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Final Report

Assessment of Environmental Effects

Economic Impacts of HWP Waitohi Irrigation and Hydro Scheme

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1 Executive Summary

Hurunui Water Project (HWP) is applying for resource consent to develop a series of dams and associated infrastructure in the Waitohi catchment for the purposes of irrigating land in the Hurunui and nearby catchments, and for generation of hydro power. The Waitohi Irrigation and Hydro Scheme (the Scheme) comprises four dams, the largest at Hurricane Gully, and three lower dams providing reregulation of flows, additional hydro generation, and some additional storage.

This report describes the economic impact of the scheme. It focuses on the Scheme costs, the returns, cashflow analysis, affordability and regional impacts. The report draws extensively on the models and methodology used by Butcher 2010 and 2011[1]for farm budgets and affordability, but uses the capital and infrastructure data from the new HWP Waitohi Irrigation and Hydro Scheme (WIHS).

Capital costs for the Scheme are $210 million for the Hurricane Gully dam and diversion structures, and a further $36 million for the lower dams in the catchment. The distribution will cost in the order of $130 million for the 58,500 ha irrigated. The total cost of the Scheme will be approximately $380 million.

Operating costs will be in the order of $2.1 million per annum for operation and maintenance. The pumping costs will be a further $5.2 million per annum, but most of this will be recovered through generation at approximately $5.3 million per annum. The net operating costs will therefore be approximately $2 million per annum.

Discounted cash flow analysis suggests that the total economic benefits of the scheme are approximately $910 million (NPV, 8%), and the costs are $710 million (NPV, 8%). The net benefit of the scheme is approximately $200 million (NPV, 8%). This suggests that the Scheme overall has a significant net benefit, although it should be noted that this includes only costs and benefits to irrigators, and does not include costs and benefits to other parties such as any environmental externalities which may occur. The impacts on the regional economy are also not included in this figure, but are discussed below. The majority of the net benefit is associated with the main Hurricane Gully dam, and the lower dams contributes less than $10 million NPV to the scheme overall.

[1] Butcher Partners and the Agribusiness Group 2010. Regional Economic Impact and Cost Benefit Analysis of the proposed Hurunui Irrigation Scheme. Report prepared for the Hurunui Water Project, May 2010.
Butcher Partners 2011. Affordability of Water Storage for Irrigation. Unpublished report prepared for the Hurunui Water Project, March 2011.

[2] This assumes farmers are the owners of the entire scheme, so gives a net present value of the total project including on-farm investments

The scheme costs are around $7400 per hectare for the capital costs of the storage and distribution infrastructure on an overnight basis[2]. The analysis of affordability shows that once on farm costs and conversion costs are included, the scheme will generate a surplus for dairy farmers and other pastoral land uses under current average returns, but not for arable farmers and horticultural operations. The scheme affordability will depend on the skill level of the operator, since some will be able to generate higher returns than average, and on the way that water is priced for different land uses and locations.

The scheme will have very significant impacts on the district and regional economies. The regional impact analysis shows a total increase in GDP of $160 million in the district and $470 million in the region. Household incomes will increase by $70 million per annum in the district and by $210 million in the region, and employment will increase by 1060 FTEs in the district and 3,310 FTEs in the region. These are very significant impacts on a district scale with the increase being in the order of 52% for GDP and 28% for employment. At a regional level the impacts represent approximately 2% of GDP and 1% of employment.

2 Background and method

Hurunui Water Project (HWP) is applying for resource consent to develop a series of dams and associated infrastructure in the Waitohi catchment for the purposes of irrigating land in the Hurunui and nearby catchments, and for generation of hydro power.

This report describes the economic impact of the Scheme. It focuses on the Scheme costs, the returns, cashflow analysis, affordability and regional impacts.

An outline of the scheme and its key statistics are shown in Table 1 below. The scheme comprises four dams, the largest at Hurricane Gully, and three lower dams providing reregulation of flows, additional hydro generation, and some additional storage. The scheme is described in greater detail in the Riley (2011)[3] report.

The figures in tables below have been provided in greater detail for individual line items, although this level of accuracy is probably spurious given the error margins in the data and assumptions used. For totals in the tables, rounding has been undertaken to better reflect the likely accuracy of the figures. This does mean that the totals in the tables will not always match the sum of the individual items.

[2] On the basis that the project could be constructed overnight.
[3] Rileys, 2011. HWP Irrigation and Hydro Scheme: Engineering Report. Report prepared for the Hurunui Water Project, September 2011.

Table 1: Waitohi Irrigation and Hydro scheme description

	Hurricane Gully	Seven Hills rereg (all storage in stage 1)	Inches Rd Dam	Lower Gorge 1	Full Scheme
Irrigated area total	56,800	1,700		-	58,500
Irrigated net of AIC and other A block water after final stage	49,800	1,700		-	51,500
First stage area	-	15,500[4]		-	15,500
Live Storage Volume (Mm3)	209.5	9.3	3.9	0.4	221.1
Dam height	105	46	31	21	
Operating range	50	20	20	1	
Pumping height	117	0	0	0	117
Generation height	100	40	30	15	185

The analysis has drawn on the following sources of information:

- Construction cost estimates – Rileys (2011) have provided information on the construction and operating costs of different elements of the storage and distribution infrastructure and operating costs. These costs have been adopted after discussion and clarification where necessary.

- Farm returns – data on farm gate returns produced by Stuart Ford (The Agribusiness Group) for Butcher (2011) were adopted with the following main changes:
  - Input costs were adjusted to reflect a 3 year average cost
  - Output prices were based on five year's historical data rather than five years historical and three years of forecast prices.

  The detail of the farm budgets supporting these estimates of returns can be found in the Butcher 2010 report.

- Irrigated areas for Stage 1 and Stage 2 irrigation development have been sourced from PDP (2011)[5] reports. Note that the irrigated areas used in the calculations are approximate only. In particular the estimate of 7000 ha irrigated from the Hurunui A block water is based on an informed estimate.

- Land use patterns are adopted as described in the Butcher 2010 report, although it is noted that with the increase in costs it is possible that a higher proportion of potential irrigators will adopt a dairy milking or dairy support land use than was used by Butcher. Since the Butcher data was based on a survey of irrigator intentions, and because it is likely to produce conservative estimates of the economic impacts, these have been used in the current analysis without change.

[4] This figure reflects all storage in Stage 1 including on plains storage

[5] Pattle Delamore Partners, 2011. Assessment of Environmental Effects: HWP Waitohi Irrigation and Hydro Scheme. Report prepared for the Hurunui Water Project, September 2011.

- Analysis of pumping costs and hydro generation was undertaken by Parsons Brinckerhoff[6] and the results included in the estimates provided here. The hydro model is a daily model using 36 years of hydrology information and is driven by irrigation flows rather than optimising hydro generation. It uses typical efficiency estimates for pumps and generators rather than optimum ones.

- Flow on economic impact – Butcher (2010) produced estimates of the flow on impact to the local and regional community. The same model data has been used in developing the estimates of flow on impact described in this report.

Key assumptions are shown in Appendix 1.

3 Results

3.1 Capital costs

The capital costs are shown in Table 2, and the detail is supplied in Table 23 in the appendix.

Table 2: Capital costs of Waitohi scheme ($million total, overnight basis)

	Hurricane Gully (full distribution costs)	Seven Hills rereg (plus Stage 1 distribution)	Inches Rd Dam	Lower Gorge 1	Full Scheme
Storage ($million)					
General ($million)	$0.2	$0.6	$0.1	$0.0	$0.9
Diversion ($million)	$21.3	$0.0	$0.0	$0.0	$21.3
Pumping ($million)	$21.6	$0.6	$0.6	$0.6	$23.5
Generation ($million)	$28.5	$2.9	$2.2	$1.5	$35.1
Dam ($million)	$65.7	$7.1	$5.9	$1.7	$80.4
Contingencies, engineering, etc ($million)	$74.3	$6.2	$4.6	$1.8	$86.9
Total Storage ($ million, rounded)	**$210**	**$17**	**$13**	**$6**	**$250**
Distribution ($million, rounded)	**$130**	**$61**	**$0**	**$0**	**$130**
Total ($million, rounded)	**$340**	**$80**	**$13**	**$6**	**$380**

The largest part of the costs is associated with dam construction, with the intake costs a smaller component. The generation costs, which are significant, are optimised for returns relative to capital costs rather than for maximum recovery of energy, and it may be that these costs will alter as further refinements are made to power pricing and hydrology.

[6] Tony Mulholland, Parsons Brinckerhoff. Sept 2011 pers.comm.

3.2 Operating costs

The operating costs are shown in Table 3. The pumping costs dominate the operating costs, and there are significant risks with these costs due to changing prices and pumping requirements. As prices increase and changes occur, differences in seasonal pricing, the net electricity costs will potentially increase. The sensitivity of the operating costs to changes in price is outlined in the Section 5.

The total energy used in pumping and generation are shown in Table 4, and the net returns at low, average and high power prices are shown in Table 5. They show that although the scheme is in a small energy negative situation after generation, the ability to pump at lower cost times of the day and generate at higher price times of the day means that the net pumping/generation return is positive in an average year. It is likely that with further optimisation of pumping and generation this positive return would increase.

While changes to average power prices (see Section 5) have little impact on the overall returns, the differences between summer and winter prices will potentially have a significant impact on the operating costs faced in any year. This arises because the pumping is largely undertaken in the autumn/winter period, and the generation in the summer period. In an average price year total generation covers revenue, but in a high price year with significant differential, the overall pumping/generation system operates at a $6.9 million loss ($120/ha). The generation system is a useful hedge against increases in power prices, but does not completely insulate the scheme from potential changes to pumping costs.

The hydro system has not been optimised for hydro returns. There are opportunities, when the reservoir is full, to pump during night time and generate during the day which would increase the returns to the system overall and result in lower operating costs. These opportunities will be explored in greater detail in the later stages of the project. There is also the opportunity to integrate this scheme with other hydro schemes and increase returns.

Table 3: Waitohi Irrigation and Hydro Scheme operating costs ($million/year)

	Hurricane Gully	**Seven Hills rereg**	**Inches Dam**	**Lower Gorge 1**	**Full Scheme**
Operations and maintenance (including distribution operating costs)	$1.6	$0.2	$0.1	$0.1	$2.0
Pumping	$5.2	$0.0	$0.0	$0.0	$5.2
Generation	$3.6	$0.6	$0.6	$0.4	$5.3
Net operating costs ($million/annum)	**$3.2**	**-$0.4**	**-$0.5**	**-$0.3**	**$2.0**

Table 4: Energy usage and generation for major HWP irrigation and hydro scheme components (Parsons Brinckerhoff, 2011)

Dam	Energy (MWhrs)	Energy Cumulative MWhrs)
Pump station	-95,158	-95,158
Hurricane Gully	+54,915	-40,243
Seven Hills	+10,203	-30,040
Inches Rd	+10,449	-19,591
Lower Gorge 1	+6,966	-12,625

Table 5: Annual costs and returns from pumping and generation components of HWP Irrigation and Hydro Scheme (Parsons Brinckerhoff, 2011)

Dam	Low Power Price ($million/year)	Average Power Price ($million/year)	High Power Price ($million/year)
Pump station	$2.9	$5.2	$16.0
Hurricane Gully	$1.8	$3.6	$6.7
Seven Hills	$0.3	$0.6	$1.3
Inches Rd	$0.3	$0.6	$1.4
Lower Gorge 1	$0.2	$0.4	$0.9
Profit/Loss (rounded)	**-$0.2**	**$0.1**	**-$6.9**

3.3 Returns

The per ha returns are shown in Table 6 below, and are based on estimates in the Butcher 2010 report. Dairying will be the highest value land use, returning over $3000 per ha/year after expenses.

The returns for the existing Balmoral scheme which benefit from increased reliability associated with storage were estimated in Butcher 2011. The Butcher 2011 benefits were reduced by 50% in this analysis to ensure a conservative result. The increased reliability will also result in a release of A block currently held by the AIC[7] which has been included in the total irrigated area.

The Stage 1 irrigation development is of a lower reliability than the main development, at 93% supply/demand ratio. To allow for lower reliability, returns have been decreased by 10% for the period during which only Stage 1 storage is available.

[7] AIC uses this ‘spare’ A block water to accommodate the current low reliability of the Balmoral Scheme.

Table 6:Estimated average returns for land uses in the Waitohi Irrigation and Hydro scheme ($/ha/year, after cash farm expenses but before interest, tax, depreciation)

Land use	Proportion	Average change in returns (Irrigated EBITDA – Dryland EBITDA)[8] high reliability[9] ($/ha/year)
Dairy	54%	$3,110
Arable	11%	$1,000
Sheep and beef	24%	$1,160
Dairy support	10%	$1,110
Viticulture	1%	$1,700
Blackcurrants	1%	$2,030
Weighted average	**100%**	**$2,200**

At peak uptake, it is expected that the increase in net returns (EBITDA - after expenses but excluding tax and capital charges) from each of the stages will be:

- $15 million/annum for stage 1
- $120 million/annum once Stage 2 is implemented including Stage 1 area and increased reliability for Balmoral scheme.
- $5 million/annum for hydro generation[10]

3.4 Discounted Cashflow (DCF) analysis

Discounted cashflow analysis provides an indication of whether the total benefits of a project are greater than the total costs. It allows for costs and benefits occurring at different times in the future by a process known as discounting, where all future figures are brought back to the present day at a constant discount rate. The discount rate is equivalent to the opportunity cost of capital, and in this case a figure of 8% has been chosen. This represents HWP's estimation of its likely cost of accessing capital to undertake the project.

The analysis undertaken for this project includes all costs and all benefits experienced by scheme users and investors. This includes the off farm expenditure on storage and distribution, but also the on farm expenditure on installing irrigation and changing the farm system to make use of the higher production.

The detailed cash flows are shown in Appendix 1, and the summary of costs and benefits is shown in Table 7.

[8] EBIT: Earnings Before Interest, Tax Depreciation and Amortisation

[9] Returns were reduced by 10% to simulate the lower reliability experienced in Stage 1 irrigation.

[10] At current prices. Actual prices will be higher because expected real increases in price have been included in the analysis.

Table 7: NPV estimates for costs and benefits of Waitohi Irrigation and Hydro Scheme ($ million NPV, 8% discount rate) (Source: Rileys, Butcher 2010)

	Hurricane Gully dam only ($million NPV, 8%)	Seven Hills ($million NPV, 8%)	Inches Rd ($million NPV, 8%)	Lower Gorge 1 ($million NPV, 8%)	Hurricane Gully Full development including lower dams ($million NPV, 8%)
Costs ($million NPV, 8%)					
Storage	$148	$13	$10	$4	$175
Distribution	$87	$8	$0	$0	$95
On farm capital	$339	$29	$0	$0	$369
Operating costs	$69	$3	$1	$1	$74
Total costs benefits ($million NPV, 8%, rounded)	**$640**	**$53**	**$11**	**$5**	**$710**
Benefits ($million NPV, 8%)					
Farm returns	$804	$64	$0	$0	$869
Generation	$32	$5	$6	$4	$46
Total benefits ($million NPV, 8%, rounded)	**$840**	**$70**	**$6**	**$4**	**$910**
Net Benefit (benefits - costs) ($million NPV, 8%, rounded)	**$190**	**$16**	**-$6**	**-$1**	**$200**

The results suggest that there is a significant net benefit to the project of approximately $200 million. The returns from the Seven Hills and Inches Rd dams together are lower, but still positive and therefore likely to be worthwhile (these need to be taken together because the Stage 1 farm return benefits have not been separated between the two dams). The returns to the Lower Gorge 1 dam are negative, but it is required as an intake for the distribution system, and generation will be added if it is economic once the scheme has been optimised.

It should be noted that the results reported here do not include other impacts or externalities that may arise as a result of the project such as environmental, social and recreational costs and benefits. Nor does it include the flow on district and regional economic and employment impacts as described below. As such it only reports the benefits and costs to irrigators and scheme investors.

3.5 Staging

The application proposal is for staging of construction, with the Seven Hills, Inches Rd, Lower Gorge dams along with the lower Hurunui Intake and on plains storage are to be built as soon as consents are available, utilising in catchment water for storage and Hurunui water as run of river when available. The Hurricane Gully dam and the upper Hurunui intake would be built once detailed engineering had been completed and consents obtained. This would enable some 15,500 ha irrigation to commence at an earlier stage than otherwise would occur, and provides storage for an additional 1700 ha of irrigation once the Hurricane Gully dam is built[11]. The early irrigation also increases the viability of the lower dams which would be marginal from the point of view of generation alone.

Table 7 shows the NPV for the Stage 1 dams, which is a positive value of approximately $5 million for the Seven Hills and Inches Rd dams. This positive value arises partly because the smaller total irrigated area in Stage 1 is able to access the more reliable parts of the B block water. That results in a smaller storage requirement/ha irrigated, and thus a lower total capital cost. Furthermore the proposal is that the initial irrigated areas are within the Waitohi catchment, which has reasonably low distribution costs. The combination of these factors means that the irrigators in Stage 1 are able to access water at a low enough cost to generate a net benefit. It also is likely that this group of irrigators would incorporate more dairy milking operations than has been assumed for the main analysis, which would result in greater benefits from Stage 1 than has been assumed here.

The expectation in this analysis is for a two year gap between the first and second stages of irrigation, which means that the Stage 1 irrigators would access water only 2 years earlier than Stage 2. However it is possible that the gap could be significantly longer, which would result in greater benefits from Stage 1. The benefits from Stage 1 in NPV terms with a shorter and longer gap between the first and second stages are shown in Table 8.

Table 8: Impact of differing gaps between Stage 1 and Stage 2 on the NPV for Stage 1 ($ million, 8% discount rate)

Gap between first and second stage	Base Case (2 years)	1 year	5 years
NPV Stage 1 dams only ($ million, 8%)	$9.3	$3.4	$30.2

3.6 Affordability

The total cost of the storage and distribution infrastructure, including construction financing is shown in Table 9. The total costs, excluding financing the scheme construction at 8%, are approximately $7,400/ha on an overnight basis[12]. When on farm capital is included, the total capital required will range from $10,000 per ha for arable properties, to $29,000 per ha for a horticultural property. Dairy conversions would cost in the order of $24,000 per ha including irrigation and farm conversion.

For assessing affordability, the capital costs were turned into an equivalent interest charge at 8%. The returns minus the operating costs and annual interest charge gives an indication of whether there is a net surplus after the costs of paying for the scheme. If the answer is positive, it is likely that the land use could pay the interest costs of funding the capital requirements. If the answer is negative, the returns from converting to irrigation would be insufficient to pay the interest costs.

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[11] The irrigated area is lower once the full development occurs because the higher reliability A and B block water is spread across a larger area, so greater storage volumes are required for each irrigated ha.

[12] Overnight refers to the capital required if the scheme could be built overnight. The actual amount of capital required will differ from this because of construction finance costs. However the size of these costs are still to be determined because the construction timing and financing of the scheme have not been investigated.

Table 9 shows that dairying is likely to generate sufficient surplus to pay for the interest costs of irrigation and conversion. Other pastoral land uses such as dairy support and sheep and beef may generate a small surplus, but arable and horticulture under current average returns and capital costs would not. These results suggest that conversion to dairying will be highly favoured. However there are likely to be situations where dairy support linked to a dairy property, partial irrigation of arable and sheep and beef properties, and highly skilled operators in all land uses, show higher returns than are indicated here and the land use will be more worthwhile than has been estimated by average returns. The affordability will also be affected by the pricing structure of water, and if price is differentiated for different land uses and locations the scheme affordability will change for individuals.

Table 9: Per ha capital costs and estimates of affordability, full Waitohi Irrigation and Hydro scheme (overnight basis)

	Dairy	**Arable**	**Other pastoral**	**Horticulture (blackcurrants)**	**Weighted average**
Storage cost/ha	$4,817	$4,817	$4,817	$4,817	$4,817
Distribution cost/ha	$2,577	$2,577	$2,577	$2,577	$2,577
Total	**$7,400**	**$7,400**	**$7,400**	**$7,400**	**$7,400**
On farm capital	$17,000	$3,000	$4,000	$22,000	$9,000
Total Overnight Capital Required	**$24,000**	**$10,000**	**$11,000**	**$29,000**	**$16,000**

Table 10: Annual per ha costs and estimates of affordability, full Waitohi Irrigation and Hydro scheme

Land use	**Dairy**	**Arable**	**Other pastoral**	**Horticulture (blackcurrants)[13]**	**Weighted average**
Storage, distribution, financing capital at 8% ($/ha/year)	$684	$684	$684	$684	$684
On farm capital at 8% ($/ha/year)	$1,360	$240	$320	$1,760	$720
Operating costs ($/ha/year)	$69	$69	$69	$69	$69
Returns ($/ha/year)	$3,111	$1,001	$1,160	$2,026	$2,198
Depreciation, increase in drawings ($/ha/year)	$312	$170	$30	$435	$215
Net returns after change to irrigation (Returns - capital charge - operating costs - depreciation) ($/ha/year, rounded)	**$690**	**-$160**	**$60**	**-$920**	**$510**

[13] Blackcurrants were used historically from the earlier project analyses, but there are likely to be better returning horticultural uses that could be used the analysis now. This does not have a major impact on the results because it is only a small proportion of the land use area.

4 Regional impacts

The models developed for Butcher (2010) were used to estimate the regional impact of the scheme at full uptake and full production. The key impact measures are:

- GDP – this largely measures the value added by an economic activity by capital, labour and management expertise. It is measured by the output (revenue) less any inputs purchased from outside the enterprise excluding labour.

- Household income – this measures the returns to households as a result of the activity. It includes wages, salaries and profits to owners.

- Employment – this is measured by Full Time Equivalents (FTEs). A FTE is calculated for a 40 hour working week, so two half time employees equals one FTE. Because a significant part of the workforce is part time, the number of people employed is likely to be more than the FTEs estimated.

The direct impacts are those on the farm, while the district and regional impacts measure those that occur as a result of flow on economic activity – purchases and sales by the farmers stimulating activity in other enterprises. Because of the nature of input/output models used to make these estimates, it is likely that the numbers produced overestimate the total impacts and should be regarded as an upper bound estimate rather than an exact calculation. Other model types which may give a lower estimate, such as general equilibrium models, are not appropriate for use at the regional or district level because of data limitations.

The results are shown in Table 11 and suggest that the district GDP will increase by $160 million, while regional GDP will increase by $470 million. Income to households will increase by $70 million within the district and by $210 million within the region, while employment will increase by 1060 workers on farm, and 3,310 FTEs in the region.

The majority of the economic impacts will arise through the irrigated dairying, both because it is likely to be the dominant land use, but also because its high returns and high expenditure results in greater flow on economic impacts per ha. Both viticulture and blackcurrants are very intensive with respect to economic impacts, particularly employment impacts, on a per ha basis, but because they are likely to be only small land uses their impact overall is not likely to be significant.

Table 11: District and Regional GDP impacts from the Waitohi irrigation scheme (all results annual, excludes processing).

GDP				
Land Use	**Direct ($ million)**	**Additional flow on impacts in District ($ million)**	**Additional flow on impacts in Region ($ million)**	**Total Regional GDP (including farm, processing and flow on) ($ million)**
Dairy	$94	$36	$246	$376
Arable	$5	$4	$35	$44
Sheep and beef	$8	$6	$17	$32
Dairy support	$3	$3	$1	$7
Viticulture	$3	$4	$4	$11
Blackcurrants	$1	$2	$2	$5
Total (rounded)	**$110**	**$50**	**$310**	**$470**

Table 12: District and Regional Gross Household income impacts from the Waitohi irrigation scheme (all results annual, excludes processing).

Gross Household income				
Land Use	**Direct ($ million)**	**Additional flow on impacts in District ($ million)**	**Additional flow on impacts in Region ($ million)**	**Total Regional Household Income (including farm, processing and flow on) ($ million)**
Dairy	$31	$19	$105	$155
Arable	$2	$1	$21	$24
Sheep and beef	$1	$1	$13	$15
Dairy support	$0	$1	$1	$3
Viticulture	$2	$2	$3	$7
Blackcurrants	$1	$1	$1	$3
Total (rounded)	**$40**	**$30**	**$140**	**$210**

Table 13: District and Regional Employment impacts from the Waitohi irrigation scheme (all results annual, excluding processing).

Employment				
Land Use	**Direct (FTE)**	**Additional flow on impacts in District (FTE)**	**Additional flow on impacts in Region (FTE)**	**Total Regional Employment (including farm, processing and flow on) (FTE)**
Dairy	416	374	1,381	2,172
Arable	37	35	551	623
Sheep and beef	14	22	195	231
Dairy support	9	23	18	50
Viticulture	54	45	84	184
Blackcurrants	9	21	17	47
Total (rounded)	**540**	**520**	**2,250**	**3,310**

In the context of the district, these are very significant impacts. At a district level, the economy would be 52% larger in GDP terms and 28% larger in employment terms, with the majority of this occurring in the agricultural sector. At a regional level the Scheme represents a 2% increase in GDP and 1% increase in employment.

Table 14: Scheme Increase as % of Hurunui Economic activity (2005/06 year)

	GDP			**Employment (FTEs)**		
	Total economy ($m / yr)	**Scheme Change ($m/yr)**	**Change compared to base (%)**	**District (FTEs)**	**Scheme Change (FTEs)**	**Change compared to base (%)**
District economy	330	$172	52%	3,800	1,076	28%
Regional economy	20,000	$482	2%	238,000	3,358	1%

5 Sensitivity

The sensitivity of the results to changes in a number of key assumptions was tested. These tests included:

- Discount rate - Table 15
- Average power prices - Table 16
- Infrastructure costs - Table 17
- Farm conversion costs - Table 18

- Returns - Table 19
- Proportion in irrigated dairy land use - Table 20
- Gap between first and second stages - Table 21

The items tested were:

- NPV – based on a discounted cash flow of costs and benefits into the future, taking into account their timing. This gives a measure of net welfare gain from the investment.
- Affordability – as measured by whether there is a net cash surplus after the interest costs of capital invested in the project have been taken into account. Although this includes a construction financing charge, it does not fully take into account the timing of costs and benefits in the future.
- Regional impacts – GDP (Gross domestic product) measures that value that will be added through the regional economy, Household income measures the increase in household incomes in the region before tax including profits, wages and salaries; and regional employment measures the change in full time equivalent employment as a result of the changes in the regional economy.

The sensitivity tests suggest that:

- The overall positive NPV is reasonably robust under a range of changes in single assumptions.
- Affordability for dairy farming is reasonably robust under a range of different scenarios, but affordability for other pastoral land uses is quite sensitive to increases in costs and decreases in returns. Affordability for these other land uses is also sensitive to higher costs of capital.
- Power prices, proportion in dairying and the gap between first and second stages do not have major effects overall on the positive or negative nature of outcomes. The gap between Stage 1 and Stage 2 does however have an impact on the viability of Stage 1 development.
- The regional impacts are largely determined by revenue and returns, since these determine the level of economic activity. They area also affected by the proportion of land in dairying because of the greater intensity of this land use relative to other pastoral land uses.

The results suggest that the major determinant of scheme success, apart from costs of the infrastructure, will be the costs on farm and the revenue and returns that can be obtained from the irrigated land uses.

5.1 Discount rate

Table 15: Sensitivity of major results for Waitohi Irrigation and Hydro Scheme to changes in Discount Rate

Discount rate		8%	6%	10%
NPV	Costs ($million)	$710	$800	$640
	Benefits ($million)	$910	$1,260	$680
	Net ($million)	$200	$450	$50
Affordability	Dairy ($/ha/year)	$690	$1,200	$180
	Other pastoral ($/ha/year)	$60	$310	($190)
	Weighted average ($/ha/year)	$510	$860	$160
Regional impacts	Regional GDP ($million)	$470	$470	$470
	Regional household income ($million)	$210	$210	$210
	Regional employment (FTE)	3,310	3,310	3,310

The discount rate primarily affects the NPV calculations, with a higher discount rate decreasing the current value of costs and benefits. Because the benefits are further in the future than the costs, they are affected to a greater extent resulting in a lower net value at a higher discount rate. The regional impacts are not affected because they are primarily driven by revenue from an activity rather than the capital investment (because impacts of construction activity have not been taken into account).

5.2 Power price sensitivity

Table 16: Sensitivity of major results for Waitohi Irrigation and Hydro Scheme to changes in Power prices

Change in power price		Base	+20%	-20%
NPV	Costs ($million)	$710	$700	$720
	Benefits ($million)	$910	$910	$920
	Net ($million)	$200	$200	$200
Affordability	Dairy ($/ha/year)	$690	$690	$690
	Other pastoral ($/ha/year)	$60	$60	$60
	Weighted average ($/ha/year)	$510	$510	$510
Regional impacts	Regional GDP ($million)	$470	$470	$470
	Regional household income ($million)	$210	$210	$210
	Regional employment (FTE)	3,310	3,310	3,310

The results show very little sensitivity to power prices, and affordability is virtually unaffected because although both generation and pumping prices increase, the net difference remains approximately the same (below the rounding margins). The regional impacts are unaffected again because the generation has not been included in the regional impact calculations.

5.3 Dam and distribution cost sensitivity

Table 17: Sensitivity of major results for Waitohi Irrigation and Hydro Scheme to changes in dam and distribution costs (does not include farm conversion costs)

Change in infrastructure costs		Base	-20%	+20%
NPV	Costs ($million)	$710	$660	$770
	Benefits ($million)	$910	$910	$910
	Net ($million)	$200	$260	$150
Affordability	Dairy ($/ha/year)	$690	$820	$550
	Other pastoral ($/ha/year)	$60	$190	($80)
	Weighted average ($/ha/year)	$510	$650	$370
Regional impacts	Regional GDP ($million)	$470	$470	$470
	Regional household income ($million)	$210	$210	$210
	Regional employment (FTE)	3,310	3,310	3,310

The infrastructure costs affect primarily the cost and therefore net benefit side of the NPV calculation, and it can be seen that although the results are sensitive, they are not made negative by either of the changes to infrastructure costs. Similarly affordability alters significantly with other pastoral land uses becoming negative in terms of surplus generated. The regional impacts are unaffected for reasons noted earlier.

5.4 Farm conversion cost sensitivity

Table 18: Sensitivity of major results for Waitohi Irrigation and Hydro Scheme to changes in Farm Conversion costs

Farm conversion costs		Base	-20%	+20%
NPV	Costs ($million)	$710	$640	$790
	Benefits ($million)	$910	$910	$910
	Net ($million)	$200	$280	$130
Affordability	Dairy ($/ha/year)	$690	$930	$450
	Other pastoral ($/ha/year)	$60	$60	($20)
	Weighted average ($/ha/year)	$510	$510	$510
Regional impacts	Regional GDP ($million)	$470	$470	$470
	Regional household income ($million)	$210	$210	$210
	Regional employment (FTE)	3,310	3,310	3,310

The NPV and affordability are both significantly affected by changes in farm conversion costs, indicating that the effects of costs on farm will be at least as significant to the overall outcomes as the costs of the off farm infrastructure.

5.5 Revenue and return sensitivity

Table 19: Sensitivity of major results for Waitohi Irrigation and Hydro Scheme to changes in Revenue and Returns (EBITDA)

Changes in revenue and returns (EBITDA)		**Base**	**-20%**	**+20%**
NPV	Costs ($million)	$710	$710	$710
	Benefits ($million)	$910	$750	$1,080
	Net ($million)	$200	$40	$370
Affordability	Dairy ($/ha/year)	$690	$60	$1,310
	Other pastoral ($/ha/year)	$60	($170)	$290
	Weighted average ($/ha/year)	$510	$230	$790
Regional impacts	Regional GDP ($million)	$470	$380	$570
	Regional household income ($million)	$210	$170	$250
	Regional employment (FTE)	3,310	2,650	3,970

The NPV results are very sensitive to changes in returns, with 20% lower returns resulting in a close to neutral NPV, while a 20% increase in returns doubles the net benefit of the project. Affordability is similarly very sensitive to returns, with the other pastoral land use category generating negative returns at a 20% reduction in average returns. The regional impacts are affected almost directly in line with the change in revenue.

5.6 Sensitivity to proportion of land in dairy milking

Table 20: Sensitivity of major results for Waitohi Irrigation and Hydro Scheme to changes in changes in the proportion of land in dairy milking

Proportion of land in dairy milking		**Base (54%)**	**40%**	**80%**
NPV	Costs ($million)	$710	$650	$820
	Benefits ($million)	$910	$810	$1,120
	Net ($million)	$200	$150	$290
Affordability	Dairy ($/ha/year)	$690	$690	$690
	Other pastoral ($/ha/year)	$60	$60	$60
	Weighted average ($/ha/year)	$510	$260	$980
Regional impacts	Regional GDP ($million)	$470	$410	$590
	Regional household income ($million)	$210	$180	$250
	Regional employment (FTE)	3,310	3,120	3,650

The proportion of land in dairy affects the NPV outcomes from the scheme as well as the regional outcomes. The regional outcomes are significantly affected because dairy is an intensive land use, with high employment and value added impacts.

5.7 Sensitivity gap between first and second stage developments

Table 21: Sensitivity of major results for Waitohi Irrigation and Hydro Scheme to changes in changes in the gap between the first and second stage of development

Gap between first and second stages of development (years)		**Base (2 years)**	**1 year**	**5 years**
NPV	Costs ($million)	$710	$700	$760
	Benefits ($million)	$910	$890	$990
	Net ($million)	$200	$200	$220
Affordability (Stage 2 only)	Dairy ($/ha/year)	$690	$680	$700
	Other pastoral ($/ha/year)	$60	$50	$70
	Weighted average ($/ha/year)	$510	$510	$520
Regional impacts	Regional GDP ($million)	$470	$470	$470
	Regional household income ($million)	$210	$210	$210
	Regional employment (FTE)	3,310	3,310	3,310

The sensitivity table shows an increasing cost with a longer gap between the stages, because the costs are incurred earlier. However the benefits increase proportionately more, resulting in a $20 million increase in NPV overall with a longer gap. Affordability is slightly affected because of changes to construction financing costs. The results from this analysis suggest that the gap between the first and second stages of development will have a minimal impact on the overall scheme economics and impact.

6 Appendices

Table 22: Base assumptions for land use, costs and returns for Waitohi Irrigation and Hydro Scheme

Land use	Proportion of total irrigated land	Costs of lower reliability Stage 1 $/ha/year	Returns high reliability $/ha/year	Irrigation costs ($/ha)	Farm system conversion costs ($/ha)	Depreciation ($/ha/year)	Revenue – dryland ($/ha/year)	Income – irrigated ($/ha/year)
Dairy	54%	$311	$3,111	$2,200	$14,757	312	$873	8893.182955
Arable	11%	$100	$1,001	$2,200	$720	170	$873	3758
Sheep and beef	24%	$116	$1,160	$2,200	$2,190	30	$873	3361.232469
Dairy support	10%	$111	$1,106	$2,200	$40	30	$873	2791.376133
Viticulture	1%	$1,702	$1,702		$37,500	$3,085	$873	15983
Blackcurrants	1%	$2,026	$2,026		$22,050	$435	$873	8000
Weighted average	**100%**	**$237**	**$2,198**	**$2,178**	**$8,875**	**$215**	**$873**	**$6,421**

Other assumptions

- Power prices were inflated by the MED Outlook 2010 energy price forecast index for electricity (Source: http://www.med.govt.nz/templates/MultipageDocumentTOC____45552.aspx; page accessed September 7 2011)
- Distribution costs were based on costings provided by Rileys separately for Stage 1 and Stage 2, assuming the 305m canal option for Stage 1. Distribution costs for any additional area not costed by Riley's has been based on the *pro rata* cost of minor distribution canals.
- Weighted average return for Balmoral was assumed to be $570 increase above the current situation. This is approximately 50% of the impact forecast by Butcher 2011, and was altered to ensure the results remained reasonably conservative given uncertainty about the size of the impact.
- The discount rate used is 8%, which was the initially estimated cost of capital for the scheme. It may be that this has decreased but a review of the actual cost of capital has not been undertaken at this stage.

Table 23: Waitohi Irrigation and Hydro Scheme cashflows excluding construction financing ($000)

				Year	1	2	3	4	5	6	7	8	9	Years 10 - 40
			Total cost	NPV										
General														
Buildings Inundated			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Farm Access			$345	$229	$0	$0	$0	$0	$115	$0	$230	$0	$0	$0
New Site Access Road			$600	$441	$0	$0	$0	$0	$600	$0	$0	$0	$0	$0
Public Road			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Diversion														
Intake			$3,188	$2,174	$0	$0	$0	$0	$1,063	$1,063	$1,063	$0	$0	$0
Tunnel			$8,180	$5,578	$0	$0	$0	$0	$2,727	$2,727	$2,727	$0	$0	$0
Road Crossings			$100	$68	$0	$0	$0	$0	$33	$33	$33	$0	$0	$0
Channel			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Rising main			$9,800	$6,683	$0	$0	$0	$0	$3,267	$3,267	$3,267	$0	$0	$0
Pumping & Generation														
Pumps			$14,918	$10,173	$0	$0	$0	$0	$4,973	$4,973	$4,973	$0	$0	$0
Generators			$31,650	$21,409	$0	$0	$0	$0	$8,750	$10,850	$12,050	$0	$0	$0
Pump Generators			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Penstock			$2,774	$1,854	$0	$0	$0	$0	$529	$996	$1,249	$0	$0	$0
Powerhouse / Pump Station			$7,520	$5,061	$0	$0	$0	$0	$1,867	$2,507	$3,147	$0	$0	$0
Power Lines in Reservoir			$640	$436	$0	$0	$0	$0	$213	$213	$213	$0	$0	$0
Extra Power lines for pumping			$1,080	$736	$0	$0	$0	$0	$360	$360	$360	$0	$0	$0
Intake structure and outlet			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
RCC Dam														
RCC			$80,419	$55,868	$0	$0	$0	$6,511	$28,401	$22,753	$22,753	$0	$0	$0
Construction Cost of Scheme:			$161,213	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Additional costs to scheme														
Preliminary and General @10%			$16,121	$13,069	$2,418	$2,418	$2,418	$2,418	$2,418	$2,015	$2,015	$0	$0	$0
Engineering and administration @ 10%			$16,121	$13,069	$2,418	$2,418	$2,418	$2,418	$2,418	$2,015	$2,015	$0	$0	$0

Contingencies @ 25%			**$40,303**	**$27,874**	**$0**	**$0**	**$0**	**$2,519**	**$13,956**	**$11,914**	**$11,914**	**$0**	**$0**	**$0**
Reparation for used land			**$14,331**	**$10,628**	**$0**	**$0**	**$0**	**$1,700**	**$12,529**	**$102**	**$0**	**$0**	**$0**	**$0**
Total storage cost:			**$248,090**	**$175,352**	**$4,836**	**$4,836**	**$4,836**	**$15,566**	**$84,217**	**$65,788**	**$68,009**	**$0**	**$0**	**$0**
Distribution														
Intake			**$2,178**	**$1,665**	**$0**	**$0**	**$0**	**$1,089**	**$1,089**	**$0**	**$0**	**$0**	**$0**	**$0**
Main canals			**$39,552**	**$29,802**	**$0**	**$0**	**$0**	**$17,793**	**$17,793**	**$1,984**	**$1,984**	**$0**	**$0**	**$0**
Minor Canals			**$93,552**	**$63,868**	**$0**	**$0**	**$0**	**$11,723**	**$11,723**	**$35,053**	**$35,053**	**$0**	**$0**	**$0**
Total Distribution			**$135,282**	**$95,336**	**$0**	**$0**	**$0**	**$30,604**	**$30,604**	**$35,751**	**$35,751**	**$0**	**$0**	**$0**
Operation Costs														
Operations and Maintenance														
Operation/Maintenance - General			**$175**	**$1,335**	**$0**	**$0**	**$0**	**$0**	**$0**	**$50**	**$50**	**$175**	**$175**	**$175**
Operation/Maintenance - Pump/Hydro			**$1,202**	**$8,906**	**$0**	**$0**	**$0**	**$0**	**$0**	**$143**	**$143**	**$1,202**	**$1,202**	**$1,202**
Dam Safety & Environmental			**$475**	**$3,643**	**$0**	**$0**	**$0**	**$0**	**$0**	**$150**	**$150**	**$475**	**$475**	**$475**
Intake			**$196**	**$1,421**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$196**	**$196**	**$196**
Pumping/Generation														
Cost of power consumed ($/year)			**$5,197**	**$45,404**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$5,677**	**$6,134**	**$6,134**
Revenue from power generated ($/year)			**$5,281**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Annual cost of power ($)			**($84)**	**($730)**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**($91)**	**($99)**	**($99)**
Distribution			**$1,803**	**$13,466**	**$0**	**$0**	**$0**	**$0**	**$0**	**$434**	**$488**	**$1,551**	**$1,677**	**$1,803**
Annual Operation cost ($/year)			**$3,766**	**$74,175**	**$0**	**$0**	**$0**	**$0**	**$0**	**$777**	**$831**	**$9,275**	**$9,859**	**$9,985**
On farm costs	**Stage 1**	**Irrigatio n**	**$2**	**$24,276**	**$0**	**$0**	**$0**	**$0**	**$27,007**	**$3,376**	**$3,376**	**$0**	**$0**	**$0**
		System	**$9**	**$98,925**	**$0**	**$0**	**$0**	**$0**	**$110,054**	**$13,757**	**$13,757**	**$0**	**$0**	**$0**
	Stage 2	**Irrigatio n**	**$2**	**$48,339**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$62,726**	**$7,841**	**$7,841**	**$0**
		System	**$9**	**$196,983**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$255,610**	**$31,951**	**$31,951**	**$0**
Total on farm cost			**$569,246**	**$368,523**	**$0**	**$0**	**$0**	**$0**	**$137,061**	**$17,133**	**$335,469**	**$39,792**	**$39,792**	**$0**

Total Cost			**$956,385**	**$713,386**	**$4,836**	**$4,836**	**$4,836**	**$46,171**	**$251,883**	**$150,052**	**$470,664**	**$49,067**	**$49,651**	**$9,985**
Benefits														
Irrigated area	**Stage 1**				**0**	**0**	**0**	**0**	**0**	**12400**	**13950**	**15500**	**15500**	**15500**
	Stage 2				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**28800**	**32400**	**36000**
Hydro	**Generation**		**$5,281**	**$46,134**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$5,768**	**$6,233**	**$6,233**
Farm	**Stage 1**		**$2**	**$285,026**	**$0**	**$0**	**$0**	**$0**	**$0**	**$27,251**	**$30,658**	**$34,064**	**$34,064**	**$34,064**
	Stage 2		**$2**	**$560,541**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$63,293**	**$71,205**	**$79,117**
				$23,024	**$0**	**$0**	**$0**	**$0**	**$0**	**($2,725)**	**($3,066)**	**$563**	**$3,969**	**$3,969**
Total Benefits				**$914,725**										
Net Benefit				**$201,339**										