REPORT

MINISTRY FOR THE ENVIRONMENT

Environmental, Economic and Social Impacts of Irrigation in the Mackenzie Basin

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January 2005

Report commissioned by the Ministry for the Environment

for consideration by the Waitaki Catchment Water Allocation Board

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Published in February 2005 by the
Ministry for the Environment
Manatū Mō Te Taiao
PO Box 10-362, Wellington, New Zealand

ISBN: 0-478-18997-4
ME number: 583

This document is available on the Ministry for the Environment's website:
www.waitaki.mfe.govt.nz

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Executive Summary

1. This report assesses the environmental, economic and social impacts of allocating to irrigation an amount of water that matches the provisions in the now defunct 1969 Order in Council that granted water rights to the Minister of Electricity for the Upper Waitaki Power Scheme The assumption is made that after allowing for existing irrigation that a further 25,000 hectares could be irrigated with the quantity of water specified in the Order in Council as being able to be used for irrigation.

2. The environmental impacts section of this report is based on material sourced from existing publications and interviews with a number of people with knowledge of the area and the issues. Economic and social impacts were assessed using methodologies similar to those used by Harris et al (2004). The report does not include an assessment of the economic, social and cultural impacts of any environmental changes.

Environmental impacts

3. From an environmental perspective the establishment of a further 25,000 hectares under irrigation within the upper Waitaki could have both a positive and negative impact on the environment. From a positive perspective, irrigation would reduce the erosion risk within the basin and also increase the opportunities for enhancing biodiversity values. From a negative perspective, irrigation increases the risk of contamination of ground and surface waters and could adversely impact upon landscape values.

4. Wind erosion is a significant issue in the upper Waitaki Catchment. The sparse vegetation on large areas of land in the Mackenzie Basin gives little protection to the shallow, friable soils which continue to be eroded by frost heave and westerly winds. A mean soil loss of 0.22 mm/year or 2.2 tonnes of soil lost per across a number of sites within the Mackenzie Basin has been reported. While it cannot be assumed from this information that erosion rates will continued at this level in the future, the results do confirm a strong relationship between the percentage of vegetation cover and erosion risk. The problem of bare ground and exposure to wind erosion has been compounded since the early 1990s by the rapid spread of hieracium particularly on the poorest soils. One of the most significant impacts of further irrigation in this area would be a reduction in the amount of bare ground and corresponding reduction in wind erosion risk.

5. Testing has shown that water quality in most ground and surface water bodies within the upper Waitaki Catchment is generally very good. However, under a scenario where a further 25,000 hectares is irrigated, it is likely that significant quantities of nitrogen will be added to the system. Evidence from other regions suggests that where ever there is an intensification of land use the risks of nutrient and faecal contamination of waterways increases significantly. There is some suggestion that the effect of increased nitrogen inputs to waterways may be limited unless there is a corresponding proportional increase in phosphorus inputs, but this is uncertain. Most vulnerable are the smaller streams and rivers. Loss of water quality has both regional and national costs through impacts on recreation and other amenity values, human health and vulnerable ecosystems. This risk may be partly offset by the method of irrigation used and other improved land management techniques.

6. Irrigation of the dry Mackenzie Basin to create greener landscapes may be seen by some as detracting from the general appearance and visual character of a nationally significant landscape. In the Mackenzie the major landscape disturbance has already occurred with the completion of potential storage and supply structures from the Upper Waitaki Power Scheme. In addition hieracium invasion has reduced tussock density and visual appeal in many areas. Irrigation will undoubtedly further change the visual appearance of some areas within the upper Waitaki. However, not all irrigated areas will be visible from the main highways lessening the impact upon visitors to the region.

7. While the ecological character of the upper Waitaki has been well documented no specific studies have been reported on the impacts of intensification on biodiversity values. Many areas within the upper Waitaki have already been protected as a result of the tenure review process and voluntary covenants. Irrigation may provide the opportunity to enhance further areas.

Economic impacts

8. The economic analysis assumes a further 25,000 hectares could be irrigated within with the quantity of water specified in the former Order in Council as being able to be used for irrigation. The 25,000 hectares was pro-rated across the command area using anticipated development scenario from the Mackenzie Irrigation Company provision of information to the WCWAB. One scenario looked at the takes occurring only above Ohau A power station, and the other scenario included takes above Waitaki, Aviemore and Benmore as well as takes above Ohau A. All other assumptions are adopted directly from the Harris et al (2004).

9. It should be noted that the analysis is undertaken on a particular scenario, but that this scenario does not necessarily represent the single "right" scenario. The scenario selected to represent a reasonable level of inputs and returns that could reasonably confidently be expected to occur based on available evidence. There are other scenarios which may arise, and for this reason sensitivity testing was also undertaken using higher and lower assumptions than the base scenario.

10. The results show that the options for irrigation tested produce considerable surplus in terms of net benefit from agricultural production, but a considerable loss in terms of hydro-generation. Using base case assumptions the hydro losses are greater than the agricultural benefits in both scenarios of development. There is little difference in terms of agricultural outcomes between the two scenarios, but the electricity generation losses are 10 to 20 percent greater when the quantity of water specified in the former Order in Council is concentrated in the upper part of the catchment. The negative outcome overall is not changed by the discount rate used, but is very sensitive to the assumptions about agricultural returns and inputs including water use.

11. Over 50 percent of the properties in the Mackenzie Basin are currently in negotiation with Land Information New Zealand (LINZ) over tenure review. In the majority of these negotiations access to water for irrigation will be a significant factor. For this reason the two processes, provision of water and tenure review, are likely to be linked.

Social impacts

12. It is generally accepted that irrigation can transform society as well as land and landscapes. As land use intensifies through the upper Waitaki Catchment and land use changes occur it is expected that significant, mostly positive, social changes will also occur. Some of the changes identified include:

    - an inflow of newcomers to the district to purchase properties and work on the farms
    - the arrest of rural decline in non-irrigated areas and strengthened viability of educational, health and other community services in nearby townships
    - the age structure of both the residential population and the farmers and farm workers occupational group is likely to become more youthful
    - participation in community activities and membership of voluntary organisations and clubs may decline in the short term, as newcomers adjust to their new circumstances, but strengthen in the longer term
    - value conflicts between some urban residents and farming communities over the environmental impacts of intensive farming systems.

13. Under the base case used in the economic analysis, there was expected to be an increase of approximately 300 to 400 full-time equivalent (FTE) employees directly employed in agriculture (70/cumec), and an associated population gain of approximately 800 to 900 people (180/cumec). Value added, an indicator of economic activity, changes by approximately $12 to $13 million per annum[1] ($2 to $3 million per cumec) directly associated with the increase in agricultural production. Further flow-on effects are expected in the local economy, but these have not been calculated.

[1] Although it should be noted that this does not include the change in added value associated with the lost energy generation, which would be substantial but largely does not affect the local economy.

1 Introduction

1.1 Background

The development of the water resources of the upper Waitaki for hydro-electric power generation during the 1960s and 1970s made possible the complimentary use of the resource for irrigation. In 1966 an interdepartmental committee was set up to report to the Commissioner of Works on the water needs of the farmers in the area in the context of the proposed hydroelectric developments. The commitment to provide water for irrigation was ultimately set out in the 1969 Order in Council that was the instrument that granted water rights to the Minister of Electricity for the Upper Waitaki Power Scheme. The Order in Council allowed for a volumetric entitlement of 172,687,430m^3 of water for irrigation for the Mackenzie Basin with at a peak rate of 14.72 cumecs.

In 1990, the Electricity Corporation of New Zealand, that by then owned the Waitaki Power Scheme, opted to not seek a renewal of the Order in Council, but to instead make application to the Canterbury Regional Council for "normal" water rights under the Water and Soil Conservation Act. These were granted in 1991, and shortly afterwards became water permits on the commencement of the Resource Management Act. As a consequence of this sequence, the Order in Council was effectively extinguished in 1991, and this was formally recognised by an amendment to the RMA in 1993.

In 2003, the Environment Court declared that the Order in Council no longer applied. Subsequently, Mackenzie farmers and Meridian Energy entered into separate negotiations and in December 2004 agreement was reached to provide water for up to 60 farms. The provisional deal provides Upper Waitaki farmers with access to a volume of water which is similar to that provided for in the 1969 Order in Council.

McIndoe (2004) estimates that the 172,687,430 m^3 of that could potentially be taken annually equated to a continuous flow rate of 5.48 cumecs using the peak flow of 14.7 cumecs for 136 days of irrigation. Using assessed seasonal use based on 900 millimetres for border-strip irrigation and 600 millimetres for spray irrigation being applied to the consented area (3331 ha), only 15 percent of the quantity of water specified in the former Order in Council as being able to be used for irrigation. is currently used. Based on these estimates he considers that a further 25,000 hectares could be irrigated using this water. Irrigation of an additional 25,000 hectares in the upper Waitaki would undoubtedly change the whole character of pastoral farming in the area environmentally, economically and socially.

1.2 Scope of work

The purpose of this document is to report to the Waitaki Catchment Water Allocation Board (WCWAB) on the environmental, economic and social impacts of allocating to irrigation an amount of water that matches the provisions in the now defunct 1969 Order in Council.

The environmental impacts section of this report (section 3) is based on material sourced from existing publications and interviews with a number of people with knowledge of the area and the issues. Economic and social impacts (sections 4 and 5) were assessed using methodologies similar to those used by Harris et al (2004); however, the report does not include an assessment of the economic, social and cultural impacts of any environmental changes.

2 Environmental Impacts

From an environmental perspective the establishment of a further 25,000 hectares under irrigation within the upper Waitaki could have both a positive and negative impact on the environment. From a positive perspective, irrigation would reduce the erosion risk within the basin and also increase the opportunities for environmental enhancement. From a negative perspective, irrigation increases the risk of contamination of ground and surface waters and could adversely impact upon landscape values. All of these potential impacts are over and above any impacts that occur as a result of construction activities.

2.1 Soil degradation and erosion

Soil erosion, particularly wind erosion, has long been recognised as an important high country issue (Martin et al, 1994). The sparse vegetation on large areas of land in the Mackenzie Basin gives little protection to the shallow, friable soils which continue to be eroded by frost heave and westerly winds. Under the Rabbit and Land Management Programme, vegetation monitoring sites were established on properties in the Mackenzie Basin in 1991 and 1992 (Cuff, 1993). These sites have been assessed at mostly two-yearly intervals since their establishment. At the same time, the regional council established a number of sites in the area which have been assessed on a five-yearly basis. Results from these sites have helped identify the trends in vegetation cover through the basin. (See for example Cuff, 2001.)

Cuff (1994) used a mix of satellite imagery and field assessments to assess ground cover on 132,000 hectares in the middle of the Mackenzie Basin. Overall ground cover across the basin was assessed at 72.8 percent with large areas in the centre of the basin with more than 30 percent bare ground.

Basher (1996), using Caesium 137 techniques, found evidence for the widespread occurrence of erosion in the Mackenzie Basin. Variation in Caesium 137 levels in the soils through the basin appeared to be related to erosion. Highest levels of Caesium 137 were found on pedestalled, vegetated areas and lowest levels in bare, deflated areas. Soil losses of up to 67 millimetres were recorded. Mean soil losses over a 40-year period from bare sites ranged from 13–35 mm an overall mean loss of 25 mm. From pedestalled sites the loss was 4 mm and from fully vegetated sites there was no soil loss. The mean loss across all sites was 9 mm which equates to a mean soil loss of 0.22 mm/year or 2.2 tonnes of soil lost per year. Across the upper Mackenzie Basin this represents a significant soil loss over this time. However, it can not be assumed from this information that erosion rates will continue at this level. The information does confirm a strong relationship between the percentage of vegetation cover and erosion risk (Basher, personal communication).

The erosion problem has been compounded by the spread of flatweed, hieracium, through the 1990s. Fastier (2004) reported an increase in hieracium on the flat outwash soils on his property from 0.03 percent in 1991 to 35 percent in 2000. Similar trends have been reported on other properties throughout the basin particularly on the poorer soils with some areas approaching 50 percent bare ground (Shearer, personal communication). Espie (personal communication) has shown that the zones of bare soil around hieracium patches with winter frost lift increases susceptibility to wind erosion.

It is now generally accepted that any land management practice that increases vegetation cover and reduces the amount of bare ground will reduce the erosion risk in the Mackenzie Basin. Irrigation and the establishment of strong pasture swards falls into this category.

2.2 Water quality

The issue of poor water quality in areas of intensive agriculture has been highlighted in the recently released report by the Parliamentary Commissioner for Environment (PCE, 2004). Pollution of surface and ground water by intensive agriculture is a major indirect consequence of new forms of land use through irrigation. Because of the high capital costs of irrigation, plus high operational costs, farmers are inevitably drawn to higher yielding land uses, often requiring higher fertiliser and other inputs.

Environment Canterbury's Proposed Natural Resource Regional Plan (2003) recognises that increased nutrient loading in water in the upper Waitaki is an issue particularly given the high water quality that is there now. Loss of water quality in areas such as this has both regional and national costs through impacts on recreation and other amenity values, human health and vulnerable ecosystems.

A project which investigates current water quality (both groundwater and surface water) in the Waimate District, with particular emphasis on intensification and change in land-use, was initiated by Environment Canterbury in 1995 (Meredith, personal communication). The Mackenzie Basin was added to this project in 2002 following concerns expressed by a number of parties over the effects that intensification of agriculture in the basin may have on water quality. The approach was to sequentially develop background water quality of a number of streams through the basin. In addition Meridian Energy have continued some baseline and trend detection monitoring at four sites including the Twizel River, Ruataniwha Stream, and Lakes Ruataniwha and Benmore. Environment Canterbury undertook to annually report and interpret this data for Meridian Energy.

From an analysis of the results to date it appears streams through the upper Waitaki basin are only slightly nutrient enriched, and of very low nutrient status compared to other streams in Canterbury (Meredith and Hayward, 2002). Overall, there are no indications of appreciable degradation of water quality in the Mackenzie Basin monitored so far. However, there are indications of some catchments (eg, Mary Burn, Wairepo) showing significant changes (enrichment), such that trends and effects should continue to be scrutinised, particularly in those areas currently subject to land use changes (Meredith and Smith, 2004).

In an attempt to predict the impacts of future intensification of land use through the upper Waitaki, Meridian Energy has commissioned a modelling study on intensification and nutrient levels in the groundwater and lakes of the upper Waitaki (R Potts, personal communication). The study uses three scenarios: 10,000, 30,000 and 90,000 hectares under irrigation with a mix of land uses including some dairying, intensive sheep and beef and deer. The preliminary analysis has shown a significant tonnage of nitrogen entering groundwater, and ultimately the streams and lakes, under all scenarios tested. This study does not predict corresponding increases in phosphorus loadings via the same pathways, which implies that the effect of increased nitrogen may be limited by the availability of phosphorus. A full report on the Meridian work is due in February 2005.

Recent monitoring of Mackenzie Basin streams by Environment Canterbury has shown that the ratios of both soluble and total N:P nutrient ratios are very low (generally <10) indicating that, although both nutrients are in low concentrations, the streams (and therefore groundwater) are more nitrogen-limited than phosphorus-limited (Meredith and Smith, 2004). With the optimum nitrogen to phosphorus ratio for algae and macrophyte growth being around 15–20:1, any increase in nitrogen loading increases the risk of increased or nuisance levels of plant and algal growth caused by contamination. Water bodies with the lowest N:P ratios and therefore most likely to be immediately at risk are the smaller streams and rivers and their recreational and biodiversity values (Meredith, personal communication).

A cautious approach to future irrigation development is warranted given that adverse trends have been recorded in other regions of similar pristine water quality and climatic environment (Otago Regional Council, 2003). From an intensive study over a 15-month period on the Taieri River in the Maniototo, with sampling sites above, below and through the main irrigation area, a significant decline in a number of nutrient and bacterial water quality parameters was shown. While not specifically identified, it is likely that the decline was due to a combination of factors including stock access to waterways, irrigation bywash, increased stocking rates and dairy effluent irrigation. What the Otago study shows is that often it is not a single factor that causes the problem but rather a combination of management activities. It also clearly demonstrates that an integrated irrigation/land management programme is essential if future problems are to be avoided.

All the evidence points to an enhanced risk of ground and surface water contamination in the upper Waitaki Catchment as a result of intensification through irrigation. This risk may be partly offset by the method of irrigation used although considerable care will still be needed to avoid adverse impacts. It is expected that almost all future irrigation in the upper Waitaki will involve spray rather than flood irrigation methods (Shearer, personal communication). Spray irrigation gives greater control over application rates and allows surface runoff to be avoided. Electronic soil moisture measurements allow application rates to be matched to crop requirements and weather forecasts to take advantage of rainfall and avoid over watering.

2.3 Landscape

The Mackenzie Basin is described in a report by Boffa Miskell (1992) as a vast open landscape where landforms are often huge and vistas are wide and uncluttered. The low form of the vegetation allows the landform to dominate the landscape and define the horizon.

Irrigation of the dry Mackenzie Basin to create greener landscapes may be seen by some as detracting from the general appearance and visual character of a nationally significant landscape. The issue is mentioned in landscape assessment undertaken by Densem (2004) and Boffa Miskell (1992); however, neither provides specific information on the impacts of irrigation development on landscape values in the upper Waitaki.

In the Mackenzie the major landscape disturbance has already occurred with the completion of storage and supply structures from the Upper Waitaki Power Scheme. In addition hieracium invasion has reduced tussock density and visual appeal in many areas. Irrigation will undoubtedly further change the visual appearance of some areas within the upper Waitaki. Not all of these areas will be visible from the main highways thus lessening the impact on visitors to the region.

2.4 Biodiversity

The ecological character of the upper Waitaki has been well documented (Knox, 1969; O'Connor, 1976; Espie et al, 1984) and specific assessments have been undertaken on those properties involved in tenure review. No specific studies have been reported on the impacts of intensification on biodiversity values.

The conversion of semi-natural grasslands to improved irrigated pastures will significantly reduce indigenous plant and invertebrate biodiversity. Espie (2004) suggests that representative examples of these systems need to be protected. He submits that these have already been identified through the Protected Natural Areas Programme and that a variety of protection mechanisms are available, with potentially large areas becoming available through the tenure review process of Crown pastoral lease land.

Espie notes that extensive areas of basin floor tussock grasslands are already in full Crown ownership for conservation management after completion of tenure reviews in the Mackenzie. Other areas with significant conservation values have been protected through reservation or voluntarily through Queen Elizabeth II covenants (eg, Tekapo Scientific Reserve, Omarama Station, Glenmore, Ohau Station QE II covenant and so on).

Urquhart (2004) notes that irrigation development provides an opportunity to enhance ecological values. He suggests as an example that wetlands for wading birds could be included in the irrigation design. Similarly, Espie notes that centre pivot irrigation is restricted by its radial design to use only part of the available area, leaving considerable extents of surrounding land as de facto biodiversity preservation under existing land uses.

2.5 Biota effects

There is a reasonable amount of data on the native and introduced fisheries within the Mackenzie Basin. Most indicates a generally healthy resource (M Webb, personal communication; Meredith, personal communication). The two main concerns relating to the protection of this resource are:

- abstraction and direct effects on flows in the rivers
- water contamination from intensification and its effect on aquatic life.

There are currently 3,300 hectares consented for irrigation in the upper Waitaki east of the Ohau river. Water for this area is drawn from both river sources and hydro canals with approximately two-thirds currently drawn from river sources. Any additional extraction from the streams and rivers will put further pressure on these waterways and the biota within them (Shearer, personal communication).

In some cases existing irrigation takes from streams could potentially be replaced with hydro canal water to allow natural streams to be maintained over the summer irrigation season. For example, this could be readily achieved at the Mary Burn where providing access to irrigation water from the canal would allow natural flows to be maintained in the stream (Shearer and Miller, 2004).

The impacts of intensification of land use on water quality have been discussed previously in section 2.2. There is a significant risk, particularly to the fisheries on smaller streams, and planning for this risk is required during the development phase of any irrigation schemes.

3 Economic Impacts

In September 2003, the Ministry of Economic Development commissioned Sinclair Knight Merz (SKM, 2004), to undertake a study into the costs and benefits of water use in the Waitaki Catchment. This study was aimed primarily at understanding the impacts of the different competing uses for the water in the catchment. In November 2004, the Ministry for Environment commissioned a complementary study to address the regional social and economic benefits (Harris et al, 2004). Analyses of the economics of irrigation for farmers within the upper Waitaki Catchment were also undertaken by Collier (2004) and Donnelly (2004) as part of their provision of information to the WCWAB on behalf of Mackenzie Irrigation Ltd. Using similar methodologies as used by Harris et al (2004), a separate analysis has been undertaken as part of the current review specific to the volumes of water and area defined under the 1969 Order in Council.

3.1 Analysis of economic impacts of irrigation using 14.7 m^3/s

3.1.1 Approach taken

The analysis used McIndoe's estimate of a further 25,000 hectares which could be irrigated with the quantity of water specified in the former Order in Council as being able to be used for irrigation. This available irrigable area was allocated to different parts of the command area using figures from the MacKenzie Irrigation Company submission to the WCWAB. Their anticipated development scenario (section 8 of the submission) was pro-rated across the potential 25,000 hectares in two ways. The first assumed that the Order in Council applied only to takes above Ohau A, and the second assumed that the Order in Council could apply to any takes above the Waitaki Dam. These estimates are shown in Table 1 below.

Table 1: Estimates of irrigation development areas for the quantity of water specified in the former Order in Council

Area	MacKenzie Irrigation Company estimate of development uptake (ha)	Estimates pro-rated above Ohau A only (ha)	Estimates pro-rated for areas above Waitaki Dam (ha)
Lake Tekapo	5,500	5,978	4,583
Tekapo canal	8,000	8,696	6,667
Lake Pukaki	9,500	10,326	7,917
Ruataniwha	500		417
OHB-OHC canal	300		250
Benmore	5,000		4,167
Aviemore	600		500
Waitaki	600		500
Total	30,000	25,000	25,000

The costs and benefits of the two different estimates were assessed using the method set out in Harris et al (2004). Costs and benefits were estimated from a national perspective, and the ongoing direct impacts in terms of employment, population and value added in the economy are assessed from a regional perspective. The assumptions have been adopted directly from Harris et al (2004) and are summarised in a series of tables in Appendix 1. They assume uptake of water commences in year one, and takes two years to full utilisation of the take. The assumptions do not include a time lag for full production to be achieved on the irrigated land, although this is likely to be significant where poorer soils are irrigated. It should be noted that the analysis is undertaken on a particular scenario, but that this scenario does not necessarily represent the single "right" scenario. The scenario selected to represent a reasonable level of inputs and returns that could reasonably confidently be expected to occur based on available evidence. There are other scenarios which may arise, and for this reason sensitivity testing was also undertaken using higher and lower assumptions that the base scenario. The results from the base case and sensitivity testing are discussed below.

3.1.2 Results

These results have been presented in terms of the total outcomes and average outcomes per cumec of water in Tables 2 and 3 below. The detailed results are also presented in Tables 11 to 14 within Appendix 2.

The results show that:

- the options for irrigation using the quantity of water specified in the former Order in Council produce considerable surplus in terms of net benefit from agricultural production
- however when the opportunity costs of hydro-generation are taken into account, the results are negative overall in all scenarios using base case assumptions
- the negative outcome is worsened by the inclusion of additional hydro-generation in the lower Waitaki which effectively increases the opportunity cost of water extracted for irrigation
- there is little difference in terms of agricultural outcomes between the two scenarios, but that the electricity generation losses are 10–20 percent greater when the quantity of water specified in the former Order in Council is concentrated in the upper part of the catchment
- the discount rate at 7.5 percent produces higher losses but also higher agricultural returns per cumec of water than does the 10 percent discount rate. While there is some movement of the net outcome with these different discount rates, the negative sign of the outcome is not changed.

These tables also show the direct impacts of the agricultural development in terms of employment and value added. These estimates show:

- an increase of approximately 300 to 400 full-time equivalent (FTE) employees directly employed in agriculture (70/cumec)
- an associated population gain of approximately 800 to 900 people (180/cumec)
- value added, an indicator of economic activity, changes by approximately $12 to $13 million per annum[2] ($2 to $3 million per cumec) directly associated with the increase in agricultural production.

[2] Although it should be noted that this does not include the change in added value associated with the lost energy generation, which would be substantial but largely does not affect the local economy.

There will be wider impacts on the regional community, and the Harris et al report uses an estimate of 1.8 to 1.9 total FTEs for every one FTE of direct employment, and approximately 2.2 to 2.3 ratio of total value added to direct value added in a regional community comprising Timaru, Mackenzie, Oamaru and Waimate districts.

The agricultural gross margin used in the main exercise is based on estimates of a property running a system where the irrigation would be complementary to its existing farming enterprise. A sensitivity analysis was also undertaken using a high set of assumptions such as where the irrigation was used to undertake a very intensive livestock system (Collier, personal communication), and a low set of assumptions where the returns were lower and costs higher than the base case. The results for this are shown in Table 4 below for the scenarios with no new hydro in the system. They show that the results are very sensitive to the agricultural gross margin and water use assumptions. In this analysis they vary between large net positive outcome overall and a large net negative outcome overall depending on the assumptions used.

Table 2: Outcomes for the quantity of water specified in the former Order in Council in the Waitaki, 7.5% discount rate

	Water use	Lost electricity		Direct agricultural outcomes			
	Take (cumecs)	No new hydro (NPV, 7.5%, 30 years)	New hydro installed (NPV, 7.5%, 30 years)	Primary production (NPV, 7.5%, 30 years)	Ongoing employment FTE	Ongoing population change	Ongoing value added
Aggregate impact – development upstream of Ohau A	4.8	$102 m	$138 m	$65 m	300	800	$12 m
Aggregate impact – development upstream of Waitaki	4.9	$88 m	$125 m	$65 m	400	900	$13 m
Per cumec impact – development upstream of Ohau A		$22 m/m^3	$29 m/m^3	$14 m/m^3	70/m^3	180/m^3	$2 m/m^3
Per cumec impact – development upstream of Waitaki		$18 m/m^3	$25 m/m^3	$13 m/m^3	70/m^3	190/m^3	$3 m/m^3

Table 3: Outcomes for the quantity of water specified in the former Order in Council in the Waitaki, 10% discount rate

	Water use	Lost electricity		Direct agricultural outcomes			
	Take (cumecs)	No new hydro (NPV, 10%, 30 years)	New hydro installed (NPV, 10%, 30 years)	Primary production (NPV, 10%, 30 years)	Ongoing employment FTE	Ongoing population change	Ongoing value added
Aggregate impact – development upstream of Ohau A	4.8	$73 m	$96 m	$39 m	300	800	$12 m
Aggregate impact – development upstream of Waitaki	4.9	$63 m	$86 m	$37 m	400	900	$13 m
Per cumec impact – development upstream of Ohau A		$15 m/m^3	$20 m/m^3	$8 m/m^3	70/m^3	180/m^3	$2 m/m^3
Per cumec impact – development upstream of Waitaki		$13 m/m^3	$18 m/m^3	$8 m/m^3	70/m^3	190/m^3	$3 m/m^3

Table 4: Sensitivity tests for outcomes development upstream of Ohau A

	Water use	Lost electricity		Direct agricultural outcomes			
	Take (cumecs)	No new hydro (NPV, 30 years)	New hydro installed (NPV, 30 years)	Primary production (NPV, 30 years)	Ongoing employment FTE	Ongoing population change	Ongoing value added
High agricultural gross margins, low water use, 7.5% discount rate	4.0	$85 m	$115 m	$132 m	485	1211	$17 m
High agricultural gross margins, low water use, 10% discount rate	4.0	$61 m	$80 m	$91 m	485	1211	$17 m
Low agricultural gross margins, high water use, 7.5% discount rate	5.5	$120 m	$160 m	-$37 m	138	344	$5 m
Low agricultural gross margins, high water use, 10% discount rate	5.5	$85 m	$112 m	-$44 m	138	344	$5 m

3.2 Irrigation and tenure review

There are approximately 25 Crown pastoral lease properties in the Mackenzie basin (M Clark, personal communication). Over 50 percent of these properties are currently in negotiation with Land Information New Zealand (LINZ) over tenure review. In the majority of these negotiations access to water for irrigation will be a significant factor as irrigation increases the options available to pastoral lessees who are looking to freehold part of their land. For this reason the two processes, provision of water and tenure review, are likely to be linked.

4 Social Impacts

4.1 Irrigation and social change

There is very little social impact data specific to the upper Waitaki. However, it is known that irrigation can transform society as well as land and landscapes (Taylor et al, 2003).

Taylor describes three "waves" of development which characteristically occur through irrigation development.

- Firstly, existing pastoral farmers move to improve their traditional farming base.
- Secondly, new-generation farmers enter into major irrigation investment. They increase stock numbers and productivity but generally stay with the same production base.
- Thirdly, widespread changes in land use and farm ownership take place which include conversion to dairying and other intensive land use options.

Irrigation schemes generally stimulate population growth, help arrest population decline and by so doing help maintain the rolls of rural schools. It may also provide increased employment to the area provided the new land uses contribute more on farm jobs than existing forms of agricultural production. Combined, these factors help maintain social networks and sustain community vitality.

While there is only limited social impact data for the upper Waitaki, it is reasonable to assume that social changes, along the lines that have been found in other areas that have undergone a shift to large scale irrigation, will occur if the proposed irrigation schemes proceed (Taylor, personal communication).

4.2 Irrigation social costs and benefits

A broad-based assessment of the social impacts of irrigation has been completed as part of a regional economic analysis on the uses of water in the Waitaki Catchment (Harris et al, 2004). According to Taylor (personal communication), who was one of the authors of the Harris report, the analysis undertaken provides only a broad indication of the likely social impacts of irrigation in the Mackenzie Basin and the results need to be interpreted with care.

Under the scenarios used in the Harris report dairy conversion is projected to account for 30 percent of the projected land use change. Conversion to dairying to this extent is not expected in the Mackenzie Basin because of climatic limitations (Taylor, personal communication). Nevertheless some of the social changes expected in the wider catchment will also apply to the Mackenzie Basin. These include:

- more intensive use of existing grazing properties by some current owners.
- other current owners converting to dairying or dairy support
- some older farmers, particularly of smaller dryland grazing properties, selling to purchasers who will convert the properties to dairy production
- an inflow of newcomers to the district to purchase properties and work on the farms

- the arrest of rural decline in non-irrigated areas and strengthened viability of educational, health and other community services in nearby townships
- the age structure of both the residential population and the farmers and farm workers occupational group is likely to become more youthful
- value conflicts between dryland farmers and dairy farmers because of their different lifestyle, work routines and rates of community participation
- participation in community activities and membership of voluntary organisations and clubs may decline in the short term, as newcomers adjust to their new circumstances, but strengthen in the longer term
- value conflicts between some urban residents and farming communities over the environmental impacts of intensive farming systems
- lag effects as the service sector in rural areas adjusts to the supply of new irrigation farming systems.

According to Harris et al (2004), irrigation should have a positive effect on the demographics of the Waitaki valley and would arrest the expected population decline. The additional population and employment will not only stimulate economic growth in the region by increasing the value of production, but also strengthen its social structure and networks through ensuring the voluntary organisations and essential services such as health and education are more viable.

The Harris report uses a multiplier of 2.5 per FTE to estimate population changes associated with the move to irrigation. Using these figures an assessment of the potential employment gain from irrigating an additional 25,000 hectares was made. The assessment indicated an increase of approximately 300 to 400 full time equivalent (FTE) employees directly employed in agriculture (70/cumec) and an associated population gain of approximately 800 to 900 people (180/cumec) (see Tables 2 and 3).

The potential impact at farm level has been demonstrated by Fastier (2003). Presently one labour unit is employed to run 2670 stock units on an area of 3800 hectares. It is estimated that under irrigation this area would be capable of running 50,000 stock units on an annual basis. With an automated irrigation system each employee would be capable of running around 4500 stock units on 400 hectares. There would be a minimum of 10 full-time employee positions created on the property. In addition there would be significant amounts of work created for trucking companies, fertiliser companies and agricultural servicing firms.

While not specific and detailed, the information provided does indicate that the social impacts of further irrigation would generally be positive.

5 Conclusions

This report assesses the environmental, economic and social impacts of allocating to irrigation an amount of water that matches the provisions in the now defunct 1969 Order in Council. The assumption is made that after allowing for existing irrigation that a further 25,000 hectares could be irrigated with the quantity of water specified in the former Order in Council. The conclusions reached through this report are based on material sourced from existing publications, interviews with a number of people with knowledge of the area and the issues and limited analysis.

5.1 Environmental impacts

From an environmental perspective the establishment of a further 25,000 hectares under irrigation within the upper Waitaki could have both a positive and negative impact on the environment.

Wind erosion is a significant issue in the upper Waitaki catchment. One of the most significant impacts of further irrigation in this area will be a reduction in the amount of bare ground and corresponding reduction in wind erosion risk.

There is a significant risk of ground and surface water contamination in the upper Waitaki as a result of land use intensification through irrigation. This risk may be partly offset by the method of irrigation used and other improved land management techniques.

Irrigation will undoubtedly change the visual appearance of some areas within the upper Waitaki. However, much of the area that has been designated as suitable for irrigation will not be visible from the main highways, lessening the overall impact on visitors to the region.

While the ecological character of the upper Waitaki has been well documented no specific studies have been reported on the impacts of intensification on biodiversity values. Many areas within the upper Waitaki have already been protected as a result of the tenure review process and voluntary covenants. Irrigation may provide the opportunity to enhance further areas.

5.2 Economic impacts

The results of the analysis show that the options for irrigation from with the quantity of water specified in the former Order in Council produce considerable surplus in terms of net benefit from agricultural production, but a considerable loss in terms of hydro-generation.

Using base case assumptions the hydro losses are greater than the agricultural benefits in both scenarios of development. There is little difference in terms of agricultural outcomes between the two scenarios, but the electricity generation losses are 10 to 20 percent greater when irrigation development is concentrated in the upper part of the catchment.

The negative outcome overall is not changed by the discount rate used, but is very sensitive to the assumptions about agricultural returns and inputs including water use.

5.3 Social impacts

It is generally accepted that irrigation can transform society as well as land and landscapes. As land use intensifies through the upper Waitaki Catchment and land use changes occur it is expected that significant, mostly positive, social changes will also occur.

Under the base case used in the economic analysis, there was expected to be an increase of approximately 300 to 400 full-time equivalent (FTE) employees directly employed in agriculture (70/cumec), and an associated population gain of approximately 800 to 900 people (180/cumec). Value added, an indicator of economic activity, changes by approximately $12 to $13 million per annum[3] ($2 to $3 million per cumec) directly associated with the increase in agricultural production. Further flow-on effects are expected in the local economy, but these have not been calculated.

[3] Although it should be noted that this does not include the change in added value associated with the lost energy generation, which would be substantial but largely does not affect the local economy.

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7 List of Interviewees and Other Contacts

Basher L – Landcare Research, Nelson
Brookes H – Waitaki First, Oamaru
Clark M – Land Information NZ, Christchurch
Collier G – AgFirst, Alexandra
Cuff J – Environment Canterbury, Timaru
Donnelly P – Phillip Donnelly and Associates, Christchurch
Elliot G – MAF Policy, Dunedin
Espie P – AgScience Ltd, Dunedin
Green R – Agricom, Ashburton
McFadden G – Retired ex MAF Policy, Christchurch
McIndoe, I – Aqualinc, Lincoln
Meredith A – Environment Canterbury, Christchurch
Miller M – Environment Canterbury, Timaru
Moss R – Meridian Energy, Christchurch
Potts R – Glasson Potts Fowler, Christchurch
Scott D, – Retired ex AgResearch, Tekapo
Shearer, A – Environment Canterbury, Twizel
Webb M – Central South Island Fish and Game, Temuka
Webb T – Landcare Research, Lincoln

Appendices

Appendix 1: Assumptions used in economic analysis

The assumptions used in the economic analysis in this report were based on those in Harris et al (2004). This document should be referred to for the full assumptions. A summary of the assumptions used are provided below.

Table 5: Gross margin assumptions ($/ha)

		Dryland		Irrigation	
		Grazing	Arable	Grazing	Dairy support
us Ohau A	Low	4.25	0	230	230
	Mid	8.5	0	565	565
	High	106	0	900	900
us Waitaki	Low	180	450	760	650
	Mid	270	650	1050	1150
	High	360	1000	1450	1600

Table 6: Water use assumptions (mm/ha/year)

		Irrigation	
		Grazing	Dairy support
us Ohau A	Low	500	500
	Mid	600	600
	High	700	700
us Waitaki	Low	600	600
	Mid	700	700
	High	800	800

Table 7: On-farm capital costs ($/ha)

		Irrigation	
		Grazing	Dairy support
On farm capital	Low	1700	1700
	Mid	1850	2200
	High	2700	2700
Farm transition cost		1000	500

Table 8: Off-farm O&M costs ($/ha/annum)

Location	Low	Mid	High
Benmore, Aviemore, Waitaki	200	225	250
us Ohau A	100	125	150

Table 9: Off-farm capital estimates ($/ha)

Location/scheme	Capital estimate ($/ha)
us Ohau A	500
us Waitaki	1500

Table 10: Scheme description and land use assumptions

Demand description	System location	Current profile (%)		New profile (%)	
		Dryland		Irrigated	
		Grazing	Arable	Grazing	Dairy support
us Ohau A	us Ohau A	100%	0%	80%	20%
us Waitaki	us Waitaki	100%	0%	80%	20%

Appendix 2: Tables of results

Table 11: NPV (7.5%, 30 years) of former Order in Council irrigation area with uptake above Ohau A, no new hydro installed

Benefits	National		Primary production sector	Energy sector
Irrigation sector expansion				
Increased agricultural output	$145 m	$145 m	$145 m	
Total benefits		$145 m	$145 m	$0 m
Costs				
Investment for irrigation				
Off-farm infrastructure	$10 m		$10 m	
On-farm infrastructure	$39 m		$39 m	
On-farm transition	$18 m		$18 m	
Operations and maintenance cost	$12 m		$12 m	
Lost generation capacity	$102 m	$182 m		$102 m
Total costs		**$182 m**	**$80 m**	**$102 m**
Net present value 7.5%		-$37 m	$65 m	-$102 m
Net present value 10%	$0 m	-$34 m	$39 m	-$73 m
NPV @ 5%	$0 m	-$54 m	$107 m	-$162 m
NPV @ 12.5%	$0 m	-$35 m	$21 m	-$56 m

Table 12: NPV (7.5%, 30 years) of former Order in Council area with uptake above Ohau A, new hydro installed

Benefits	National		Primary production sector	Energy sector
Irrigation sector expansion				
Increased agricultural output	$145 m	$145 m	$145 m	
Total benefits		$145 m	$145 m	$0 m
Costs				
Investment for irrigation				
Off-farm infrastructure	$10 m		$10 m	
On-farm infrastructure	$39 m		$39 m	
On-farm transition	$18 m		$18 m	
Operations and maintenance cost	$12 m		$12 m	
Lost generation capacity	$138 m	$217 m		$138 m
Total costs		**$217 m**	**$80 m**	**$138 m**
Net present value 7.5%		-$72 m	$65 m	-$138 m
Net present value 10%	$0 m	-$57 m	$39 m	-$96 m
NPV @ 5%	$0 m	-$116 m	$107 m	-$224 m
NPV @ 12.5%	$0 m	-$50 m	$21 m	-$71 m

Table 13: NPV (7.5%, 30 years) of former Order in Council area with uptake above Waitaki Dam, no new hydro installed

Benefits	National		Primary production sector	Energy sector
Irrigation sector expansion				
Increased agricultural output	$158 m	$158 m	$158 m	
Total benefits		$158 m	$158 m	$0 m
Costs				
Investment for irrigation				
Off-farm infrastructure	$15 m		$15 m	
On-farm infrastructure	$39 m		$39 m	
On-farm transition	$18 m		$18 m	
Operations and maintenance cost	$21 m		$21 m	
Lost generation capacity	$88 m	$182 m		$88 m
Total costs		**$182 m**	**$94 m**	**$88 m**
Net present value 7.5%		-$23 m	$65 m	-$88 m
Net present value 10%	$0 m	-$25 m	$37 m	-$63 m
NPV @ 5%	$0 m	-$31 m	$107 m	-$139 m
NPV @ 12.5%	$0 m	-$28 m	$20 m	-$48 m

Table 14: NPV (7.5%, 30 years) of former Order in Council area with uptake above Waitaki Dam, new hydro installed

Benefits	National		Primary production sector	Energy sector
Irrigation sector expansion				
Increased agricultural output	$158 m	$158 m	$158 m	
Total benefits		$158 m	$158 m	$0 m
Costs				
Investment for irrigation				
Off-farm infrastructure	$15 m		$15 m	
On-farm infrastructure	$39 m		$39 m	
On-farm transition	$18 m		$18 m	
Operations and maintenance cost	$21 m		$21 m	
Lost generation capacity	$125 m	$218 m		$125 m
Total costs		**$218 m**	**$94 m**	**$125 m**
Net present value 7.5%		-$60 m	$65 m	-$125 m
Net present value 10%	$0 m	-$49 m	$37 m	-$86 m
NPV @ 5%	$0 m	-$96 m	$107 m	-$203 m
NPV @ 12.5%	$0 m	-$45 m	$20 m	-$64 m

Table 15: NPV (7.5%, 30 years) of former Order in Council area with uptake above Ohau A, no new hydro installed, high agricultural assumptions

Benefits	National		Primary production sector	Energy sector
Irrigation sector expansion				
Increased agricultural output	$207 m	$207 m	$207 m	
Total benefits		$207 m	$207 m	$0 m
Costs				
Investment for irrigation				
Off-farm infrastructure	$10 m		$10 m	
On-farm infrastructure	$35 m		$35 m	
On-farm transition	$18 m		$18 m	
Operations and maintenance cost	$12 m		$12 m	
Lost generation capacity	$85 m	$161 m		$85 m
Total costs		**$161 m**	**$75 m**	**$85 m**
Net present value 7.5%		$47 m	$132 m	-$85 m
Net present value 10%	$0 m	$30 m	$91 m	-$61 m
NPV @ 5%	$0 m	$60 m	$195 m	-$135 m
NPV @ 12.5%	$0 m	$17 m	$64 m	-$47 m

Table 16: NPV (7.5%, 30 years) of former Order in Council area with uptake above Ohau A, no new hydro installed, low agricultural assumptions

Benefits	National		Primary production sector	Energy sector
Irrigation sector expansion				
Increased agricultural output	$59 m	$59 m	$59 m	
Total benefits		$59 m	$59 m	$0 m
Costs				
Investment for irrigation				
Off-farm infrastructure	$10 m		$10 m	
On-farm infrastructure	$55 m		$55 m	
On-farm transition	$18 m		$18 m	
Operations and maintenance cost	$12 m		$12 m	
Lost generation capacity	$120 m	$216 m		$120 m
Total costs		**$216 m**	**$96 m**	**$120 m**
Net present value 7.5%		-$157 m	-$37 m	-$120 m
Net present value 10%	$0 m	-$129 m	-$44 m	-$85 m
NPV @ 5%	$0 m	-$214 m	-$25 m	-$189 m
NPV @ 12.5%	$0 m	-$112 m	-$47 m	-$65 m