Ruataniwha Plains Water Storage Project

Demand Study

Report to Hawkes Bay Regional Council

September 2012

Acronyms and Abbreviations

HBRC	Hawkes Bay Regional Council
MRB	MacFarlane Rural Business Ltd
NIWA	National Institute of Water and Atmospheric Research
RWSP	Ruataniwha Water Storage Project
SPASMO	Soil and Plant Atmosphere System Model

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Executive Summary

Castalia have been engaged by the Hawkes Bay Regional Council (HBRC) to forecast demand for irrigation water from the proposed Ruataniwha Plains Water Storage Project (RWSP).

The forecast provided in this report includes estimated water demand in each year for 35 years from the project start date, which is expected to be 2017.

A survey of farmers in the area was conducted during August and September. The survey sampled farmer preferences towards investing in irrigation, land use and related issues. The full survey results are included in a separate note. In addition, we derived information from interviews with farmers within and outside the project command area, interviews with processors and investors, and from the farm budget estimates earlier commissioned by HBRC.

Full allocation of the project's capacity is defined as 90 million m^3 per annum demanded, based on 95 percent reliability. Our baseline forecast estimates that the scheme will be fully allocated 8 years after it is operational (or 14 years if existing consented water use demand is not automatically transferred to the scheme).

We address uncertainty in key variables via scenarios. The baseline, high and low scenarios reflect the most likely outcome, an optimistic view and a pessimistic view respectively of the key variables in the forecast.

The timeframe to reach full allocation of water under the scheme ranges between 2020 (under the high scenario and assuming that existing consented water use demand is transferred to the scheme) and 2047 (under the low scenario and assuming that existing water consents are not included).

Summarised forecast results

	Baseline Scenario	High Scenario	Low Scenario
Years to reach 90m m^3 p.a. with existing consent demand transferring	Y8: 2024	Y4: 2020	Y14: 2030
Years to reach 90m m^3 without existing consent demand	Y14: 2030	Y6: 2022	Y31: 2047

* Refer to tables in appendices for exact levels as fully allocating will occur between years

This forecast is created on the basis of an expected water price of 25 cents per m^3, being the mid-point in the 20-30 cent range indicated by previous reports to HBRC on financial feasibility. Farmer responses were based on a farm-gate service and an assumed long-term take-or-pay contract. In addition, the forecast is built on a set of assumptions about returns to different land uses and investments in irrigation defined by MacFarlane Rural Business Ltd (MRB). The forecast also depends on the assumptions regarding the area that water can be distributed to and the usable land within that area.

Demand is not an abstract concept. It will depend on how the distribution network is rolled out, how the service is marketed, the full portfolio of contract and spot options available to farmers, and other factors which will be confirmed as the project is developed further.

1 Introduction

Castalia has been commissioned by the Hawkes Bay Regional Council (HBRC) to provide an independent demand analysis for the Ruataniwha Plains Water Storage Project (RWSP) as part of the feasibility study currently underway. The forecasts presented in this report are based on a combination of information derived from a survey of farmers in the project catchment area, interviews with farmers and processors outside the area, demographic data and farmer budgets developed by an earlier report commissioned by HBRC. In the course of surveying farmers, we were also able to gather insights into how potential users may respond to different contracting and pricing offers.

The demand forecast presented in this report should be seen in the context of the current stage of project development. User demand is not an abstract concept. It will depend on the specifics of pricing plans being offered, on the design and roll-out of the local distribution system, and on marketing strategies adopted by the scheme. Contractual arrangements between farmers and processors which are tied to the utilisation of the scheme (to ensure reliable supply) would further enhance demand.

While considerable technical development has gone into the design and costing of the dam, the design, layout and cost of the distribution system is still at a conceptual level. Similarly, pricing and contracting strategies are still being developed. For this reason, the analysis in this report is based on a benchmark pricing and service scenario, rather than on a specific marketing strategy.

1.1 Context for this Report

A pre-feasibility study was initiated by HBRC in 2009 and completed in December 2010. Further specialist reports have helped to establish the engineering, environmental, and economic feasibility of the project. A full feasibility study was formally initiated when HBRC commissioned Tonkin & Taylor to advance the geotechnical, water resource and engineering investigations of the RWSP.

An initial survey into irrigation water demand from the RWSP took place in 2010. At that time, there was limited information on the costs of the project or the price that farmers would likely have to pay to make the project financially viable.

A group of technical specialists at a range of Crown Research Institutes was commissioned to define the potential volumes of water needed to irrigate a range of agricultural and horticultural activities.

- AgResearch mapped the area and defined the current and potential land uses
- Plant and Food Research simulated irrigation demand (and associated nitrogen and phosphorus losses) for alternative land uses using the Soil and Plant Atmosphere System Model (SPASMO), and
- NIWA predicted the impact of various land use intensifications on the quality of land and surface water.

The results of these studies suggest that water storage on the Ruataniwha Plains is a viable option for addressing current water allocation constraints (further groundwater and river abstraction rights are on hold). The studies also suggest that irrigation from the RWSP has the potential to enable more productive economic and environmental uses for agricultural land in the region.

Significant work has been completed by MacFarlane Rural Business Ltd (MRB) on the farm profitability potential of the region. This work applied the SPASMO model outputs identifying potential land uses in the region, based on the available soil types. Potential land uses have also been investigated by evaluating what land uses would be possible with a more reliable water supply, and estimating the returns to different uses of land given likely future commodity prices.

1.2 Structure of this Report

This report presents our forecast demand for RWSP water, as well as high and low scenarios for key decision variables.

- Section Two describes our approach to forecasting and presents the decision framework facing current and future landowners. We also identify sources of information for putting together the forecast and how the sensitivities for each decision in the framework were selected.
- Section Three looks at the impact of market sentiment on control and land use decisions, including the different perceptions of current landowners versus potential investors from outside the region. This discussion looks at the strategic importance of water to the region and other water supply options.
- Section Four summarises the optimal land uses identified by MRB's on-farm modelling, and explores how sensitivities to commodity prices and productivity assumptions might impact our demand forecast.
- Section Five details the different demand scenarios, identifying the different decisions and parameters chosen for high, baseline, and low settings.
- Section Six presents forecast results, in terms of total water demanded and demand by land use.

2 Our Approach to Forecasting

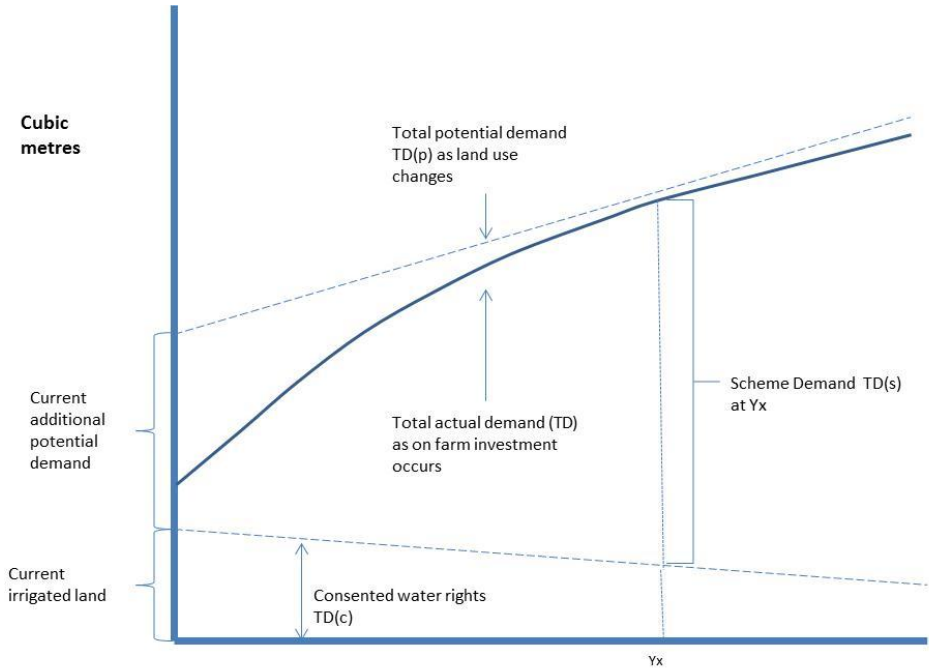
Our approach to forecasting water demand is based on the following steps:

- Identifying the choices facing farmers at the end of each season: whether to sell their land or to keep farming
- Identifying the choices available to those who choose to remain incumbent: whether to continue in their current use (with or without irrigation water) or to convert to an optimal land use with irrigation
- Identifying the choices available to those who newly acquire land in the region
- Estimating the likely rates at which farmers make the keep/sell and continue/switch choices in each year
- Identifying the land uses to which land use would switch, and
- Deriving the total demand for water based on the MRB estimates of per hectare water demand for each land use.

Conceptual framework for demand forecasting

Figure 2.1 presents a conceptual framework for forecasting the total demand for water from the scheme (TDs). It is bounded at the top by total potential demand (TDp) as estimated by the on farm modelling. It is bounded at the bottom by the level of existing water extraction consents (TDc) which is satisfying a portion of the potential demand already (which may be transferred to the Scheme as consents expire).

Figure 2.1: Conceptual Framework for Forecasting Water Demand



We expect that over time, land use will be converted to its highest value. Scheme demand will then be close to, or equal to, potential demand—subject to any capacity constraints. The speed with which this occurs depends on the relative level of returns from irrigating compared with the current level and farmer sentiment towards irrigating, land use change and sale. For example, new entrant farmers are more likely to switch to a more optimal land use following acquisition than the incumbents who may continue farming at sub-optimal levels out of habit or for lifestyle reasons.

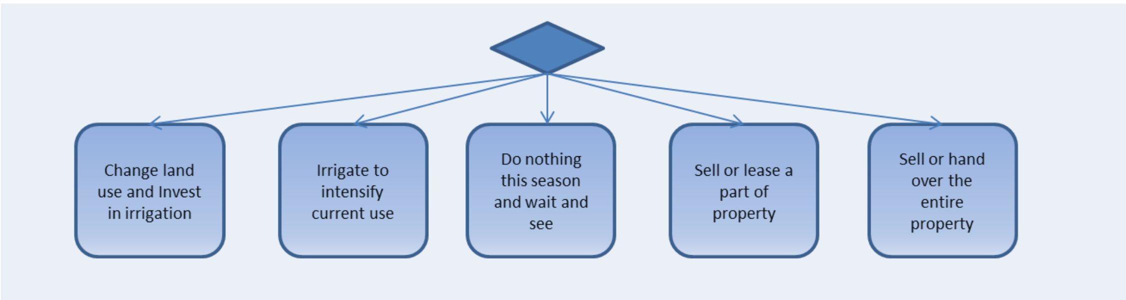
Our approach is, therefore, to derive the proportion of the total land within the project zone that is likely to be irrigated in each year by examining the rates at which land use change may occur in that period, in addition to the land use change that had occurred in the preceding periods. We assume that once land is converted to optimal irrigated land use, it remains in that use. The irrigation rate for the total land use in each year determines the total water demand in the area.

2.1 Farmer Decisions

Our forecasting model is based on modelling land use decisions at the end of each season. In this section, we examine those decisions more closely, and explain how they feed into the forecasts.

Farmers and land owners will be faced with a set of circumstances regarding their current land use, the nature of their soils, land contours, current irrigation levels and consents, and differing personal and financial circumstances which affect the options open to them:

Figure 2.2: The Decision facing Incumbent Farmers

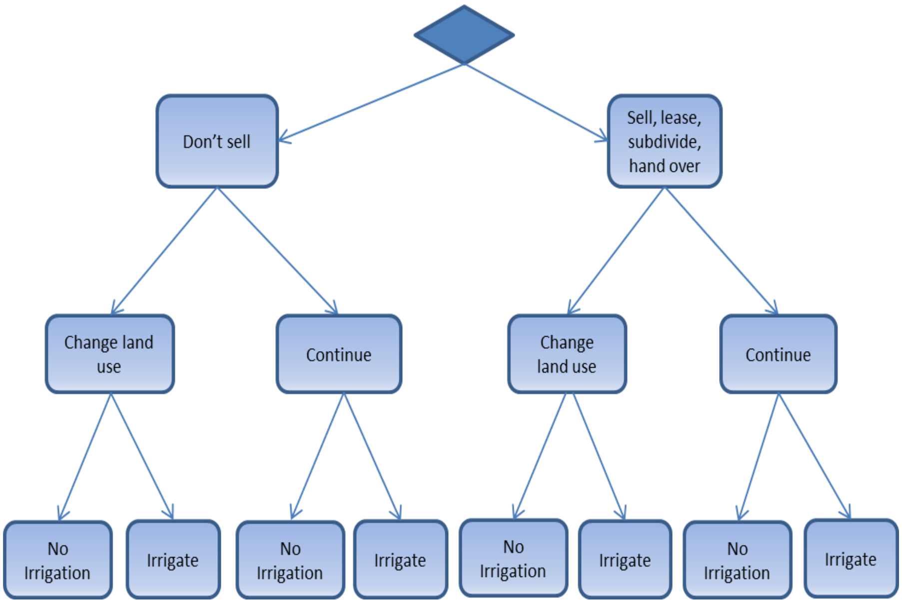


If they choose not to sell, lease, or otherwise hand their land over to someone else, farmers will face this strategic decision again in subsequent seasons.

The full decision tree in the figure below shows the full range of possible available to farmers and landowners, both incumbent and new. In essence, we use various information sources to model the probability that a farmer in the relevant position will make one of the two choices available to them:

- An incumbent farmer could choose to sell or lease land, or to keep it
- If an incumbent keeps it, they could choose to continue with the current land use, or switch to an alternative land use
- For the selected land use, the incumbent farmer could choose to intensify and irrigate or continue with dry land farming practices
- Similarly, if the land is sold or leased out, the new farmer could choose to maintain the existing land use or switch to an alternative land use
- Again, either for the existing land use or for an alternative land use, there is a choice between irrigating or not.

Figure 2.3: Farmer Decision Tree Structure



In our model, the choice process is repeated every season. The probability of moving down each limb of the decision tree is derived from a number of information sources, including farmer survey, interviews, modelling and other data. As we explain below, the probability at each pivot depends on:

- Who makes the decision—for example, incumbent farmers are more likely to go down the path of continued land use, while new purchasers are more likely to switch to optimal land use and intensive farming practices
- When the choice is made—for example, as time goes on, the probability of change in land use among the declining number of remaining incumbents may fall, as the most conservative farmers will remain or because continuation of the existing farming practice signals that it is more efficient given the specific soil conditions on the farm, and
- Demographics—in addition to a possible incentive to sell land if the prospect of irrigation increases land prices, there will be a natural rate of turn-over of ownership, which will over time reduce the influence of incumbency.

The demand forecast in a given year is the sum of the irrigation decisions that have been made on both sides of the tree, both in that year, and in the preceding years.

2.2 Information Sources

Our model estimates the likely switch rates for each key decision facing farmers using three key information sources:

- A survey of farmers in the area
- MRB analysis of farm profitability, and
- Consultation with investors and processors from inside and outside the region.

2.2.1 Within Area Farmer Survey

The likely water charges and the indicative costs of on-farm irrigation infrastructure has been presented to farmers within zones A, B, C, D, and M. This was done to gauge perceptions about future profitability and determine intentions to irrigate or sell.

We received 49 responses from farmers, reflecting more than 50 percent of the potential command area. The survey asked for short, medium and long-term decisions but in general did not go beyond a ten year timeframe. The survey questionnaire and the detailed analysis of the responses are presented in the Appendices to this report.

The information from the survey is used for the forecast in several ways. The intentions of the farmers to irrigate in the survey period are used to estimate the irrigation rates for the incumbent farmers in that period. The stated intentions of farmers to sell or hand over their land are used to estimate the land that is available for conversion to a new land use (as a proportion of the total project command area). The reasons that farmers have chosen not to irrigate feed into the low, high and base scenarios to estimate reasonable switch rates under different circumstances.

The survey estimates the stated preference of farmers in the area. Their revealed preference will only be known when they actually make the decision. This is likely to be at least three years in the future. These preferences might diverge because:

- Sample bias where the sample that filled in the survey are not representative of the whole population (for example some farmers are busier at the time of year the survey was completed)
- Negotiating bias where the stated preference is a negotiating position because farmers wish the project to proceed or not to proceed for other reasons (for example they feel their existing extraction right would be threatened by the scheme), and
- Information levels upon which decisions are made may change materially (for example some farmers have no experience with irrigation and would not state an intention to irrigate without having full knowledge of the returns on their farm).

This is relevant for the forecast because the survey responses are converted into irrigation decisions and sale decisions to estimate demand. The possibility that the survey might under- or over-represent preferences is a factor to take into account in interpreting the forecast. Section 5.3.1 describes the range used in the scenarios to translate survey information into forecast levels of demand.

Survey responses were received from 48 farmers, covering each use of land in the area and 50.04 percent of the overall land estimated by MRB and considered for potential irrigation. There was a low proportion of respondents in the vineyard category, but this is a very small proportion of the overall land area. Mixed arable and dairy support reported a higher level of use than the MRB estimate in the area, causing the response rate to go over 100 percent.

Table 2.1: Survey response rates

Land use (MRB)	Percentage of area covered by the survey (each land use)
Sheep and Beef incl. finishing	62.16%
Mixed arable and dairy support	111.62%
Orchard	19.82%
Arable	25.35%
Vineyard	3.75%
Dairy	22.39%
Total	50.04%

Survey information is used in the forecast and scaled up to account for the area not surveyed.

2.2.2 MacFarlane (MRB) analysis

MRB considered model farm types to estimate the range of likely land use scenarios that will be pursued in the region once irrigation water is available. These budgets determine the likely profitability for different model farm types based on the key input prices and costs and the expected prices for different outputs.

The key determinants of farmers' investment decisions include:

- Relative commodity prices
- Changes in farm productivity levels due to irrigation
- The price of irrigation water, and
- Required on-farm irrigation investment.

MRB farm budgets and predictions are important for the forecast in several ways. The optimal farm models that MRB have described have been used as the basis for what will eventually occur in the Ruataniwha area. Optimal rates of irrigation by farm type, as determined by MRB, are therefore the basis for the rate of irrigation that will occur when a farmer chooses to intensify their current operation.

In addition, MRB created an optimal distribution of land uses based on their modelling and this is used as one of the options for land that is converted when it is sold or handed over. The other drivers of what will happen to land that is sold include the current land use and the views of external investors who would be likely to buy the land and undertake the conversion.

If factors in the MRB analysis change materially, such as commodity prices or farm costs, this would lead to a different distribution of land uses or a different optimal level of irrigation for each farm type. Possible deviations in the distribution of land uses when land is turned over are incorporated in our high and low scenarios to reflect the possibility that the MRB relationships do not hold. Section 5.2.1 describes the possibilities considered in the scenarios for the land use decisions that are made.

2.2.3 Other Consultations

We have consulted with a range of farming interests outside the region to assess the willingness of potential farm purchasers to enter the region to intensify or change land use. These responses have suggested investor interest in converting available land to dairy production if reliable water supply could be achieved. This is based primarily on the capability and capacity of the dairy industry to seek land and convert to dairying.

We have discussed with agricultural and horticultural processors what the effect of a large scale water storage and distribution network would have on them—particularly their strategic plans for the Hawkes Bay region. Given their downstream position from farmers, we also gauged processors' views on the likelihood of the predicted MRB land uses being achieved and the barriers to intensification or land conversion.

This information feeds into our assessment of the probability of land use change when land is sold within the area. MRB analysis of optimal land uses based on returns is important (as is the current land use), but so too is the appetite of investors to buy land and make the necessary conversions and intensifications. Section 5.2.1 illustrates how external investor preferences enter into the definition of the forecast scenarios.

Section 5 explains the forecast scenarios in detail and how the information is used to populate the scenarios and estimate the demand levels. The table below summarises the use of information in each decision.

Table 2.2: Information used in decision tree nodes

Decision Tree Node	Scenario Variable	Information source
Farm control decision	Hand over rates	Within area survey Regional turnover rates
	Sale rates	Within area survey Regional turnover rates
Land use decision	Existing use	MRB
	MacFarlane optimal state	MRB
	External investor view	Consultation with external investors
Irrigation decision	Optimal irrigation rate	MRB
	Stated preferences	Within area survey Consultation with external investors
	Propensity to irrigate	Within area survey

3 Market Sentiment

Our approach to forecasting demand from the RWSP centres on the different decisions that farmers will make in response to the scheme. This is because decisions on turning-over control of the farm (by sale, lease, or handover), changing land use, and investing in on-farm irrigation infrastructure will ultimately drive demand for the scheme.

This section presents our understanding of how the sentiment of farmers and potential investors from outside the region will influence these key decisions. We separately analyse how sentiment is likely to result in different outcomes on:

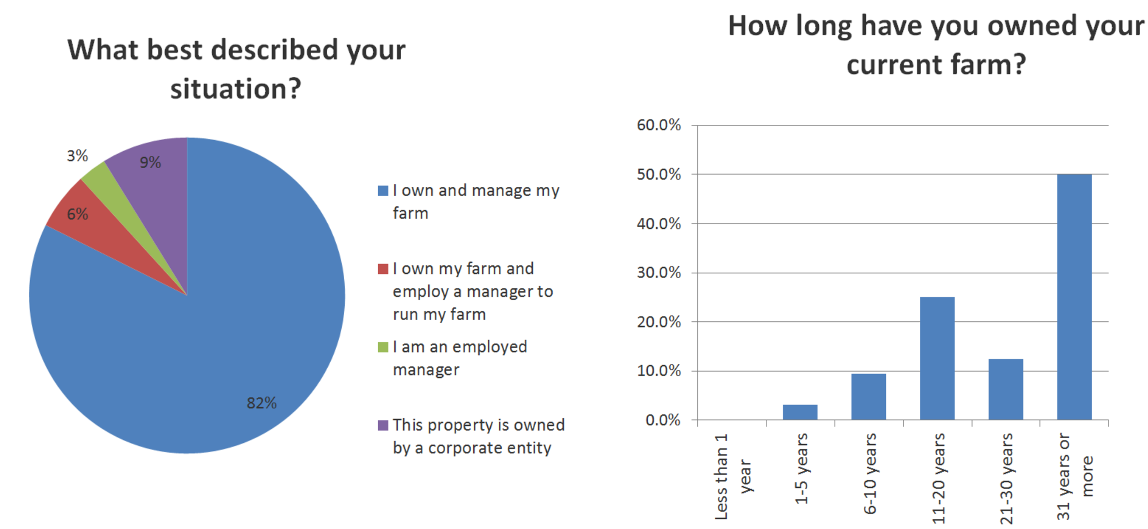
- **Farm control decisions** (Section 3.1)—We assess current farmers' stated intentions on whether they will sell, lease or handover their land
- **Land use decisions** (Section 3.2)—We assess farmers' stated intentions to convert their land into a different use, farmers' views on the future returns from different land uses, and purchaser intentions informed by experience in other parts of New Zealand and the likely availability of production facilities, and
- **Irrigation decisions** (Section 3.3)—We assess whether irrigation will occur, which is influenced by the perceived impact of drought, the factors that currently limit investment in irrigation, and perceptions on alternative sources of water supply (on-farm storage and groundwater).

This analysis is based on responses to the farmer survey described in Section 2.2.1, and through our discussions with outside investors and processors. The evidence on market sentiment presented in this section is then used to inform different demand scenarios, which are described in Section 5.

Farmer demographics in the Ruataniwha region

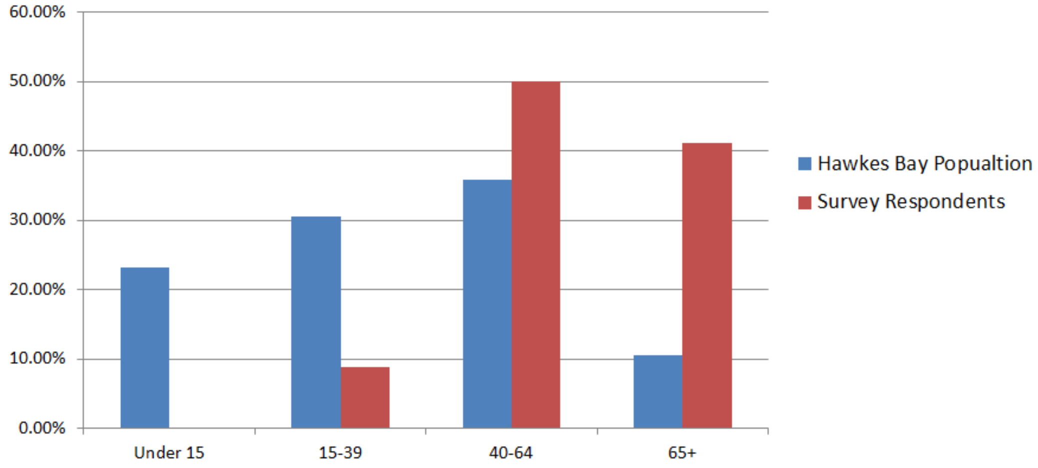
Survey respondents were predominantly owners and managers of their own farms, with most having been in the region for more than 30 years (see Figure 3.1 below).

Figure 3.1: Survey Respondents in the Ruataniwha Region



40 percent of respondents are older than 65, with a number of respondents in their 80s. Only one respondent was younger than 30.

Figure 3.2: Age of survey respondents versus general Hawkes Bay population



3.1 The Impact of Sentiment on Farm Control Decisions

The turnover of land through sale, lease, or handover provides a source of land that could be converted to other uses that demand irrigation water. Anecdotally, we understand that land turnover rates in the study area are low relative to other parts of New Zealand. However, irrigation schemes in other parts of the country have generated social change, leading to an increase in land turnover. For example, the trend of increasing land turnover has been observed in the Canterbury region, which has seen more investment in irrigation than other parts of New Zealand.

The survey of farmer sentiment asked current landowners whether they would sell their land in any of the first six years after irrigation water becomes available. The turnover rates implied by the responses are shown in Table 3.1 below. The results suggest an initial burst of sales and handovers in the first year after irrigation water becomes available, with 15 percent of respondents intending to sell or handover their farm in that year. Results in the following years vary between no sales or handovers and a turnover rate of around 2.5 percent (close to the current level of land turnover in the area).

Table 3.1: Turnover Rates in the First 6 Years of the Scheme

Year	Percentage of total area sold or handed over in the year
2017	15.0%
2018	2.5%
2019	0.6%
2020	0.2%
2021	0.0%
2022	2.5%

Farmers were also asked whether they would sell or handover their land even if the scheme was not commissioned. 85.7 percent of farmers that plan to sell in the first season reported that the scheme was not the driving factor for their decision to relinquish control of their farm, but rather that a change in control would take place in any case.

The survey responses on land turnover rates from 2017-2022 presented above are used in this report in all three scenarios for forecasting demand (see Section 5).

3.2 The Impact of Sentiment on Land Use Decisions

Land use choices will be determined by existing farmers (incumbents) as well as new landowners (outside investors) that relocate to the area. Incumbents will select a land use that is based on their expectations of how to maximise their future returns given a range of uncertain variables, such as future commodity prices and input costs. Outside investors will be attracted to the region based on their expectations on the impact that irrigation will have on their ability to earn financial returns.

3.2.1 Incumbent perceptions of the returns from different land uses

Land use decisions by existing farmers will depend on the returns that they expect to earn from different land uses. The expected returns from land uses are determined by expected output prices and the costs of inputs, including irrigation water. A pessimistic view of future prices for commodities that require irrigation water, or a perceived level of volatility in those prices, will reduce the likelihood that farmers will change land use towards activities that depend on irrigation. In contrast, an optimistic view will lead to a higher propensity by incumbents to change land use once the scheme is in place.

The farmer survey asked respondents whether assumptions on the returns from different land uses, future commodity prices, and the costs of investing in irrigation used in the MRB models (previously undertaken for the HBRC) were too high, about right, or too low. A summary of responses is provided in Table 3.2. Most farmers considered the estimates of future commodity prices to be about right, while most farmers considered the estimated costs of investing in irrigation to be too high. Respondents were evenly split on whether the assumed returns from their land use were too high or about right.

Table 3.2: Farmer Perceptions of Future Returns

	Too High	About Right	Too Low	Don't know
Perceptions of Returns from their farm type	44.2%	46.5%	4.7%	4.7%
Perceptions of commodity price forecasts	29.5%	65.9%	0.0%	4.5%
Perceptions of costs of investing in irrigation	60.5%	25.6%	2.3%	11.6%

Farmer perceptions of future returns help to explain the decisions that are made by incumbent farmers on whether to change land use and intensify their farm production when irrigation water becomes available. These results are not used directly in the demand forecast scenarios described in Section 5, but provide a cross-check on the level of irrigation intensification that farmers expect to occur over the survey period.

3.2.2 Perceptions of outside investors on different land uses

Investors that are currently based outside the Hawkes Bay area show a keen interest in sourcing land within the area and using irrigated water. This interest is particularly evident among investors who would convert farms which are currently used for non-dairy purposes. Investors also show interest in intensive arable farming using irrigated water. This is consistent with the farm modelling outcomes (described in Section 4), which identify dairy and arable uses as the most profitable when irrigated water becomes available.

The high level of interest from outside investors appears to be consistent with experience in other regions. We spoke with farmers in the Canterbury region who have first-hand experience with irrigation schemes, and they reported high levels of resulting land use change and intensification.

Investor sentiment also seems consistent with the expected capacity of agricultural processors. We asked agricultural and horticultural processors about the likely effect of a large-scale water storage and distribution network, and their strategic plans for investment in the Hawkes Bay region. Dairy processors with nationwide scale consider that local production capacity and the ability to transport products to facilities outside the region will be sufficient to handle any increase in production resulting from the scheme. However, Fonterra indicated that it would plan for an increase in dairy production in the region if the scheme proceeds. Horticultural processors (such as McCain's) also consider that processing expansion is possible. McCain's is currently not operating at full capacity at its Hastings facility. McCain's considers that irrigation would increase overall production, but more importantly would improve reliability of supply—since droughts have significantly reduced plant utilisation in recent years.

Outside investors view the availability of land as the main constraint that will limit changes from existing land uses. The level of investment that outside investors consider likely would quickly outstrip the land that will become available in the area under normal land turnover rates. This highlights the importance of the farm control decision discussed in Section 3.1 above because the availability of land through sale constrains changes in land use, rather than the availability of investors or capital. In addition, over time, the market will need to resolve any possible mismatch in expectations between the sellers and buyers of land. Current landowners may seek to capture the value of land in its next land use (following irrigation) during the sale. An increase land values would reduce the return from the change in land use available to the buyers of land, and at some point, would make such a purchase unattractive. The market price will eventually settle at a level that is attractive to both buyers and sellers. However, the time it takes for the market to settle may have an impact on the rate of land use change.

The views of outside investors are used to define the high demand scenario for land use change that is described in Section 5. Outside investors clearly have a more optimistic view than incumbent landowners on the potential for irrigation water to drive profitable changes in land use, and we assume that the perceptions of outside investors lie at the upper end of likely future demand outcomes.

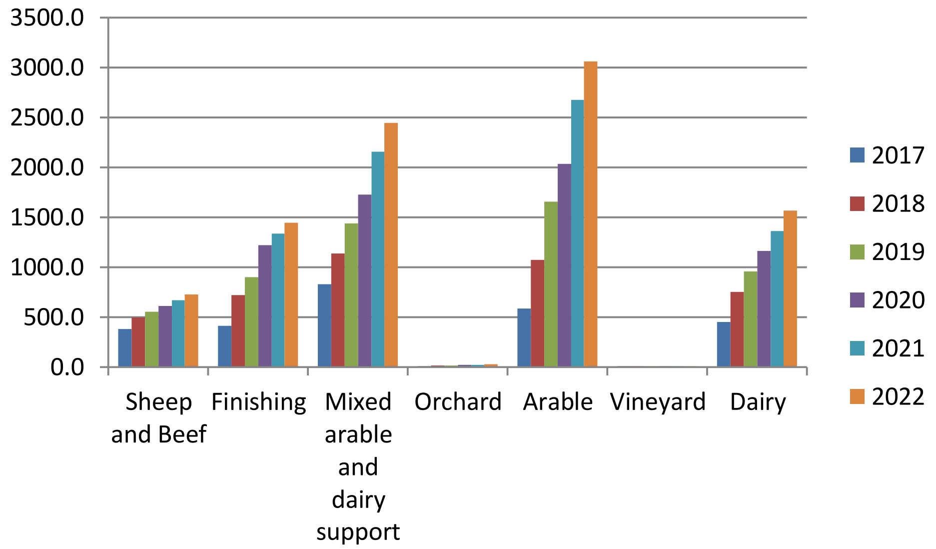
3.3 The Impact of Sentiment on Irrigation Decisions

Farm control and land use decisions feed through into landowners decisions on whether to irrigate their land. Decisions on irrigation will also be based on farmer perceptions on the seriousness of drought as an issue in the area, the factors currently preventing them from irrigating, and the cost of alternative water supply options. Each of these factors is discussed under the following sub-headings.

3.3.1 Incumbent interest in irrigation

Existing farmer intentions on the use of irrigation water will clearly affect future demand from the scheme. Figure 3.3 shows farmers' survey responses on the additional land that they intend to irrigate (over and above current irrigated land). Demand from arable and mixed arable farmers is the strongest, totalling more than 3,000 hectares by 2022. Dairy has a high proportion of irrigation already, and farmers expect this to grow by a further 1,500 hectares by 2022. Orchards and vineyards had low response rates due to a low number of incumbents.

Figure 3.3: Expected Irrigation Hectares in the First Six Years by Land Use



The total amount of irrigation for each land use will also reflect existing consents. Dairy and arable uses have the greatest amount of consented water, with 3,000 hectares consented for dairy and 2,600 hectares consented for arable uses. Of the farmers that currently irrigate their land, 35.7 percent have changed their land use due to irrigation.

The survey response information on irrigation intentions is used to forecast irrigation water demand from incumbents in the baseline scenario described in Section 5.

3.3.2 The importance of drought as an issue in the area

The perceptions of drought as a factor that limits the returns from farming is an important input into the decision farmers will make on whether to use irrigation water. Interest in irrigation will increase if farmers are concerned about drought and perceive the financial consequences of drought to be severe.

The following two tables summarise results from the farmer survey on perceptions of drought frequency, and the magnitude of the financial impacts of drought. These results suggest that on average farmers perceive droughts to occur once out of every 4 to 5 seasons, and that between 11-50 percent of annual revenue is at risk when drought occurs.

Table 3.3: Perceptions of Drought Frequency and Magnitude

	1 in 2 seasons	1 in 3 seasons	1 in 4 seasons	1 in 5 seasons	1 in 10 seasons	1 in 20 seasons	Never
Drought frequency	4.7%	14%	34.9%	30.2%	14.0%	0.0%	2.3%

Table 3.4: Perceptions of revenue at risk during a drought

	5% or less	5-10%	11-30%	31-50%	51% or more	Don't know
Revenue at risk	7.0%	16.3%	30.2%	30.2%	11.6%	4.7%

These results confirm that drought is perceived as a significant issue in the area. More than 83 percent of respondents perceive drought as occurring more than 1 in every 5 years, and 72 percent of respondents perceive that more than 10 percent of their revenues are at risk when drought occurs.

Farmer perceptions on the frequency and financial impact of droughts are not used directly in our demand forecasts. However, these perceptions provide a useful cross-check on the expectations of future irrigation demand from incumbents.

3.3.3 Factors limiting current irrigation investment

The demand for irrigation will be influenced by the constraints on investing in irrigation. These constraints could be real (for example, if there is no water available), or perceived (for example, if irrigation is seen as a complicated and risky process). The current reality in the area is that very little water is available for irrigation and no further water consents are currently being issued. This is reflected in the perceptions of farmers summarised in Table 3.5.

Table 3.5: Reasons for Not Currently Irrigating

Constraint	
No access to water supply	44%
Yet to consider it	12%
Affordability	24%
Capacity to manage workload	8%
Land use does not require it	12%
Farm is optimised already	28%

Note: Multiple responses to this question were allowed

These results suggest that a significant proportion of the farmers surveyed would be unlikely to demand irrigation water from the scheme. The bottom three constraints listed in Table 3.5 would exist even if water was available from the scheme. A total of 48 percent of respondents reported they have either optimised their farm already, do not have the capacity to manage an irrigated farm, or have land or a land use that will not benefit from irrigation. This segment of the farming community will be the least likely to demand irrigation water without a change of land use or ownership.

The factors that currently constrain irrigation are used to define the high demand scenario described in Section 5. This is because addressing any of the first three constraints listed in Table 3.5 above will increase the demand for irrigation water from the scheme.

3.3.4 Alternative water supply options

Farmers are less likely to demand water from the scheme if there are alternative supply options that they perceive as less costly or higher quality.

On-farm water storage is one possible alternative to irrigation water. In the farmer survey, 32.5 percent of respondents reported that they had investigated on-farm storage, but the vast majority had rejected the investment because it was not financially viable. Only one survey respondent reported having received resource consent for an on-farm storage facility. As a result, we do not consider on-farm water storage to be a credible alternative to irrigation water.

A total of 35.6 percent of surveyed farmers stated that they currently irrigate their farm, and 76.5 percent of the farmers that irrigate do so using groundwater consents. Respondents perceive groundwater consents to be more secure than surface water consents, with 82.3 percent of existing irrigators perceiving that their consents will remain viable for more than 11 years (as shown in Table 3.6).

Table 3.6: Perceptions of existing consent tenure

	5 years or less	6-10 years	11-15 years	16 years or more
Expected length of consent tenure	11.8%	5.9%	29.4%	52.9%

Demand for irrigation water from farmers holding existing consents is a complex issue. Current irrigators will have the skills and experience needed to maximise the value of irrigation water, and the best understanding of the financial returns from irrigation. These factors will tend to increase demand from existing irrigators and lead to early adoption of irrigation water. However, farmers that have optimised their land use using groundwater consents may be unwilling to pay for irrigation water at prices that are above the costs of groundwater (up to 15 cents per m^3 cost for deep bore extraction). This will tend to reduce the demand for irrigation water from farmers with existing consents.

Perceptions of alternative water supply options are not used directly in the demand forecasts presented in this report.

4 Optimal Land Use Derived From Farm Budget Modelling

This section considers the potential demand for water from the area if farmers optimised their land use, according to the on-farm modelling completed by MRB. We first explain how the MRB results are incorporated into our demand forecasting model, and then identify the key sensitivities that have implications for our results.

The results of MRB's analysis are summarised here due to the importance of the returns to irrigation to the strategic decisions that farmers will take.

4.1 How we use the MRB Model Outputs

MRB has defined and analysed model farm types for the range of likely land use scenarios that will be pursued in the region once irrigation water is available. These models have financial budgets that determine the profitability of different model farm types, based on key input prices and costs and the expected returns from producing different outputs.

The profitability of different farm types, based on certain output prices and an assumed efficiency of farm operations, tells us which land use is optimal—ranking the potential new uses of land according to the expected profitability if water was available. This ranking is also driven by how much water is needed by each land use. Arable and dairy farm types are estimated to use a similar volume of water and result in similar estimated proportions of post-storage land use.

MRB predicts the final distribution of land use and the final proportion of irrigated land in the project command area based on experiences with irrigation in Canterbury, the 'best' land uses based on soil types and nitrogen loading, and profit-maximising decisions informed by relative commodity prices used in the MRB model. The relative profitability outcomes reflect prices at the time the work was carried out.

By contrast, our model—informed by the survey and the interviews—takes into the account farmer inertia, doubt, lack of information, and other factors. In other words, our forecasting model focuses on the rate at which the actual outcomes are likely to approach the MRB modelled optimal outcomes.

In turn, the MRB results enter directly into our model by influencing the land use choice and providing data on the likely proportion of land that would be irrigated for each land use choice, as well as on the demand for irrigation water per hectare of each land use.

The predicted optimal land uses

MRB estimate that the Project will benefit 42,000 ha of productive land in the Ruataniwha Plains—25,000 ha under direct irrigation and a further 17,000 ha indirectly.

- This is expected to increase farm productivity for a total 42,000 ha once the wider 'area of influence' is taken into account (for example, non-irrigation portions of partially irrigated farms).
- MRB expects dairy, arable, and sheep & beef farm conversions or intensifications to make up approximately 20,000 ha (80 percent) of the irrigated land.

The proportions in Table 4.1 have dictated how we have modelled the rate and type of land use conversion for the region over time.

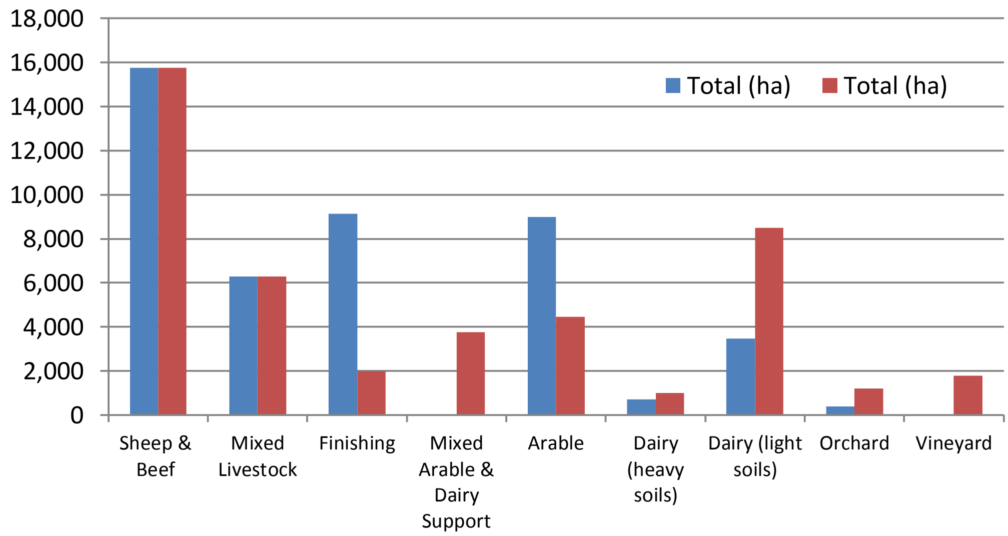
Table 4.1: MRB Estimates Post-scheme Land Uses

	Sheep & Beef	Finishing	Mixed arable & dairy support	Orchard	Arable	Vineyard	Dairy
MRB Distribution	33.75%	4.29%	11.12%	2.69%	22.27%	4.04%	21.84%

Source: MRB (2012)

The MRB estimates for overall land use outcomes and associated irrigation demand are summarised below, with Figure 4.1 summarising pre- and post-storage land use assumptions for the catchment area. The expectation is that significant reductions in finishing and arable farming would lead to significant increases in dairying on light soils and mixed arable and dairy support models. There would also be a small but significant increase in orchards and vineyards.

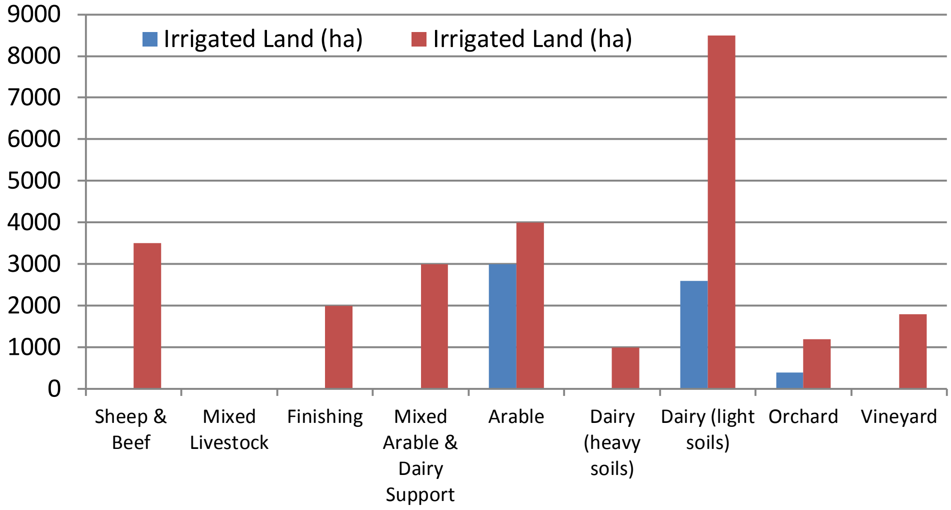
Figure 4.1: MRB estimates of land use pre and post Scheme



Source: MRB (2012)

The demand for irrigation water would come from a variety of uses, with the exception of 'mixed livestock' models. The majority of the demand would come from dairying on light soils and arable models. Other uses also provide a significant demand for irrigation, in aggregate.

Figure 4.2: MRB estimates of irrigation demand pre and post Scheme



Source: MRB (2012)

The MRB estimate of irrigation water demand assumes that all land is transferred to its highest value use. MRB's model farms are necessarily static representations—in reality, actual land uses will evolve over time towards these optimal configurations if the assumptions underlying the analysis continue to hold. The adjustment path may take many years due to a bias towards historical land uses, or a perception of relative commodity prices that may be 'temporary'.

The MRB models—in line with the objective for which they are designed—do not capture the timing issues. The models are intended to consider the final demands and land uses, not transition paths, which are of key interest to this study. The key challenge for our analysis is to marry the MRB estimates of optimal land uses with farmers' perceptions and expectations about the future values of the key MRB model variables.

4.2 How Sensitivities in the MRB results might affect our Demand Forecast

MRB considers the project to be extremely sensitive to overall farm commodity prices. MRB also assumes post-storage farm productivity would reflect performance of a farmer at the top 20th percentile of current farming across New Zealand, and state that this assumption could be conservative on a 30+ year investment horizon, since farming improvements should push future productivity past current top performers. This is on the basis of:

- Conversion investments will largely attract top performing and younger (more aggressive) farmers willing to take higher risks
- Conversions will utilise new farming techniques, and better water reliability will enable farmers to improve productivity without being distracted by drought risk, and
- Experience with other schemes suggests that farmers who undertake conversions will see opportunity in buying adjacent land from farmers who may not otherwise undertake conversions.

This assumption is reasonable given that the top 20 percent relates to the current level of productivity, while the demand forecast stretches out over 35 years. Therefore, as productivity increases over time, the assumption only requires that farms reach the top 20 percent of today's productivity range over the course of the forecast.

MRB have tested the sensitivities of these absolute changes—i.e. how water demand is affected if commodity prices or farm productivity on average is different to their assumptions (this is shown in Table 4.2). Plus or minus 15 percent of farm income and 3 percent working expenses gives a range in return on marginal capital from 6.8 percent up to 18.3 percent.

Table 4.2: Sensitivity of farm profitability to different productivity levels and prices

Scenario	Pre RWSP	Post RWSP	Marginal capital
Average productivity (rather than top 20 percent)	4.2%	4.5%	5.4%
Lower commodity prices	2.4%	3.7%	6.8%
Higher commodity prices	6.0%	9.6%	18.3%

Source: MRB 2012)

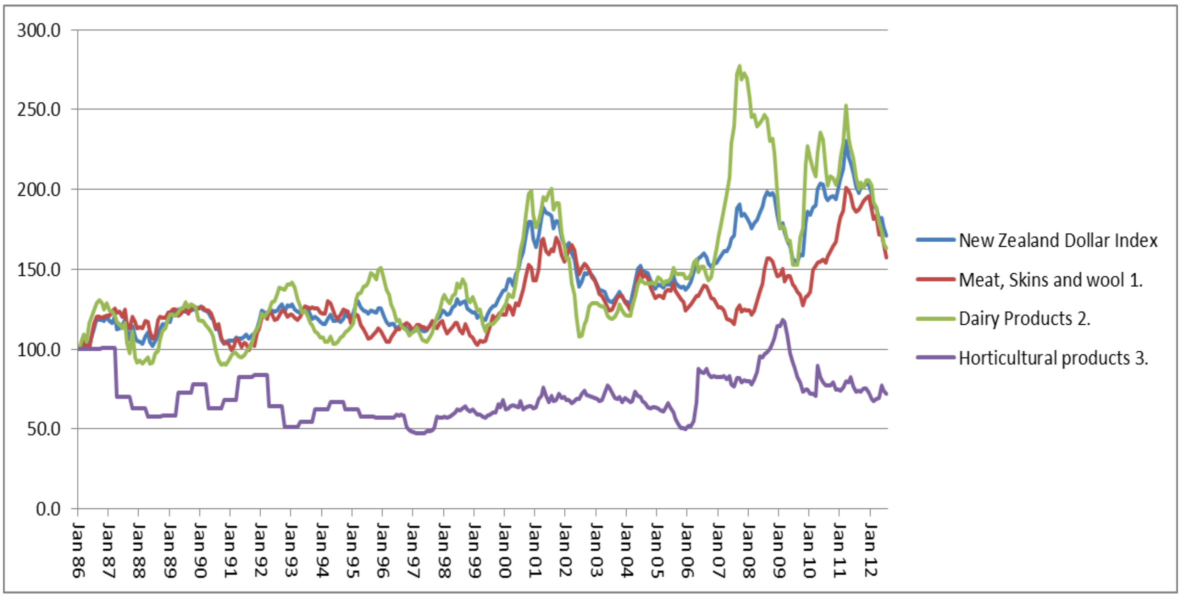
For the purposes of our forecasts, the two key sensitivities that influence how the MRB optimal farm-types enter our demand forecast are:

- Commodity prices—specifically the relativity of different output prices. To the extent that relative commodity prices change, the optimal land uses for farmers who <u>do</u> convert could change. If sheep and beef prices improve relative to the dairy payout, for example, there will be fewer dairy conversions and less water demanded from the scheme—since sheep and beef farms irrigate less land proportionally than dairy farms, or may be more profitable with in the absence of irrigation
- The efficiency (or productivity) of on-farm management practices—particularly in how they relate to each farm type. While on average, over time, farm productivity in the region may tend toward the current top 20th percentile, in early years this is harder for the average farm to achieve than in later years. Hence, the MRB estimate of incremental returns to irrigation needs to be adjusted for the timing of conversion: it may be conservative in later years, but potentially over-optimistic in the early years of the scheme. In considering forecast sensitivities, we make adjustments for the effect of the productivity assumption depending on the timing of conversion.

Farmers' perceptions and expectations about these variables and their forecasts will determine the strategic decisions that they make regarding the purchase of irrigation water. The way in which commodity prices affect our projected demand forecast is not direct—we estimate demand based on farmer perceptions of expected future returns and their willingness to invest in order to achieve those returns.

As the forecast timeframe progresses, it becomes more difficult to determine which products will be most lucrative. To provide a context for how volatile output prices have been in relation to each other, historical commodity price trends are shown in the figure below. There is a significant divergence of dairy prices from 2007. Meat prices improved subsequently and horticultural products remain flat, despite a brief resurgence in 2009.

Figure 4.3: Historic Commodity Price Trends (Indexed Values since 1986)



Source: ANZ

These historical relativities will strongly influence farmer perceptions of future relative returns—particularly the likelihood of sustained returns. For example, historical perceptions of the relative meat and dairy prices could slow dairy conversions.

Overall, while we rely on MRB estimates, we are conscious of the inherent sensitivities underlying the calculations, and how these sensitivities could feed into our own estimates.

5 Demand Scenarios

The forecast is divided into three scenarios (baseline, high, and low), providing a range that describes the bounds of likely outcomes with the central estimate—the baseline—describing the most likely.

These scenarios are created from different decisions at each of the key pivot points in the decision tree. The critical decisions, and the estimated results of these decisions that our forecast is based on, are discussed below to show how variations in the decision outcomes affect the forecasted demand. Our high and low scenarios of demand reflect our view of optimistic and pessimistic assumptions for each of these critical estimations.

As shown in 2.4 above, the key outcomes for water demand will be determined by the decisions farmers make and are described by the key variables in the forecast which are:

- Farm control decisions
- Land use decisions, and
- Irrigation decisions.

These decision drivers are described below in terms of the ranges that have been applied for each scenario, and the reasons that we believe the ranges ascribed to each variable are reasonable. This decision set exists for any given level of price and for any given area that water is available in.

These critical variables are used to populate the water demand levels in each year as the farmer decision tree is repeated until all land gravitates to an optimised use or a capacity constraint is reached.

5.1 The Farm Control Decision

The farm control decision is the decision for an incumbent to continue farming or to sell or hand over their land to a family member. The variable in the forecast that determines this decision is the turnover rate which is the sum of the sell and hand over decisions.

5.1.1 Turnover rates of land within the zone

The 'turnover rate' is the sum of land that is sold and land that is handed over to a family member. The survey of incumbent land owners identified current intentions to hand over or sell land in the survey period including leasing and subdividing. The demand forecast applies a turnover rate to land that reflects the survey responses and also turnover rates in the region generally.

Baseline Assumption

There are different definitions of turnover rates of land in the region and a rate of five percent is a recent average. However, according to local perceptions, the turnover rates in this particular part of the region are low.

In the baseline scenario, the rates expressed in the survey apply for the years surveyed. In the years following the survey period, we apply the average rates stated in the survey. There are very few data points in the area to make reliable assumptions about the turnover rates in the area, and therefore the survey is the best source of information.

High Scenario

In the high scenario, we assume that turnover rates approach the regional average, with more sales taking place than the survey suggests after the irrigation project comes on stream. This might occur if a high degree of change is brought about in the area that causes farmers approaching retirement to change their mind about staying longer and to sell more quickly instead.

Low Scenario

In the low scenario, the turnover rates are lower in years after the survey period than during the survey period. This would be consistent with an initial period of change brought about by the irrigation project and aggressive marketing, followed by a return to average rates observed in the survey excluding the initial jump in turnover.

Table 5.1: Turnover and hand over rates of land in the water storage zone

Variable Description	Low	Baseline	High
Hand over rate	1.5%	3.0%	2.5%
Sale rate	0.5%	0.5%	2.5%
Turnover rate	2.0%	3.5%	5.0%

5.2 Land use decision

The land use decision is the type of farm that is adopted on land that is turned over. This is determined by applying a distribution of land uses to the total area in hectares that is turned over in a given year.

5.2.1 Land use distribution

Land that is turned over in any given year will be subject to a decision about intensification and land use. There are several sources of information regarding the likely land use for land that is sold or handed over. MRB derived a distribution of land use in the area post project that is a steady state distribution of land uses based on the estimated returns to different land uses. The current land use distribution is also known. The final source of information for land use is the consultation undertaken with external investors, consultants and downstream processors. These sentiments have then been quantified to represent the views that were conveyed to us.

These distributions are shown below:

Table 5.2: Distribution of land uses for land that is turned over

	Sheep & Beef	Finishing	Mixed arable & dairy support	Orchard	Arable	Vineyard	Dairy
MRB Distribution	33.75%	4.29%	11.12%	2.69%	22.27%	4.04%	21.84%
Current	33.67%	21.68%	13.61%	1.66%	19.24%	0.24%	9.90%
External consultation*	5.00%	5.00%	15.00%	2.50%	15.00%	2.50%	55.00%

* External consultation is not a quantitative study; rather, it reflects the views and experiences of a range of participants in the industry and in other areas who have experienced irrigation projects

External consultation was undertaken with consultants experienced in irrigation projects and with investors and farmers. This consultation was not a quantitative process but a series of written and telephone interviews to determine the likely nature of investment.

The general consensus is that dairy conversion is a high likelihood for land sold in the region when irrigation is available if the price is right. Intensive arable farming was also probable, but less likely on the basis that there is a higher skill set in the dairy industry for intensive conversions and more availability of people that are likely to undertake the necessary investment. Less profitable land uses, such as sheep and beef and finishing, were of a lesser likelihood according to those consulted with.

The best representation, therefore, of the investors' views is that the minor uses will continue to some degree but are of a lesser likelihood than dairy. This is represented in the distribution in Table 5.2 as a skew towards dairy.

The forecast takes three approaches to the destination land use. We assume in all cases that conversions have optimal irrigation rates applied, according to MRB irrigation optimums. The investor view is in fact the most likely to lead to higher irrigation levels as the dairy (or arable) uses have the highest intensity of irrigation and the highest use of water per hectare. It does not matter greatly for the demand forecast whether it is arable or dairy investment as they have similar water demand profiles. Current uses are the least likely to generate irrigation demand as they are dominated by less irrigation intensive sheep and beef uses.

Baseline scenario

The baseline scenario uses an average of external investor views and MRB optimal use. We assume that the investor view will create a skew from the average use identified by MRB. For the more minor land uses, such as vineyards, we assume that MRB distribution will apply.

High scenario

The high scenario assumes that land is converted according to the views of external investors, and hence is converted to a higher degree of dairy and dairy support with other uses following the status quo. This would become more likely if dairy (or arable) land becomes more profitable in the intervening period. This would in turn drive a higher degree of conversion into these uses. This in turn drives a higher demand for irrigation.

Low scenario

The low scenario assumes that land stays in its current use for incumbents, but intensifies to the optimum irrigation level for that use when it is sold or converted. This reflects a conservative view and the high handover rate and intergenerational nature of farming in the area. It would also become more likely if there was a water price that made some conversions unprofitable. In the low scenario, for example, the likelihood that a piece of land turned over would become a sheep and beef farm is equal to the proportion of sheep and beef farms currently in the area. Incumbent land that is not irrigated remains in its non-optimal state over time.

Table 5.3: Land use scenarios for land that is turned over

	Sheep & Beef	Finishing	Mixed arable & dairy support	Orchard	Arable	Vineyard	Dairy
High	5.00%	5.00%	15.00%	2.50%	15.00%	2.50%	55.00%
Baseline	19.37%	4.64%	13.06%	2.60%	18.64%	3.27%	38.42%
Low	33.67%	21.68%	13.61%	1.66%	19.24%	0.24%	9.90%

5.3 Irrigation Decision

The irrigation decision is the decision to invest in irrigation in any given year. The variables that determine this in the forecast are the 'stated preference to irrigate' in the survey and the 'rate of intensification of incumbent land' after the survey period.

5.3.1 Stated Preferences to Irrigate

Survey respondents identified their intentions to irrigate over the survey period. The forecast translates survey information into irrigation demand for incumbent land owners by land use and by year based on the responses. As mentioned before, we recognise the possible stated preference biases, and reflect these in the range of scenarios.

Baseline Assumption

The baseline assumption is that the stated preference to irrigate is an unbiased predictor of what would actually occur. The reasons for this assumption are that

- The survey sample is a high proportion of the total population. Over 20,000 hectares of land was surveyed out of an area of 34,700 hectares that can be irrigated. The land use of those responding approximated the land use of the area in total.
- There are potential biases that might cause overstatement of intentions but also biases that might cause an understatement of intentions:
  - Understatement bias due to those with existing consents feeling that the scheme might threaten their current consent.
  - Understatement bias in that some farmers felt they did not have the information on returns to state a preference to irrigate. This could, however, be rectified by the time the scheme is operational.
  - Overstatement bias due to some farmers feeling that the scheme would be good for the area, and for their land price, if it went ahead.
  - A general potential for overstatement bias due to the fact that intentions do not always translate to reality due to unforeseen consequences. This could impact in both directions as selling decisions could also be affected.

High Scenario

In the high scenario, we assume that the survey under-estimates take up from those who retain their land. This might be likely if, for example, information about returns to irrigation could be widely distributed among existing landowners. Intentions could also be affected by financing arrangements. A 50 percent increase represents half of the one-third of respondents who suggested some form of barrier to irrigating despite a potential interest. The high scenario would be more likely if perceptions about returns to irrigation improved or if supportive contracting and other strategies were implemented (we discuss these in Section 6).

Low Scenario

For the low scenario, we assume that the survey may over-estimate take up from existing land owners. In particular, this may occur if perception of potential returns to irrigation declines in the period before the dam is constructed for any reason. A 20 percent reduction implies that one-fifth of those stating an interest do not take action in the event that the Scheme is developed.

Table 5.4: Stated and revealed preferences to irrigate in Y1

Variable Description	Low	Baseline	High
Degree to which stated preferences become revealed preferences	80%	100%	150%

5.3.2 Intensification Rates of Incumbent Owners after the Survey Period

The survey of land owners identified the level of irrigation intensification that would occur in the area over the survey period. It also identified the turnover rates of land that would be subject to an intensification decision. The other variable to consider is intensification of land that is not turned over after the survey period. This area of land gets progressively smaller as land is turned over through sale or handover.

Baseline assumption

The baseline scenario forecasts that the high returns to irrigation for dairy and arable mean that intensification continues beyond what is foreseen in the survey period. The rate of intensification is the same as during the survey period until the irrigation levels reach optimality in those land uses. The other uses intensify only to the extent that they said they would in the survey.

High scenario

The high scenario reflects continuing intensification across all uses, again, limited due to the land reaching its optimal irrigation levels in due course. The assumption is that the survey respondents have simply not considered irrigation in subsequent years but would make similar decisions when that time comes.

Low scenario

The low scenario forecast assumes that no intensification occurs by incumbent land owners beyond what is stated in the survey. Any intensification of land after the survey period comes from turnover. This is assuming that in fact the propensity to irrigate shown by survey respondents was the only irrigation that they would choose to undertake until they sell the land.

Table 5.5: Rates of intensification of incumbent land not turned over

	Sheep & Beef	Finishing	Mixed arable & dairy support	Orchard	Arable	Vineyard	Dairy
High	0.33%	2.00%	0.33%	0.33%	2.00%	0.33%	4.00%
Baseline	0%	0%	0%	0%	2%	0%	4%
Low	0%	0%	0%	0%	0%	0%	0%

6 Forecast Results

The forecast results describe the demand for water by land use in each year from Y1 through to Y35. This is done for each of the three scenarios described in Section 5 above and for variations including existing consents and excluding existing consents. Full tables are included in the appendices that show demand by land use by year and by scenario.

6.1 Total Water Demand

The summary results are described below for a water price of 25c per m^3 and starting in 2017. These results assume that the storage scheme can provide for at least 90 million m^3 per year (based on 95 percent reliability), but that the land that can be serviced is limited according to the MRB assumptions of distributable and usable area.

The demand forecast therefore reaches a steady state when that area capacity is reached, with different levels of water demand based on land use differences. As shown in Table 6.1, this steady state is forecast to occur between 2020 (under the high scenario and assuming that existing consented water use demand is automatically transferred to the scheme from inception), and 2047 (under the lower scenario and assuming that existing water consents are not automatically included).

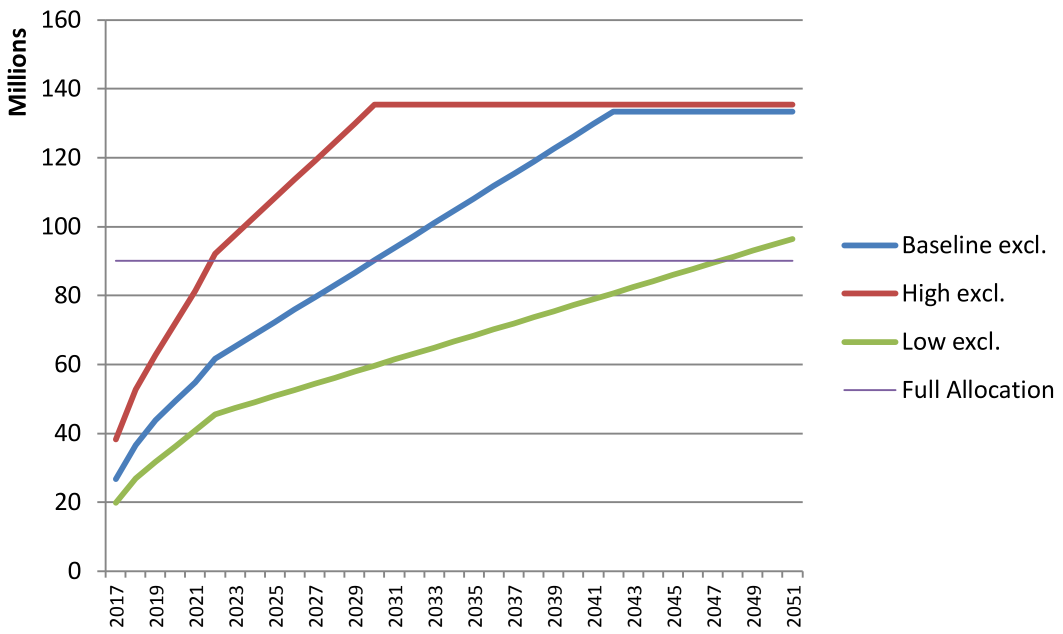
Table 6.1: Summary forecast results at 25c per m^3

	Baseline Scenario	**High Scenario**	**Low Scenario**
Years to reach 90m m^3 p.a. with existing consent demand transferring	Y8: 2024	Y4: 2020	Y14: 2030
Years to reach 90m m^3 without existing consent demand	Y14: 2030	Y6: 2022	Y31: 2047

* Refer to tables for exact levels as fully allocating will occur between years

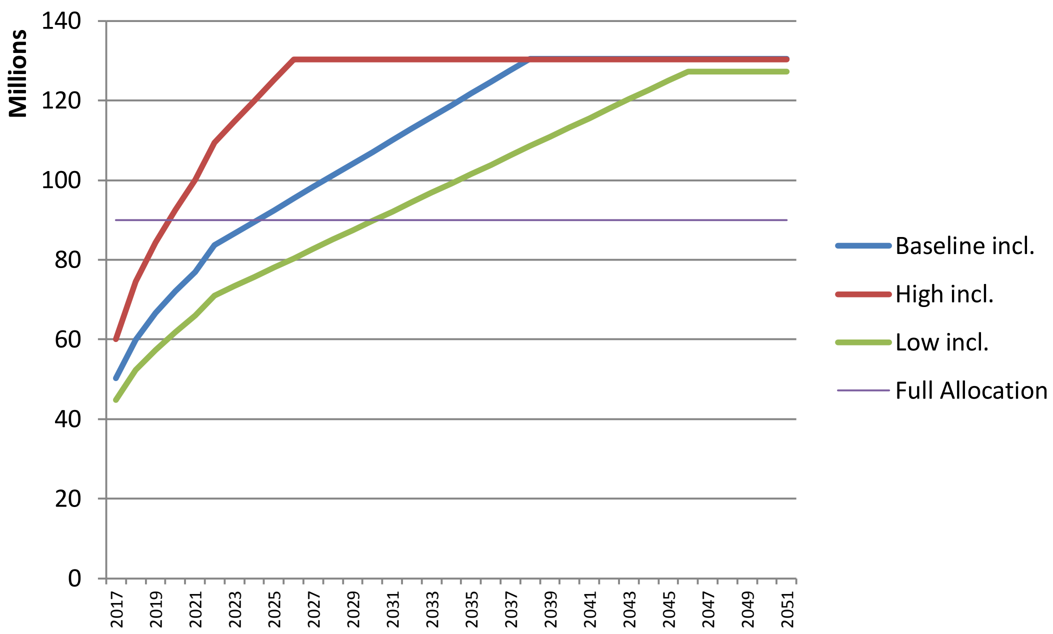
The distribution of scenarios with and without existing consent demand automatically added is shown graphically in Figure 6.1.

Figure 6.1: Irrigation water demand scenarios without existing consents



The three scenarios of demand with existing consents included are shown graphically below.

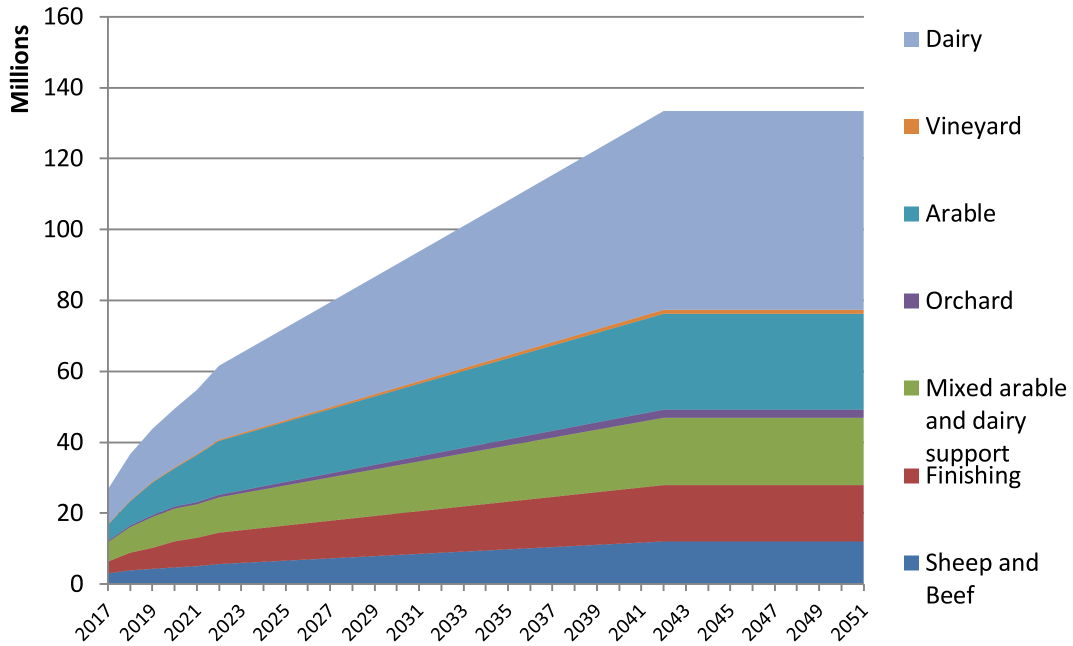
Figure 6.2: Irrigation water demand scenarios with existing consents



6.2 Demand by land use

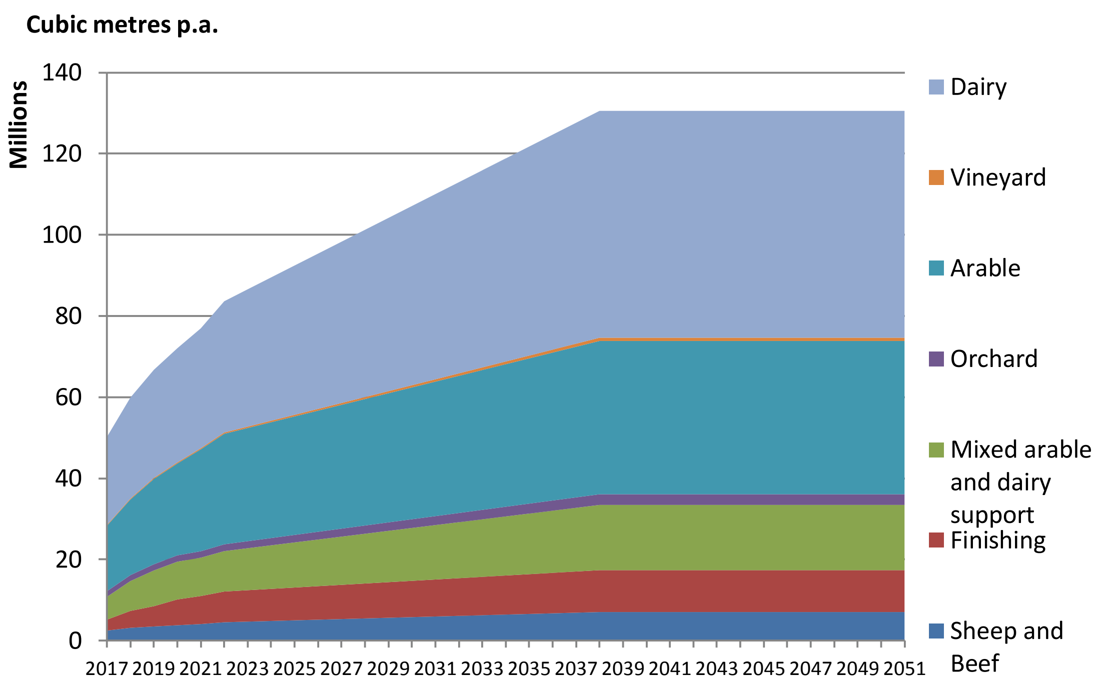
The baseline forecasts are shown graphically below by land use with and without consents at a price of 25cents per m^3:

Figure 6.3: Baseline forecast water demand in m³ p.a. excl. consents



Land use is shown graphically below for the baseline scenario with existing consents included.

Figure 6.4: Baseline forecast water demand in m³ p.a. incl. consents



6.3 Sensitivity analysis

Sensitivity testing of the baseline result has been performed to assess the importance of each individual forecast variable on the result. In this analysis only one variable is changed and all others are held constant at the baseline level. The difference in the time it takes to fully allocate represents the importance of the variable relative to the others. The tests were performed on:

- Increasing the incumbent land owners' intensification rates of land they hold to 5 percent per annum cumulative
- Doubling the sale rate of land to 3 percent per year
- Lowering the price to 23 cents per m^3
- Doubling the handover rates to 5 percent per annum
- Imposing a high arable and low dairy land use profile for land that has a policy change
- Imposing a high dairy and low arable land use profile for land that has a policy change

The results of this analysis are shown in the chart below relative to the baseline full allocated year of Y8.

Table 6.2: Increased uptake from individual variables

	5% intensification rates	Doubled sale rate	Price at 23 cents	Doubled handover rate	Land use mostly arable	Land use mostly dairy
Percentage increased up-take in Y8	2.05%	15.07%	2.80%	5.25%	8.00%	10.85%

The sale rate of land has the highest impact of any individual variable. This variable reflects land that is most likely to be converted into a highly intensive use. The next two important variables are the land use that is imposed. It is less relevant which land use is dominant. Other variables are of lesser importance.

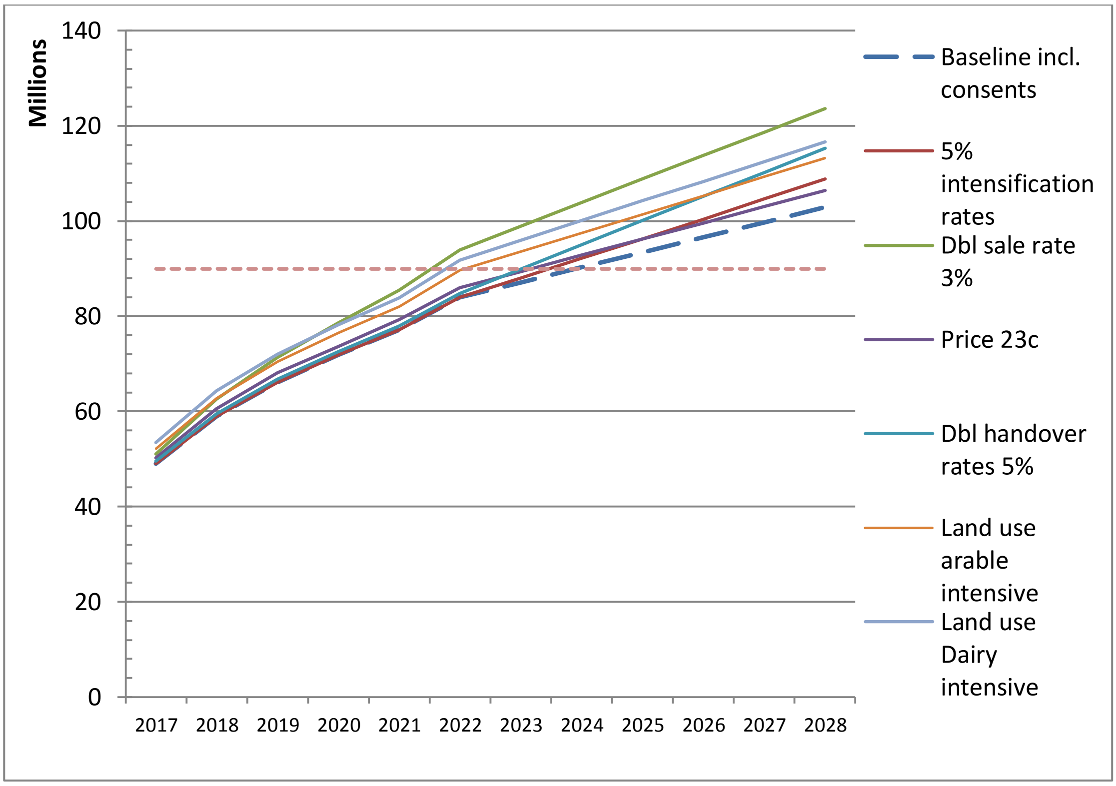
The closest year to full allocation for each of these cases is shown in the table below:

Table 6.3: Sensitivity to changing individual variables in the baseline scenario

	Baseline incl. consents	5% intensification rates	Dbl sale rate 3%	Price 23c	Dbl handover rates 5%	Land use arable intensive	Land use Dairy intensive
2017	49085953	49085953	51105468	50193795	49578982	52247313	53424659
2018	58938516	58938516	62603331	60514226	59550359	62861726	64322798
2019	66112523	66112523	71367497	68050712	66788038	70444003	72057123
2020	71803982	71803982	78635349	73671971	72529404	76455471	78187768
2021	77095818	77095818	85498396	79233326	77865964	82034087	83873186
2022	83923290	83923290	93972051	85980227	84813133	89629068	91754000
2023	87101096	88008685	98927677	89387053	89915279	93565552	95914340
2024	90263121	92110711	103867869	92794410	94998220	97486005	100058385
2025	93425302	96246931	108808573	96202309	100077825	101406360	104202063
2026	96587641	100419055	113749800	99610761	105154028	105326615	108345365
2027	99750144	104628878	118691559	103019778	110226760	109246767	112488286
2028	102912812	108878286	123633861	106429369	115295951	113166816	116630816

The sensitivity of the result to different individual variables is shown graphically below.

Figure 6.5: Sensitivity to changing individual variables in the baseline scenario



7 Conclusion

The forecast in this report is based on a reference price and service scenario: a water price of $0.25 per m^3 under a long-term take-or-pay contract, delivered at medium pressure to a single connection point at the farm gate. Further development of pricing and service options could further influence earlier uptake.

The design of the distribution system will have an important influence on the on-farm economics of irrigation. MRB, who also assume a reference case of the single point of connection, estimate reasonable, but not spectacular, returns from the additional on-farm investment in irrigation. However, in practice, the layout of the distribution system may enable multiple pressurised connections to the distribution network at different location on the property. This would substantially reduce the required on-farm investment, increasing returns to irrigation. Hence, the specifics of the distribution layout could have a significant impact on the immediate attractiveness of irrigation and the rates of uptake.

The design of the distribution system may also have an effect on farmer sentiment and the incentive to act. Targeting the roll-out of the distribution network to clusters of farmers may be an opportunity to increase early uptake, as well as to reduce distribution costs. For example, if connections would only be provided if more than, say, half the farmers within an identified cluster pre-commit in some form, those who prefer to irrigate may invest time and effort in explaining the benefits of irrigation to their more conservative neighbours. This may reduce the reluctance of the incumbents to switch to irrigated land use.

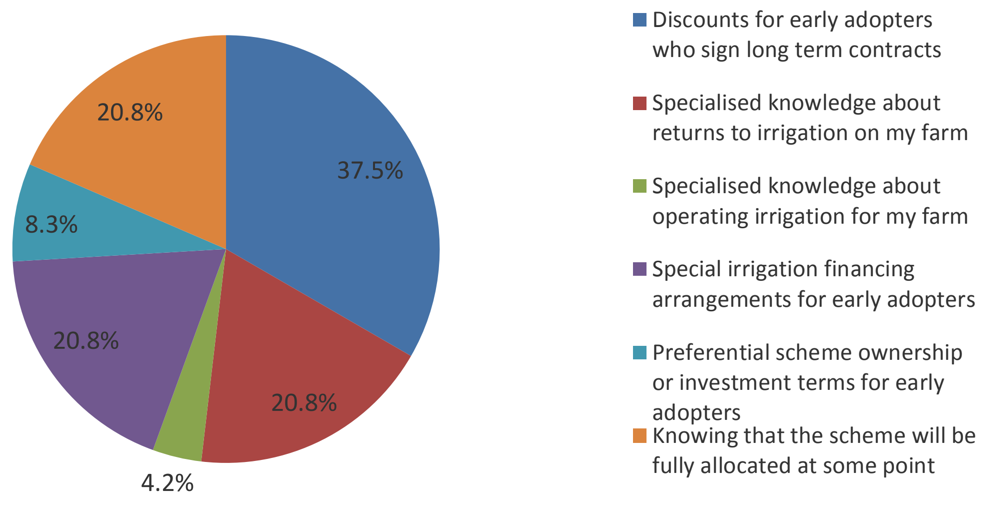
Overall, the reference service assumption of a single connection being available at the gate would, in our view, tend to produce more conservative replies to the survey, and induce more conservative behaviours than could be possible with alternative network roll-out models.

Our survey of farmers also indicates that the factors which are likely to affect the rate of adoption fall into three broad categories:

- Roughly 25 percent of the respondents highlighted lack of knowledge about irrigation, whether financial or technical, as a key factor. This group, it appears, could be influenced by well-targeted educational activities, as well as by the actions of their neighbours (given the informal information exchange with the neighbours)
- About 65 percent indicated a sensitivity to price and to how the offering is structured. For example, about 21 percent of the respondents indicated that special financing for conversion would influence their decision on whether to adopt the Scheme early. We understand that lending for conversion would generally be available for farmers who meet the typical lending criteria for their existing operations. Hence, for those farmers, special financing would be a form of price discount rather than a form of liquidity support. For some farmers, however, access to liquidity may be a more important constraint. Targeted incentives for early adoption could also have a role
- Finally, about 20 percent of the farmers in the survey indicated that the prospect of the scheme reaching its capacity would drive take up.

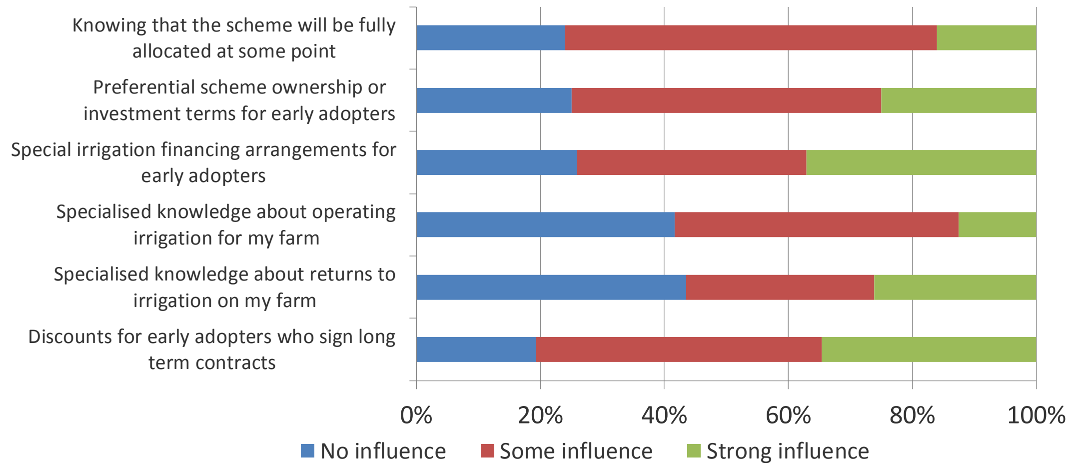
The figure below presents the survey responses.

Figure 7.1: Factors influencing early adoption



The chart below shows the strength of the above influences, as indicated by the survey.

Figure 7.2: Early adoption drivers



Overall, the forecasts presented in this report suggest a range of possible scenarios for the take up of the RWSP. However, given the current phase of project development, these forecast scenarios could only be developed for:

- A reference service offering (single medium pressure connection at the gate)
- A reference price (25 cents per m^3), and
- A reference contract (long-term take-or-pay).

In practice, the demand for water from the scheme, and in particular early adoption, will depend on the factors discussed in this section: price, contract structure, distribution layout and roll-out plan, zonal water allocations and so on.

The risks around the forecast scenarios need to be understood within the context of further project development. The risks will evolve as the project becomes more defined, and as pricing and marketing strategies emerge.

Appendix A: Total Demand Scenarios

Table 7.1: Total demand scenario forecasts at 25cents per m^3 (incl & excl. consents) and full allocation highlighted

		Baseline excl.	High excl.	Low excl.	Baseline incl.	High incl.	Low incl.
Y1	**2017**	26754953	38279659	19901711	50182202	60093264	44834495
Y2	**2018**	36607516	52647919	26855901	59886422	74549654	52289364
Y3	**2019**	43781523	62758167	31766918	66728690	84270517	57376419
Y4	**2020**	49472982	72092100	36167028	72042629	92492952	61871431
Y5	**2021**	54764818	81384880	40799005	76939710	100097044	65940040
Y6	**2022**	61592290	92136603	45576963	83621775	109452256	70978436
Y7	**2023**	65163976	97528434	47332628	86568123	114669381	73326360
Y8	**2024**	68737300	102922410	49088292	89498598	119886333	75674283
Y9	**2025**	72312323	108318620	50843957	92429136	125103112	78022207
Y10	**2026**	75889110	113717154	52599621	95359737	130319715	80370130
Y11	**2027**	79467729	119118108	54355286	98290403	130319715	82718054
Y12	**2028**	83048249	124521579	56110951	101221135	130319715	85065977
Y13	**2029**	86630744	129927672	57866615	104151935	130319715	87413901
Y14	**2030**	90215289	135336492	59622280	107082804	130319715	89761824
Y15	**2031**	93801963	135336492	61377944	110013743	130319715	92109748
Y16	**2032**	97390847	135336492	63133609	112944754	130319715	94457672
Y17	**2033**	100982025	135336492	64889274	115875838	130319715	96805595
Y18	**2034**	104575587	135336492	66644938	118806996	130319715	99153519
Y19	**2035**	108171624	135336492	68400603	121738231	130319715	101501442
Y20	**2036**	111770231	135336492	70156267	124669543	130319715	103849366
Y21	**2037**	115371506	135336492	71911932	127600934	130319715	106197289
Y22	**2038**	118975553	135336492	73667597	130532407	130319715	108545213
Y23	**2039**	122582479	135336492	75423261	130532407	130319715	110893136
Y24	**2040**	126192394	135336492	77178926	130532407	130319715	113241060
Y25	**2041**	129805414	135336492	78934590	130532407	130319715	115588983
Y26	**2042**	133421659	135336492	80690255	130532407	130319715	117936907
Y27	**2043**	133421659	135336492	82445920	130532407	130319715	120284830
Y28	**2044**	133421659	135336492	84201584	130532407	130319715	122632754
Y29	**2045**	133421659	135336492	85957249	130532407	130319715	124980677
Y30	**2046**	133421659	135336492	87712913	130532407	130319715	127328601
Y31	**2047**	133421659	135336492	89468578	130532407	130319715	127328601
Y32	**2048**	133421659	135336492	91224243	130532407	130319715	127328601
Y33	**2049**	133421659	135336492	92979907	130532407	130319715	127328601
Y34	**2050**	133421659	135336492	94735572	130532407	130319715	127328601
Y35	**2051**	133421659	135336492	96491236	130532407	130319715	127328601

Appendix B: Baseline Land Use with Consents

Table 7.2: Baseline forecast by land use with existing consents

		Water demand in millions of m3							
		Sheep and Beef	Finishing	Mixed arable and dairy support	Orchard	Arable	Vineyard	Dairy	Total
Y1	**2017**	2479872	2692275	5621709	1383160	16136436	187260	21681489	50182202
Y2	**2018**	3162345	4165235	7348405	1470862	18626868	227002	24885704	59886422
Y3	**2019**	3492538	4993893	8807318	1516869	21030808	245744	26641520	66728690
Y4	**2020**	3795168	6356867	9306933	1552467	22631948	259244	28140001	72042629
Y5	**2021**	4087422	6902339	9451729	1584147	25101704	270770	29541600	76939710
Y6	**2022**	4529801	7571024	9960603	1672516	27232170	310849	32344812	83621775
Y7	**2023**	4687824	7743150	10343833	1732187	27884138	340903	33836088	86568123
Y8	**2024**	4845792	7915215	10726929	1791838	28536965	370947	35310913	89498598
Y9	**2025**	5003703	8087219	11109888	1851467	29190669	400980	36785211	92429136
Y10	**2026**	5161556	8259160	11492707	1911074	29845266	431002	38258971	95359737
Y11	**2027**	5319351	8431037	11875384	1970659	30500775	461014	39732183	98290403
Y12	**2028**	5477086	8602849	12257916	2030221	31157214	491013	41204836	101221135
Y13	**2029**	5634760	8774594	12640300	2089760	31814601	521001	42676919	104151935
Y14	**2030**	5792372	8946272	13022532	2149276	32472955	550977	44148419	107082804
Y15	**2031**	5949920	9117880	13404611	2208768	33132296	580942	45619327	110013743
Y16	**2032**	6107403	9289418	13786532	2268235	33792644	610893	47089629	112944754
Y17	**2033**	6264820	9460883	14168293	2327677	34454018	640833	48559314	115875838
Y18	**2034**	6422170	9632275	14549890	2387094	35116439	670759	50028369	118806996
Y19	**2035**	6579451	9803593	14931320	2446485	35779928	700672	51496782	121738231
Y20	**2036**	6736661	9974833	15312581	2505849	36444507	730572	52964539	124669543
Y21	**2037**	6893800	10145996	15693667	2565187	37110196	760459	54431629	127600934
Y22	**2038**	7050867	10317079	16074577	2624496	37777020	790331	55898037	130532407
Y23	**2039**	7207858	10488082	16455306	2683778	38444999	820189	57363749	133463961
Y24	**2040**	7364774	10659001	16835851	2743031	39114157	850033	58828753	136395600
Y25	**2041**	7521612	10829836	17216208	2802255	39784518	879862	60293033	139327324
Y26	**2042**	7678371	11000585	17596373	2861449	40456106	909676	61756575	142259136
Y27	**2043**	7835050	11171246	17976343	2920612	41128946	939475	63219365	145191036
Y28	**2044**	7991646	11341818	18356113	2979744	41803062	969258	64681387	148123028
Y29	**2045**	8148159	11512298	18735680	3038845	42478479	999025	66142626	151055113
Y30	**2046**	8304586	11682685	19115040	3097913	43155225	1028776	67603067	153987292
Y31	**2047**	8460925	11852977	19494188	3156949	43833325	1058511	69062693	156919567
Y32	**2048**	8617176	12023172	19873120	3215951	44512807	1088228	70521488	159851941
Y33	**2049**	8773336	12193269	20251832	3274918	45193698	1117928	71979435	162784416
Y34	**2050**	8929403	12363264	20630319	3333851	45876026	1147611	73436518	165716993
Y35	**2051**	9085376	12533157	21008578	3392748	46559821	1177275	74892720	168649674

Appendix C: Baseline Land Use without Consents

Table 7.3: Baseline forecast by land use without existing consents

		Water demand in millions of m3							
		Sheep and Beef	Finishing	Mixed arable and dairy support	Orchard	Arable	Vineyard	Dairy	Total
Y1	**2017**	3032821	3325180	5442946	393823	4535383	192572	9832228	26754953
Y2	**2018**	3871206	4975343	7181513	492651	6840515	237904	13008384	36607516
Y3	**2019**	4298806	5914054	8680387	549852	9197632	262276	14878516	43781523
Y4	**2020**	4684240	7370320	9226977	596661	10786515	281417	16526853	49472982
Y5	**2021**	5053798	8002772	9421386	639558	13257028	298587	18091688	54764818
Y6	**2022**	5653026	8849735	9941681	739052	15199977	344255	20864563	61592290
Y7	**2023**	5972936	9204679	10395612	817886	15783207	383948	22605708	65163976
Y8	**2024**	6292683	9559441	10849311	896680	16367235	423622	24348329	68737300
Y9	**2025**	6612261	9914015	11302771	975432	16952073	463274	26092497	72312323
Y10	**2026**	6931665	10268398	11755985	1054141	17537736	502905	27838280	75889110
Y11	**2027**	7250891	10622582	12208945	1132806	18124237	542514	29585754	79467729
Y12	**2028**	7569933	10976562	12661644	1211426	18711590	582100	31334994	83048249
Y13	**2029**	7888785	11330332	13114074	1289999	19299809	621662	33086083	86630744
Y14	**2030**	8207442	11683885	13566228	1368524	19888908	661201	34839103	90215289
Y15	**2031**	8525898	12037215	14018095	1447000	20478901	700714	36594141	93801963
Y16	**2032**	8844146	12390315	14469669	1525424	21069802	740201	38351289	97390847
Y17	**2033**	9162181	12743178	14920940	1603796	21661628	779662	40110641	100982025
Y18	**2034**	9479996	13095797	15371898	1682113	22254391	819096	41872296	104575587
Y19	**2035**	9797584	13448164	15822535	1760375	22848107	858502	43636358	108171624
Y20	**2036**	10114938	13800272	16272839	1838579	23442791	897878	45402933	111770231
Y21	**2037**	10432052	14152112	16722802	1916724	24038459	937225	47172133	115371506
Y22	**2038**	10748916	14503677	17172412	1994807	24635124	976541	48944075	118975553
Y23	**2039**	11065525	14854957	17621659	2072827	25232804	1015825	50718881	122582479
Y24	**2040**	11381870	15205945	18070531	2150783	25831513	1055076	52496676	126192394
Y25	**2041**	11697942	15556630	18519017	2228671	26431268	1094294	54277593	129805414
Y26	**2042**	12013733	15907004	18967104	2306490	27032083	1133476	56061769	133421659
Y27	**2043**	12013733	15907004	18967104	2306490	27032083	1133476	56061769	133421659
Y28	**2044**	12013733	15907004	18967104	2306490	27032083	1133476	56061769	133421659
Y29	**2045**	12013733	15907004	18967104	2306490	27032083	1133476	56061769	133421659
Y30	**2046**	12013733	15907004	18967104	2306490	27032083	1133476	56061769	133421659
Y31	**2047**	12013733	15907004	18967104	2306490	27032083	1133476	56061769	133421659
Y32	**2048**	12013733	15907004	18967104	2306490	27032083	1133476	56061769	133421659
Y33	**2049**	12013733	15907004	18967104	2306490	27032083	1133476	56061769	133421659
Y34	**2050**	12013733	15907004	18967104	2306490	27032083	1133476	56061769	133421659
Y35	**2051**	12013733	15907004	18967104	2306490	27032083	1133476	56061769	133421659

Appendix D: Project Background

Ruataniwha is an area where agricultural production is limited by the availability of water. Three consecutive years of drought has seen increased interest in irrigation. Run-of-river surface water resources are fully allocated, and further allocation of shallow ground water has been put on hold until the relationship with surface water is better understood. This provides a strong rationale for investigating options for expanding the water supply through an irrigation scheme, as long as the productivity improvements from irrigation outweigh the costs of the scheme.

This section explores what productivity improvements the RWSP could provide—focusing in particular on improving the reliability of water supply to farms in the area. We then look at how land in the area is currently used, and how land use might change with more reliable water supply. Finally, we establish a benchmark level of reliability that the RWSP would need to deliver to achieve the project's objective, and we consider what land area the scheme would need to cover.

D.1 The Scheme provides Water Reliability

Further intensification of land use in the Hawkes Bay is limited to a large extent by water reliability. Reliability expresses how often a water supply fails to deliver sufficient water for the needs of the user. Reliability is commonly expressed as a percentage or as an expected failure frequency—for example, a 90 percent storage system has a 10 percent chance of failing, or a one-in-ten failure rate. The normal rainfall pattern will reflect a natural level of reliability (the drought frequency).

Average annual rainfall in the east of the area is 800mm, increasing to 1,000mm on the western boundary. The one-in-five year drought figures for January rainfall range from 20-30 mm. More detailed analysis of rainfall patterns shows there is considerable annual variation.

A water storage scheme enables a higher level of reliability of water supply. Water resource investigations for the RWSP to date have aimed at confirming the required dam storage capacity for delivery of 19 in 20 year reliability to 25,000 Ha of area.

By taking water from the RWSP, farmers would be purchasing the right to draw water up to the amount of their contract every year. Farmers are therefore purchasing water reliability at a level of 19 in 20 years for the land use of their choice, a significant improvement on the natural level of reliability of 3 in 4 years for existing land uses. The rationale for the RWSP is that this improved reliability will enable intensification of some land uses, will allow for profitable farming uses that are not currently contemplated due to limits on water reliability.

D.2 Current Land Uses in the Region

Current land uses in the Ruataniwha Plains area are described in the table below. These farm types are partially irrigated as described.

Table 7.4: Current Land Uses in the Ruataniwha Plains Area

	Farm Type	Current Land Use		
		Irrigated Land (ha)	Dry Land (ha)	Total (ha)
1	Sheep & Beef	0	15,750	15,750
2	Mixed Livestock	0	6,300	6,300
3	Finishing	0	9,128	9,128
4	Mixed Arable & Dairy Support	0	0	0
5	Arable	3,000	6,000	9,000
6	Dairy (heavy soils)	0	700	700
7	Dairy (light soils)	2,600	867	3,467
8	Orchard	400	0	400
9	Vineyard	0	0	0
	Total	**6,000**	**38,745**	**44,745**

Source: MarFarlane (2012)

The region contains a variety of different soils types. 'Light' and 'heavy' soils are colloquial descriptions for soil that is more and less (respectively) susceptible to drought.

By improving the reliability of water, current land uses could be intensified, and higher-value land uses could be adopted. MRB estimates that the RWSP could irrigate an additional 25,000 ha of farm land (current irrigation is approximately 6,000 ha as described in table 2.1 above).

D.3 Water Demands for Different Land Uses

Modelling of irrigation demand is based on historical and future climate and rainfall datasets from NIWA's Virtual Climate Network (VCN). Irrigation is a way of supplementing the natural rainfall, in order to offset moisture losses through evapotranspiration in the air or through plant growth.

Deficit irrigation is where irrigation is only applied during drought-sensitive periods. Outside these periods, irrigation is limited or even unnecessary—provided rainfall delivers a minimum supply of water for plant growth required by the land use. In this sense, irrigation water is a hedge intended to offset potential losses that may be incurred through periods of reduced rainfall or drought. As land uses intensify the hedge becomes more and more likely to be used.

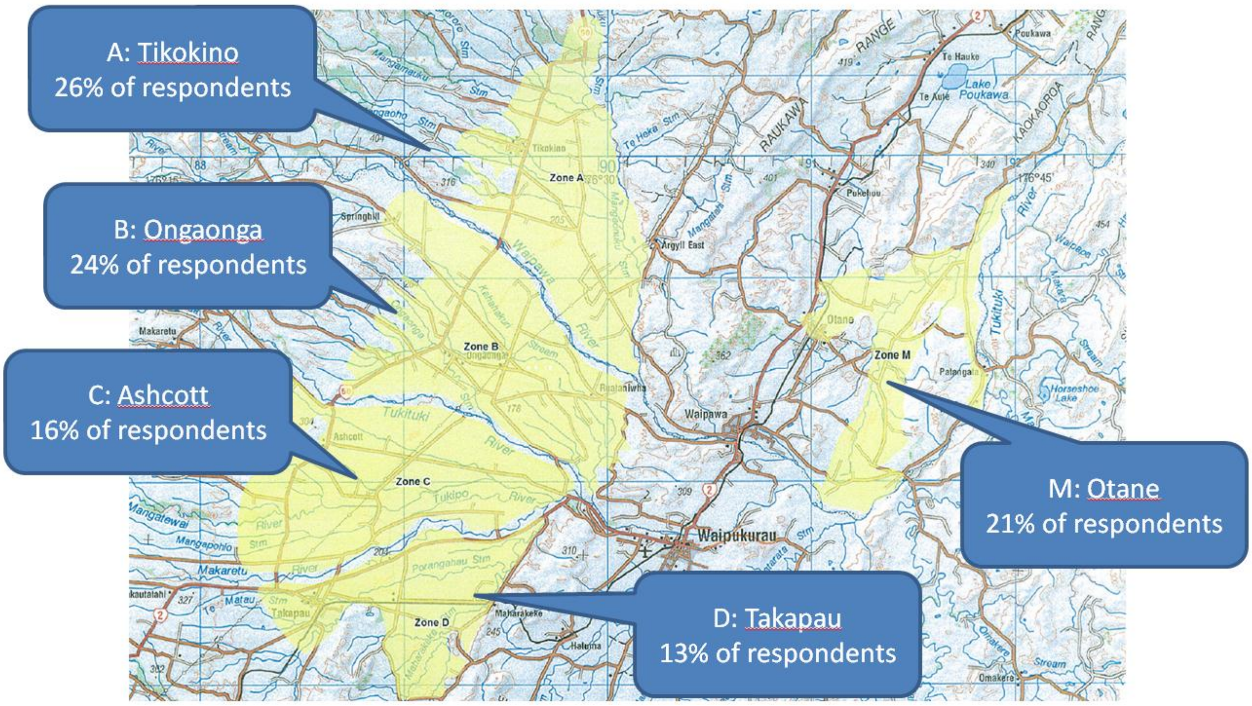
D.4 The RWSP's Targeted Reliability is 1 in 20 Years

An irrigation demand of 3,500 m^3 per hectare in a 1 in 20 dry year has been considered by Tonkin and Taylor as an appropriately conservative area average demand. On this basis, a gross water storage requirement of 4,000 m^3/ha of irrigated land has been adopted for assessment of storage potential and arrangements. This allows for losses due to erosion and sedimentation, caused by the dam infrastructure.

D.5 Project Capability to Deliver Water

The map below describes the projects expected area of distribution defined by five zones (A,B,C,D and M) and identifies the proportions of responses to the farmer survey.

Figure 7.3: Irrigation zone maps



Source: HBRC 2012

There is a trade-off between distributing water to a wider area to increase initial demand and the cost of that distribution. The area that water can be distributed to is smaller than the total area that will be impacted by land use change associated with irrigation. The area that water can be distributed to has been increased incorporating a zone previously outside the distribution area (zone M). The expectation is that the total area distributable is 34,700 hectares, while the total area, including the areas of command and influence, is 42,100 hectares.

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