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Lower Manuherikia Valley distribution

Prepared for the Manuherikia Catchment Water Strategy Group

Report C12119/6

October 2012

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EXECUTIVE SUMMARY

Given that the Manuherikia Valley is not fundamentally water short, it is less important than originally thought to find alternative water sources in the Lower Manuherikia, such as Clutha River water or a dam in the Manor Burn catchment. The existing supply from the Manuherikia River is the cheapest and most energy efficient option. The present water allocation to the Lower Manuherikia is sufficient to provide for the reasonable future irrigation needs. Efficiency improvements will however be necessary to realise these benefits.

For the Lower Manuherikia Valley, there is no clear distinction between "do minimum" costs, and development costs. Efficiency improvements will be required as part of obtaining resource consents. However if the irrigation schemes are to retain their present allocation rates, efficiency improvements will need to go hand in hand with an expansion in the irrigated area. Much of the upgrade works necessary for resource consent purposes, such as the installation of flow recorders and automatic gates, are also of considerable operational value to the schemes.

Upgrade works will likely include:

1. Flow recorders on all takes in excess of 5 l/s;
2. Automatic gates on the MIS and Chatto Creek intakes;
3. Automation of some secondary races;
4. Buffer storage ponds and flow automation system to reduce bywash;
5. Lining sections of leaky races;
6. Replacing some races with piped supplies; and
7. Replacement of the aging Chinky Gully Aqueduct.

In many areas, gravity pipe supplies, fed from the Manuherikia Irrigation Scheme Main Race, are an attractive option. Below the race there is good fall, allowing pressures to build up over a short section of pipe. About half of the supply area, including Dunstan Flats and Galloway, could be supplied with a fully pressurised gravity pipe supply. Pressurised pipe supplies have a number of advantages including:

- No need for on-farm pumping or storage ponds;
- A continuous, on-demand supply;
- Negligible distribution losses;
- Minimal operation and maintenance costs; and
- A very simple system [for life style blocks in-particular] to operate on-farm.

Distribution upgrades are expected to cost $6.6M, given conservative expansion in the irrigated area, or $7.7M given optimistic expansion. In addition the Manuherikia Irrigation Scheme (MIS) and Galloway Irrigation Scheme would need to contribute to Falls Dam "do minimum" upgrade costs. We have assumed a contribution of $4.7 M. The Lower Manuherikia differs from the Upper Manuherikia. No new water is required; therefore where there is an expansion in the irrigated area, this will reduce the cost to existing irrigators. Another difference is 50% of the area can be supplied with fully pressurised water. Fully pressurised water, compared with no pressure, is worth about $2,500/ha extra to spray irrigators. We do not expect all irrigators would be charged a flat rate, with rates varying depending on whether they are an existing or new irrigator, and the level of pressure delivered. Distribution upgrades is well suited to being staged. Costs are summarised below. Per hectare costs to individual irrigators depends on how scheme upgrade costs are apportioned. The apportioning approach below is only one possible method. MCSWG may adopt an alternative approach. Per hectare costs are cheaper under the optimistic expansion scenario, since upgrade costs are spread over a greater area.

Lower Valley Distribution Upgrade costs (conservative expansion)

Irrigators	Supply area (ha)		Cost/ha		Total
	Existing	New	Existing	New	
Dunstan Flats (fully pressurised)	300	200	$3,500	$6,500	$2.4M
MIS other (unpressurised)	1,300	450	$1,000	$4,000	$3.1M
MIS other (fully pressurised)	600	200	$3,500	$6,500	$3.4M
Galloway (fully pressurised)	520	30	$4,300	6,500	$2.4M
Total	**2,720**	**880**			**$11.3M**

Lower Valley Distribution Upgrade costs (optimistic expansion)

Irrigators	Supply area (ha)		Cost/ha		Total
	Existing	New	Existing	New	
Dunstan Flats (fully pressurised)	300	400	$2,900	$6,000	$3.3M
MIS other (unpressurised)	1,300	650	$400	$3,500	$2.8M
MIS other (fully pressurised)	600	350	$2,900	$6,000	$3.8M
Galloway (fully pressurised)	520	80	$3,900	$6,000	$2.5M
Total	**2,720**	**1,480**			**$12.4M**

Upgrade costs would provide for a significantly improved level of service to irrigators compared to the status quo. Improvements include the provision of on-demand supply, fully pressurised supplies to 50% of the supply area, increased security of supply through asset upgrades, decreased operating costs, and in some locations frost fighting capacity. On-farm spray conversion costs would be significantly higher without this investment in scheme infrastructure. Upgrade costs should not therefore be viewed as simply a resource consent compliance cost.

1 Introduction

The Manuherikia Catchment Water Strategy Group (MCWSG) was set up to develop and oversee the implementation of a water strategy for the catchment. The MCWSG has proposed that a project be undertaken in three sections to:

(i) Define the potential irrigation demand in the Manuherikia River catchment (land),
(ii) Provide an initial assessment of the water availability for meeting this demand (hydrology), and
(iii) Options to close the gap between supply and demand (options).

The project has been broken into two parts, Part A (Sections (i), (ii) and (iii a)) and Part B (Section (iii b)). Part A provides the initial big-picture information to understand the overall water resources in the catchment. Part B looks in more detail at specific options to progress water resources development. The MCWSG envisages that the project will provide information to help the community make informed decisions, leading to a comprehensive Manuherikia Catchment water strategy. Figure 1 provides an overview of the study.

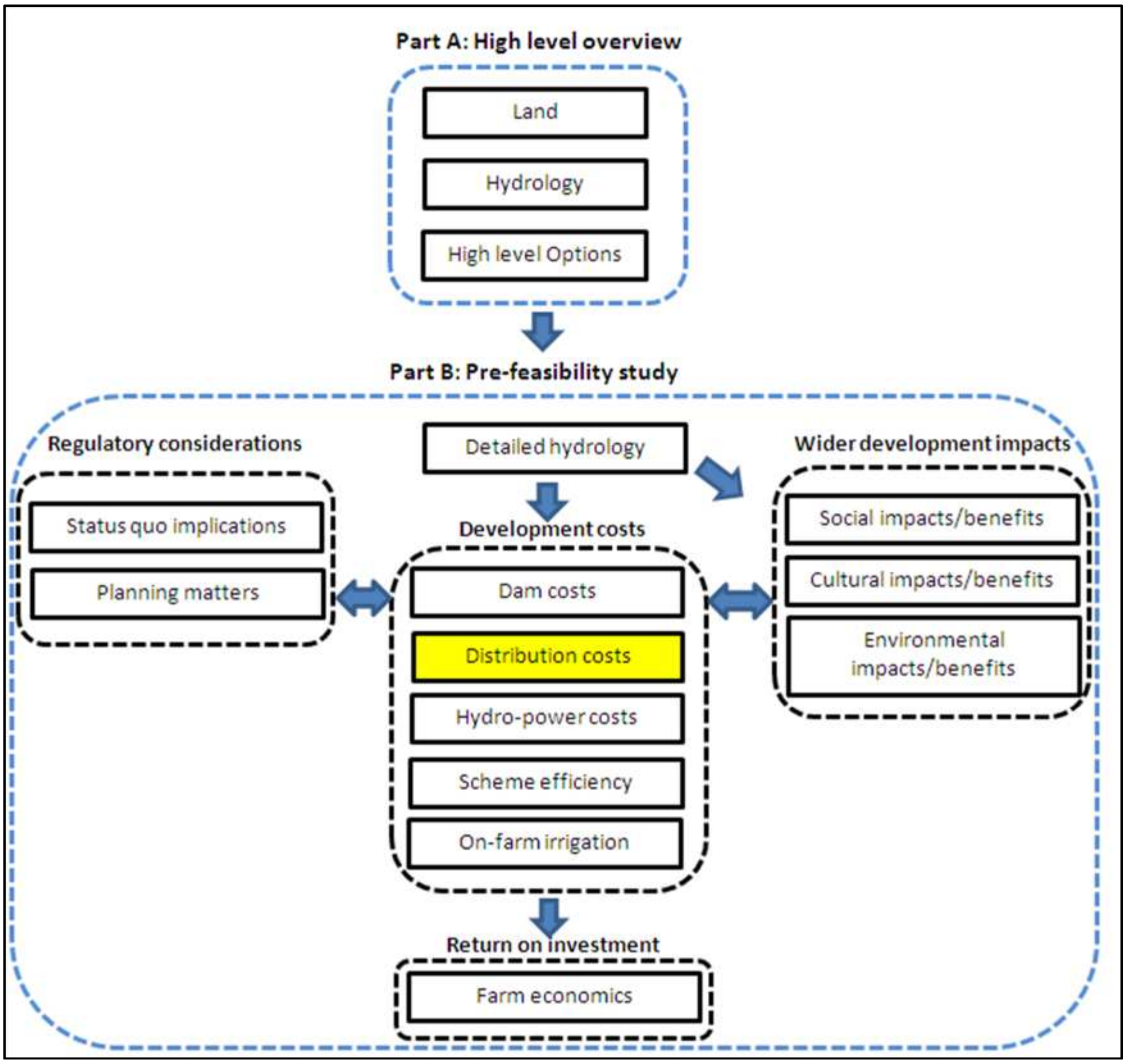

Figure 1: Manuherikia Catchment Study overview

This report covers distribution options and costs in the Lower Manuherikia Valley. A separate report addresses Upper Manuherikia Valley distribution options.

This report builds on the Upper Manuherikia Valley High Level Options report, where efficiency improvements were identified as a solution for meeting the reasonable future irrigation demands of the Lower Valley.

This report should be read in conjunction with the Land, Hydrology and Upper Valley distribution reports.

Design and costings are at a pre-feasibility level. Total costs are expected to be accurate to ±30%. Cost uncertainty may be higher for individual items.

This study has been made possible by the generosity of the following who have contributed by way of direct funding or by in-kind contributions. MCWSG are grateful for this support and wish to thank the following:

- Ministry of Primary Industries with funding via the Irrigation Acceleration Fund.
- The Otago Regional Council (ORC).
- The Central Otago District Council (CODC).
- The Manuherikia Community.

2 Regulatory requirements

Compared to other irrigated areas in New Zealand, most irrigated pastoral farms in the Lower Manuherikia Valley are generally low input–output systems. Investment in water infrastructure, to maximise productivity per unit of water, lags well behind the vast majority of irrigation in New Zealand. There is some high output horticulture and viticulture systems, which in general have high water use efficiency, however most water use is currently associated with pastoral systems.

No-one knows for sure exactly what conditions irrigators and irrigation schemes may be subject to, when deemed water permits are replaced with RMA consents. However, it is inevitable that major changes will be required to bring practices in line with other irrigated areas in New Zealand. National water quality requirements will likely have the greatest impact; these requirements will only become more, not less stringent as 2021 approaches.

2.1 A shift to spray irrigation

We expect the biggest changes will be on-farm, rather than off-farm. ORC have indicated that water quality requirements, together with water use efficiency requirements, will likely mean that much of the existing surface irrigation will need to convert to efficient spray irrigation. This will require major on-farm investment; in the order of $3,000 - $5,000 per hectare. While improvement in irrigation practices should mean significant production improvements, the necessary investment will inevitably mean a major shift from the existing low input-output systems to more intensive agriculture.

For farms supplied with pressurised water, on-farm irrigation system costs will be lower, since on-farm pumps and storage ponds are not required. For life-style blocks with a pressurised water supply, the cheapest on-farm system for pasture would be k-line irrigation, which would typically cost $1,500 per hectare.

We envisage that consent conditions would allow for a transition period, where systems such as wild-flooding are phased out. We don't expect changes would need to be fully implemented before RMA consents were granted. Retaining the best performing contour irrigation on steeper slopes may also be acceptable, provided runoff is captured and reused and drainage is not excessive.

A major shift from surface to spray irrigation will have a significant impact on the Manuherikia and Galloway irrigation schemes. Ideally, in the best interests of their shareholders, schemes should modify their distribution system to make it as easy as possible for irrigators to convert from surface to spray irrigation.

Instead of providing high flows on a roster supply, the schemes will need to provide low flow on-demand supplies to spray irrigators. To add to the challenges, not everyone will convert to spray systems at the same time. Schemes need to be able to accommodate a transition period, when there is a mix of surface systems (which will still require a roster supply) and spray systems.

There is significant opportunity in the Lower Manuherikia Valley for the irrigation schemes to provide some areas with a gravity pressurised pipe supply. On-going pumping costs are the major expense for operating spray systems. Providing a fully pressurised supply is potentially worth an additional $2,500 per hectare (present value) to irrigators in long term energy and pump maintenance savings alone. Other advantages include: (1) pipes have negligible losses (2) there is no need for on-farm storage ponds; and (3) it is a very simple system for life-style blocks which only irrigate a small area. In some circumstances pressurised pipe systems will also be able to provide frost fighting or fire fighting capacity.

2.2 Distribution efficiency improvements

Current on-farm allocation rates are generally well in excess of that required to achieve full production under efficient spray irrigation. We estimate distribution losses are also high at about 35%. We expect water use efficiency improvements will be an inevitable consequence of complying with ORC's Water Plan.

A distribution efficiency of 85 to 90% (i.e. 10-15% losses) may be a realistic target. We envisage that consent conditions would allow for a transition period, where distribution efficiency can be progressively improved.

If irrigation schemes are to retain their present allocation rates, efficiency improvements will need to go hand in hand with an expansion in the irrigated area. There is some opportunity to partially fund upgrades through expanding the irrigated area and selling water that is saved elsewhere from efficiency improvements.

2.3 Other requirements

Other consent requirements are likely to include flow recorders on all intakes and possibly fish screens or physiological fish deterrents on the Manuherikia and Chatto Creek intakes.

As part of the consenting process, an assessment of environmental effects will be required. Water quality requirements may require the schemes to implement a farm plan or nutrient management system and/or undertake some on-going monitoring. These costs should be relatively small compared with other scheme upgrade costs.

3 Design philosophy

Our design approach has been to promote ideas that we expect will have the greatest chance of getting off the ground. Ideally irrigation development should:

- Be consistent with a whole catchment solution;
- Be affordable;
- Maintain existing water rights, where allocation is reasonable;
- Be environmentally acceptable;
- Maximise community benefits;
- Have high or very high supply reliability;
- Minimise pumping;

Affordability is a key design consideration. We have focused on options where off-farm Present Value costs for new irrigation are less than $5,000 per hectare. For existing irrigators, we have focused on options that are either comparable or cheaper than retaining existing races.

Water right conflicts have the potential to derail irrigation development. In order to avoid legal disputes, irrigation proposals need to be attractive enough to individual or corporate water right holders for them to want to be part of a larger catchment solution.

We have considered likely environmental requirements in our design approach and pricing. Milestone 8 will provide further details on environmental impacts.

We have sought to provide for the reasonable future irrigation needs, thereby maximising future community benefits.

Irrigation in New Zealand has seen a major shift in the last 20 years from being viewed as drought insurance to an integral part of farming systems. To support economic value, greater importance is now placed on supply reliability. Our design approach has been to assume the Manuherikia Irrigation Scheme (MIS) and Galloway Irrigation Scheme will deliver high to very high supply reliability.

Long term, the degree of pumping largely determines the cost of operating an irrigation scheme. While inflation eventually minimises capital expenditure costs over the lifetime of a system, pumping costs continue indefinitely; increasing at a rate greater than inflation. Our design approach has been to assume the vast majority of land irrigated will be gravity supply. Where possible we have sought to provide pressurised supplies, minimising on-farm pumping costs.

4 Supply areas

Currently, about 2,200 ha are irrigated from MIS and 520 ha from Galloway Irrigation Scheme. Most of the land supplied currently is the same as it was in the 1920's.

There is a small area of new irrigation above the MIS High Race associated with the McArthur Ridge development. About 200 ha are supplied, most of this is viticulture and consequently water use is low. We have not allowed for any increase in water to this area or above the High Race in general.

Figure 2 and Table 1 illustrate the potential supply area that is either already supplied from MIS or Galloway, or could be supplied at a reasonable cost. Excluding crown land associated with roads and river margins, the supply area totals about 5,100 ha. We estimate [depending on the level of uptake] between 3,600 and 4,200 ha of this land could realistically be irrigated (Table 1).

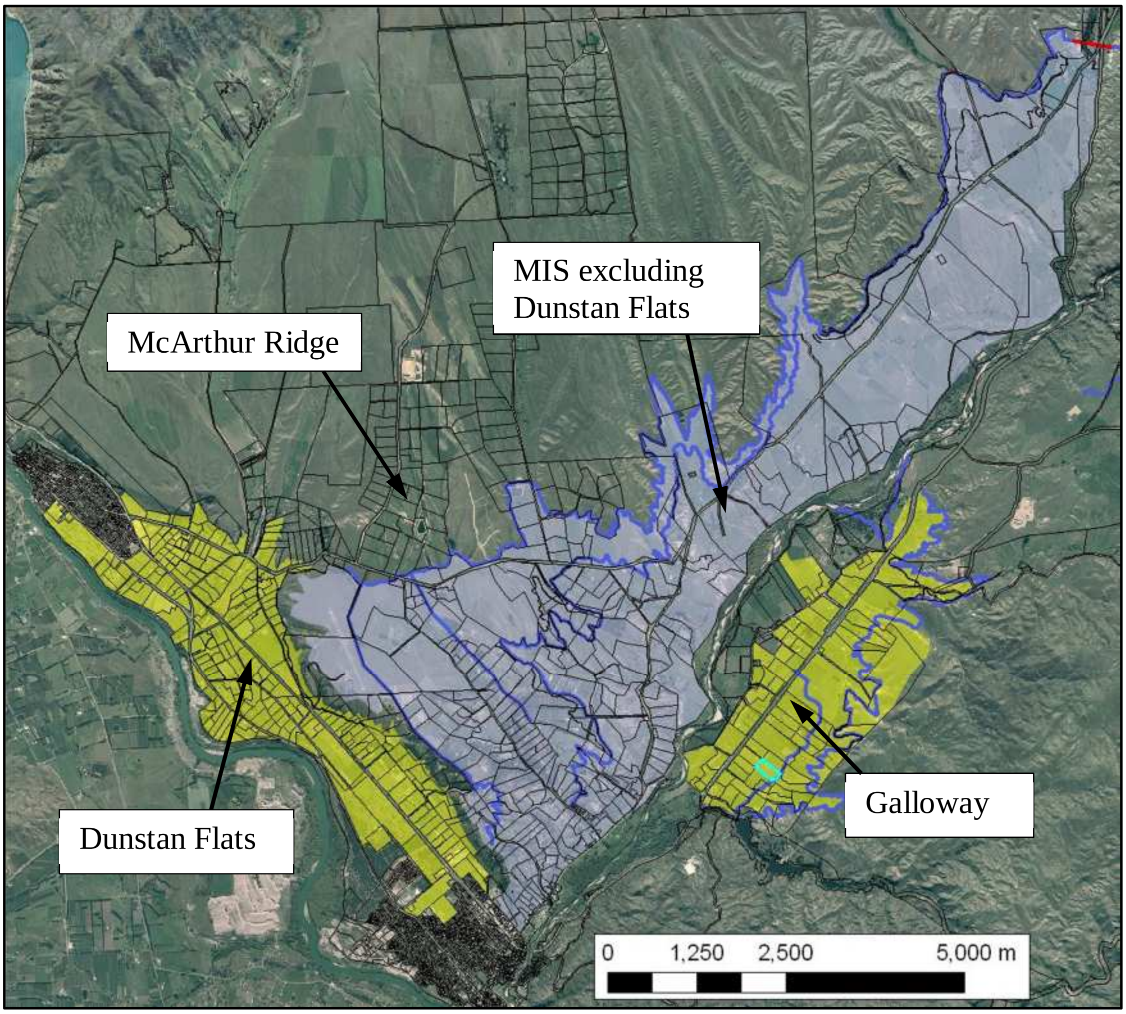

Figure 2: Potential MIS and Galloway supply areas

Table 1: Potential MIS and Galloway supply areas

Area	Supply area (ha)*	Existing irrigated area (ha)	Potential irrigated area[1]	
			Conservative	Optimistic
Dunstan Flats	850	300	500	700
MIS excl. Dunstan Flats	3,370	1,700	2,350	2,700
McArthur Ridge	200	200	200	200
Galloway	710	520	550	600
Total	**5,130**	**2,720**	**3,600**	**4,200**

[1]The supply area is the total irrigable land. The potential irrigated area is the actual land under supply contracts, and will always be less than the supply area because uptake is seldom 100%. We considered both a conservative uptake scenario and an optimistic uptake scenario.

Supply areas are further illustrated in Appendices A.

5 Existing allocation

Currently MIS has about 2,550 l/s of reliable water (Table 2). MIS has allocated about 1,700 l/s or 60 heads[1] on-farm. On-farm allocation rates are up to 7.5 mm per day, although averaged over the estimated 2,200 ha supply area the average allocation is 6.7 mm per day. Allocation rates are generally in excess of the 5 mm per day required to achieve full production under efficient spray irrigation. Consequently when irrigators convert to spray irrigation, the required allocation rate will generally be lower than the present allocation rate, freeing up water than the scheme could sell to new supply areas.

Table 2: Lower Manuherikia water allocation

Source	Reliable water[(1)] (l/s)
Manuherikia Irrigation Scheme	
Manuherikia from Ophir Gorge	2,360[(1)]
Chatto Creek	140
MIS minor creeks	50
Total	**2,550**
Galloway Irrigation Scheme	
Manuherikia at Tiger Hill Road	310
Lower Manor Burn dam	110
Dip Creek	20
Total	**440**
Lower Manuherikia main-stem private water rights	
Robinson	50
Shaky Bridge Enterprises	7
Total	**57**
(1) Flow available 90% of the time during the irrigation season. (2) MWD (1988).	

Current MIS distribution losses are estimated to be about 30-35%[2]. Improvements in distribution efficiency should free up a significant amount of water to sell to new supply areas.

Currently Galloway has about 440 l/s of reliable water. No reliable estimates of distribution losses are available. Given the nature and age of the scheme we estimate losses are probably in the range of 25-35%.

Further work is required as part of feasibility investigations to refine distribution loss estimates, including identifying the proportion of leakage, bywash, and over-allocation losses.

[1] Estimate from 2011/12 roster. For comparison Mckenzie et al. (1928) stated the scheme supplied 2,350 ha with an on-farm allocation of 55 head (1557 l/s) in the 1920's.

[2] MIS have 90 heads or 2,550 l/s of reliable water, but only allocate 60 heads on-farm. This would indicate losses are 30 heads or 33% (30/90).

In addition to MIS and Galloway irrigation schemes, there are two other private irrigation takes from the Manuherikia River below Ophir. These have a combined take of 57 l/s.

Cumulatively there is about 3.0 m^3/s of reliable water currently allocated for irrigation in the Lower Manuherikia Valley. 3.0 m^3/s could supply up to 4,500 ha at an average on-farm supply rate of 5 mm per day, provided scheme distribution losses were limited to 15%.

The present water allocation to the Lower Manuherikia Valley is sufficient to provide for the reasonable future irrigation needs. Efficiency improvements will however be necessary to realise these benefits.

An advantage of allowing MIS and Galloway to retain most or all of their allocation is that it allows for the continuation of irrigation flows to be conveyed from Falls Dam to their intakes, a distance of about 50 km and 63 km, respectively. The current use of the Manuherikia River main-stem as a conduit for irrigation water results in higher flows in the river than are presently provided by minimum flows. This is a beneficial impact. If Lower Manuherikia allocation was cut back, and the water allocated further up the catchment, some of the benefits of this conveyance flow would be lost.

Lower Manuherikia Valley allocation also helps to balance the catchment hydrologically. At present, a significant proportion of the water taken by MIS and Galloway is distribution losses and irrigation drainage and run-off water from the Upper Valley. The synergy between the Upper and Lower Valley maximises catchment scale water use efficiency.

6 Overview of upgrades

Scheme "do minimum" costs are the upgrade works that are necessary to obtain resource consents, and replace critical aging infrastructure. For the Lower Manuherikia Valley, there is no clear distinction between "do minimum" costs, and development costs. Efficiency improvements are expected to be part of resource consent requirements. However, if MIS and Galloway are to retain their present allocation rates, efficiency improvements will need to go hand in hand with an expansion in the irrigated area. Much of the upgrade works necessary for resource consent purposes, such as the installation of flow recorders and automatic gates, are also of considerable operational value to the schemes.

Upgrade works will likely include:

8. Flow recorders on all takes in excess of 5 l/s;
9. Automatic gates on the MIS and Chatto Creek intakes;
10. Automation of some secondary races;
11. Buffer storage ponds and Flow automation system to reduce bywash;
12. Lining sections of leaky races;
13. Replacing some races with piped supplies; and
14. Replacement of the aging Chinky Gully Aqueduct.

Given a shift to spray irrigation, we envisage the best solution for MIS will largely be secondary piped distribution, fed from the Main Race. Below the race there are many areas with good fall, allowing pressures to build up over a relatively short section of pipe.

We envisage some of the secondary races, such as the Borough race, could be retained as drainage systems, with drainage water being reused for irrigation. Others, such as Laterals 9 and 10 would be retained to service the plateau areas around the airport and Letts Gully Road. Secondary races on Dunstan Flats would likely be abandoned in favour of a piped system. We do not envisage any additional races.

Fish screens or physiological fish deterrents may be required on the Manuherikia River and Chatto Creek intakes. Fish and Game has recommended that the necessity of fish screens be considered on a case by case basis. In some situations there may be an advantage in allowing fish to have access to races, since races can provide good spawning environments due to the stable flows.

The MIS rock weir intake should provide good fish passage, and we do not envisage any changes to this weir would be necessary (Figure 3).

We do not envisage fish screens would be required on the Galloway Manuherikia River intake, since the race probably provides a valuable spawning area, with good fish access in and out of the River (Figure 4). Finer screens may possibly be required on the pump intakes.

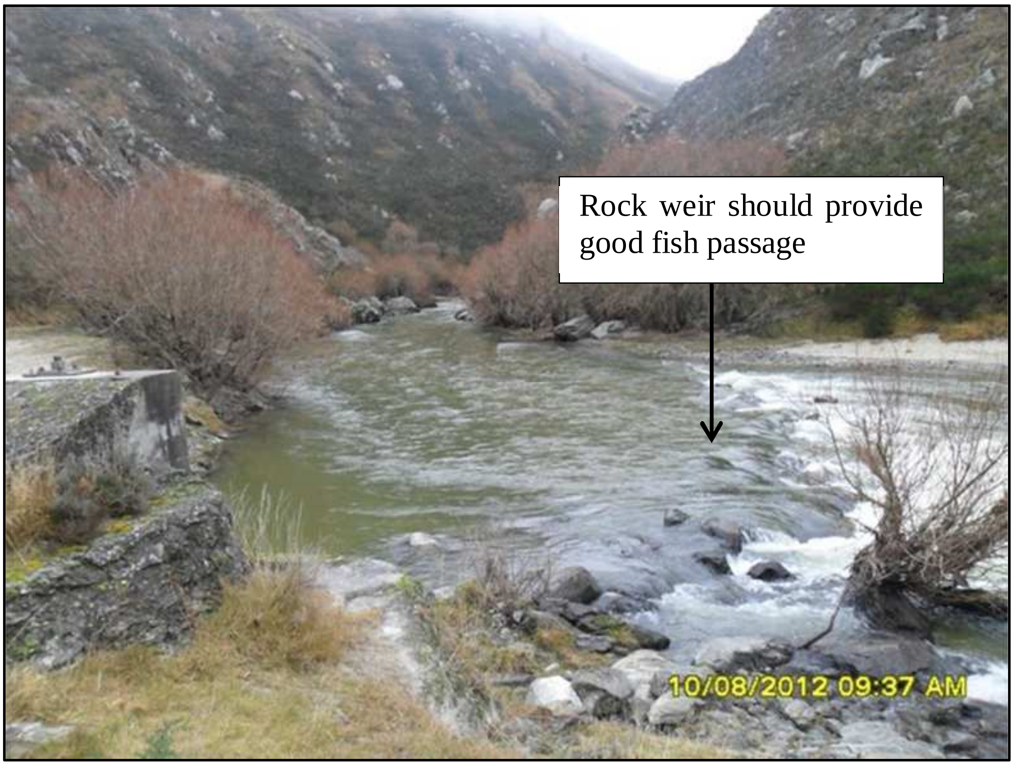

Figure 3: Manuherikia Irrigation Scheme intake

Figure 4: Galloway Irrigation Scheme Manuherikia intake

Chinky Gully Aqueduct has long been recognised as a high risk aging asset in need of replacement. If the structure was to fail suddenly, most the MIS scheme could be without water for several weeks. We have included an allowance for the replacement of this aqueduct with a siphon.

Figure 5: Chinky Gully Aqueduct

Distribution upgrades are expected to cost $5.4M to $7.7M, depending on the extent of irrigation expansion (Tables 6-8). In addition MIS and Galloway would need to contribute to Falls Dam "do minimum" upgrade costs. We have assumed a contribution of $4.7 M. The Lower Manuherikia differs from the Upper Manuherikia. No new water is required; therefore where there is an expansion in the irrigated area, this will reduce the cost to existing irrigators. Another difference is 50% of the area can be supplied with fully pressurised water. Fully pressurised water, compared with no pressure, is worth about $2,500/ha extra to spray irrigators. We do not expect all irrigators would be charged a flat rate, with rates varying depending on whether they are an existing or new irrigator, and the level of pressure delivered. Distribution upgrades is well suited to being staged. Costs are summarised below. Per hectare costs to individual irrigators depends on how scheme upgrade costs are apportioned. The apportioning approach below is only one possible method. MCSWG may adopt an alternative approach. Per hectare costs are cheaper under the optimistic expansion scenario, since upgrade costs are spread over a greater area.

Table 3: Lower Valley Distribution Upgrade costs (no area expansion)

Irrigators	Supply area (ha)		Cost/ha		Total(1)
	Existing	New	Existing	New	
Dunstan Flats (fully pressurised)	300	0	$5,000	N/A	$1.5M
MIS other (unpressurised)	1,300	0	$2,600		$3.4M
MIS other (fully pressurised)	600	0	$5,000		$3.0M
Galloway (fully pressurised)	520	0	$4,300		$2.2M
Total	**2,720**	**0**			**$10.1M**
(1) Includes a contribution of $4.7M to Falls Dam upgrades					

Table 4: Lower Valley Distribution Upgrade costs (conservative area expansion)

Irrigators	Supply area (ha)		Cost/ha		Total(1)
	Existing	New	Existing	New	
Dunstan Flats (fully pressurised)	300	200	$3,500	$6,500	$2.4M
MIS other (unpressurised)	1,300	450	$1,000	$4,000	$3.1M
MIS other (fully pressurised)	600	200	$3,500	$6,500	$3.4M
Galloway (fully pressurised)	520	30	$4,300	6,500	$2.4M
Total	**2,720**	**880**			**$11.3M**
(1) Includes a contribution of $4.7M to Falls Dam upgrades					

Table 5: Lower Valley Distribution Upgrade costs (optimistic area expansion)

Irrigators	Supply area (ha)		Cost/ha		Total(1)
	Existing	New	Existing	New	
Dunstan Flats (fully pressurised)	300	400	$2,900	$6,000	$3.3M
MIS other (unpressurised)	1,300	650	$400	$3,500	$2.8M
MIS other (fully pressurised)	600	350	$2,900	$6,000	$3.8M
Galloway (fully pressurised)	520	80	$3,900	$6,000	$2.5M
Total	**2,720**	**1,480**			**$12.4M**
(1) Includes a contribution of $4.7M to Falls Dam upgrades					

Upgrade costs would provide for a significantly improved level of service to irrigators compared to the status quo. Improvements include the provision of on-demand supply, fully pressurised supplies to 50% of the supply area, increased security of supply through asset upgrades, decreased operating costs, and in some locations frost fighting capacity. On-farm spray conversion costs would be significantly higher without this investment in scheme infrastructure. Upgrade costs should not therefore be viewed as simply a resource consent compliance cost.

Table 6: Lower Valley distribution upgrades – total 2,720 ha supplied (status quo)

Item	Description	Unit	No.	Rate	Amount
A	**Engineering** (8% of B-C)	LS	1	$201,080	**$201,080**
B	**Preliminary and General** (10% of C)	LS	1	$228,500	**$228,500**
C	**MIS distribution** (excl. Dunstan flats)				
C1	Automatic gates at Manuherikia intake (completed)	LS	0	$150,000	$0
C2	Automatic gates on Chatto Creek intake (completed)	LS	0	$50,000	$0
C3	Automatic gates on secondary races	Num	4	$20,000	$80,000
C4	Water level and flow recorders	Num	5	$5,000	$25,000
C5	Scheme buffer storage ponds	m^3	100,000	$5	$500,000
C6	Flow automation system	LS	1	$50,000	$50,000
C7	Line leaky race sections	m	5,000	$50	$250,000
C8	Replace Chinky Gully siphon	LS	1	$300,000	$300,000
C9	Other repairs and replacements	LS	1	$400,000	$400,000
C10	Piping 80% of secondary gravity distribution	ha	1,360	$500	$680,000
	Subtotal				**$2,285,000**
D	**Contingency** (10% of A-F)	LS	1	$542,916	**$542,916**
E	**Pressurised Pipe - Dunstan Flats**	ha	250	$3,000	**$750,000**
F	**Pressurised Pipe - Galloway**	ha	470	$3,000	**$1,410,000**
	TOTAL CAPITAL				**$5,417,496**
	Average/ha				**$1,990**
	Costs exclude GST and any land purchase costs				

Table 7: Lower Valley distribution upgrades – total 3,600 ha supplied

Item	Description	Unit	No.	Rate	Amount
A	**Engineering** (8% of B-C)	LS	1	$273,240	**$273,240**
B	**Preliminary and General** (10% of C)	LS	1	$310,500	**$310,500**
C	**MIS distribution** (excl. Dunstan flats)				
C1	Automatic gates at Manuherikia intake (completed)	LS	0	$150,000	$0
C2	Automatic gates on Chatto Creek intake (completed)	LS	0	$50,000	$0
C3	Automatic gates on main races	Num	4	$20,000	$80,000
C4	Water level and flow recorders	Num	5	$5,000	$25,000
C5	Scheme buffer storage ponds	m^3	100,000	$5	$500,000
C6	Flow automation system	LS	1	$50,000	$50,000
C7	Line leaky race sections	m	5,000	$50	$250,000
C8	Replace Chinky Gully siphon	LS	1	$300,000	$300,000
C9	Other repairs and replacements	LS	1	$400,000	$400,000
C10	Piping 80% of secondary gravity distribution	ha	1,800	$500	$900,000
	Subtotal				**$2,505,000**
D	**Contingency** (10% of A-C)	LS	1	$737,748	**$737,748**
E	**Pressurised Pipe - Dunstan Flats**	ha	500	$3,000	**$1,500,000**
F	**Pressurised Pipe - Galloway**	ha	500	$3,000	**$1,500,000**
	TOTAL CAPITAL				**$6,571,128**
	Average/ha				**$1,825**
	Costs exclude GST and any land purchase costs				

Table 8: Lower Valley distribution upgrades – total 4,200 ha supplied

Item	Description	Unit	No.	Rate	Amount
A	**Engineering** (8% of B-C)	LS	1	$453,640	**$453,640**
B	**Preliminary and General** (10% of C)	LS	1	$515,500	**$515,500**
C	**MIS distribution** (excl. Dunstan flats)				
C1	Automatic gates at Manuherikia intake (completed)	LS	0	$150,000	$0
C2	Automatic gates on Chatto Creek intake (completed)	LS	0	$50,000	$0
C3	Automatic gates on main races	Num	4	$20,000	$80,000
C4	Water level and flow recorders	Num	5	$5,000	$25,000
C5	Scheme buffer storage ponds	m^3	100,000	$5	$500,000
C6	Flow automation system	LS	1	$50,000	$50,000
C7	Line leaky race sections	m	5,000	$50	$250,000
C8	Replace Chinky Gully siphon	LS	1	$300,000	$300,000
C9	Other repairs and replacements	LS	1	$400,000	$400,000
C10	Piping 85% of secondary gravity distribution	ha	2,300	$500	$1,150,000
	Subtotal				**$2,755,000**
D	**Contingency** (10% of A-C)	LS	1	$1,224,828	**$1,224,828**
E	**Pressurised Pipe - Dunstan Flats**	ha	700	$3,000	**$2,100,000**
F	**Pressurised Pipe - Galloway**	ha	550	$3,000	**$1,650,000**
	TOTAL CAPITAL				**$7,677,528**
	Average/ha				**$1,830**
	Costs exclude GST and any land purchase costs				

7 Piped supply

Given a shift to spray irrigation, we envisage many parts of MIS will be best supplied from pipes fed from the Main Race. Below the race there are many areas with good fall, allowing pressures to build up over a relatively short section of pipe. PVC or Polyethylene (PE) pipe, supplied from a headrace, offers a number of advantages including:

- Negligible distribution losses;
- Continuous supply; and
- Partial [and in some cases full] pressure supply.

A fully pressurised pipe supply should be particularly attractive to life-style block owners with spray irrigation, since it is a much simpler and less time consuming system to use than an open race delivery system. A fully pressurised supply will significantly lower on-farm spray costs, with no need for pumps or a storage pond. Indicatively, a simple long lateral or k-line system without pumps or a pond would cost about $1,500/ha. Other options include fixed set sprinklers or drip systems, which have a higher capital cost but have a very low labour requirement.

The size of pipes required depends on the flow rate and the amount of allowable head loss in the pipe. In most situations, head loss allowances will range from 2 to 10 m per kilometre. Table 9 provides an indication of pipe sizes given different flow rates and supply areas. We envisage the maximum pipe size necessary would be 450 mm, so that PVC or PE, which is readily available, can be used. Supply and installation of these smaller diameter pipes is straight forward, reducing costs.

Table 9: PVC pipe capacity

Pipe NB[1] (mm)	Capacity (l/s)		Area supplied at 5mm/d	
	10 m/km headloss	2 m/km headloss	10 m/km headloss	2 m/km headloss
100	10 l/s	4 l/s	16 ha	7 ha
125	16 l/s	7 l/s	28 ha	12 ha
150	23 l/s	10 l/s	40 ha	17 ha
175	42 l/s	18 l/s	73 ha	30 ha
200	58 l/s	24 l/s	99 ha	42 ha
225	76 l/s	32 l/s	131 ha	55 ha
250	102 l/s	43 l/s	176 ha	74 ha
300	139 l/s	58 l/s	240 ha	101 ha
375	261 l/s	110 l/s	450 ha	189 ha
450	470 l/s	197 l/s	810 ha	340 ha
(1) Nominal bore. Roughly equal to the internal diameter (ID)				

Piping costs depend on the length of pipe, the flow rate, and the amount of fall between the headrace and the point of supply. Indicative PVC pipe prices are given in Table 10 and Table 11. The biggest factor in piping costs is the length of pipe: the shorter the distance from the headrace to the point of supply, the lower the cost. A key advantage of pipes over races is generally the shortest route can be used, since pipes do not need to follow the land contour, and because pipes are below the ground, the disruption to land once installed, is minimal. The cost of piping increases as pipe head losses decreases. The advantage of minimising pipe head loss is this maximises the pressure that can be delivered on-farm. On a per l/s basis, piping costs decrease as pipe sizes increase. This is because doubling the pipe diameter increases the pipe capacity six-fold, while costs only increase three-fold. Practically this means a preference for fewer, larger pipes where possible.

Table 10: Indicative piping costs for PN6 PVC with large pipe orders (5 km+)

Pipe size		Pipe costs				Capacity cost	
mm		*$/m*				*$/m per l/s*	
NB	ID	Pipe	Fittings (1)	Install.	Total	10m/km headloss	2m/km headloss
100	107	$11.3	$1.1	$9	**$21.4**	$2.25	$5.36
125	131	$15.1	$1.5	$10	**$26.6**	$1.64	$3.90
150	150	$19.4	$1.9	$11	**$32.4**	$1.40	$3.34
175	189	$27.6	$2.8	$12	**$42.4**	$1.01	$2.40
200	213	$35.1	$3.5	$13	**$51.6**	$0.90	$2.14
225	237	$43.1	$4.3	$14	**$61.5**	$0.81	$1.93
250	265	$53.9	$5.4	$15	**$74.3**	$0.73	$1.73
300	298	$68.7	$6.9	$20	**$95.6**	$0.69	$1.64
375	379	$110.7	$11.1	$22	**$143.8**	$0.55	$1.31
450	473	$173.4	$17.3	$24	**$214.7**	$0.46	$1.09
(1) 10% of pipe costs							

Table 11: Indicative piping costs for PN9 PVC with large pipe orders (5 km+)

Pipe size		Pipe costs				Capacity cost	
mm		*$/m*				*$/m per l/s*	
NB	ID	Pipe	Fittings (1)	Install.	Total	10m/km headloss	2m/km headloss
100	105	$14.4	$1.4	$9.0	**$24.9**	$2.62	$6.23
125	129	$21.9	$2.2	$10.0	**$34.1**	$2.10	$5.01
150	147	$28.2	$2.8	$11.0	**$42.0**	$1.82	$4.33
175	186	$39.8	$4.0	$12.0	**$55.8**	$1.32	$3.15
200	209	$50.1	$5.0	$13.0	**$68.1**	$1.18	$2.82
225	232	$61.8	$6.2	$14.0	**$82.0**	$1.08	$2.57
250	260	$76.4	$7.6	$15.0	**$99.1**	$0.97	$2.31
300	293	$98.3	$9.8	$20.0	**$128.2**	$0.92	$2.20
375	372	$158.1	$15.8	$22.0	**$195.9**	$0.75	$1.79
450	465	$246.2	$24.6	$24.0	**$294.8**	$0.63	$1.49
(1) 10% of pipe costs							

By way of example, an ideal farm suited for a piped supply from the Main Race is Simpson's Farm at Springvale. This 230 ha farm is located 400 m from the Main Race, with 40 m fall between the Main Race and the top of the farm. A 300 ID pipe would be sufficient to provide 135 l/s at 5 mm/d, and 35 m+ pressure. Pipe costs and an intake in the Main Race would be about $70,000 or $300/ha. This is a small fraction of the Present Value cost of continuing to use secondary open race delivery, constructing a storage pond, and pumping from the pond. The other key benefit is secondary distribution losses are virtually nil.

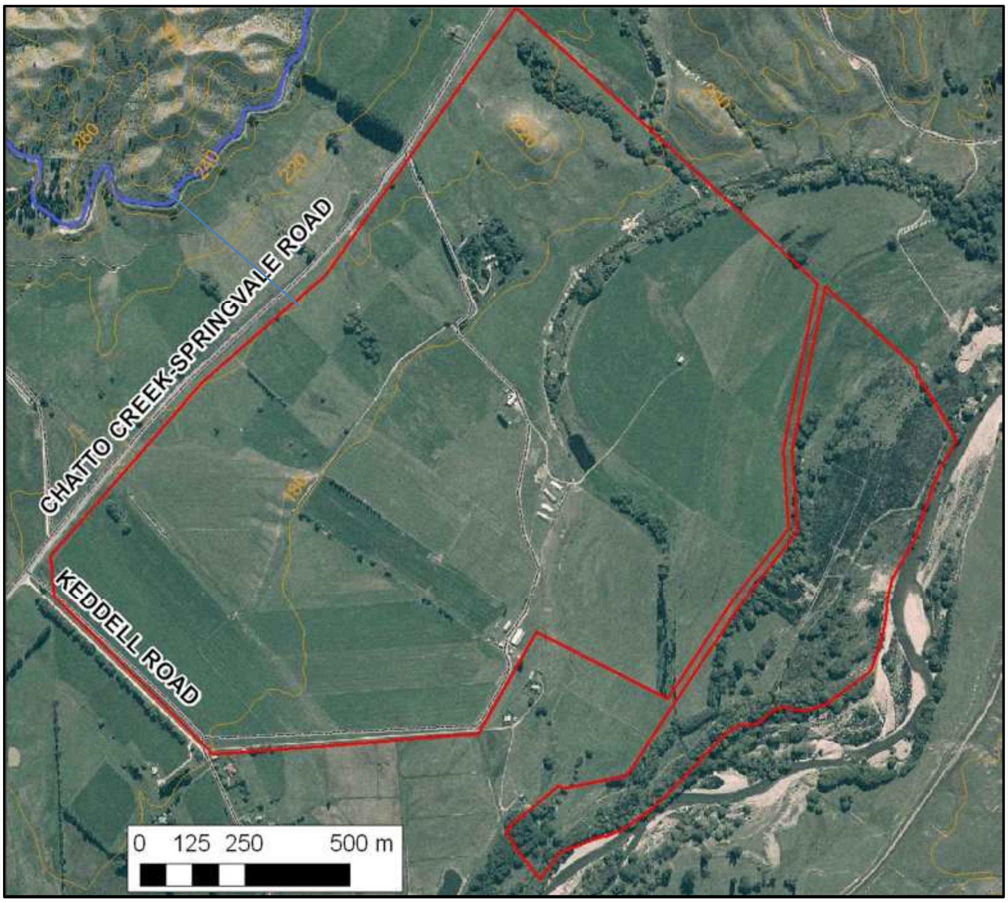

Figure 6: Simpson farm

All of the Dunstan Flats, Galloway and about 35% of the MIS gravity supply area could be supplied with 35 m+ pressure under gravity, which for most irrigators would mean no on-farm pumping would be necessary (see Table 12 and Figure 7). Collectively, about 50% of the Lower Valley irrigators could be supplied with fully pressurised irrigation water, delivered under gravity.

Table 12: Lower Valley areas that could be supplied with 35m+ pressure

Area	Total supply area		Fully pressurised supply	
	Conservative*	Optimistic*	Conservative*	Optimistic*
Dunstan Flats	500	700	500	700
Galloway	550	600	550	600
MIS gravity	2,350	2,700	800	950
Arthur Ridge	200	200	0	0
Total	**3,600**	**4,200**	**1,850**	**2,250**
*Conservative and optimistic area expansion scenarios from Table 1.				

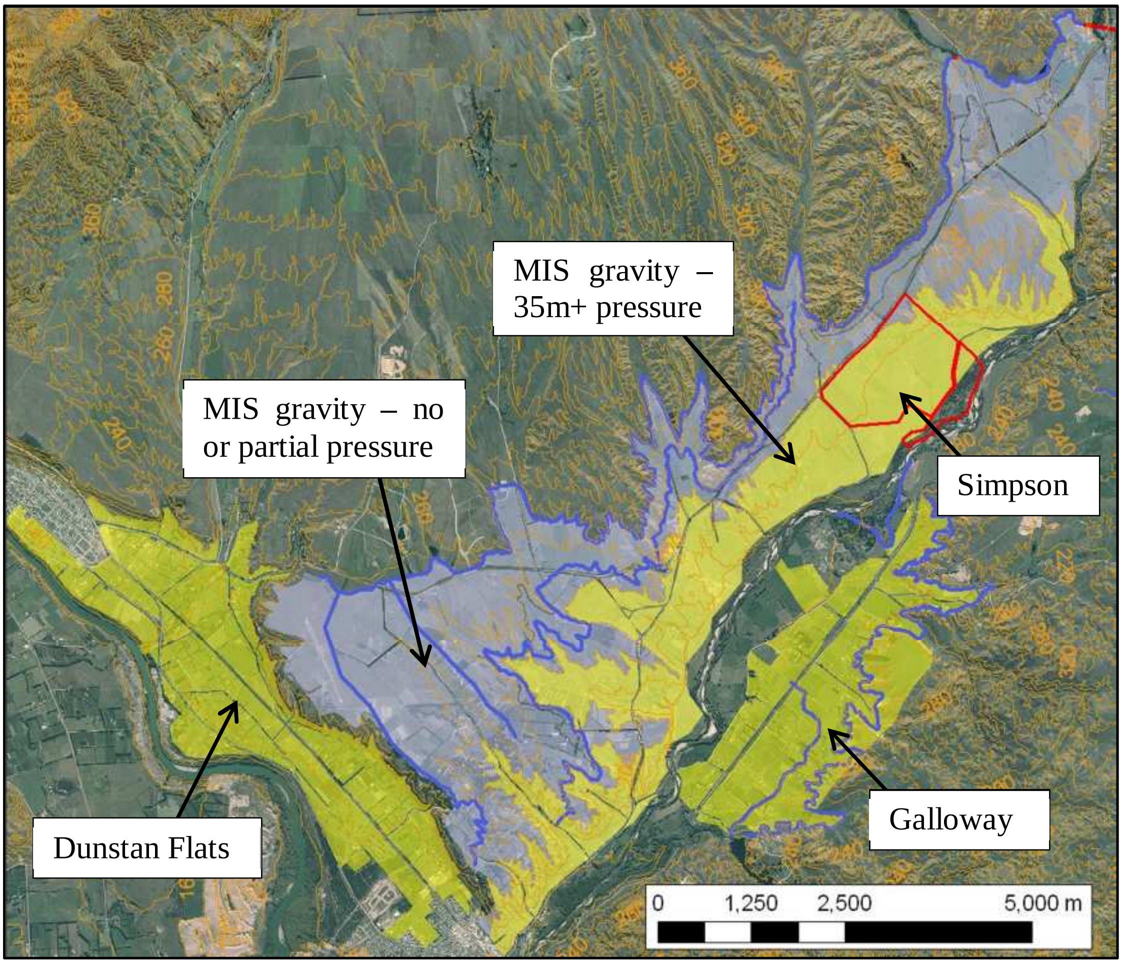

Figure 7: Lower Valley areas that could be supplied with 35m+ pressure

8 Dunstan Flats

8.1 Overview

We considered three options for supplying the Dunstan Flats:

1. Retain and upgrade existing races;
2. A pressurised pipe supply from MIS; and
3. A partial pressure supply from Lake Dunstan.

A piped supply from MIS should be a cheaper option for irrigators on the Flats, compared with upgrading races and constructing on-farm storage ponds. Another advantage of a piped supply from MIS is the main supply pond for the Flats is at the end of the MIS Main Race. The pond location is strategic for minimising total MIS bywash, in conjunction with flow automation. The high demand on the Flats (500-700 ha supply area) should reduce the total amount of buffer storage MIS requires.

Contrary to intuition, because of large efficiency improvements, even if 700 ha were irrigated on the Flats, an increase of 400 ha over the current area, total annual water use on the Flats would be about 30% less than current water use. The reason is because a piped supply from MIS decreases total MIS losses, through minimising bywash

A pipe supply from Lake Dunstan is less favourable. When on-farm pumping costs are considered, the scheme is over twice as expensive as the MIS supply option. The higher costs are because of the lack of elevation difference between Lake Dunstan and the flats, and because of layout of the command area favours being supplied from the North-East. The lack of elevation also means a supply from Lake Dunstan could not service the whole of the Dunstan Flats without some scheme pumping.

In favour of a Lake Dunstan supply is the use of Clutha River water rather than the more scarce Manuherikia River water. However, whether or not this is actually beneficial will depend on other factors such as whether the scheme is economically viable, the impact on MIS bywash volumes, and what happens to any Manuherikia River water savings. If Manuherikia water savings were transferred to the Upper Manuherikia Valley, this is likely to have a negative environmental impact because of the loss in conveyance flows in the main river. Another complication is water rights. If all MIS area expansions are through efficiency improvements, it may be difficult legally to reduce MIS's allocation, since no new water is involved.

We also briefly considered the option of a piped scheme from Lake Dunstan that provided both irrigation for the Flats and a water source for Alexandra. This option did not appear favourable, because the lack of elevation difference between Lake Dunstan and the flats and the distance between Lake Dunstan and Alexandra.

8.2 Upgrade existing races

If existing races are retained, a number of on and off-farm upgrades will be necessary to accommodate spray irrigation and resource consent requirements.

We have assumed 250 ha are currently supplied from MIS races on Dunstan Flats. This area excludes about 50 ha already supplied with pressurised pipes from ponds located on the Hills. We have assumed no new land would be supplied under this option.

Distribution losses will likely need to be reduced as part of obtaining resource consent. Distribution losses on the Flats are high, since all the MIS Main Race bywash discharges to the Flats. On average about 6 Mm^3 is discharged to the plains. This figure is based on an average flow down the Steps of 11 head, during the irrigation season (pers comm Alex Lawrence). This compares with on-farm water requirements of 1.5 Mm^3, necessary to supply 250 ha with an average of 600 mm per year, which equates to only 25% of the water supplied. Losses are in part due to the porous gravels and the high proportion of life-style blocks, but are mainly due to the Flats being at the end of the Main Race.

Reducing distribution losses would likely involve lining of the particularly leaky race sections, and installing automatic gates to reduce bywash and shorten roster return periods. We envisage storage would primarily be provided on-farm, with perhaps an average of 7 days storage being necessary.

A major additional cost to irrigators compared to a pressurised pipe supply are on-going pumping costs. We estimate the Present Value (PV) of on-farm pumping is worth about $2,500 per hectare. Pumping costs assume an average water use of 600 mm/y, an average pumping head of 35 m, an average pump efficiency of 60%, and a compound interest rate of 7.5%. Compared to typical efficiencies of 75-80% for large pumps, an average efficiency for small pumps is about 60%. This estimate has been used because there would be a large number of small pumps associated with life-style properties.

We estimate the capital costs of distribution upgrades and on-farm ponds and pumps will be in the order of $4,000/ha. Over half this cost is associated with constructing on-farm storage. If PV pumping costs are added, the total PV cost of a pressurised water supply would be in the order of $6,500/ha. There is reasonable uncertainty in cost estimates for this option since it involves the retrofit of an existing system, and our assessment was not based on a detailed understanding of the condition and operation of that system.

Figure 8: Example of a race on Dunstan Flats

Table 13: Dunstan Flat race from MIS (250 ha supplied)

Item	Description	Unit	Qnt	Rate	Amount
A	**Engineering** (8% of B-C)	LS	1	$66,880.00	**$66,880**
B	**Preliminary and General** (10% of C)	LS	1	$76,000	**$76,000**
C	**Race & on-farm upgrades**				
C1	Line leaky race sections	m	3,000	$50	$150,000
C2	Automatic gates	Num	3	$20,000	$60,000
C3	On-farm pumps	Num	20	$5,000	$100,000
C3	On-farm buffer storage ponds (7 days storage)	m^3	90,000	$5	$450,000
	Subtotal				**$760,000**
D	**Contingency** (10% of A-C)	LS	1	$90,288	**$90,288**
E	**PV on-farm pumping** (600mm/y, 35 m pumping @ 60% efficiency, $0.20/kWh & 7.5%/y compound interest)	ha	250	$2,500	**$625,000**
	TOTAL CAPITAL				**$993,168**
	CAPITAL COST/HA				**$3,973**
	PV COST/HA				**$6,473**
	Costs exclude GST				

8.3 Piped supply from MIS

This option involves piped distribution on the Dunstan Flats, supplied from two existing ponds situated near the airport (see Figure 9 and Figure 10). The ponds, at an elevation of about 232 and 225 m respectively, provide an ideal amount of head for the Dunstan Flats. They are also close to the highest part of the flats, minimising pipe pressure losses where it matters most.

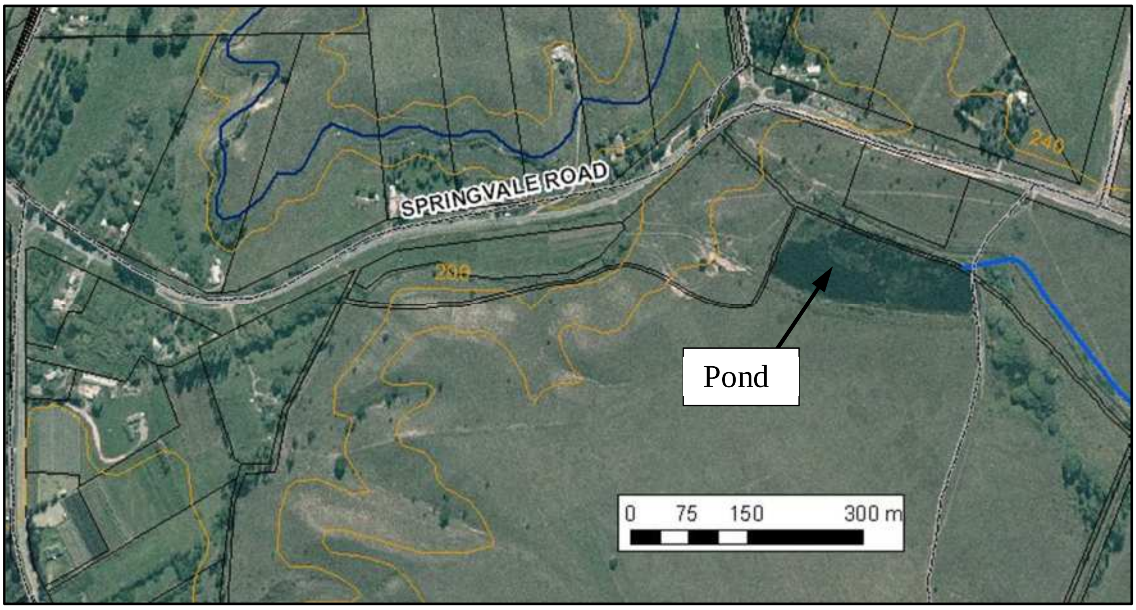

Figure 9: Potential supply pond 1

Figure 10: Potential supply pond 2

The two supply ponds have a surface area of 2.0 ha and 1.0 ha. Given an operating range of 1.5 m, these ponds would provide 45,000 m^3 of storage, which is 36 hours of storage given peak irrigation demands. This should be more than sufficient buffer storage for the Flats, given flow automation of MIS races. These two ponds are privately owned. We have assumed MIS would be able to negotiate an arrangement with the owners of these ponds.

Scheme mainline pipes would largely follow road reserves, because the roading network provides legal access to most if not all the properties that would be serviced. Installing pipes in the road reserve also minimises the need for easements on private land. Obtaining permission from CODC and NZTA to install buried pipes should be a straight forward process.

Pipe sizes would range from 375 mm NB, down to 100 mm NB. Either PVC or PE pipe would be suitable.

We assumed the scheme would service the entire Dunstan Flats. We assumed uptake would be 80%, with 700 ha irrigated, with a design allocation rate of 4.5 mm per day. If uptake is higher or irrigation demands greater, the impact on delivery pressures would be relatively minor.

Delivery pressures at farm turnouts, under full demand, would range from 35 m to 60 m. Delivery pressures are illustrated in Figure 11.

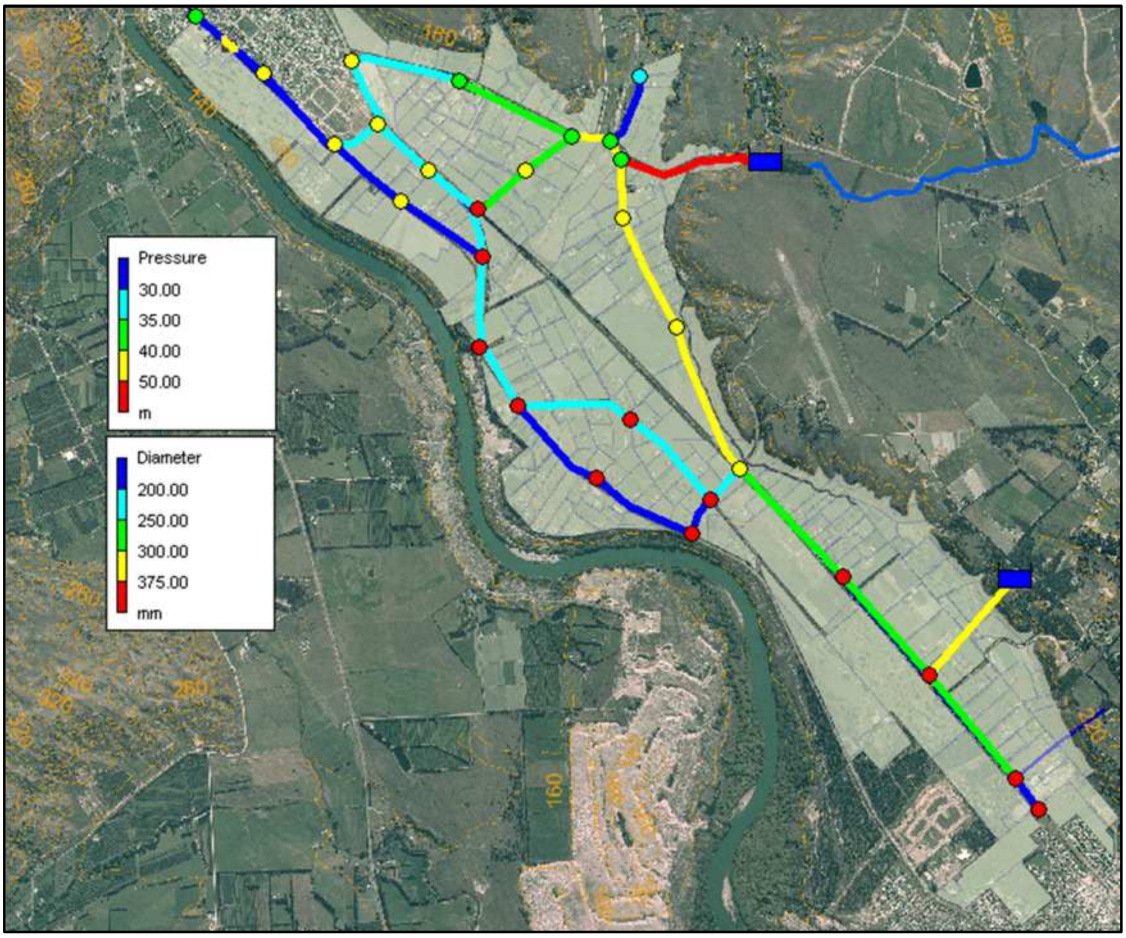

Figure 11: Dustan Flats piped from MIS – turnout pressure under full demand.

Mainline pipe alignments are pre-feasibility level only; detailed design alignments may differ in some areas.

The system would be able to also provide frost fighting capacity to parts of the flats. Indicatively 50 ha could be serviced at a rate of 4 mm/h. Frost fighting occurs infrequently and does not coincide with periods of high irrigation demand. Consequently, the impact of frost fighting on other irrigators should be minor. Frost fighting flow rates are about 20 times higher on a per hectare basis than irrigation and would require particular attention at a detailed design phase. It may not be practical to supply some areas directly with frost fighting capacity.

The piped distribution is expected to cost $2.1M or $3,000 per hectare. Charging a higher rate of (say) $10,000 per hectare for frost fighting capacity could reduce costs to other irrigators.

We have not assessed a conservative uptake option of only 500 ha supplied rather than 700 ha. Indicatively, given a smaller supply area, we would expect the per hectare cost to be within 15% of the 700 ha supply area scenario. Whether costs increase or not will depend on the extent that the command area (and hence the total pipe length) is reduced.

A conversion from the existing open race system to piped distribution would require existing irrigators with surface irrigation to convert to spray irrigation or allow for a smaller continuous supply at about the same time.

Under this option it would be easy to accommodate the four life style blocks on Waikerikeri Road that currently have an unreliable water source. Some scheme or on-farm pumping would be necessary.

One of the issues that need to be addressed with this option is the impact on groundwater recharge on the Dunstan Flats. This effect will be considered as part of a separate environmental impact report. Preliminary work indicates that the benefits of piping significantly outweigh negative impacts of reduced groundwater recharge. One of the reasons is because the Dunstan aquifer is an inefficient conveyance system both in terms of water quantity and energy. Water use efficiency is very low. ORC (2012b) estimate only 4% of the groundwater that flows through Dunstan aquifer is used[3]. From an energy perspective, groundwater water levels on the Flats are typically 90-100 m below the height of the ponds on Airport Hill. This means groundwater users need to pump about 70-90 m[4] resulting in high power and pump maintenance costs. By comparison the MIS pipe supply option requires virtually no on or off farm pumping. Another disadvantage of the aquifer as a supply source is there is little opportunity to expand the irrigated area from groundwater.

[3] Table 7. Mean inflow = 10.7Mm3/y. Of this only 0.43Mm3/y is pumped or used

[4] Assumes depth to groundwater = 35 m, well drawdown = 10 m, and spray irrigation operating pressure = 35 m.

Table 14: Dunstan Flat piped from MIS (700 ha supplied)

Item	Description	Unit	Qnt.	Rate	Amount
A	**Engineering** (8% of B-D)	LS	1	$138,489	**$138,489**
B	**Preliminary and General** (10% of C-D)	LS	1	$157,374	**$157,374**
C	**Mainline pipes**				
C1	375mm NB PVC, PN6 (installed incl. fittings)	m	1,020	$145	$147,900
C2	300mm NB PVC, PN6 (installed incl. fittings)	m	3,430	$95	$325,850
C3	250mm NB PVC, PN6 (installed incl. fittings)	m	4,300	$75	$322,500
C4	200mm NB PVC, PN6 (installed incl. fittings)	m	5,570	$52	$289,640
C5	150mm NB PVC, PN6 (installed incl. fittings)	m	4,060	$32	$129,920
C6	100mm NB PVC, PN6 (installed incl. fittings)	m	830	$21	$17,430
C7	Sealed road crossings E/O	Num	12	$6,000	$72,000
	Subtotal				**$1,305,240**
D	**Other**				
D1	PRVs	Num	4	$4,000	$16,000
D2	Turnout connection incl. value and flow meter	Num	60	$2,500	$150,000
D3	E/O turnout pipe. 50 - 150mm NB	m	1,000	$15	$15,000
D4	Turnout connection: sealed road crossings E/O	Num	25	$3,500	$87,500
	Subtotal				**$268,500**
E	**Contingency and unscheduled items** (10% of A-D)	LS	1	$186,960	**$186,960**
	TOTAL CAPITAL				**$2,056,563**
	COST/HA				**$2,938**
	Costs exclude GST				

8.4 Pipe supply from Lake Dunstan

A gravity pipe supply from Lake Dunstan cannot practically supply the whole of the Flats under gravity. This is because excessively large pipe sizes would be necessary to limit pipe pressure losses to ensure that positive pressure could be delivered around Springvale Road, and south of Airport Road.

An alternative option is to supply only parts of the Dunstan Flats from Lake Dunstan. A possible scheme is illustrated in Figure 12. The scheme would cover the area between the Rail Trail and the Clutha River, extending as far as Airport Road. We assumed uptake would be 80%, with 230 ha irrigated, with a design allocation rate of 4.5 mm per day. Only low pressure would be provided at turnouts; consequently on-farm pumping would be necessary.

The scheme would not be able to service most of the existing irrigators currently supplied from MIS. Most of these irrigators would need to continue to be supplied from MIS.

Pipe sizes would range from 300 mm NB, down to 150 mm NB. Either PVC or PE pipe would be suitable.

We envisage a simple intake structure at Lake Dunstan (see Figure 13). Two options are available: (1) a pipe on the true left bank of the dam; or (2) a pipe connecting into an existing core through the dam. A pipe around the true left bank of the dam would siphon water out of the lake. A small vacuum pump would prime the system.

The mainline pipe would need to pass through Clyde, down Sunderland Street (see Figure 14 and Figure 15). About 850 m of urban installation would be necessary.

Mainline pipe alignments are pre-feasibility level only; detailed design alignments may differ in some areas.

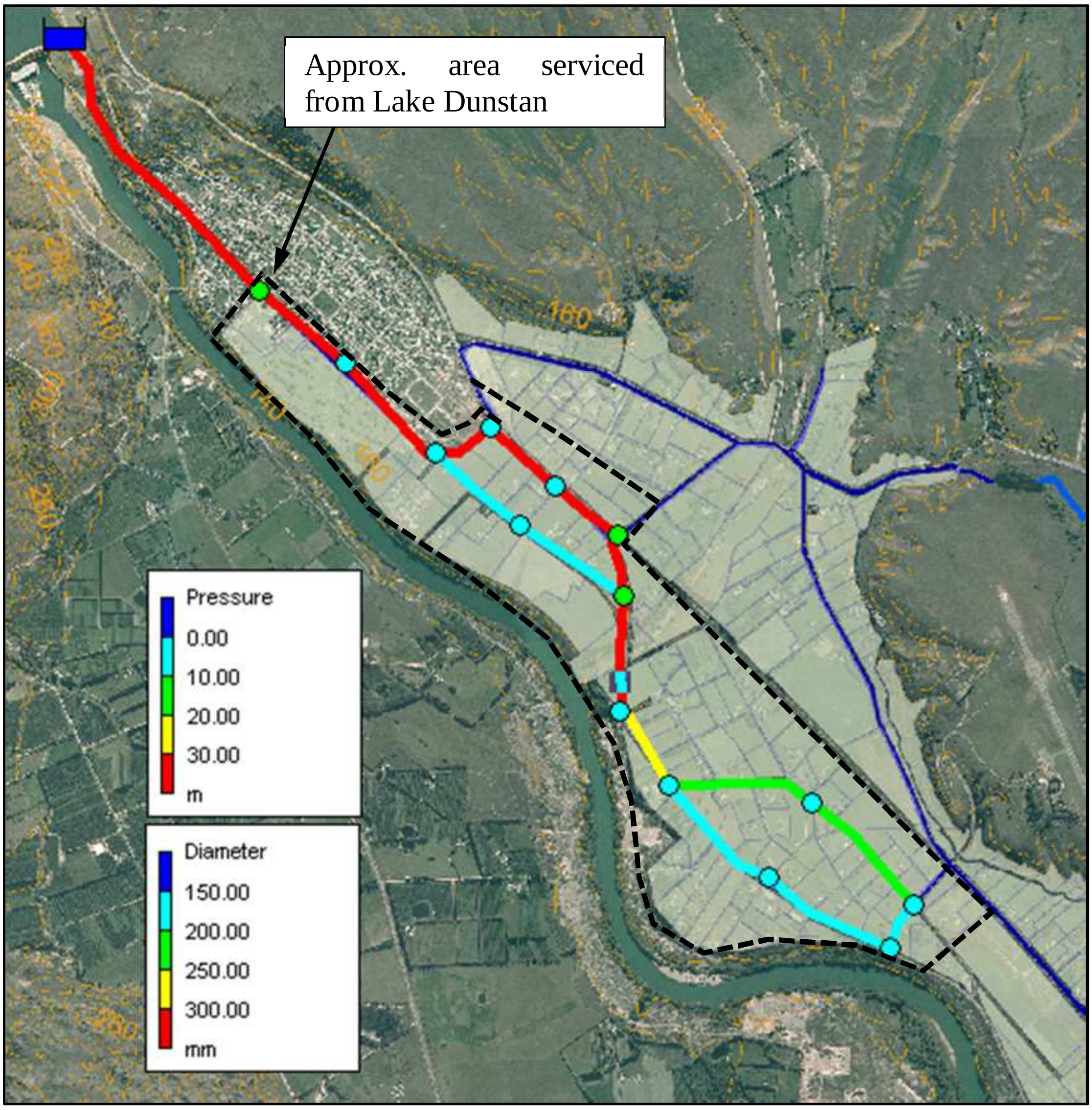

Figure 12: Dunstan Flats piped from L. Dunstan – turnout pressure under full demand.

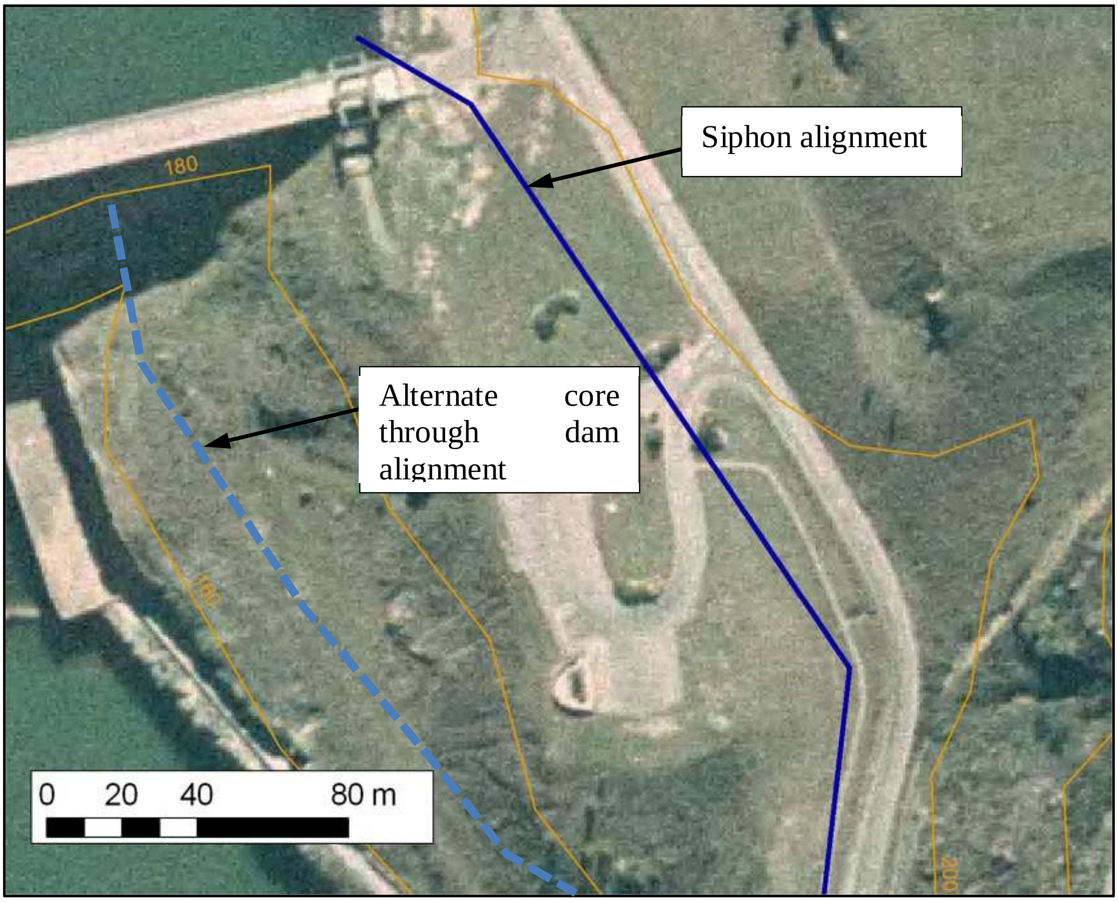

Figure 13: Lake Dunstan intake

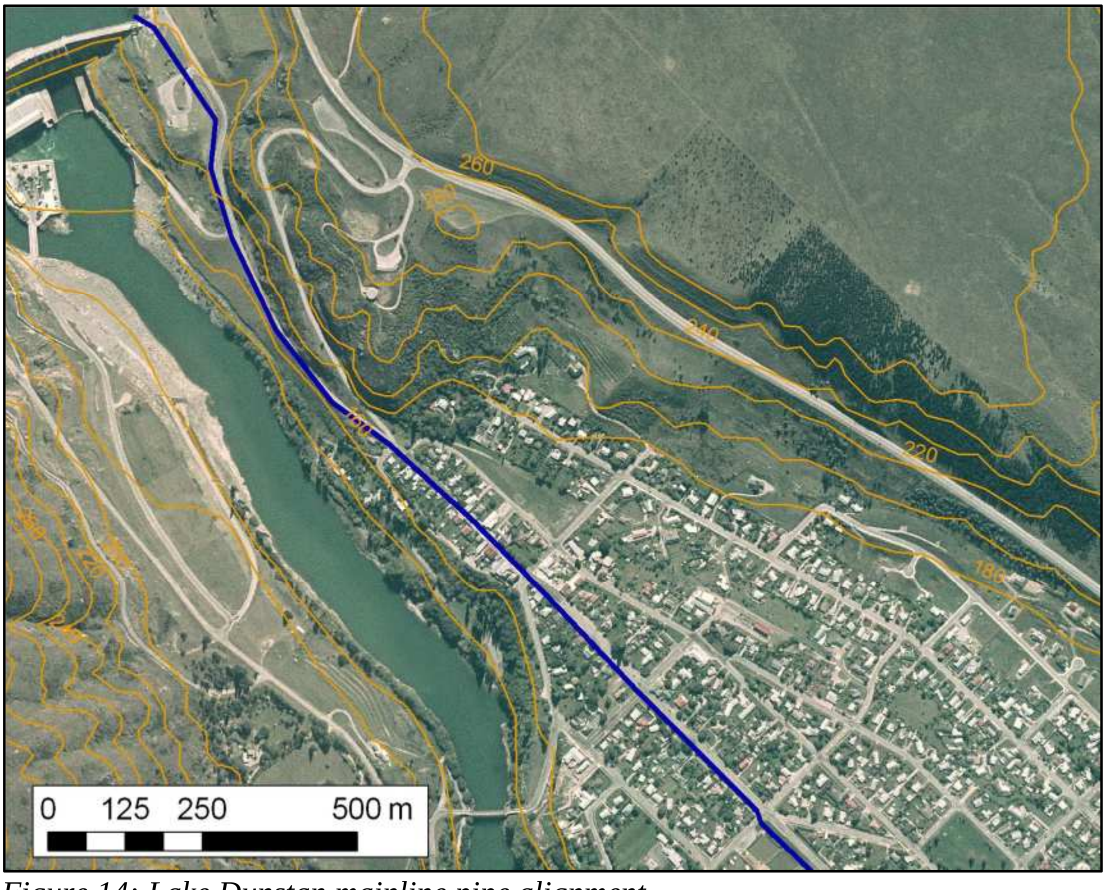

Figure 14: Lake Dunstan mainline pipe alignment

Figure 15: Mainline pipe would be installed down Sunderland Street

The scheme would cost considerably more than the alternative MIS pipe supply option on a per hectare basis ($5,200/ha vs $3,000/ha). The higher costs are because the limited elevation difference between Lake Dunstan and the Flats requires the use of larger pipes, and because the layout of the command area favours being supplied from the North-East. When Present Value on-farm pumping costs are included, the total cost is $6,800/ha, over twice the price of the MIS supply option (Table 15). In addition there would be a reduction in generation revenue from Clyde Dam.

Table 15: Dunstan Flats pipe from Lake Dunstan – 230 ha supplied

Item	Description	Unit	Qnt	Rate	Amount
A	**Engineering** (8% of B-D)	LS	1	$80,462	**$80,462**
B	**Preliminary and General** (10% of C-D)	LS	1	$91,434	**$91,434**
C	**Mainline pipes**				
C1	300mm NB PVC, PN6 (installed incl. fittings)	m	5,060	$95	$480,700
C2	250mm NB PVC, PN6 (installed incl. fittings)	m	460	$75	$34,500
C3	200mm NB PVC, PN6 (installed incl. fittings)	m	1,510	$52	$78,520
C4	150mm NB PVC, PN6 (installed incl. fittings)	m	2,910	$32	$93,120
C5	Sealed road crossings E/O	Num	7	$6,000	$42,000
C6	Urban pipe installation E/O	m	850	$100	$85,000
	Subtotal				**$813,840**
D	**Other**				
D1	Turnout connection incl. value and flow meter	Num	25	$2,500	$62,500
D2	E/O turnout pipe. 50 - 150mm NB	m	200	$15	$3,000
D3	Turnout connection: sealed road crossings E/O	Num	10	$3,500	$35,000
	Subtotal				**$100,500**
E	**Contingency** (10% of A-D)	LS	1	$108,624	**$108,624**
F	**PV on-farm pumping** (600mm/y, 25m pumping @ 60% efficiency, $0.20/kWh & 7.5%/y compound interest)	ha	230	$1,500	**$345,000**
	TOTAL CAPITAL				**$1,194,860**
	COST/HA				**$5,195**
	PV COST/HA				**$6,695**
	Costs exclude GST				

8.5 Other options considered

We considered the option of a piped scheme from Lake Dunstan that provided both irrigation for the Flats, and a water source for Alexandra Township. This option did not appear favourable, because the lack of elevation difference between Lake Dunstan and the Flats and the long distance between Lake Dunstan and Alexandra.

A 10 km long, 450 NB pipe would be required to convey 20 million litres/day or 230 l/s from Lake Dunstan to Alexandra (Figure 16). Indicatively, this would cost $3M. If (say) 200 ha of irrigation was also supplied from this pipe, the pipe size would need to be upgraded to 550 mm ID. This would indicatively add an additional $1.0M to the cost, which equates to $5,000/ha. Irrigators would only be delivered partial pressure.

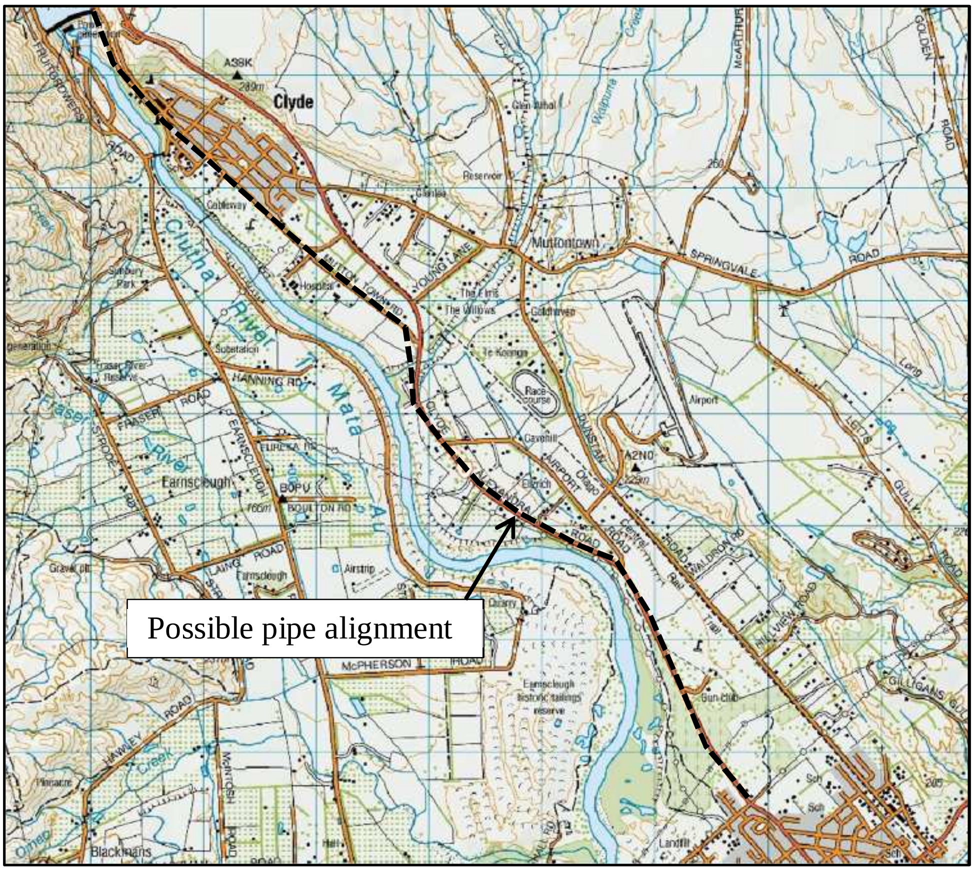

Figure 16: Possible pipe alignment for a water supply for Alexandra from Lake Dunstan.

We also considered the option of a pumped supply from Lake Dunstan. This option would involve a similar pipe layout to that in Figure 11, but would require some scheme pumping to supply the whole of the Dunstan Flats. Such an option is likely to be 2-3 times more expensive than the MIS supply option, and is unlikely to be attractive to existing MIS irrigators.

We briefly considered the option of a piped network that services the whole of the Dunstan Flats that was fed from both Lake Dunstan and MIS. Hydraulically, the system would not work efficiently, because of the 40 m pressure difference between Lake Dunstan and the MIS ponds.

We considered the option of a potable rural water supply for the Flats in conjunction with an irrigation supply. Two options are available. The first is individual users could treat irrigation water for house-hold use. One of the difficulties with this option is the MIS supply is a high risk source in terms of pathogenic contamination, and it would be difficult to ensure household treatment systems were providing effective protection.

Another problem is supplying the system outside of the irrigation season. An alternative option would be to install separate pipes for a rural water supply scheme in the same trench as the irrigation pipes. This potable supply could be supplied with either treated Clyde or Alexandra water (or both). A restricted supply would require only small diameter PE pipe: 75mm OD and below. Indicatively, a restricted water supply delivering 1 m^3/day to 60 households might cost an additional $200,000. This would equate to a cost of about $3,300 per house-hold in addition to the cost of a house-hold tank. This option should deliver superior water quality (in terms of the NZ Drinking Water Standard), compared with household treatment.

9 Galloway options

9.1 Overview

Either upgrading existing races or a piped supply from MIS are attractive options for Galloway.

A piped system has a higher capital cost compared to upgrading existing races, but no on-going pumping costs. Including on and off farm pumping costs, a piped supply is likely to have a lower Present Value cost.

Supply from a new dam in the Manor Burn catchment, either 300 m upstream of the existing Lower Manor Burn dam, or on Little Valley Creek West Branch, is not attractive due to the high costs. There are also significant environmental and recreational impacts associated with a new Lower Manor Burn dam.

9.2 Upgrade existing races

If existing races are retained, a number of on and off-farm upgrades will be necessary to accommodate spray irrigation and resource consent requirements.

Currently Galloway has a contract supply area of 520 ha. In the future, we estimate this area could increase to 550 – 600 ha.

We estimate current distribution losses may be 25-35%. Distribution losses will likely need to be reduced as part of obtaining resource consent. Reducing distribution losses could involve lining particularly leaky race sections, installing automatic gates and buffer storage ponds to minimise bywash losses. Reducing or eliminating bywash may also be necessary to meet water quality rules.

We estimate the capital costs of distribution upgrades and on-farm ponds and pumps will be in the order of $1,500/ha. Per hectare costs would be slightly lower if there was an expansion in the irrigated area. If PV pumping costs are added, the total PV cost of a pressurised water supply will be in the order of $5,000/ha. There is reasonable uncertainty in cost estimates for this option since it involves the retrofit of an existing system, and our assessment was not based on a detailed understanding of the condition and operation of that system.

Our Present Value power calculations are based on market irrigation rates. An issue that may require further consideration is how Galloway's access to discounted power through the Fraser Dam lease to Pioneer Generation may affect Present Value economics. We do not expect this to have a significant impact on costs since most pumping costs are on-farm rather than scheme costs and we would not expect discounted power rates to apply to individual irrigators.

Figure 17: Example of a Galloway race

Table 16: Galloway race supply (550 ha supplied)

Item	Description	Unit	Qnt	Rate	Amount
A	**Engineering** (8% of B-C)	LS	1	$58,080	**$58,080**
B	**Preliminary and General** (10% of C)	LS	1	$66,000	**$66,000**
C	**Race & on-farm upgrades**				
C1	Line leaky race sections	m	3,000	$50	$150,000
C2	Automatic gates	Num	3	$20,000	$60,000
C3	Buffer storage ponds	m^3	50,000	$5	$250,000
C4	On-farm pumps	Num	40	$5,000	$200,000
	Subtotal				**$660,000**
D	**Contingency** (10% of A-C)	LS	1	$78,408	**$78,408**
E	**PV on-farm pumping** (600mm/y, 35m pumping @ 60% efficiency, $0.20/kWh & 7.5%/y compound interest)	**ha**	**530**	**$2,500**	**$1,325,000**
F	**PV scheme pumping** (100kW,120 days $0.15/kWh & 7.5%/y compound interest)	**LS**	**1**	**$580,000**	**$580,000**
	TOTAL CAPITAL				**$862,488**
	CAPITAL COST/HA				**$1,568.16**
	PV COST				**$2,767,488**
	PV COST/HA				**$5,032**
	Costs exclude GST and land purchase costs				

9.3 Piped supply from MIS

This option involves a pipe from the MIS Main Race, supplying a mainline pipe running down the length of Galloway Road. The Main Race is at an elevation of 240 m, allowing turnout delivery pressures of 50-90 m that are sufficient to operate spray irrigation systems without any on-farm pumping, up to an elevation of about 180 m.

The existing Galloway races would largely become redundant, although there may be some value in retaining the Dip Creek supply to the race north of Crawford Hills Road. Perhaps 30-50 ha could continue to be supplied from this race.

This option would see the Galloway Manuherikia River intake become redundant. Instead Galloway's water would be conveyed via the MIS intake. If the Chinky Gully siphon is upgraded, there is sufficient capacity in MIS's Main Race to accommodate this additional flow.

A fully pressurised pipe supply should be particularly attractive to life-style block owners with spray irrigation, since it is a much simpler and less time consuming system to use than an open race delivery system.

Pipe sizes would be at most 450 mm NB. Either PVC or PE pipe would be suitable. We assumed uptake would be 65-80%, with 450 - 600 ha irrigated, with a design allocation rate of 4.5 mm per day.

Mainline pipe alignments are pre-feasibility level only; detailed design alignments may differ in some areas.

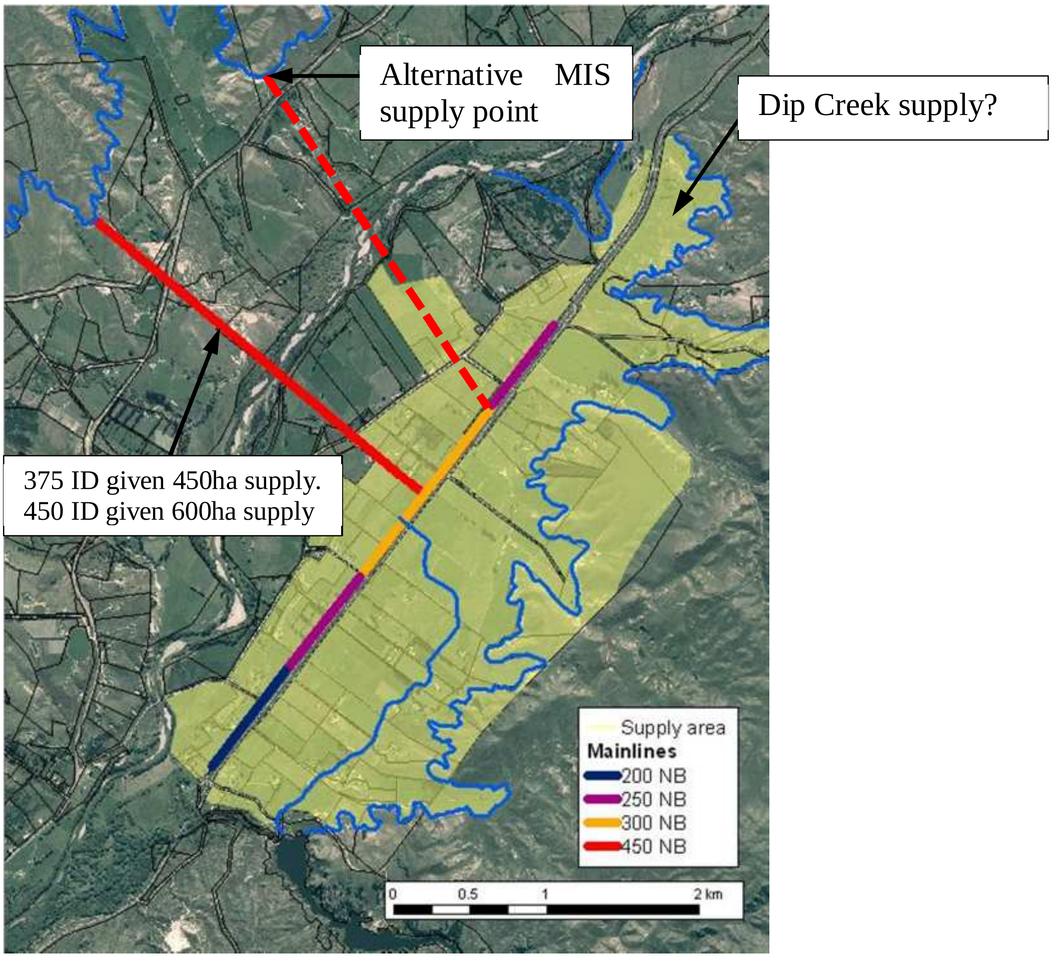

Figure 18: Galloway pressurised pipe supply from MIS

Table 17: Galloway MIS piped supply (450 ha supplied)

Item	Description	Unit	Qnt	Rate	Amount
A	**Engineering** (8% of B-D)	LS	1	$96,492	**$96,492**
B	**Preliminary and General** (10% of C-D)	LS	1	$109,650	**$109,650**
C	**Mainline pipes**				
C1	375mm NB PVC, PN6 (installed incl. fittings)	m	1,200	$145	$174,000
C2	375mm NB PVC, PN9 (installed incl. fittings)	m	1,600	$195	$312,000
C3	300mm NB PVC, PN9 (installed incl. fittings)	m	1,600	$130	$208,000
C4	250mm NB PVC, PN9 (installed incl. fittings)	Num	1,300	$100	$130,000
C5	200mm NB PVC, PN9 (installed incl. fittings)	Num	800	$70	$56,000
C6	Manuherikia River Crossing E/O	m	200	$100	$20,000
C7	Sealed road crossings E/O	Num	2	$7,000	$14,000
	Subtotal				**$914,000**
D	**Turnouts** (mainline to property boundary)				
D1	E/O turnout pipe. 50 - 150mm NB	m	2,000	$15	$30,000
D2	Turnout connection: sealed road crossings E/O	Num	15	$3,500	$52,500
D3	Turnout connection incl. value and flow meter	Num	40	$2,500	$100,000
	Subtotal				**$182,500**
E	**Contingency** (10% of A-D)	LS	1	$130,264	**$130,264**
	TOTAL CAPITAL				**$1,432,906**
	COST/HA				**$3,184**
	Costs exclude GST				

Table 18: Galloway MIS piped supply (600 ha supplied)

Item	Description	Unit	Qnt	Rate	Amount
A	**Engineering** (8% of B-D)	LS	1	$117,964	**$117,964**
B	**Preliminary and General** (10% of C-D)	LS	1	$134,050	**$134,050**
C	**Mainline pipes**				
C1	450mm NB PVC, PN6 (installed incl. fittings)	m	1,200	$215	$258,000
C2	450mm NB PVC, PN9 (installed incl. fittings)	m	1,600	$295	$472,000
C3	300mm NB PVC, PN9 (installed incl. fittings)	m	1,600	$130	$208,000
C4	250mm NB PVC, PN9 (installed incl. fittings)	m	1,300	$100	$130,000
C5	200mm NB PVC, PN9 (installed incl. fittings)	m	800	$70	$56,000
C6	Manuherikia River Crossing E/O	m	200	$100	$20,000
C7	Sealed road crossings E/O	Num	2	$7,000	$14,000
	Subtotal				**$1,158,000**
D	**Turnouts** (mainline to property boundary)				
D1	E/O turnout pipe. 50 - 150mm NB	m	2,000	$15	$30,000
D2	Turnout connection: sealed road crossings E/O	Num	15	$3,500	$52,500
D3	Turnout connection incl. value and flow meter	Num	40	$2,500	$100,000
	Subtotal				**$182,500**
E	**Contingency** (10% of A-D)	LS	1	$159,251	**$159,251**
	TOTAL CAPITAL				**$1,751,765**
	COST/HA				**$2,920**
	Costs exclude GST				

9.4 Gravity dam supply

In the High Level Options report (Aqualinc 2012c), a new dam in the Manor Burn catchment was proposed. Two possible dam sites with sufficient capacity to fully supply Galloway were identified at 300 m upstream of the existing Lower Manor Burn dam and on Little Valley Creek West Branch. Water from the new dam would be conveyed via the Galloway High Race. The High Race would need to be reconstructed to flow back in the opposite direction. A pump station would be required to lift water about 30 m from the Lower Manor Burn dam to the High Race.

This option is likely to be considerably more expensive that the alternatives of upgrading the existing races or a piped supply from MIS. Optimistically, we estimate this option has a capital cost of $5.5M or $10,000/ha. There is considerable uncertainty in dam costs and costs could be significantly higher. If PV pumping costs are added, the total PV cost of a pressurised water supply would be in the order of $14,000/ha (Table 19).

Other difficulties are the lower dam site would have a significant negative impact on recreational and environmental values.

The Lower Manor Burn dam is one of the most popular places for ice skating in New Zealand (Figure 20). People have been skating on the Manor Burn dam since its construction. During the 1950′s and 1960′s dozens of buses would travel from Invercargill and Dunedin filled with skaters, although since 1992 the number of skaters making use of the dam has reduced due to the local ice sports organisation no longer officially opening the dam for skating (Iceblock 2012). A new dam 300 m upstream of the existing dam would have a significant negative impact on ice skating opportunities because of the increase in water depth and dam operating range.

In addition to having high recreational values, the Lower Manor Burn dam also has high environmental values. Amongst other values the margins of the dam are classified as a Regionally Significant Wetland under the Otago Water Plan (ORC 2012a). A new dam would probably have a negative impact on these values because of the increased lake operating range.

The Little Valley Creek West Branch dam site would not have the same recreational and environmental impact. However, the dam would flood a significant area of land, potentially resulting in land-owner issues.

In favour of this option is that it frees up some Manuherikia River water. However, whether or not this is actually beneficial will depend on other factors such as whether the scheme is economically viable, and what happens to any Manuherikia River water savings. If any Manuherikia water savings were transferred to the Upper Manuherikia Valley, this would have a negative environmental impact because of the loss in conveyance flows. Another complication is water rights; it would be difficult to reduce Galloway’s Manuherikia River allocation if they upgrade existing distribution to achieve reasonable efficiency.

Figure 19: Lower Manor Burn reservoir


Figure 20: Ice skating on the Lower Manor Burn Dam (Iceblock 2012)

Table 19: Galloway Dam supply (550 ha supplied)

Item	Description	Unit	Qnt	Rate	Amount
A	**Engineering** (8% of B-D)	LS	1	$373,120	**$373,120**
B	**Preliminary and General (**10% of C-D)	LS	1	$424,000	**$424,000**
C	**Dam supply**				
C1	Dam construction (very rough. Costs could be significantly higher)	LS	1	$2,500,000	$2,500,000
C2	Realign high race	m	12,000	$100	$1,200,000
C3	Pump station incl. transmission upgrades (310 l/s, 30m, 75% efficient)	kW	120	$1,500	$180,000
	Subtotal				**$3,880,000**
D	**Race upgrades** (losses limited to 15%)				
D1	Line leaky race sections	m	1,000	$50	$50,000
D2	Automatic gates	Num	3	$20,000	$60,000
D3	Buffer storage ponds	m^3	50,000	$5	$250,000
	Subtotal				**$360,000**
E	**Contingency** (10% of A-D)	LS	1	$503,712	**$503,712**
F	**PV on-farm pumping** (600mm/y, 35m pumping @ 60% efficiency, $0.20/kWh & 7.5%/y compound interest)	**ha**	**530**	**$2,500**	**$1,325,000**
G	**PV scheme pumping** (120kW,120 days $0.15/kWh, 7.5%/y compound interest)	**LS**	**1**	**$690,000**	**$690,000**
	TOTAL CAPITAL				**$5,540,832**
	CAPITAL COST/HA				**$10,074**
	PV COST/HA				**$13,738**

9.5 Other options considered

Pumping from the confluence of the Clutha River, with a piped supply to Galloway has previously been put forward as a possible solution. At the confluence, the Clutha River has a water level of about 130 m amsl. This is 110 m below the height of the MIS supply point. A much longer length of pipe is required (compared with the MIS supply option) as well as a large pump station at the Clutha River intake (see Figure 21). We do not favour this option due to the high capital cost and high on-going pumping cost, with Present Value costs three times the MIS pipe supply option. Indicative costs are given in Table 20.

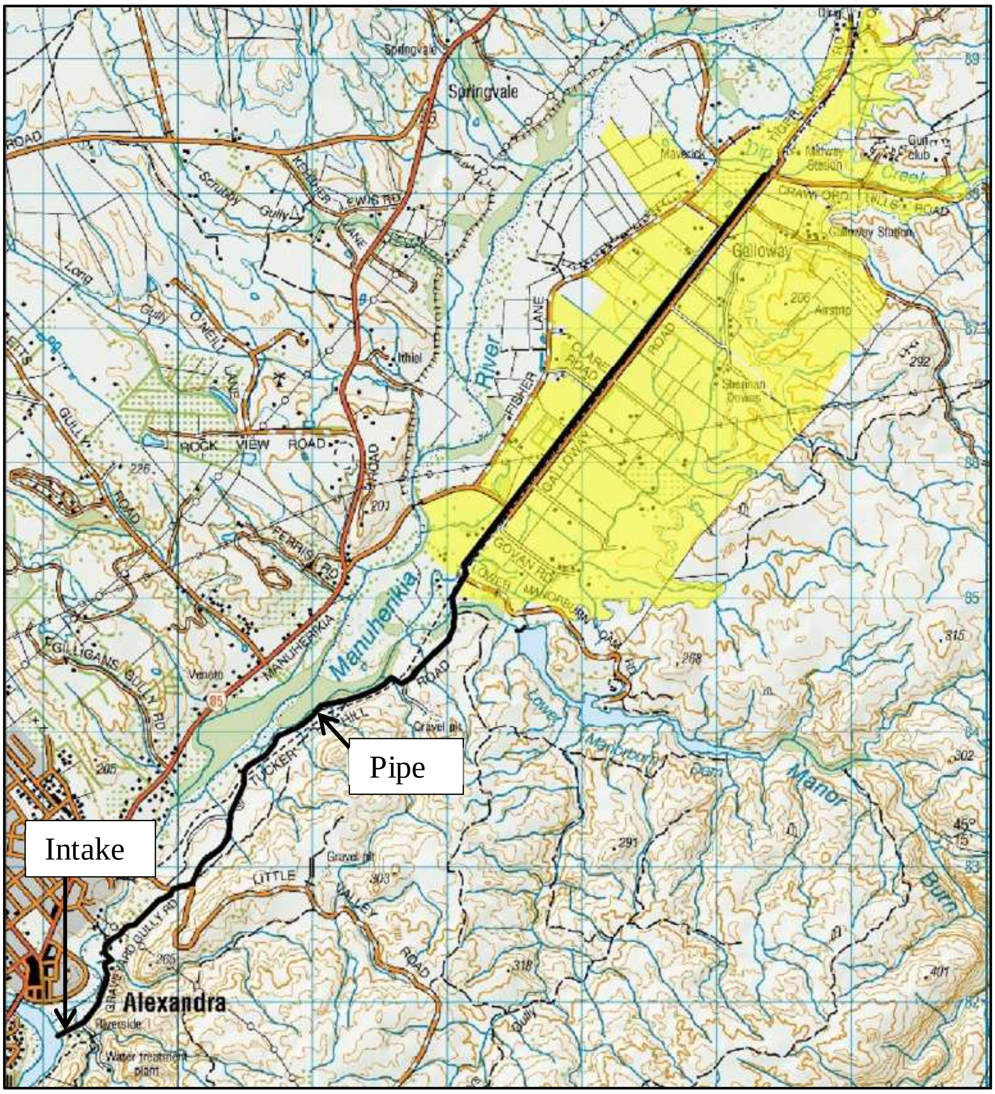

Figure 21: Galloway Clutha River piped supply

Table 20: Galloway Clutha River piped supply (600 ha supplied)

Item	Description	Unit	Qnt	Rate	Amount
A	**Engineering** (8% of B-E)	LS	1	$290,110	**$290,110**
B	**Preliminary and General** (10% of C-E)	LS	1	$329,670	**$329,670**
C	**Intake**				
C1	Clutha River screened intake	LS	1	$50,000	$50,000
C2	Pump station incl. transmission upgrades (300l/s, 120m, 75% efficient)	kW	470	$1,500	$705,000
	Subtotal				**$755,000**
D	**Mainline pipes**				
D1	450mm NB PVC, PN9 (installed incl. fittings)	m	7,400	$295	$2,183,000
D2	300mm NB PVC, PN9 (installed incl. fittings)	m	740	$130	$96,200
D3	250mm NB PVC, PN9 (installed incl. fittings)	m	660	$100	$66,000
D4	Sealed road crossings E/O	Num	2	$7,000	$14,000
	Subtotal				**$2,359,200**
E	**Turnouts (mainline to property boundary)**				
E1	E/O turnout pipe. 50 - 150mm NB	m	2,000	$15	$30,000
E2	Turnout connection: sealed road crossings E/O	Num	15	$3,500	$52,500
E3	Turnout connection incl. value and flow meter	Num	40	$2,500	$100,000
	Subtotal				**$182,500**
	-				
F	**Contingency** (10% of A-E)	LS	1	$391,648	**$391,648**
G	**PV scheme pumping** (470kW,120 days $0.15/kWh, 7.5%/y compound interest)	**LS**	**1**	**$2,707,200**	**$2,707,200**
	TOTAL CAPITAL				**$4,308,128**
	COST/HA				**$7,180**
	PV COST				**$7,015,328**
	PV COST/HA				**$11,692**

Table 20 assumes the scheme delivers similar turnout pressures as the option described in Section 9.3.

10 References

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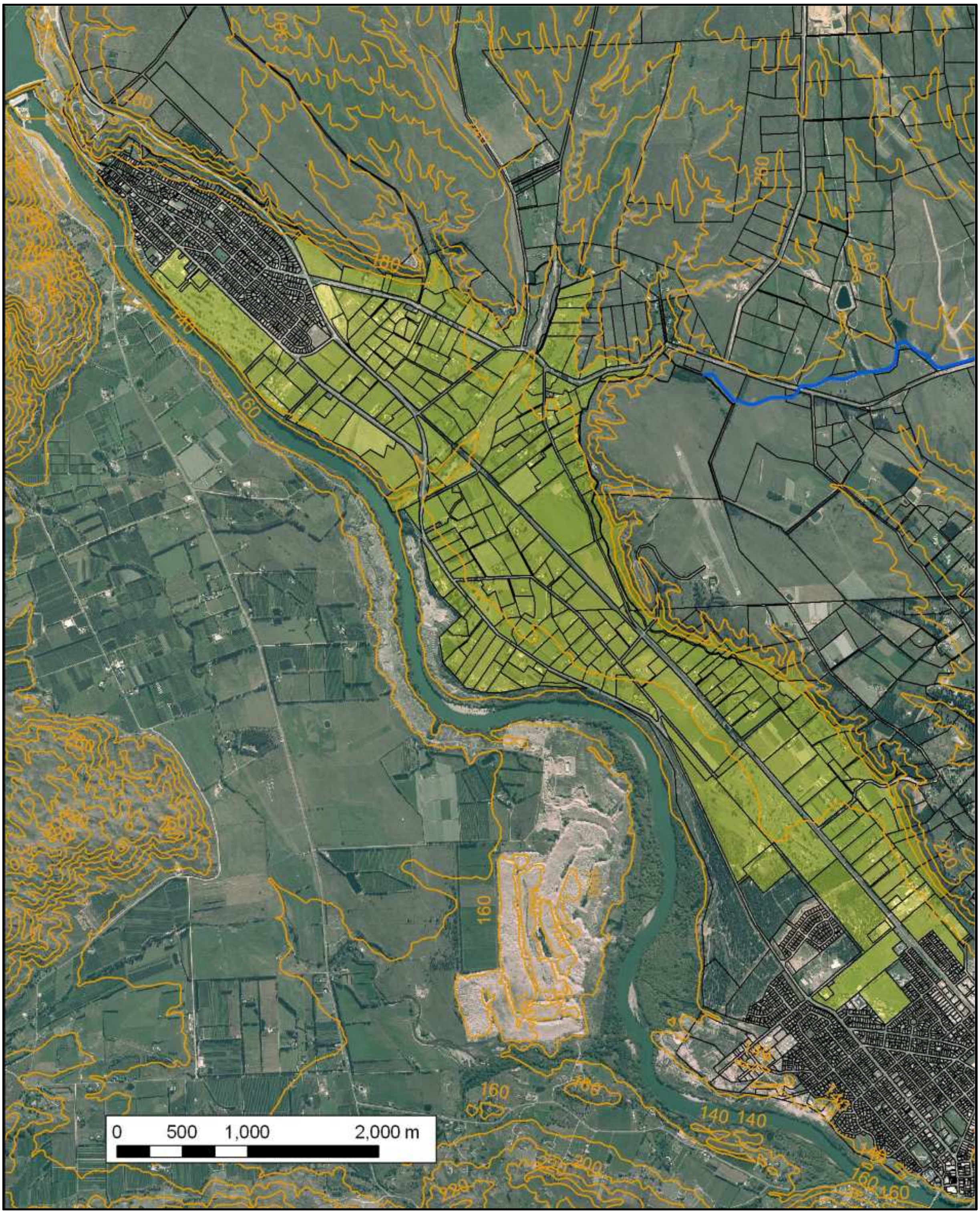
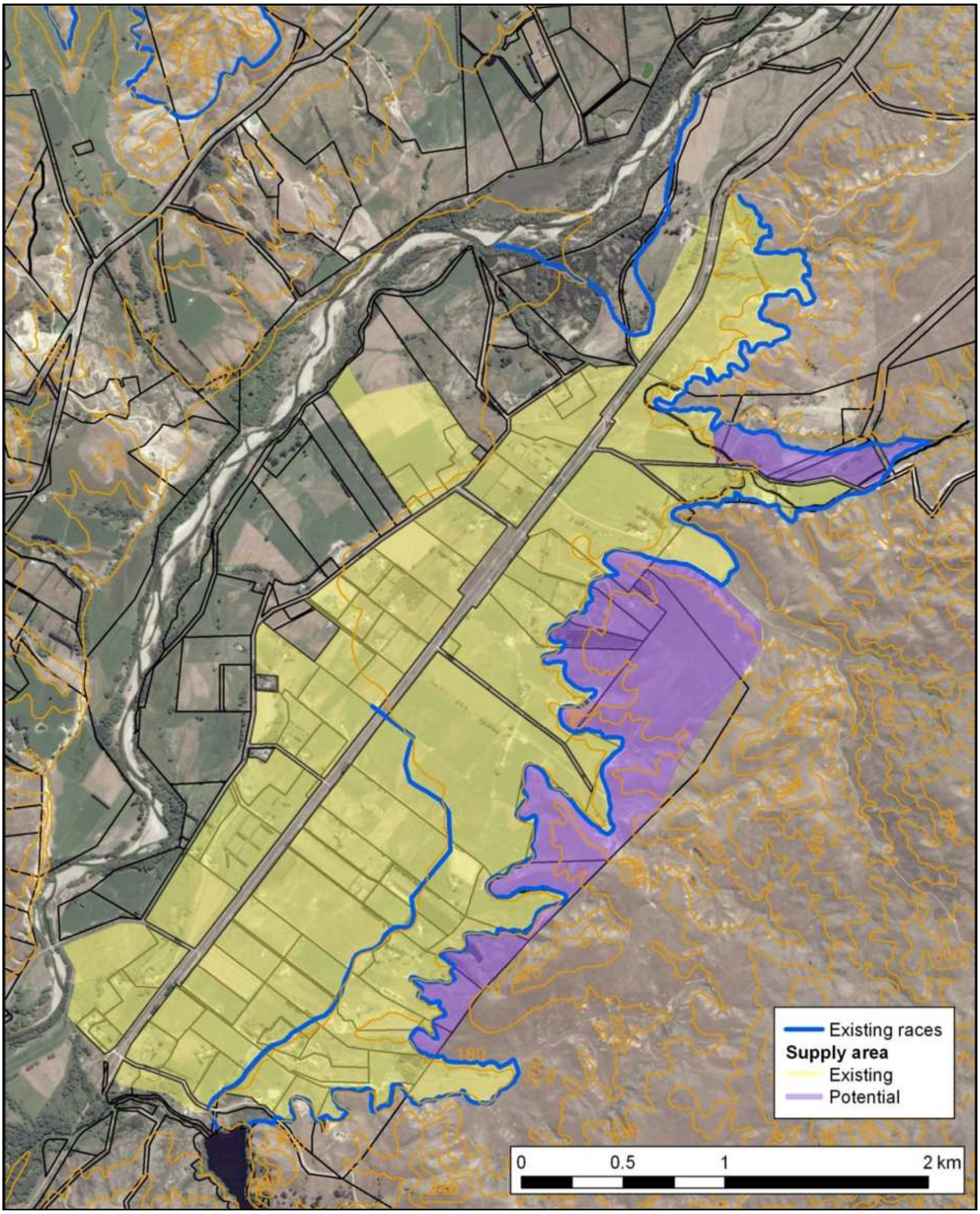
Appendix A: Supply areas

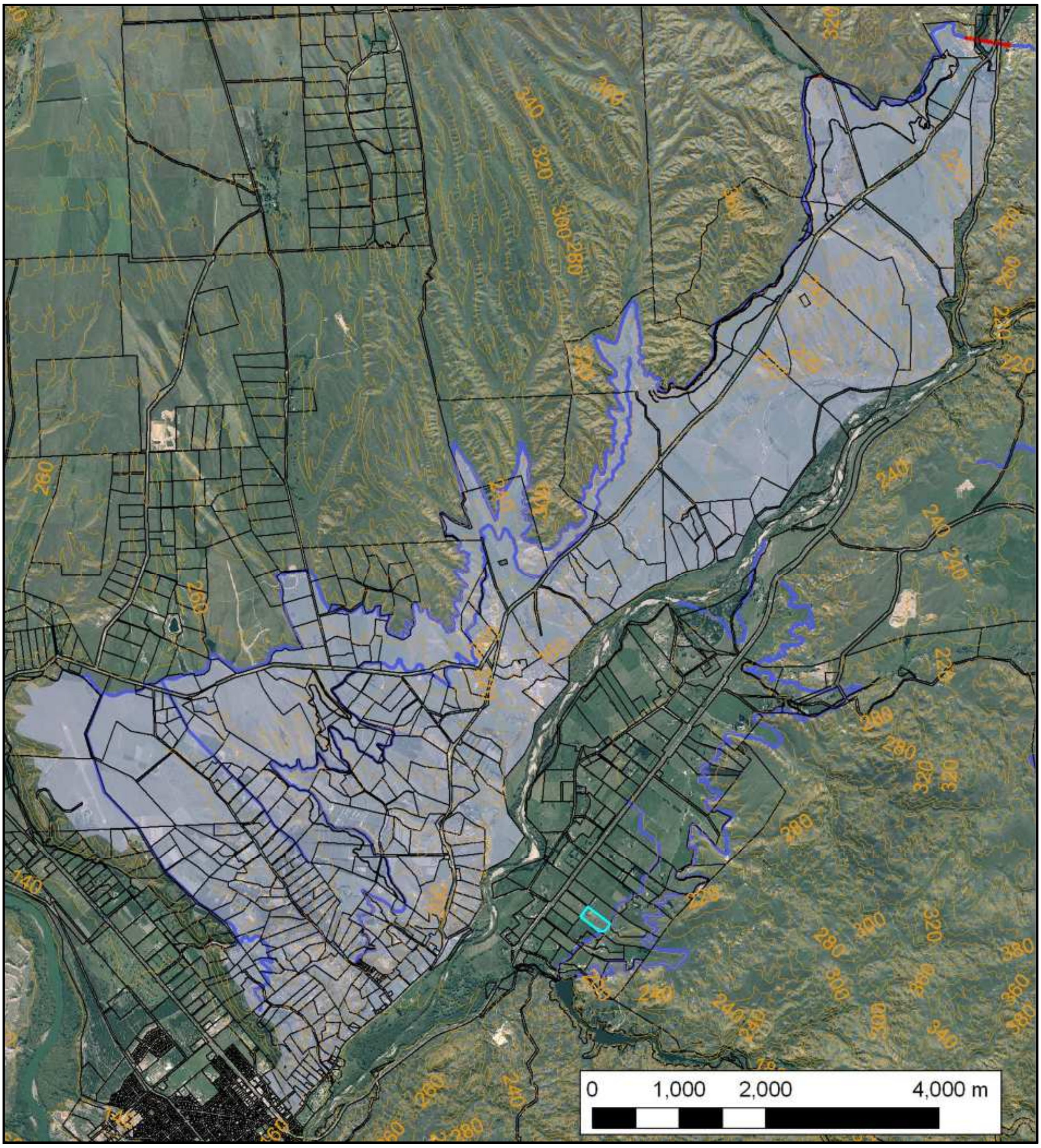


Dunstan Flats potential supply area



Galloway Irrigation Scheme existing and potential supply area

Description	Area
Existing contract area	520 ha
Existing command area	580 ha
Potential new supply area	130 ha
Total command area	710 ha



Manuherikia Irrigation Scheme supply area, excluding Dunstan Flats