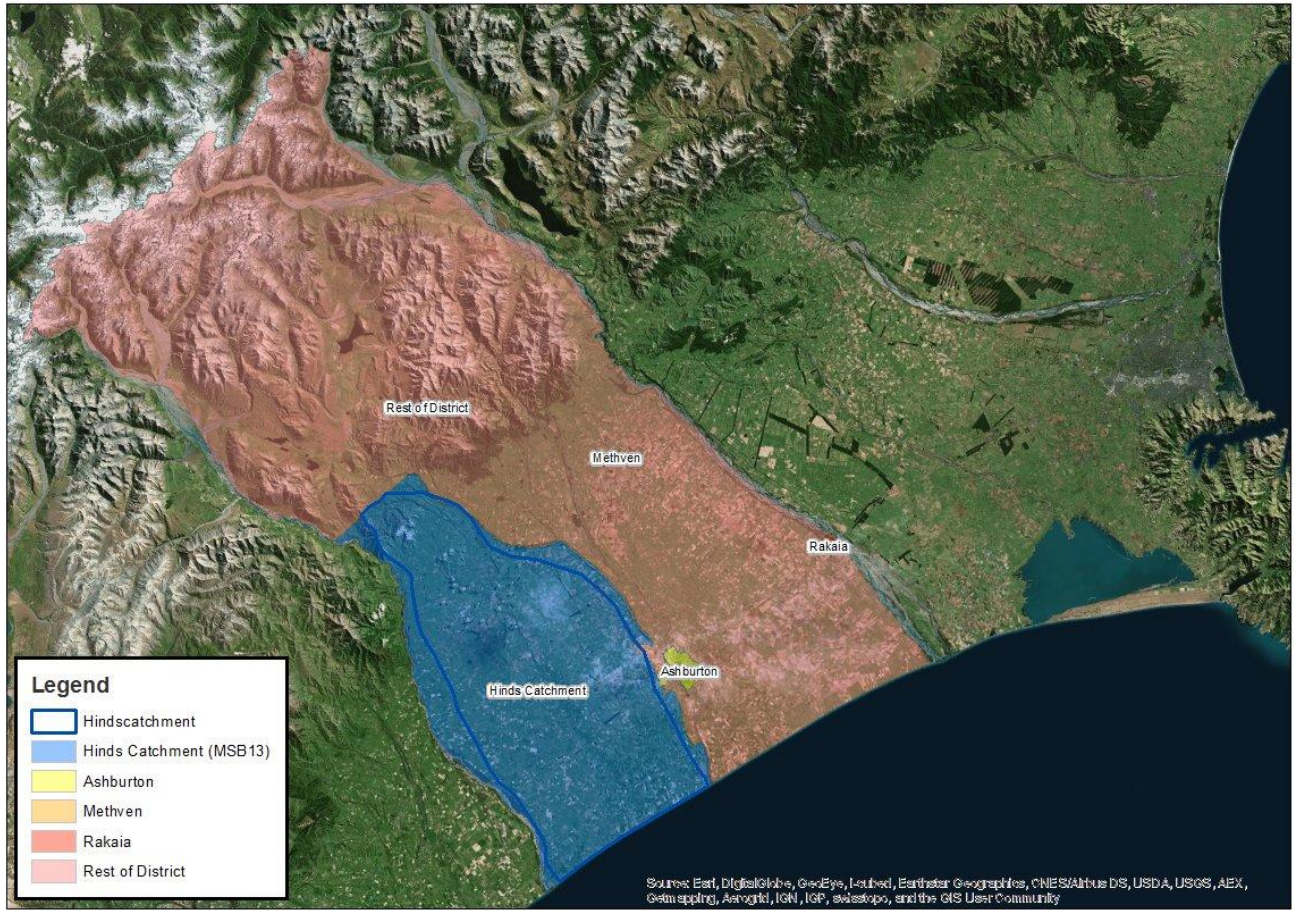
9.1 In my view, the DNZ/Fonterra – 3 stage implementation solution package would have the lowest negative effects on economic activity in the District. This is because it would be implemented later, and would place the mitigation requirement across all high emitters which contribute more to the District economy on a per ha basis.

9.2 I have also assessed the economic rationale presented by ECan in support of the proposed Variation 2 solution package. I consider that while the AgResearch assessment applies appropriate methods, it relies on base information, and future land use outcomes, which are challenged by DNZ/Fonterra experts.

Douglas Fairgray

15 May 2015

Appendix 1: Ashburton District, Hinds Catchment definition using Statistics New Zealand Meshblock 2013



Appendix 2: Summary of Farm Level data used to define Scenarios

Dr Bells provides the following annual data sets between 2015 and 2035;

1. **GMP:** which is the farm level revenue and expenses of the existing dairy and diary support farmers in the Hinds catchment, assuming they meet Good Management Practices (GMP). This data provides part of the base line.

2. **Smoothed ECan:** which measures farm level revenue and expenses of the existing dairy and diary support farmers in the Hinds catchment, assuming they meet ECan Solution package. The farmers are assumed to meet their obligation over a period of time before the solution becomes binding.

3. **Smoothed DNZ 4 stages:** which measures farm level revenue and expenses of the existing dairy and diary support farmers in the Hinds catchment, assuming they meet DNZ/Fonterra Solution package over four stages. The farmers are assumed to meet their obligation over a period of time before the solution becomes binding.

4. **Smoothed DNZ 3 stages:** which measures farm level revenue and expenses of the existing dairy and diary support farmers in the Hinds catchment, assuming they meet DNZ/Fonterra Solution package over three stages. The farmers are assumed to meet their obligation over a period of time before the solution becomes binding.

5. **New Development:** which measures farm level revenue and expenses of the new dairy farmers on 5,000 hectares of new irrigated land, where 1,000 hectare is developed per annum between 2016 and 2020. I have assumed that the capital expenditure required to develop the new dairy farms is funded by interest only mortgages with an interest rate of 8% per annum (which is a commonly used threshold used by Banks to establish viability in the dairy farm business).

6. **New Intensification:** which measures farm level revenue and expenses of the new dairy support farmers on 10,000 hectares of new irrigated land, where 1,000 hectare is developed per annum between 2016 and 2025.

7. **Existing Unirrigated:** which measures the farm level revenue and expenses of the beef and sheep farms that are converted to dairy and dairy support. This data provides part of the base line.

8. **Flexibility Cap:** which measures the revenue associated with arable land that could gain from the DNZ/Fonterra solution package. This part of the DNZ/Fonterra solution package has not been modelled, as the economic models need detailed expense data.

Appendix 3: Economic Modelling Method

In summary, the modelling of economic impacts commenced with identifying the likely types of impacts to arise under each of the scenarios considered, with these impacts measured against a reference scenario. In broad terms, three different types of economic impacts are considered for each scenario, with the sum of these impacts representing the total scenario impact. The three types of economic impacts considered are:

1. ***Changes in purchase patterns of the dairy farming industry*** *(backward or upstream impacts).* Under each of the scenarios considered, farmers are required to alter farming practices so as to reduce nutrient leaching. The focus is on identifying how these farm changes impact on businesses that depend (either directly or indirectly) on the dairy farming industry as a source of demand for produced goods and services. For example, if the number of cows able to be supported on each farm reduces, this may result in some reductions in purchases by these farms, on animal health services, feed produced offsite, and so on. Thus, the businesses responsible for producing these goods and services will experience a loss of demand, and in turn, so will the businesses that provide inputs to production in these businesses.

   When calculating these impacts, consideration is given not only to the *direct* and *indirect* impacts (i.e. all of the changes in demands for goods and services calculated by tracing economic production chains upstream), but also the *induced* impacts occurring as a result of changes in household incomes, which then result in changes in local spending.

2. ***Changes in dairy farmer's incomes*** *(backward or upstream impacts).* Under the scenarios investigated, some direct changes to household incomes (i.e. wages and salaries paid to farm workers and profits received from ownership interests in farms) are anticipated. These impacts are incorporated in the analysis by adjusting household spending on consumer goods. This then impacts on all businesses responsible for providing those goods, as well as all of the other businesses involved further up the production chain. As in (1) above, consideration is given to induced impacts arising out of other changes in household incomes.

3. ***Changes in dairy output*** *(forward supply chain impacts).* Reductions in dairy farming production are envisaged under the 4 and 4 Scenarios. With less production (milk, meat), the supply to downstream processes (mainly dairy

manufacturers, meat processors) will be reduced, ultimately leading to a reduction in sales and incomes for these industries.

With all modelling there must be simplifying assumptions that allow the complexity of the real world to be shaped into a tractable solution. Listed below are some particular assumptions and caveats relating to the estimation of district, regional and national economic impacts.

i. The IO model employed in this analysis relies on an assumption that the input structures of industries remain constant through time. In the real world, however, this production recipe changes over time as a result of new technologies, relative price shifts causing substitutions, and the introduction of new industries. For this reason, IO 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 IO tables.

ii. There are no sub-national IO tables available for New Zealand based on survey data. The multi-regional IO table utilised in this study is created through a process of regionalising the latest available national IO table published by Statistics New Zealand. The GRIT procedure used in this regionalisation process assumes that production is traded between study areas only where there is an imbalance between supply and demand (i.e. no cross hauling occurs). The GRIT procedure is likely to underestimate the degree of commodity trade occurring between study areas, depending on the extent to which the commodity/industry product aggregation hides differences in the types of products produced within different regions.

iii. A significant proportion of the economic impacts calculated in this analysis stem from changes in household incomes, and the flow on impacts that arise from consequential changes in consumer spending. Where reductions in household expenditure occur, it is assumed that this happens across all consumer goods and services, and the current pattern of household expenditure is used to spread lost expenditure across these items on a pro-rata basis. This is, however, a simplification of reality, as consumers are likely to prefer some goods over others implying that expenditure reductions are unlikely to be perfectly even.

iv. No consideration is given to changes in the possible spatial distribution of government-household transfers that may occur following changes in

economic conditions. In particular, we have not considered the possibility of additional welfare payments received within the Ashburton District following losses in employment which would to some extent help to spread impacts more evenly over the nation.

v. This study does not consider the possible causes and implications of changes in commodity and factor prices. Under normal supply-demand dynamics one might postulate, for example, that the reduction in dairy commodity supply under the scenarios will be accompanied by some increase in dairy commodity prices, thereby partly offsetting the impacts on farmers. Such price change dynamics are not considered in the analysis, but in any case are anticipated to be very small given the size of the Ashburton dairy sector compared with the global dairy sector. Of likely more significance, no consideration is given to the impacts of changes in regional and national wage rates accompanying any changes in the employment/ unemployment rates.

vi. Related to point (v) above, land is a scarce resource or factor that can be used in the production of a variety of goods. In this analysis it is assumed that even with changes in the profitability of dairy farming, the land currently devoted to this type of farming remains under that use. In the real world, however, if other types of agricultural activities (and potentially even non-agricultural activities) become relatively more profitable, and land owners have sufficient capital and ability to change to these other activities, then we should expect some land conversions to take place.

The following core steps are undertaken to develop the model,

i. 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). Clearly the data requirements for constructing these IO matrices are enormous, and it is partly for this reason that IO tables are only produced in New Zealand on

an irregular basis. The latest available IO table for the New Zealand economy is based on data for the 2006–07 financial year.

The first major step required for the assessment of economy-wide effects is regionalization of the national table so as to produce tables for the following regions or study areas: (1) Ashburton, (2) Rest of Canterbury Region and (3) rest of New Zealand. For each region, 88 different economic industries are also defined. The Generating Regional Input-Output Tables (GRIT) procedure (Jensen et al 1979; West et al 1980) was relied on to produce the multi-regional table from the 2006–07 national table. This method consists of a series of mechanical steps that reduce national input-output coefficients to sub-national (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 regions.

A final important point to note about the IO framework utilised in this study is that it is multi-regional. This means that the model considers not only the relationships between economic actors within the priority catchments, but also the relationships between economic actors within these catchments and those in the rest of MW and New Zealand. This multi-regional approach provides a means to evaluate the nation-wide implications.

ii. Step 2: Incorporating economic structural changes into the input–output model

Having defined a multi-regional IO table for the study areas, the next task is to modify the table so as to capture changes occurring within the dairy industry, under each alternative scenario, as a result of the measures introduced to reduce nitrogen leaching. These changes occur both in terms of the relative quantities of different inputs required by dairy farms, and the extent of outputs produced by dairy farms. The information on these changes is obtained directly from the Nimmo-Bell analysis. As the IO 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.

iii. Step 3: Calculation of technical coefficients and allocation coefficients tables

The multi-regional IO tables created for the reference scenario and each of the alternative scenarios 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 under each scenario, 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. So-called 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.

iv. Step 4: Calculation of output change vectors (Y and M)

The purpose of this step is to devise a set of industry output 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) the input purchases made by the dairy cattle farming industry, plus (2) purchases made by persons who own or are employed by dairy farms. Once again, the information required to determine the values of (1) are obtained directly from the Nimmo-Bell analysis. The Nimmo-Bell analysis also provides information on farm profits and wages under each of the scenarios. In order to translate this income into spending, average household expenditures shares generated from the government and household columns of the IO table are used. Note that 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.

The other output vector, M, is simply an estimate of the total dairy cattle farming output anticipated under each of the scenarios. For each of the alternative scenarios, this is obtained by adjusting the reference scenario output according to the net changes calculated by Nimmo-Bell.

v. Step 5: Calculation of backward–linkage impacts

As already explained in the main report, the direct changes in output occurring in each industry will also create indirect economic impacts that flow through the wider New Zealand economy. For example, reductions in the quantities of fertiliser purchased will mean that the fertiliser manufacturers will have less demand for their products. In turn, the industries that supply to fertiliser manufacturers will also 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, as above, A is the matrix of technical coefficients, 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. For future reference, the inverse matrix (I – A)-1 is termed the 'Leontief Matrix'.

It is interesting to note that in many IO applications, the quantities of goods and services that are consumed by households are treated as exogenous variables. This means that household demands are determined at the outset by the modeller and there is limited ability to capture feedbacks occurring between changes in industrial output and consumer spending. In the real world, however, households (i.e. consumers) earn incomes in payment for labour inputs to production and ownership of capital, and thus it is likely that any impacts on industrial outputs which alter labour and capital incomes will have flow-on implications to consumer spending. Such effects can be viewed as positive (i.e. reinforcing) feedbacks, since changes in consumer spending will further impact on industrial outputs.

In order to capture the feedbacks relating to consumer spending (often referred to as 'induced' impacts in economic impact assessments), this study utilises an IO model that is 'closed' with respect to the household sector when calculating the impacts according to Equation (1) above. 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).

Now, 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, the model will therefore 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.

vi. Step 5: 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 dairy farming output under each scenario. In these regards reference is made to Ghosh multipliers (Ghosh 1958, 1964; Miller and Blair 2009), derived from the matrix of allocation coefficients described Step 3 above. Essentially these multipliers measure, for every unit of output change in a selected industry i, the corresponding changes in output of all sectors that depend on sector i's product as an input to their own production processes. 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 considered to be a relatively reasonable assumption to apply in the assessment of 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 commodities produced by agriculture and forestry to produce manufactured products (i.e. dairy product manufacturing, wood product manufacturing, meat product manufacturing, and textile manufacturing). For these industries it is likely that there will be a relatively constant relationship between the availability of commodities for processing and the value of manufactured products produced.

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

Thus far the model produces estimates of economic output (by each economic industry) under the reference and alternative scenarios. The difference in output between the reference scenario and a particular alternative scenario constitutes the net output change for that alternative scenario. 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 output, and (2) employment per output. These ratios are assumed to be constant and are obtained from data for the 2006–07 financial year.

Appendix 4: Local Centres Modelling (Retail)

In the second part of my analysis an entirely different methodology is adopted, utilising very detailed and spatially-defined market data, for the purposes of obtaining a more in-depth understanding of the likely spatial distribution of impacts across Hinds catchment, Ashburton and Canterbury region. Note that the results from the two separate parts of our analysis are not directly comparable, as they are based on differing methodologies and thus produce slightly different impacts at the regional level. Nevertheless, there is a strong degree of consistency obtained in the types and magnitude of impacts derived between the two methods.

To understand the likely geography of the retail impacts, the patterns of dairy farming activity within the region have been examined, and the role of dairy farming within total farming and primary activity sectors. We have also examined the demand and supply patterns within the Hinds catchment, Ashburton District and wider Canterbury region, by analysing the purchasing patterns of dairy farmers and other rural dwellers in each of the local towns and the regional towns and cities: Ashburton, Darfield, Geraldine, Leeston, Lincoln, Methven, Rakaia, Rolleston, Taitapu, Temuka, Timaru and Christchurch. This is to understand the significance of the dairy farming sectors in sustaining the total roles of these towns.

This assessment shows how changes in dairying – including potential for reduced farm output and employment, consequent lower demand for goods and services and associated changes in demand for farm household goods and services – may impact on the roles of the towns. In this analysis there are five key steps,

1. **Distribution of Income Impacts:** The first step in understanding the retail impacts associated with the Proposed Variation 2 is to establish the spatial location of households that draw income directly from the dairy farming industry, this includes the owners of dairy farms (operating profit) and employees working on the dairy farms (wages and salaries). The following two processes where used to allocate farm level incomes (as provided from Dr Bell)
    a. *Operating Profit:* In this study, the Retail Impact Analysis assumes that the lost operating profits will have a direct impact on dairy farm owners' income. The 2014 Statistics New Zealand Business Directory count of businesses (Geographic Units - GU) in the Dairy Cattle Farming ANZSIC (A016000) was used to establish the location of households that own dairy farms. Generally, dairy farms are owned by working proprietors, which tend to work and live on

the farm. In this study we have assumed that there is one dairy farm household that lives on each farm and that the income of this household is decreased by the average level of operating profits that is shown in the scenarios. This means that the operating profit impact has been distributed pro rata to each location according to the count of farms. For example if a location has 5% of the dairy farms then 5% of the profit impact has been attributed to this location[34].

b. *Wages and Salaries*: Similarly, the impacts on wages and employee incomes has been distributed using the 2014 Statistics New Zealand Business Directory count of employment (EC) in the Dairy Cattle Farming ANZSIC (A016000). It is considered that the location of employment in the dairy farming industry is the best proxy for understanding the location of households that work on dairy farms. Many dairy farm workers live and work on the farm or they live in locations nearby. Following this logic, it is reasonable to assume that the impacts on wages and salaries will occur near the location of each dairy farm. However, there will be some workers that live in more distant locations which means that some of the income impact on these households may be attribute to the wrong location. Given the lack of available data on dairy households this should be viewed as a limitation of the analysis.

These two processes provide an estimate of the home origin of the direct dairy farming income impacts associated with the Proposed Variation 2.

2. **Spend Impacts**: The next step in the analysis is to convert this change in home income into spend impacts. Broadly, a reduction in dairy farm incomes may result in a reduction in spend by the dairy farm households. However, the income impacts represented in the dairy cash flows is measured in terms of gross income. Generally, only a proportion of a household's gross income will be available for spending on retail and services, the effects of taxation, savings and other expenditure types (housing, utilities etc.) must be taken into account. Dairy farm business will also choose to retain some of the operating profit, to reinvest in new capital items (eg fencing, live stock, retire debit etc). For these reason it is likely that a proportion of the gross income that was lost probably may not have necessarily resulted as local retail spend. However, some households may

[34] It was not possible to match the land use data to individual farms. For this analysis I have assumed that each farm receives the same impact.

choose to maintain their spending pattern by offsetting some of the lost income by choosing to save less. This phenomena is described by the concept of income elasticity of demand, which measures the relationship between changes in income and demand for goods and service.

For the purposes of this study it has been assumed that 80% of the lost gross income translates directly into reduced spending. For example if a dairy household lost $100 of gross income as a result of the Proposed Variation then this household is assumed to reduce spending by $80.

3. **Spend Patterns:** In the fourth step, a spatially detailed origin-destination matrix is used to understand current retail and service expenditure patterns in the region. Data from BNZ Marketview was used to build this matrix, and records the origin[35] and merchant location[36] of all credit and debit card spending by BNZ customers with merchants in the region, and by region residents at merchants in any destination outside the region. The data is split into three types of spend: food retail, non-food retail and non-retail.

   The BNZ data provided purchasing patterns information for the following local towns and the regional towns and cities: Ashburton, Darfield, Geraldine, Leeston, Lincoln, Methven, Rakaia, Rolleston, Taitapu, Temuka, Timaru and Christchurch. The customer purchase data from BNZ shows that vast majority of spend from each of the origins in the Hinds catchment is attracted to these 12 centres[37].

   It important to note that there are some other smaller towns in the catchment for which BNZ Marketview could not provide data[38]. The limited number of traders in these towns means that the BNZ Marketview confidentiality rules would not allow data to be reported for these towns. However, given the small size of these towns the impacts that could be expected will be fairly small, both in dollar terms and employment.

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[35]Customer location was identified to groupings of meshblock for locations within Ashburton, and hence, using GIS assessment to establish the catchments of each town and city. Generally the each individual grouping contains around 5 meshblocks.

[36]Merchant location was coded as one of the 12 main centres within Ashburton and wider Canterbury region, to territorial authority level for nine neighbouring councils, or to a residual "other locations" group.

[37]The data shows that 90% of the BNZ total spend from within the Hinds area is attracted to the 12 centres included in the analysis.

[38] Hinds, Mayfield, Mount Somers, Chertsey, Kirwee, Dunsandel, Prebbleton, Horarata, Sheffield, Springston and Southbridge

The Retail Impact Analysis takes the spatial purchasing pattern origin-destination matrix to allocate the spend impacts from each home origin to each destination centre within the Hinds and wider Canterbury region.

4. **Retail Environment:** The fourth step in the analysis is to establish the current and future retail environment that exists in the catchment. This information will provide context as to the relative scale and importance of the impacts associated with the Proposed Variation 2.

   The information and data used in the analysis is derived from the Market Economics Limited (MEL) Retail Supply & Demand Model (RSDM). The RSDM provides estimates of the current situation and future projections of demand ($000 pa) in each location (catchment) throughout New Zealand for each retail and service store type. The RSDM is a comprehensive and detailed model, which integrates demand information, based on comprehensive analysis of household, employment, and tourism data; and supply statistics, based on retail sales, employment and operating units by each retail and service store-type.

   The RSDM demand estimates are based on the number and composition of households, business employment and visitor numbers (international and domestic) and their mean retail spending levels. The future demand estimates allow for projected household, business and tourism growth, together with allowance for future increases in real spend per household. For this study, growth rates for 'real spend' have been applied (1.0% pa to 2036) over and above background population/market growth.

   The RSDM supply estimates are based on the Statistics NZ Business Frame Employee Count (EC) and number of geographic units (outlets or business units), actual retail sales by store type, total employment (the Modified Employment Count or MEC, which takes into account non-employee working proprietors who are not covered in the Business Frame), and floorspace estimates per person employed.

   The detailed data from the RDSM provides annual food retail spend, other spend and total spend for Ashburton, Darfield, Geraldine, Leeston, Lincoln, Methven, Rakaia, Rolleston, Taitapu, Temuka, Timaru and Christchurch.

5. **Retail Demand and Supply Comparison**: The final step in the Retail Impact Analysis is to assess the change in dairy household expenditure by centre relative to the size of each town's economy to assess the impact on each town under each scenario. This analysis has been conducted for every year between 2016 and 2035 and for each of the four scenarios.

Listed below are some particular caveats relating to the estimation of Hinds catchment and wider regional retail impacts.

i. No data exists for a count of dairy households. This analysis estimates counts of dairy households (spatially) by assuming relationships between the spatial distribution and count of dairy employment, dairy farms and total households. Dairy households are defined as those in which at least one household member is employed in the dairy industry, whether on- or off-farm.

ii. The spatial allocation of employment impacts is based on the current origin and destination of expenditure by consumers of retail and services. That data is from a sample of all retail and service spend, and excludes transactions made in cash and by non-BNZ customers. The assessment assumes that dairy households have the same spending profile (amount and location of spend) as non-dairy households.

iii. The reduction in dairy profits and wages caused by the Proposed Variation 2 may result in reduction in spend by the Dairy households. However, households may choose to maintain their spending pattern by offsetting some of the lost income by choosing to save less. It would be a time consuming undertaking to establish the income elasticity of demand for dairy households, without this information it is difficult to quantify exactly how these households would react to this reduction in income. For the purposes of this study it has been assumed that 80% of lost gross income translates directly into reduced spend.

Appendix 5: Other Issues re AgResearch Report

(a) **Economic Value of Wetlands:** The AgResearch report estimates the full value of the remaining wetlands in Ashburton District, with the remaining 71ha having a value ranging from $0.36 to $12.6 million. While this measure may be correct the really question should be what is the value of the lost wetlands in Hinds Catchment as a result of doing nothing under the baseline. The report incorrectly presents the entire 71ha as being under threat. If some of the wetlands lie outside of the Hinds catchment, using the *pro rata* area (as was used by AgResearch for the in Stream and River water value) around $0.1 to $2.7 million worth of wetland could be in the Hinds catchment. Also the AgResearch study does not provide an estimation of the proportion of this wetland that would be lost under the baseline (or conversely the area saved under the solutions package). These matters limit the usefulness of this evaluation for understanding the wetland value effects of Variation 2.

(b) **Drinking Water for Pregnant and Breast Feeding**: the AgResearch report estimates the cost of providing drinking water for women who are pregnant or breast feeding within the Hinds. This estimate was based on two key inputs, the number of females aged between 15 and 44 years old and the cost of a litre of drinking water. The AgResearch study claims that there are 5,000 females of child bearing age in the Hinds catchment and that one litre of drinking water costs between 80c and $3. First, it appears that the researchers have mistakenly taken the population for the entire Ashburton District. Census data shows there are some 1,500 women in the Hinds catchment of the age 15 to 44 years. Secondly, use of $3 per litre is high, and is broadly equivalent to buying bottled water from the local dairy or petrol station. The likely price of a litre of water will be considerably lower than this if an intervention was required. Using the correct catchment population and a more reasonable high end cost of $1 per litre gives a cost ranging from $0.1 million to $0.2 million per annum.

(c) **Economic Value of Water Improvements in Rivers and Streams in the Hinds**: the AgResearch report, has attempted to quantify the value of water using a Study of the Canterbury Region (Tait *et al* 2011). This study of Canterbury estimated the total value of water improvements for the entire Canterbury region over five years.

I have two concerns about how AgResearch has applied the results of that study. First, the AgResearch study has assumed that the regional value in Tait *et al* is located *pro rata* according to geographic area (i.e. 14% of the Region's land is in Ashburton so 14% of the value also exists in the District). Notwithstanding that this method of estimation is very approximate, we consider that the AgResearch use of District level numbers could be misleading for this study of the Hinds catchment. The Hinds catchment makes up around 21% of the Ashburton District, using the AgResearch logic the value of water in the Hinds would be NZ$2.7million to $6.2 million.

The second issue is that this value is an NPV over 5 years. The AgResearch study has generally displayed annual figures. We consider that to ensure consistency in their study and to avoid confusion the report should have converted this to annual value.

As an indication the annual value of the water improvements in the Hinds catchment would range from $0.5 million to $1.3 million.