Cost of Irrigation Scheme Water Supply in New Zealand

2014 UPDATE

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Executive summary

In 2012 Irrigation New Zealand (INZ) and Aqualinc Research Ltd (Aqualinc) conducted a survey of the cost of surface water irrigation schemes in Canterbury. From this data set a standardised cost comparison for the delivery of water to the farm gate was produced. As a further comparison the cost of installing and operating a groundwater supply was also included.

INZ conducted interviews with representatives from the irrigation schemes. From this information the annualised cost for each scheme, standardised as $/ha/year and $/m^3 of water supplied was calculated. Since the initial report (Survey of Costs of Surface Water Irrigation Schemes in Canterbury, 2012) INZ have expanded the dataset to include Otago, Canterbury, Marlborough and Northland irrigation schemes. INZ will continue to expand this dataset and update the report to keep the information comprehensive and current.

The report contains standardised costs for the delivery of water to the farm gate. It does not include any costs incurred inside the farm boundary. An adjustment is made to the cost where it is delivered under pressure to reflect and balance the costs against the schemes that deliver at zero pressure (i.e. open channel). Adjustment is also made to match all scheme costs to a supply reliability of 95%.

This report is the first update to the 2012 report. In 2014 the mean cost of water supplied by irrigation schemes was calculated as approximately $770/ha/year and $0.14/m^3. However, the range of costs is large, $130 – 1,350/ha/year or $0.01 – 0.43/m^3. Contributing factors include the range of scheme ages, the purchase or development cost of the scheme, the need and extent of infrastructure required, and differences in ongoing operational expenses.

The mean irrigation scheme costs of $770/ha/year or $0.14/m^3 are likely to be similar to a groundwater supply pumping from a depth of 85 metres and assuming an electricity rate (including capacity charges) of $0.20/kWh.

A detailed survey of land prices was not conducted as part of this project but may warrant further work in the future, as some capital cost may be capitalised into the underlying land value.

Results

The results show that the effective price of water supplied by the schemes ranged from approximately $130 – 1,350/ha/year or $0.01 – 0.43/m^3. The mean cost of water supplied by the schemes was calculated as approximately $770/ha/year or $0.14/m^3. The normalised cost of each scheme is shown in Figures 1 and 2 overleaf. The methodology used to normalise these costs is discussed within the Survey Methodology section.

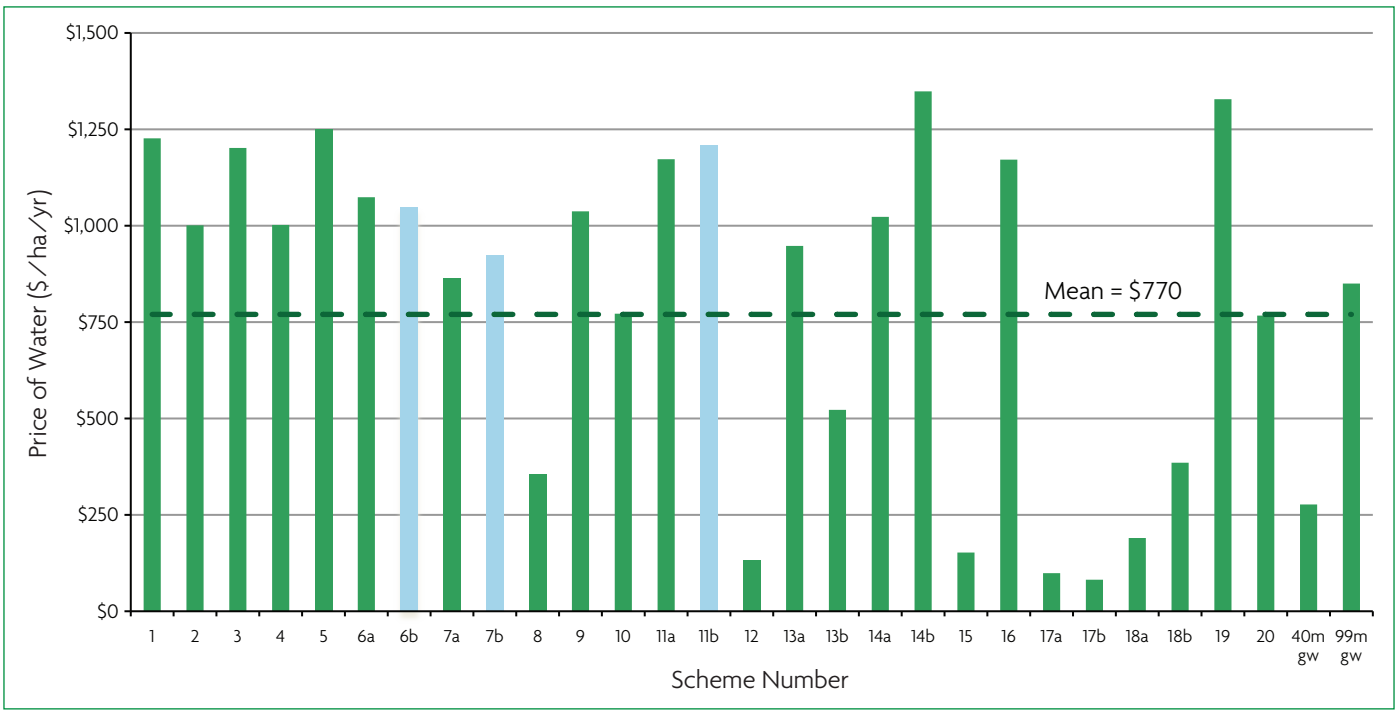

Figure 1. Cost of water $/ha/yr.

Cost of each of the surveyed irrigation schemes, normalised to $/ha/year.

Figure 2. Cost of water $/m³.

Cost of each of the surveyed irrigation schemes, normalised to $/m³.

Notes:

1. Current scheme setups are shown in green, while future development scenarios are shown in blue. The mean value includes only the "current" scenarios. Schemes are numbered with alternative scenarios, or different parts of the scheme (e.g. borderdyke or spray) separated by "a" or "b" distinctions.
2. The $/m³ is calculated using the maximum allocated volumes or default volume values (see normalisation process and assumptions section). For both Figures 1 and 2, the two groundwater costs (40m gw and 99m gw) are not included in the mean calculations.
3. Scheme number 19 is a piped delivery to viticulture crops and has a maximum system capacity of 1.8 mm/ha/day; in comparison all other schemes deliver between 3.5 to 8.3 mm/ha/day. The low system capacity has the effect of inflating the m³ cost as the capital cost is concentrated on a smaller volume.

Discussion

This report standardises scheme costs to a $ per ha and per m^3 figure based on the maximum volume allocated or default volumes (see normalisation process and assumptions section). If a scheme charges on a per ha basis and in any one year the actual usage is less than the allocated volume it has the effect of pushing the per m^3 price paid for water in that year higher (even though the actual costs stays the same) and similarly a pricing regime on a per m^3 basis the costs per ha will vary with actual use. Once an annual volume has been reached then the irrigator must negotiate with the scheme to access more water if it is available.

There are a number of factors contributing to the large range in reported costs. Contributing factors identified include the following.

SCHEME AGE

Some of the irrigation schemes in Canterbury and Otago are 40+ years old, having been initiated prior to the 1970's. Others have only been constructed in more recent years, or are currently expanding and/or upgrading infrastructure. Many of the older schemes have a cost advantage with most or all of their capital having been paid off and their costs (e.g. share prices or annual costs) reflect only the ongoing operation and maintenance costs.

CAPITAL COST OF INFRASTRUCTURE

Each of the irrigation schemes has invested in a different mixture of infrastructure, according to their location and the physical properties of the land in the area. For example, some schemes were able to make use of existing natural channels to supply water to land directly adjacent to the channels, resulting in a very low level of infrastructure investment and a low annualised cost as shown in Figures 1 and 2. Alternatively, schemes that have invested heavily in infrastructure (constructed open channel networks or pipe/pump systems) tended to have higher annualised costs.

OPERATIONAL EXPENSES

Ongoing operational expenses are a significant component of scheme costs. Operational expenses cover labour, administration, governance, infratsructure maintenance, electricity, debt servicing and repayments. Each scheme has a mix of different costs depending on the nature of the scheme and its situation. These costs have not been broken down further for this report.

The majority of irrigation schemes are run on a cooperative basis with costs reflecting the actual cost of operation. Few irrigation schemes have been accruing a capital replacement fund to account for future maintenance and upgrades.

It is also suspected that the true cost of water to a farmer within these schemes is further mixed up with the cost of land. Land values within scheme boundaries have not been compared to land outside either irrigated or dryland. A detailed survey of land prices was not conducted as part of this project. This may warrant further work in the future.

Comparison to groundwater

Aqualinc calculated the expected cost to develop and operate a groundwater supply as an alternative to the irrigation scheme supplies. The primary factors affecting this cost are the groundwater depth and the electricity price.

Figures 3 and 4 show the approximate annualised cost to install and operate a groundwater supply as the primary irrigation source, using the assumptions outlined in the Groundwater Pumping Methodology section.

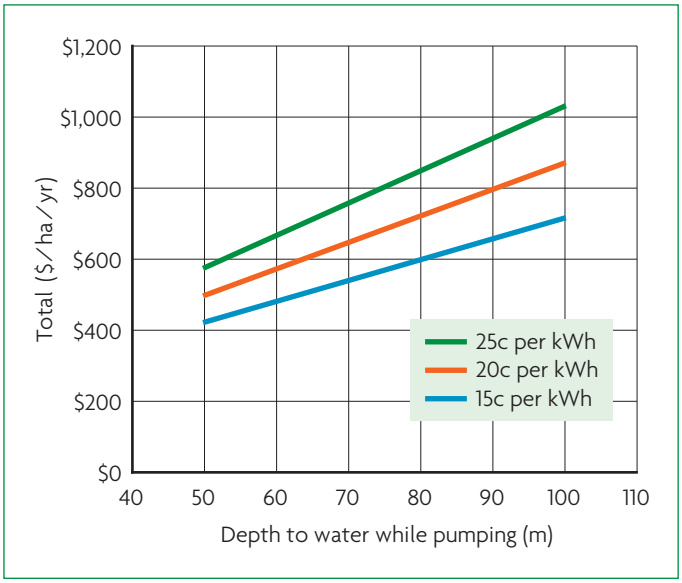

Figure 3. Calculated annualised cost of installing and operating a groundwater supply in the Canterbury region in $/ha/year.
These costs are based on groundwater being available for abstraction and do not include power extension or transformer costs

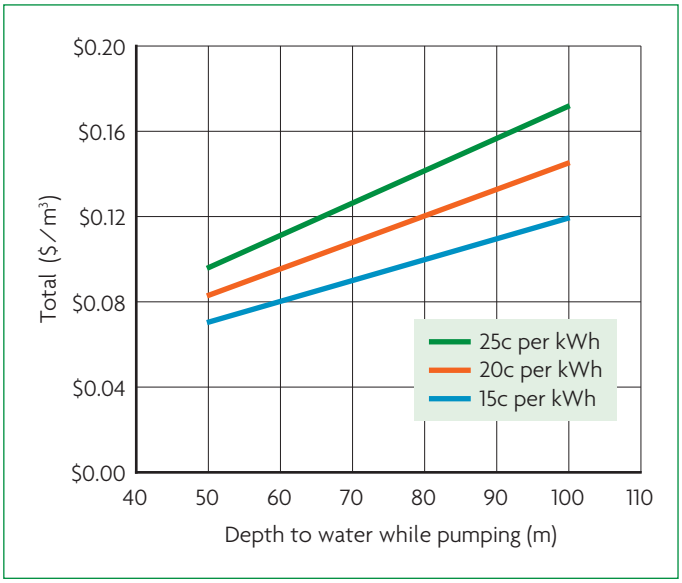

Figure 4: Calculated annualised cost of installing and operating a groundwater supply in the Canterbury region in $/m³.
These costs are based on groundwater being available for abstraction and do not include power extension or transformer costs.

According to these calculations, the following scenarios would be comparable in cost to the mean $/ha scheme cost of $770/ha/yr:

- Install and operate a well at a pumping depth of 70 m and an electricity price of 25c/kWh.
- Install and operate a well at a pumping depth of 85 m and an electricity price of 20c/kWh.

These results depend heavily on a number of assumptions (see Groundwater Pumping Methodology Section) and actual implemented costs are likely to differ from these reported values. Some key influencing factors not previously discussed include the drilling and well installation cost, the total water applied over a season, flow rate, pumping efficiency, system capacity, and the area of land being irrigated. Many of these factors will vary from property to property, and many will vary from season to season.

Survey methodology

INZ conducted interviews with representatives from the following irrigation schemes (shown alphabetically):

- Acton irrigation Ltd
- Amuri Irrigation Company Ltd (includes Waiau and Balmoral irrigation schemes)
- Ashburton Lyndhurst Irrigation Ltd
- Barhill Chertsey Irrigation Ltd (BCIL)
- Eiffelton Community Irrigation Scheme
- Greenstreet Irrigation Society Ltd.
- KeriKeri Irrigation company
- Kurow-Duntroon Irrigation company
- Lower Waitaki Irrigation company
- Manuherikea Irrigation company
- Mayfield Hinds Irrigation Ltd.
- Morven-Glenavy-Ikawai (MGI)
- North Otago Irrigation company (NOIC)
- Opuha Water Ltd – Kakahu
- Opuha Water Ltd – Levels Plains
- Opuha Water Ltd – Sutherland
- Opuha Water Ltd – Totara Valley
- Southern Valley Irrigation
- Valetta Irrigation Ltd
- Waimakariri Irrigation Ltd

The questions asked of each of the schemes were:

- What is the share price to buy into the scheme?
  (assuming there was water available and an ability to connect)
- What is the entitlement associated with a share?
- What are the annual charges?
- Are there any variable (i.e. 'pay for what you use') charges?
- Is there a requirement for storage?
- What is the reliability of the scheme?

The main components of this database are included as Table 1. Each scheme was given an identification number. Where there was more than one cost schedule within a single irrigation scheme, two lines were entered into the database, with an "a" or "b" distinction. For example, identification number 13a refers to a border-dyke cost schedule, and 13b refers to a spray irrigation cost schedule. The same identification numbers are used throughout this document. A list of the schemes and their corresponding identification numbers is purposely omitted to maintain anonymity. Anonymity was a condition of the interview process, as agreed by the irrigation scheme representatives.

Table 1:

ID	Share Price ($)	Share Basis (ℓ/s, m³, ha)	On-farm Storage reqt $/ha	Annual Charge ($)	Annual Charge Basis (ℓ/s, m³, ha)	Variable Charge ($)	Variable Charge Basis (ℓ/s, m³, ha)	Maximum System Capacity (mm/day)	Piped or Open Channel	Continuous Supply or Roster supply	Delivery Pressure (bar)	Reliability Estimate (%)	Seasonal Limit (m³/ha)
1	$3,000	ℓ/s	–	$1,335	ℓ/s	$0.065	m³	5.2	P	CS	4	97%	–
2	$4,750	ha	–	$228	ha	–	–	3.6	OC	CS	0	95%	5,625
3	$4,750	ha	–	$429	ha	–	–	3.6	OC	CS	0	95%	5,625
4	$4,750	ha	–	$229	ha	–	–	3.6	OC	CS	0	95%	5,625
5	$4,750	ha	–	$478	ha	–	–	3.6	OC	CS	0	95%	5,625
6a	$15,000	ℓ/s	–	$85	ha	–	–	3.5	OC	RS	0	95%	–
6b	$15,000	ℓ/s	–	$250	ha	–	–	3.5	P	CS	4	95%	–
7a	$4,750	ha	–	$90	ha	–	–	3.5	OC	RS	0	95%	–
7b	$5,000	ha	–	$300	ha	–	–	5.0	P	CS	4	95%	–
8	$5	ha	–	$30	ha	–	–	4.0	OC	RS	0	75%	–
9	$12,000	ℓ/s	–	$240	ha	–	–	4.4	P	CS	4	95%	–
10	$4,300	ha	–	$72	ha	–	–	5.2	OC	CS	0	94%	–
11a	$4,550	ha	–	$107	ha	–	–	4.5	OC	CS	0	75%	–
11b	$4,550	ha	–	$217	ha	–	–	4.5	OC	CS	0	90%	–
12	$0	ha	–	$131	ha	–	–	3.5	OC	CS	0	95%	–
13a	$2,136	ha	–	$60	ha	$0.06	m³	4.7	OC	RS	0	98%	9,000
13b	$2,390	ha	–	$48	ha	$0.06	m³	4.5	P	CS	6	98%	6,900
14a	$1,850	ha	–	$600	ha	$0.06	m³	3.5	P	CS	5	99%	–
14b	$3850	ha	–	$600	ha	$0.06	m³	3.5	P	CS	5	99%	–
15	$40	ha	–	$118	ha	$0.02	m³	3.5	P	CS	1.5	99%	3,000
16	$1,302	ℓ/s	$146	$765	ℓ/s	–	–	3.9	OC	CS	0	82%	–
17a	$300	ha	–	$50	ha	–	–	6.3	OC	RS	0	99%	–
17b	$300	ha	–	$33	ha	–	–	4.3	OC	CS	0	99%	–
18a	$0	ha	–	$190	ha	–	–	8.3	OC	RS	0	99%	10,000
18b	$0	ha	$1,200	$190	ha	–	–	5.0	OC	RS	0	99%	6,000
19	$4,197	ha	–	$0	ha	$0.222	m³	1.8	P	CS	3	85%	–
20	$2,500	ha	–	$160	ha	–	–	4.0	OC	RS	0	85%	–

Notes to Table 1:

1. The blue shaded lines represent future scenarios that are under investigation.
2. Reliability is only an approximation.
3. Line 18b – the on-farm storage number is provisional.
4. Line 12 – unable to determine the share price as there have been no separate sales of irrigation shares.
5. Lines 17a and b – it is the purchasers responsibility to pay for the infrastructure cost of getting water from the existing scheme infrastructure to their property.

Normalisation process and assumptions

The values in the database were "normalised" to calculate the cost of each irrigation scheme in $/ha/year and $/m^3. Normalisation was undertaken using the following steps. Results are summarised in Table 2.

- **Annualise the share cost**
  All share costs were first converted to a $/ha basis. Many of the schemes already used this basis for their share prices. The maximum allowable system capacity (i.e. mm/day) was used to convert share prices that were originally based on flow rate. This one-off share cost was then annualised at a rate of 10% for 10 years to obtain the share cost in $/ha/year.

- **Normalise fixed costs**
  All fixed annual costs were normalised to $/ha/year basis and summed. Again, many of the schemes already used this basis for their annual charges. The maximum allowable system capacity (i.e. mm/day) was used to convert charges based on flow rate.

- **Normalise variable costs**
  All variable charges (e.g. per m^3 usage charges) were converted to $/ha/year basis by assuming full utilisation of annual allocations. Where no annual allocation was specified, a default figure of 600mm/ha/year for spray and 900mm/ha/year for borderbyke or controlled flood application was assumed to be used over a 100 hectare farm.

- **Adjustment for water supplied under pressure**
  Scheme costs were normalised to zero pressure at ground level. To do this a 'credit' was given where water was delivered under pressure by the scheme. This offset the infrastructure and operating costs that would otherwise be incurred to pressurise the water on-farm. This credit was calculated using a separate pump sizing model, and by assuming: a 100ha farm; 70% pumping efficiency (combined pump and motor efficiency); an electricity price of $0.20/kWh including the capacity charge. Pump capital was annualised at 10% for 10 years. The credit was entered on $/ha/year basis.

- **Calculation of on farm storage requirement**
  For some schemes on farm storage is required. A simple calculation of the volume required per hectare multiplied by a $5/m^3 storage construction cost was used.

- **Adjustment for scheme reliability**
  Reliability of supply was assumed to limit the total volume of 'useful' water that could be obtained for the listed costs in each irrigation scheme. Where reliability estimates were less than 95%, it was assumed that an additional cost would be incurred to develop a supplementary groundwater supply. The assumptions used when calculating the cost of supplementary groundwater supply development are the same as those described in Groundwater Pumping Methodology Section. The pumping depth was assumed to be 80 m and the total volume pumped was assumed to be equal to the volume required to return reliability to 95%.

All of the normalised figures were summed to obtain an overall cost for the irrigation scheme in $/ha/year. A conversion to $/m^3 was completed by assuming full utilisation of annual or default allocations.

The mean normalised cost of all schemes was calculated from the 'current' scenarios (i.e. excluding future development scenarios). The mean does not include the two groundwater cost figures.

Groundwater pumping methodology

Aqualinc developed a model to calculate the cost of installing and operating a groundwater source for irrigation. This model is based on the following assumptions:

- Groundwater is available for abstraction
- 100m bore depth, installed at an estimated cost of $1,000/m
- Pump and electrical equipment prices are based on 2008 prices, plus 15%
- 100ha farm size
- Capital is annualised at 10% for 10 years
- 70% pumping efficiency (combined pump and motor efficiency)
- 4.5 mm/day system capacity
- The costs do not include power extension or transformer costs.

A range of electricity prices and pumping depths was modelled. These two factors have considerable effect on the overall cost of operating a groundwater source for irrigation, and are considered to be highly spatially and temporally variable. Costs were calculated on a $/ha/year basis, and converted to $/$m^3$ by assuming a 600mm/year annual allocation.

Table 2:

ID	Annual water use (mm)	Annualised share and storage cost ($/ha/yr)	Total fixed cost ($/ha/yr)	Total variable cost ($/ha/yr)	Associated on farm costs ($/ha/yr)	Adjustment for reliability of 95%	Total normalised cost ($/ha/yr)	Total normalised cost ($/m³)
1	600	$294	$803	$320	–$190	$0	$1,227	$0.22
2	563	$773	$228	$0	$0	$0	$1,001	$0.19
3	563	$773	$429	$0	$0	$0	$1,202	$0.22
4	563	$773	$229	$0	$0	$0	$1,002	$0.19
5	563	$773	$478	$0	$0	$0	$1,251	$0.23
6a	600	$989	$85	$0	$0	$0	$1,074	$0.19
6b	600	$989	$250	$0	–$190	$0	$1,048	$0.18
7a	600	$773	$90	$0	$0	$0	$863	$0.15
7b	600	$814	$300	$0	–$190	$0	$923	$0.16
8	600	$1	$30	$0	$0	$325	$356	$0.06
9	600	$988	$240	$0	–$190	$0	$1,037	$0.18
10	600	$700	$72	$0	$0	$0	$772	$0.14
11a	600	$740	$107	$0	$0	$325	$1,172	$0.21
11b	600	$740	$217	$0	$0	$250	$1,207	$0.21
12	600	$0	$131	$0	$0	$0	$131	$0.02
13a	900	$348	$60	$540	$0	$0	$948	$0.11
13b	690	$389	$48	$414	–$329	$0	$522	$0.08
14a	600	$301	$600	$360	–$238	$0	$1,023	$0.18
14b	600	$627	$600	$360	–$238	$0	$1,348	$0.24
15	300	$7	$118	$60	–$36	$0	$149	$0.05
16	600	$106	$765	$0	$0	$300	$1,171	$0.21
17a	900	$49	$50	$0	$0	$0	$99	$0.01
17b	600	$49	$33	$0	$0	$0	$82	$0.01
18a	1000	$0	$190	$0	$0	$0	$190	$0.02
18b	600	$195	$190	$0	$0	$0	$385	$0.07
19	325	$683	$0	$722	–$77	$0	$1,328	$0.43
20	900	$407	$160	$0	$0	$200	$767	$0.09

Notes to Table 2:

1. Scheme number 19 is a piped delivery to viticulture crops and has a maximum system capacity of 1.8 mm/ha/day; in comparison all other schemes deliver between 3.5 to 8.3 mm/ha/day. The low system capacity has the effect of inflating the m^3 cost as the capital cost is concentrated on a smaller volume.
2. The annual water use figure relates to either the annual allocated volume or the default volumes. For 13b there are two annual volumes allocated depending on whether the irrigation is onto light or heavy soils. The annual allocation shown is the average of the two and the calculations are using this average figure.

Conclusion

This report is the inaugural update to the 2012 report.

In 2012 the mean normalised cost of water supplied by irrigation schemes was calculated as approximately $830/ha/year and $0.15/m^3. However, the range of cost was large, $130 – 1,250/ha/year or $0.02 – 0.23/m^3. The 2012 survey only encompassed 13 of the Canterbury schemes.

In 2014 the data set was grown to 20 schemes from throughout New Zealand. As a result the mean normalised cost of water supplied by irrigation schemes is now calculated as approximately $770/ha/year and $0.14/m^3. Again, the cost range is large, $130 – 1,350/ha/year or $0.01 – 0.43/m^3.

The reason why the mean cost has decreased since the 2012 report is the expanded data set now includes several older schemes that are in the early stages of modernisation.

Of the original 13 schemes surveyed, 8 schemes have increased their costs since 2012, each rising between 4 and 20%. Increases have been driven primarily by modernisation – upgrading of schemes to incorporate on-scheme and off-scheme storage (access to Lake Coleridge water for example) and piping.

The majority of New Zealand irrigation schemes are privately owned and run on a cooperative basis. Costs tend to reflect the actual cost of operation. Few irrigation schemes have been accruing a capital replacement fund to account for future maintenance and upgrades.

The mean irrigation scheme cost of $770/ha/year or $0.14/m^3 is comparable to a groundwater supply pumping from a depth of 85 metres and assuming an electricity rate (including capacity charges) of $0.20/kWh.

A detailed survey of land prices was not conducted as part of this project but warrants further work in the future, as some capital cost may be capitalised into the underlying land value.

Reference

Irrigation NZ, Aqualinc. (2012) *Survey of Costs of Surface Water Irrigation Schemes in Canterbury*.