June 2015

MANUHERIKIA CATCHMENT WATER STRATEGY GROUP

Irrigation Distribution Report

Submitted to:
Manuherikia Catchment Water Strategy Group

Report Number. 1378110270-2000-R-Rev1-223

REPORT

Golder Associates

Executive Summary

The Manuherikia Catchment Water Strategy Group (MCWSG) was established with the aim of developing and implementing cost effective, efficient and sustainable irrigation options for water users within the Manuherikia River catchment. A staged assessment approach has been adopted in order to assess the viability of any future irrigation options. The first stage of assessment was a High Level Overview Study which assessed water availability and demand within the catchment (Aqualinc 2012a, 2012b and 2013c). This was followed by a Prefeasibility Study which assessed potential development options for improved irrigation within the catchment (Aqualinc 2012d). These studies lead the MCWSG to conclude:

> *"… that the catchment was not water short and that there are promising options that could increase the reliability of the current irrigation area or potentially increase the total area of irrigated land from approximately 15,000 hectares to 35,000 hectares"* (MCWSG 2013).

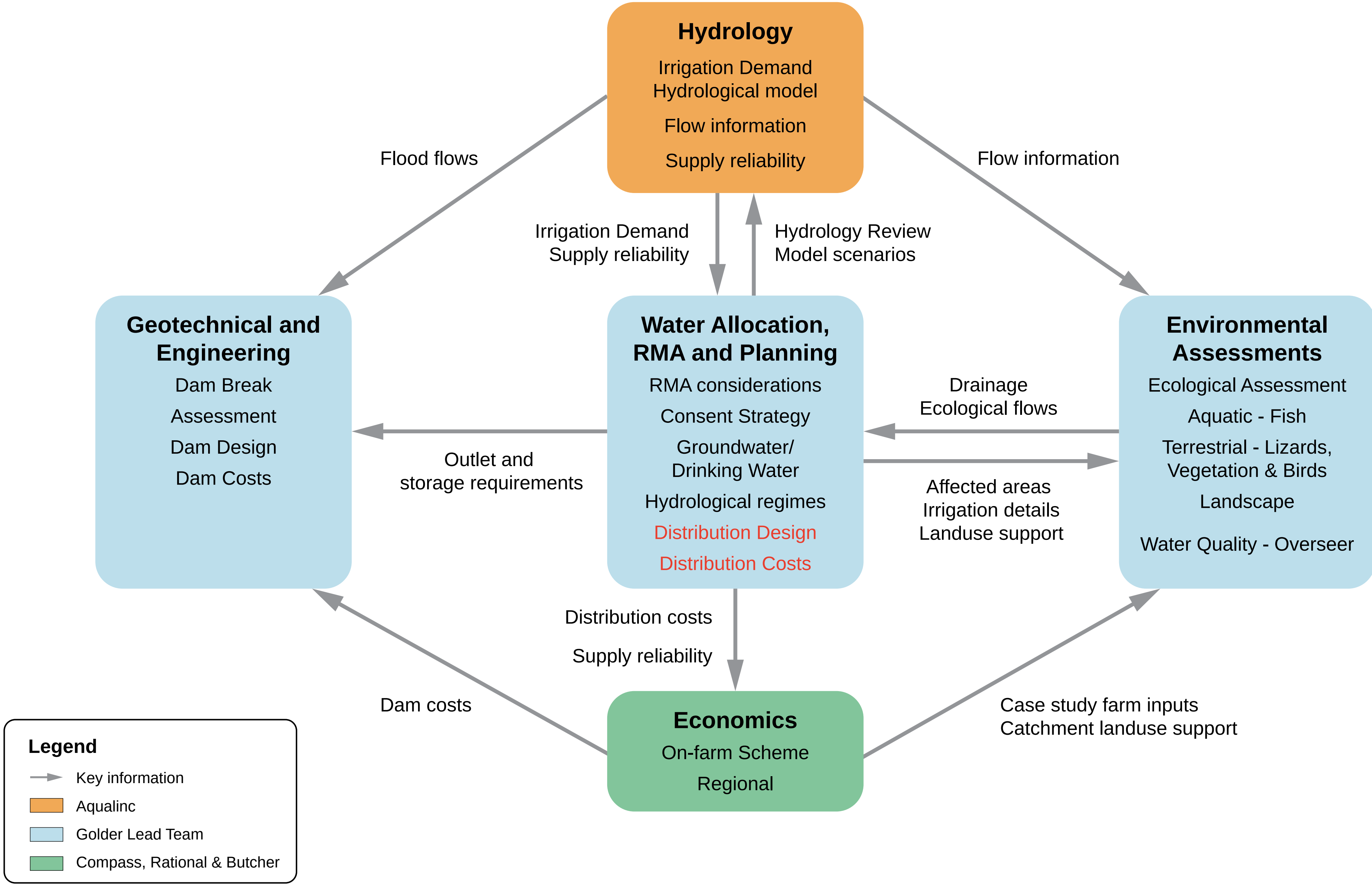
MCWSG have now commissioned a Feasibility Study (of which this report is part), to assess the technical, environmental, economic and financial feasibility of five irrigation development options. Three options involve raising the impoundment of Falls Dam by building a new dam or raising the existing dam. A fourth option is to improve the efficiency of irrigation within the Manuherikia Valley by developing efficient water distribution systems. The fifth option is the construction of a new dam (the Mount Ida Dam) on the upper Ida Burn. In addition to the five main options a preliminary assessment has being completed on the proposed Hopes Creek Dam which would supply water to the Ida Valley.

This distribution assessment is one of a number of reports that make up the overall Feasibility Study, the structure and key components of which are shown below.

For each of the five irrigation development options this distribution assessment has identified various potential distribution scenarios which are discussed on a scheme by scheme basis. For each scheme a brief description and history is provided followed by an assessment of the efficiency of the current distribution network. Proposed distribution networks under the various irrigation development options, including design schematics and costing information are provided for each of the schemes.

Irrigation in the catchment is currently characterised by an extensive open race distribution network which is operated on a roster system that supplies water to predominantly on-farm flood irrigation. Six main irrigation schemes operate in the catchment (Omakau, Blackstone, Hawkdun/Idaburn, Ida Valley, Manuherikia and Galloway) in addition to numerous private irrigators with rights to abstract water for irrigation purposes. On a catchment level the irrigation is very efficient in terms of both scheme distribution efficiency and catchment water use. Inspection and monitoring of the open race network indicates that race leakage is limited and within the 10 % which is considered acceptable for open race based distribution networks. Irrigation water is spread very thinly and often recaptured and reused down gradient. While water use efficiency is high at a catchment level, on an individual paddock or farm basis it is often poor. Improving water use efficiency at a farm or paddock level essentially represents a move from flood irrigation, which currently dominates, to spray irrigation. Spray irrigation requires a constant, on demand water supply and the irrigation schemes would need to shift away from rostered supplies.

Conversion to spray provides production benefits but is expensive ranging from $2,000/ha to $10,000/ha (Aqualinc 2012). To justify the conversion costs a reliable water supply is required. The spray conversions that have occurred within the catchment are on properties with one or more of the following: reliable high priority water rights; a large quota; access to water from scheme storage reservoirs (i.e., Falls Dam) and on-farm buffer storage. Hydrological model results (Aqualinc 2013 and 2014) indicate that in the lower Manuherikia Valley below Ophir, irrigation water supply is sufficiently reliable to justify upgrades or improvements to the distribution network and on-farm conversion to spray irrigation. Most of the rest of the catchment (Manuherikia Valley above Ophir and the Ida Valley) suffers from reduced water supply reliability. Future irrigation development in this area needs to focus on improving water supply reliability and on-farm performance, prior to considering extensive upgrades or improvements to the distribution network. Improving supply reliability relies on increased water harvesting and storage, namely raising Falls Dam or constructing the proposed Mount Ida and Hopes Creek dams.



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There is considerable existing distribution infrastructure throughout the catchment, parts of which are not fully utilised during the peak of the irrigation season due to insufficient water supply. Upgrading and improvement of the distribution networks should initially focus on activities which reduce bywash, assist management and operation, and encourage on-farm conversion to spray irrigation. Longer term distribution upgrades should focus on providing gravity pressurised piped water supply where possible.

The size, location and complexity of an irrigation distribution network are dependent on the irrigators who join the scheme and where the water is required. Limited information regarding potential irrigator demand or commitment is available. Conceptual distribution networks have been developed which provide an indication of the potential, size, extent and location of the networks to assist with cost estimation.

The benefits of gravity pressurised water supplies are significant. The key design principle used to develop the conceptual distribution networks was to provide gravity pressurised piped water supply wherever possible in order to; simplify scheme operation and management, facilitate the conversion to spray irrigation and eliminate or reduce scheme or on-farm pumping. An alignment for a new High Race has been developed which maximises the area that can potentially be supplied with pressurised water. Following selection of the preferred scheme, particularly the water storage option, further design work is required to optimise the distribution networks and confirm estimated distribution costs. This work would be undertaken during detailed design and would include: confirmation of supply areas and design flows, detailed hydraulic design of key infrastructure (particularly the siphons and intakes) and full alignment walkovers (particularly for the proposed High Race alignment through the Drybread Diggings).

The irrigation schemes and the numerous private irrigators in the catchment tend to operate in a somewhat independent and isolated manner. The Falls Dam Company and the priority associated with the various abstraction consents ensure a degree of co-operation. Irrigation development within the catchment will require a high level of co-operation and interactive management to ensure the optimum water supply and distribution solutions are identified and progressed. Similarly re-consenting of the existing irrigation activities when the deemed permits expire in 2021 is likely to be facilitated if a catchment wide approach is adopted.

In assessing the various irrigation development options current and potential irrigators need to consider the development as a whole, including: storage, distribution, on-farm development, water management and scheme operation. The various conceptual distribution options outlined in this report provide differing levels of service, particularly in regard to the provision of pressurised versus non-pressurised water. In comparing the various distribution development options we recommend the full life of asset costs be the principal means of comparison.

The following table summarises the distribution development options.

Catchment summary of distribution scenarios.

Irrigation Scheme[1]	Distribution scenarios	Irrigated area (ha)	Capital Cost ($)	Annual Operational Cost[2] ($)	Reliant on increased storage	Relevant Irrigation development option	Comments[3]
Galloway (GIS)	Pumped Open Race (Status Quo unpressurised supply)	520	410,000 (800/ha)	210,000[4] (390/ha)	No	Status Quo	Current supply reliability is sufficient to support on-farm spray irrigation and distribution development. Given the existing power arrangement, a move to pumped piped supply from the Manuherikia River is supported. If Keddell Road pipe goes ahead as part of MIS developments then investigate the potential of gravity supply from MIS main race. If Hopes Creek Dam goes ahead investigate shifting supply to the Lower Manorburn Dam. Costs exclude consideration of the Lower Manorburn Dam.
	Pumped piped pressurised supply from Manuherikia	550 (potentially more)	1,930,000 (3,500/ha)	160,000[4] (290/ha)	No	4 (Efficient Distribution)	
Manuherikia (MIS)	Open Race (Status Quo excludes areas below)	3,600	3,620,000 (1,000/ha)	230,000 (70/ha)	No	Status Quo excludes Dunstan Flats etc.	Current supply reliability sufficient to support on-farm spray irrigation and distribution development. Development of a gravity piped supply to Dunstan Flats, Keddell Road, Springvale and Long Gully areas is supported. Investigate the potential to tie the Keddell Road pipeline in with a gravity supply to the GIS. Reduced use of the Borough Race and transfer of the take to the main intake from the Manuherikia River should be investigated as it will simplify scheme operation, reduce maintenance and maximise the area that can be supplied with gravity pressurised water.
	Gravity pipe Dunstan Flats	500	3,150,000 (6,300/ha)	70,000 (140/ha)	No	4 (Efficient Distribution)	
	Gravity pipe Keddell Road, Springvale etc.	600	1,420,000 (2,400/ha)	70,000 (120/ha)	No	4 (Efficient Distribution)	
Blackstone (BIS)	Open Race (Status Quo unpressurised supply)	660	410,000 (600/ha)	70,000 (110ha)	No	Status Quo & 2 (Falls Dam low raise)	Current supply reliability is relatively poor which will limit development of spray irrigation to the area with secure peak of season water supply. Falls Dam High, Mid and Low raises increase supply reliability allowing increased spray irrigation. A gravity piped supply is possible but expensive. Focus development on-farm initially then on improving supply reliability.
	Gravity pressurised pipe supply from new High Race	1,200 (potentially more)	6,480,000 (5,400/ha)	50,000 (40/ha)	Yes	1 and 3 (Falls Dam mid and high raise)	
Omakau (OIS)	Main Race status quo (unpressurised supply)	3,759	3,830,000 (1,000/ha)	160,000 (40/ha)	No	Status Quo & 2 (Falls Dam low raise)	Current supply reliability is relatively poor (particularly for the Lauder, Matakanui and County parts of the OIS) which will limit development of spray irrigation to the area with secure peak of season water supply. Development of spray irrigation on-farm only for areas with secure peak of season water supply. Falls Dam High, Mid and Low raises increase supply reliability allowing increased spray irrigation. A gravity piped supply to the Becks Flat area from the Blackstone Race is possible and should be investigated further. Focus development on-farm initially then on improving supply reliability. Investigate potential to supply Matakanui extension area from expanded OIS main race.
	Dunstan, Lauder, Matakanui and County status quo (unpressurised supply)	2,083	2,320,000 (1,100/ha)	280,000 (130/ha)	No	Status Quo	
	Main Race expanded capacity (unpressurised supply)	6,000[5]	10,670,000 (1,800/ha)	160,000 (30/ha)	Yes	1 and 3 (Falls Dam mid and high raise)	
	Gravity pipe to Becks Flats	600	2,790,000 (4,700/ha)	10,000 (20/ha)	No	Status Quo	
High Race	High Race to Matakanui Station Boundary piped secondary distribution.	14,100[5] (~ 8,000[5] pressurised supply)	63,880,000 (4,500/ha)	230,000 (20/ha)	Yes	1 (Falls Dam high raise)	High race associated with Falls Dam Mid and High raises, would increase supply reliability allowing increased spray irrigation. Falls Dam High raise allows High Race to replace all irrigation from Dunstan, Lauder, Thomsons Creeks and associated tributaries. Falls Dam Mid raise allows High Race to replace all irrigation from Dunstan Creek and suppliants current takes from Lauder Creek. There is a large potential for gravity pressurised supply and development should focus on these areas. Focusing development closer to Falls Dam will reduce distribution costs.
	High Race to Lauder Creek piped secondary distribution.	6,500[5] (~ 4,000[5] pressurised supply)	32,680,000 (5,000/ha)	230,000 (40/ha)	Yes	3 (Falls Dam mid raise)	
Hawkdun Idaburn (HIIC)	Upgrade Mt Ida Race, gravity unpressurised supply	3,585	1,260,000 (400/ha)	90,000 (30/ha)	No	Status Quo	Current supply reliability very poor. Development of spray irrigation on-farm only for areas with secure peak of season water supply. There is potential to increase water harvesting by the Mt Ida Race through reducing leakage, upgrading intakes and potentially harvesting from additional sub-catchments, all of which should be investigated further. The proposed Mt Ida Dam improves supply reliability allowing increased spray irrigation. With Falls Dam High Raise the potential to pump over Home Hills Saddle to suppliant R race should be investigated.
	Expand Mt Ida Race	2,000	2,2900,000 (1,200/ha)	Included in above	Yes	5 (Mt Ida Dam)	
Private irrigators	Development focused on-farm	Total area unknown	n/a	n/a	No	Status Quo	For irrigators who take from the Manuherikia River, current supply reliability is sufficient to support conversion to spray irrigation. For many of the irrigators who take from the tributaries current supply reliability is relatively poor and on-farm development of spray irrigation will be limited to those areas with secure water supply during the peak of the irrigation season.

Notes: (1) The Ida Valley Irrigation Scheme (IVIS) was not assessed as it is not influenced by any of the 5 development options covered by the Feasibility Study.
(2) Unless stated annual operational costs exclude any scheme or on farm pumping.
(3) Supply reliability comments are based on hydrological model results (Aqualinc 2012f, 2013a and 2014).
(4) Operational costs for the Galloway scenarios include scheme pumping.
(5) Area is indicative only and based on assessment of current areas irrigated and potential increases suggested by the hydrological model results (Aqualinc 2012f, 2013a and 2014).
Shaded scenarios represent either full (dark grey) or partial (light grey) provision of pressurised (>30 m pressure) water to the farm gate. Unshaded scenarios require on-farm pumping for spray irrigation.

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LIST OF ABBREVIATIONS

ADV	acoustic doppler velocimeter
amsl	above mean sea level
Aqualinc	Aqualinc Research Limited
BIC	Blackstone Irrigation Company
BIS	Blackstone Irrigation Scheme
CODC	Central Otago District Council
DEM	digital elevation model
DOC	Department of Conservation
FSL	full supply level
GIS	Galloway Irrigation Scheme
GISI	Galloway Irrigation Society Incorporated
Golder	Golder Associates (NZ) Limited
ha	hectare
HIIC	Hawkdun/Idaburn Irrigation Company
HIIS	Hawkdun/Idaburn Irrigation Scheme
IVIC	Ida Valley Irrigation Company
IVIS	Ida Valley Irrigation Scheme
km	kilometer
L/s	litre per second
m	meters
7d MALF	7 day mean annual low flow
MCWSG	Manuherikia Catchment Water Strategy Group
mm	millimeters
MIC	Manuherikia Irrigation Co-Operative Society
MIS	Manuherikia Irrigation Scheme
MWD	Ministry of Works and Development
OCRT	Otago Central Rail Trail
OIC	Omakau Irrigation Company
OIS	Omakau Irrigation Scheme
ORC	Otago Regional Council
PE	polyethylene pipes
RL	Reduced level
RMA	Resource Management Act
SH85	State Highway 85

1.0 INTRODUCTION

1.1 Background

The Manuherikia Catchment Water Strategy Group (MCWSG) was established with the aim of developing and implementing cost effective, efficient and sustainable irrigation options for water users within the Manuherikia catchment. The Manuherikia catchment consists of two valley systems separated by the Ragged Range; the Manuherikia Valley to the west and the Ida Valley to the east Figure 1.

Approximately 25,000 ha is currently irrigated within the Manuherikia catchment, of which approximately 15,000 ha is consider fully irrigated with the remainder only partially irrigated (Aqualinc 2012b). Six main irrigation companies[1] operate within this area as well as a number of private irrigators with rights to abstract water for irrigation purposes. The irrigation companies are: the Omakau Irrigation Company (OIC), Blackstone Irrigation Company (BIC), Hawkdun/Idaburn Irrigation Company (HIIC), Ida Valley Irrigation Company (IVIC), Manuherikia Irrigation Co-Operative Society (MIC) and the Galloway Irrigation Society Incorporated (GISI). The Omakau, Manuherikia, Galloway and Blackstone companies have shares in the Falls Dam Company Limited which manages Falls Dam a key water storage infrastructure for these irrigation companies (MCWSG 2013). Falls Dam is also utilised for the generation of hydro-electricity and managed by Pioneer Generation Limited. The Ida Valley Irrigation Company operates the Manorburn, Greenland and Poolburn irrigation reservoirs which harvest winter runoff and snow melt for irrigation use in the southern section of the Ida Valley. An extensive network of open water races is used to distribute irrigation water from various river intakes to the irrigated areas.

A staged assessment approach has been adopted in order to assess the viability of any future irrigation options. The first stage of assessment was a High Level Overview Study which assessed water availability and demand within the catchment (Aqualinc 2012a, 2012b and 2013c). This was followed by a Prefeasibility Study (Aqualinc 2012d[2]), which assessed potential development options for improved irrigation within the catchment. The conclusions arising from these studies were:

> *"… that the catchment was not water short and that there are promising options that could increase the reliability of the current irrigation area or potentially increase the total area of irrigated land from approximately 15,000 hectares to 35,000 hectares."* (MCWSG 2013).

The existing Falls Dam is the largest storage in the Manuherikia Valley and the third largest in the Manuherikia catchment. At its full supply level of 546.2 m the existing Falls Dam is estimated to store approximately 10.3 Mm^3 of which approximately 10 Mm^3 is useable. The 10 Mm^3 of useable storage together with run of river takes has been assessed as sufficient to reliably irrigate about 6,500 ha of land within the Manuherikia Valley above Ophir (Aqualinc 2013a).

MCWSG have now commissioned a feasibility study (of which this report is part), to assess the technical, environmental, economic and financial feasibility of the options that have been identified. In addition, the feasibility study is required to ensure that sufficient information is available upon its completion for MCWSG to proceed to the next phase of the project (i.e., including sufficient information to support resource consent application(s)). The feasibility study has been separated into five interconnected components based on discipline (Hydrology, Geotechnical and Engineering, Water Allocation and RMA Planning, Environmental and Economic and Commercial). The relationship between the components and the position of this distribution assessment in the overall feasibility assessment is shown in Figure 2.

The feasibility study is focused on five irrigation development options which were identified in Aqualinc 2012d. The first three options involve raising the impoundment of Falls Dam by building a new dam or raising the existing dam. The fourth option is to improve the efficiency of irrigation within the Manuherikia Valley by developing efficient water distribution systems. The fifth option is the construction of a new dam (the Mount Ida Dam) on the upper Ida Burn. In addition to the five main options a preliminary assessment has being completed on the proposed Hopes Creek Dam (Golder 2014a). A brief description of the five options is provided below and an overall map of the project site and key features is presented in Figure 1.

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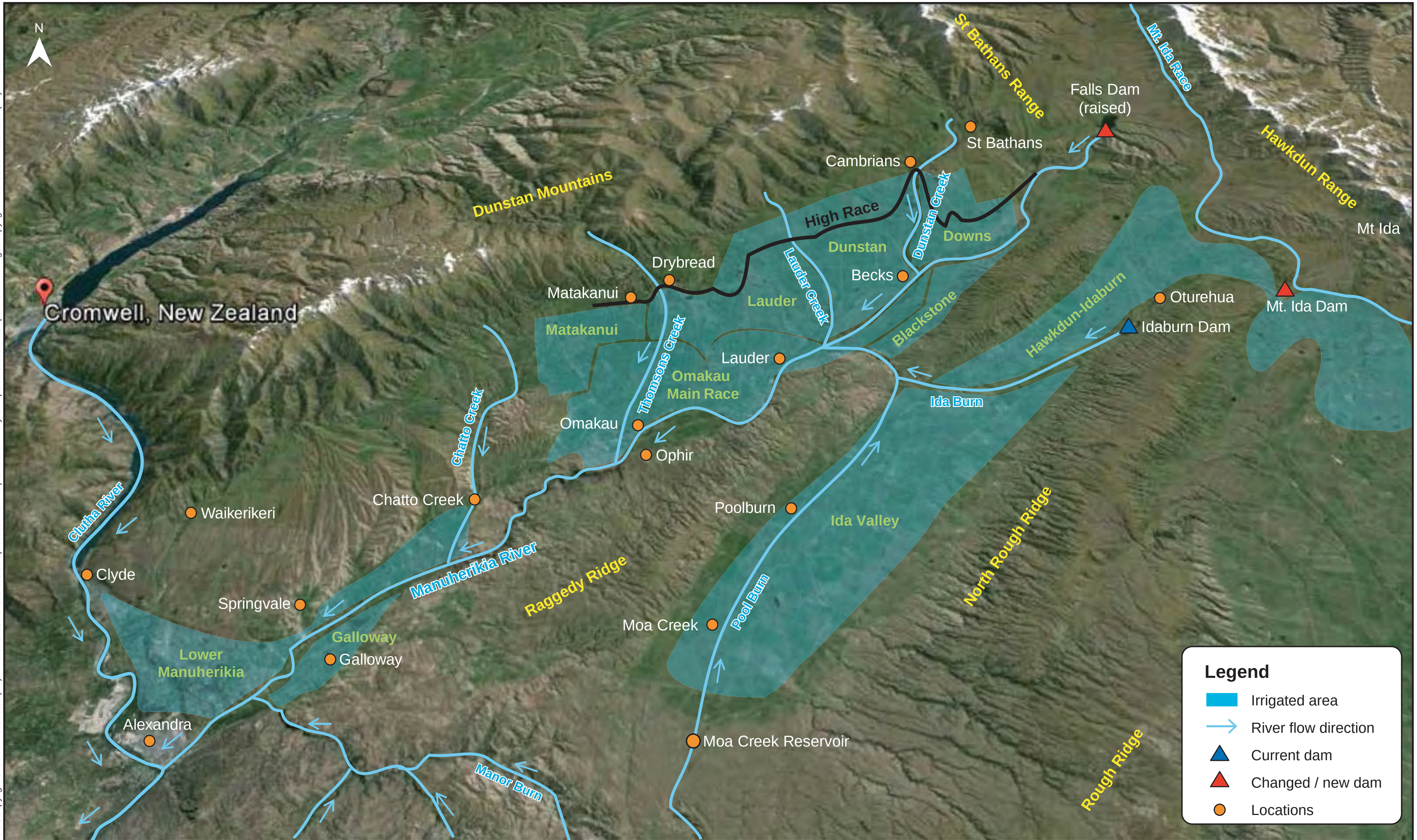
[1] 'Irrigation companies' is used to describe the various organisations that run the irrigation schemes, it includes companies, co-operative societies and incorporated societies.

[2] The Prefeasibility Study generated a number of reports the key findings of which are outlined in a summary report Aqualinc 2012d.



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TITLE MANUHERIKIA OVERVIEW MAP

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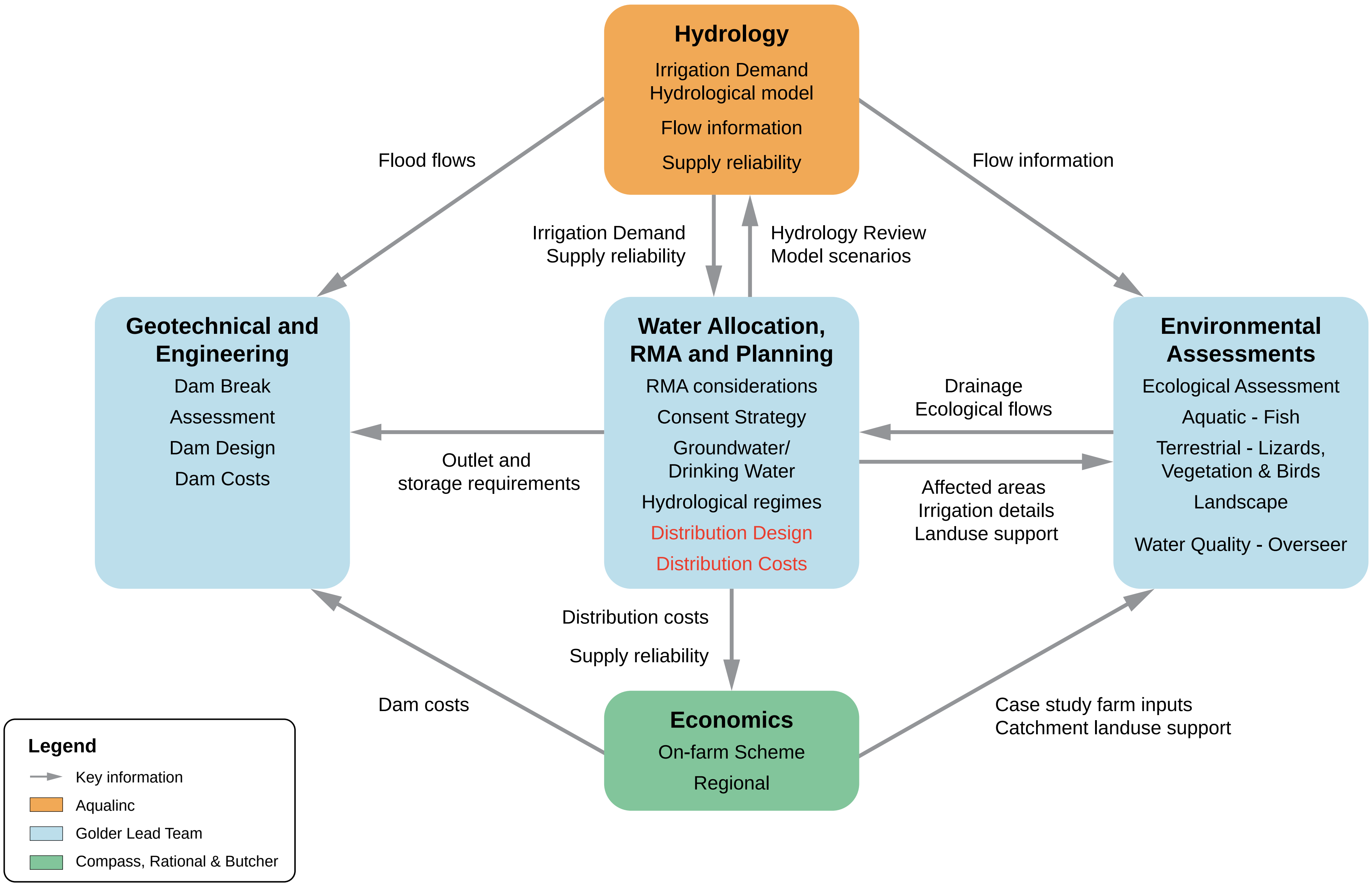

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1.2 The Five Development Options

The five irrigation development options that were defined by Aqualinc (2012d) and form the basis for the current feasibility study are described in the following sections.

1.2.1 Option 1: Falls Dam High Raise

Raise the impoundment of Falls Dam by 27 m, to a full supply level of 592.2 m, by building a new dam or raising the existing dam. At a full supply level of 592.2 m Falls Dam is estimated to store approximately 119.0 Mm^3 of which approximately 114.1 Mm^3 is potentially useable. This option aims to maximise the amount of water that can be reliably harvested at the Falls Dam site and maximise the potential for downstream irrigation development. Water balance assessments indicated that 114.1 Mm^3 of usable storage together with run of river takes is sufficient to reliably irrigate approximately 25,000 ha of land within the Manuherikia Valley (Aqualinc 2014). To distribute the irrigation water a new high race is proposed, which extends to the Matakanui Station boundary, plus upgrading much of the existing distribution network.

1.2.2 Option 2: Falls Dam Low Raise

Raise the impoundment of Falls Dam by 5.4 m, to a full supply level of 570.6 m, by building a new dam or raising the existing dam. At a full supply level of 570.6 m Falls Dam is estimated to store approximately 20.6 Mm^3 of which approximately 19.0 Mm^3 would be potentially useable. This option was considered the “do nothing” scenario during the prefeasibility study and was associated with the potential need to construct a new spillway at Falls Dam and the conceptual option of using the excavated rock from the new spillway to raise the existing embankment by 5.4 m (Opus 2013). Water balance assessments indicated that 19.0 Mm^3 of usable storage together with run of river takes is sufficient to reliably irrigate about 11,500 ha of land within the Manuherikia Valley (Aqualinc 2013a). This option essentially provides reliable water to the existing irrigators who are able to access water from Falls Dam, namely: the Blackstone Irrigation Scheme (BIS), the main race part of the Omakau Irrigation Scheme (OIS), the Manuherikia Irrigation Scheme (MIS) and the Galloway Irrigation Scheme (GIS). This option utilises the existing distribution network with upgrading and maintenance required.

1.2.3 Option 3: Falls Dam Mid Raise

Raise the impoundment of Falls Dam by 15.2 m, to a full supply level of 580.4 m, by building a new dam or raising the existing dam. At a full supply level of 580.4 m Falls Dam is estimated to store approximately 51.6 Mm^3 of which approximately 50 Mm^3 would be potentially useable. This option represents an approximate mid-point between Options 1 and 2. It aims to provide reliable water to most existing irrigators while allowing a small expansion of the irrigated area north of Lauder Creek. Water balance assessments indicated that 50.0 Mm^3 of usable storage together with run of river takes would be sufficient to reliably irrigate about 16,000 ha of land within the Manuherikia Valley (Aqualinc 2013a). To distribute the irrigation water a new high race was proposed, which extends to Lauder Creek plus upgrading much of the existing distribution network.

1.2.4 Option 4: Improved Irrigation Efficiency

This option is based on the current situation but with improved irrigation efficiency within the Manuherikia Valley, through development of efficient water distribution systems. The current distribution network is based on an extensive open race network that is operated on a roster system. Improving irrigation efficiency essentially represents a move from flood irrigation to spray irrigation. Historically all irrigation in the catchment was by flood. More recently, many individual irrigators have converted to spray irrigation. Conversion to spray provides production benefits but is expensive, ranging from $2,000/ha to $10,000/ha (Aqualinc 2012e). To justify the conversion costs a reliable, preferably continuous, water supply is preferred. Most of the spray conversions have occurred on properties which have one or more of the following: reliable high priority water rights; a large quota; access to water from Falls Dam and on-farm buffer storage. Many of the conversions have retained some areas of flood irrigation which are irrigated during the spring and wetter seasons when water is plentiful. During drier seasons when water is restricted only those areas developed for spray are actually irrigated.

The Lower Manuherikia River and particularly the MIS and GIS are relatively water rich due to a combination of; large quotas, access to water from Falls Dam, tributary inflows below Falls Dam and increased runoff and losses from upstream irrigation (Aqualinc 2012f and 2013a). Irrigators from both schemes have access to the reliable water that is required to justify conversion to spray. Option 4 is focused on the MIS and GIS and potential efficient distribution networks, which would facilitate increased spray irrigation.

1.2.5 Option 5: Mount Ida Dam

The HIIC have been investigating options for obtaining more reliable water for many years. Feasibility assessments (Hamilton 2006, Pickens 2005 and Raineffects 2006) proposed a new impoundment (Mount Ida Dam) with a 34 m high earth embankment on the upper Ida Burn near Seagull Hill. The Mount Ida Dam is estimated to store approximately 15.6 Mm^3 of which approximately 14.6 Mm^3 would be potentially useable (Hamilton 2006). The dam *“maximises the storage that can be achieved at the site”* (Hamilton 2006) and would harvest water from its upstream catchment with inflows supplemented by the Mount Ida Race. To improve the dam’s ability to refill, enlargement of the current Mount Ida Race from the upper Ida Burn to Hills Creek was proposed. Water balance assessments indicated that 14.6 Mm^3 of usable storage is sufficient to reliably irrigate about 2,000 ha of land in the Oturehua, Wedderburn and White Sow areas ((Hamilton 2006 and Aqualinc 2013b). To distribute the irrigation water both a piped and an open race network are being considered as part of this option.

1.3 Ida Valley Irrigation Scheme

The five options above do not cover the approximately 14,000 ha command area of the Ida Valley Irrigation Scheme (IVIS) which covers the southern part of the Ida Valley. The IVIS is predominantly storage based and harvests winter runoff and snow melt in the existing Manorburn, Greenland and Poolburn irrigation reservoirs for irrigation use over summer. The scheme is considered very water short and operates with a low average allocation (Aqualinc 2012b). In addition to the five main options a preliminary assessment has being completed on the proposed Hopes Creek Dam (Golder 2014a) which would provide additional storage for the IVIS.

1.4 Purpose of this report

The primary purpose of this report is to describe proposed distribution networks associated with the five development options. The report is also used to document the irrigable area within the catchment and storage at Falls Dam and Mt Ida Dam.

Following this introductory section the report is separated into five further sections as follows:

Section 2 – Irrigable Area: Describes the irrigable area within the catchment and the potential scale of the development options.

Section 3 – Dam Storage: Provides a stage storage curve for both Falls Dam and the Mt Ida Dam and outlines the inundation area under development Options 1 - 3 and 5.

Section 4 – Distribution Assessment: This section discusses each of the five existing irrigation schemes (Galloway, Manuherikia, Blackstone, Omakau and Hawkdun/Idaburn) plus a new “High Race” which would cover the majority of the irrigable land in the Manuherikia Valley above Ophir. Prior to discussing the individual schemes and the High Race a general section outlines the methodologies used during the efficiency assessments and the distribution design and cost estimation process. A sub-section is provided for each of the five schemes within which the following is presented:

1) A brief description and history of scheme, including description of the main scheme infrastructure items and reference to any relevant scheme inventories.

2) An assessment of the efficiency of the current distribution network including the results of race leakage assessments.

3) A description of a proposed distribution network under the various irrigation development options, including design schematics and costing information.

Assessment of the feasibility of Mt Ida Dam (Golder 2014f) indicated excessive cost and several significant technical challenges and consequently the distribution assessment has focused on the Mount Ida Race with limited conceptual consideration of the distribution below the dam.

A subsection is also provided on the proposed High Race, which describes the race alignment and secondary piped distribution networks, including design schematics and costing information.

Section 5 – Catchment Considerations: Provides discussion on a number of catchment wide considerations including interactions between the schemes and potential irrigation management throughout the catchment.

Section 6 – Conclusions and Recommendations: The key findings and conclusions from the study are briefly summarised along with recommendations for future work to advance the distribution options.

The report concludes with a list of references and various appendices which contain monitoring information, design details and calculation and cost estimate information.

The study area for this distribution assessment is focused on the potential irrigation command area associated with the five irrigation development options and therefore is focused on the Manuherikia Valley and a relatively small area below the proposed Mt Ida Dam.

1.4.1 Associated Feasibility Study Reports

As part of the current feasibility study two hydrological models (Aqualinc 2013a and 2013b (and reviewed in Golder 2014c and 2014d)) have been prepared that allow various storage, irrigation and flow regime scenarios to be assessed for the Manuherikia Valley and the Mount Ida Dam. The Manuherikia model (Aqualinc 2013a) predicts flow at various locations down the main stem of the Manuherikia River and predicts potential changes in flow. The Mount Ida Dam model is focused on the dam itself and its ability to refill. The models were updated in 2014 and have been used to determine the potential changes in flow associated with various irrigation development scenarios. This distribution report has been prepared using irrigation demand, storage, flow and reliability of water supply information provided by Aqualinc (2012a, 2012b, 2012f, 2013a and 2014). The reader is referred to the Aqualinc reports for detailed hydrological information.

Options 1 to 3 are linked to increased storage at Falls Dam. For geotechnical, dam engineering and dam cost information for Falls Dam the reader is referred to Golder (2015a).

For an assessment of the expected ecological effects of the proposed irrigation development options the reader is referred to Golder (2015b). An assessment of the landscape and visual amenity issues associated with raising Falls Dam and increasing irrigation in the Manuherikia Valley is provided in Espie, 2015.

1.5 Report Limitations

Your attention is drawn to the document, “Report Limitations”, as attached. The statements presented in that document are intended to advise you of what your realistic expectations of this report should be, and to present you with recommendations on how to minimise the risks to which this report relates which are associated with this project. The document is not intended to exclude or otherwise limit the obligations necessarily imposed by law on Golder Associates (NZ) Limited (Golder), but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

2.0 IRRIGABLE AREA

Aqualinc 2012a identified 63,000 ha of flat to undulating irrigable land and 16,000 ha of rolling irrigable land within the Manuherikia River catchment, of which 60,000 ha was used for the prefeasibility, whole of catchment water demand assessments (Aqualinc 2012d). This total includes both the Ida Valley and the Manuherikia Valley. Four of the feasibility options focus on irrigation within the Manuherika Valley while the Mount Ida Dam option is focused on approximately 1,000 ha within the northern part of the Ida Valley near Oturehua[3]. In considering irrigation from the MIS, Golder were instructed to not consider irrigation above the MIS Main Race as much of this area is cover by the proposed Dairy Creek Irrigation Scheme, which is the subject of a separate assessment.

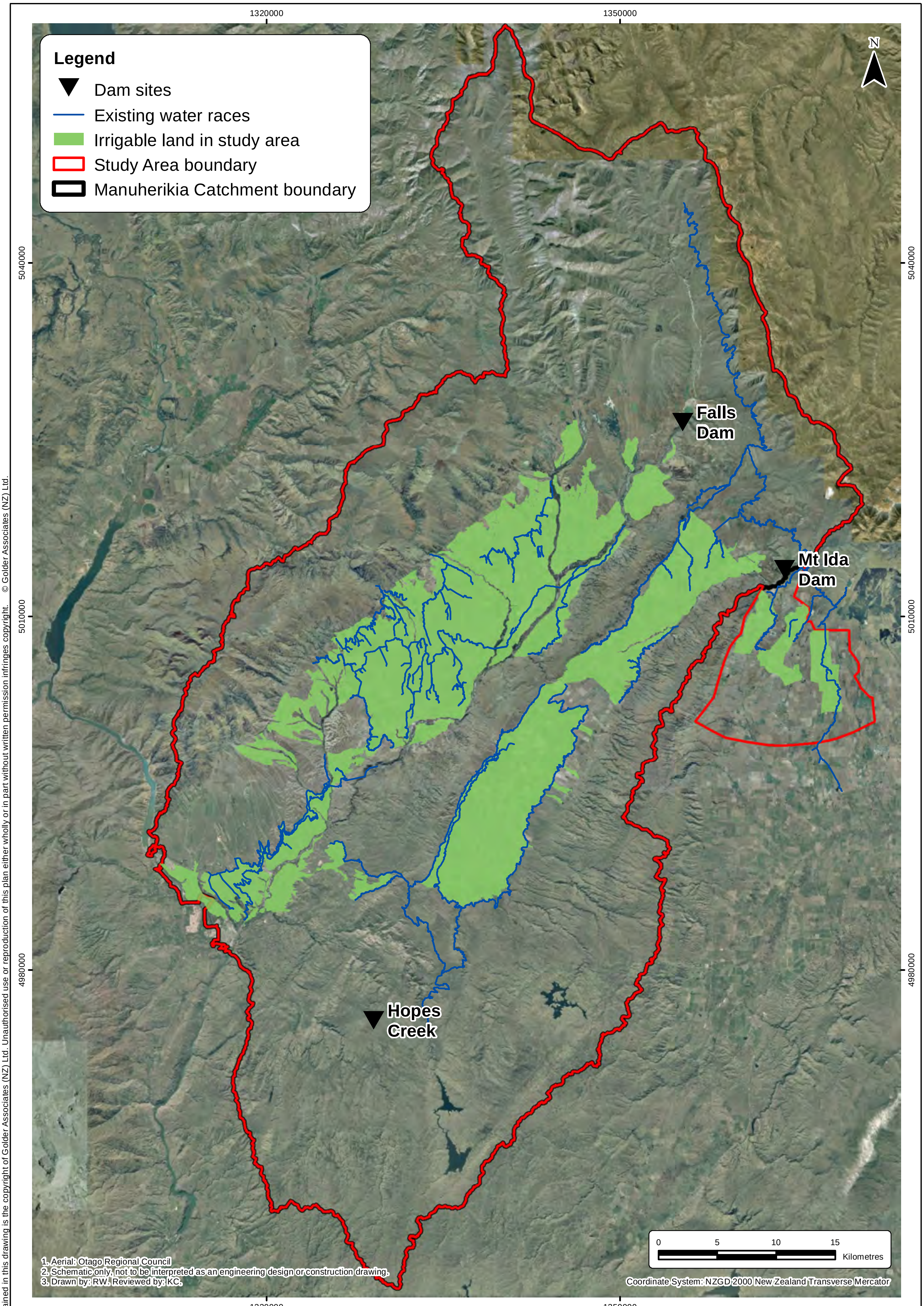
Using the irrigation area identified by Aqualinc during the prefeasibility assessments as a guide, aerial photographs were assessed to confirm the potential irrigable area for this study. Urban areas, obvious wetlands and riverbeds, heavily vegetated riparian strips, steep broken topography and small disconnected irrigable areas, remote from water sources, which would require extensive distribution networks, were removed. The assessment identified a total of approximately 36,100 ha within the Manuherikia Valley (excluding Crawford Hills) which is considered irrigable (Table 1 and Figure 3). This is similar to, but approximately 350 ha more than, the 35,744 ha identified in the prefeasibility assessment (Aqualinc 2012e). The increase is due to a proposed higher elevation High Race alignment (Section 4.6) than used in the prefeasibility assessment.

Table 1: Irrigable land within the Manuherikia Valley.

Location				Area (ha)	Comment
Manuherikia Valley	Above Ophir	BIS, OIS & various private irrigators	Above races or pump from river	2,450	Blacks Flat included in pump from river.
			< 40 below races	14,650	Includes ~ 7,600 ha below Omakau Irrigation Scheme Main Race which could receive pressurised supply from the proposed High Race. Also includes some private irrigators who take from various waterways who could be supplied from the High Race.
			> 40 m below races, potential pressurised supply	12,400	Includes Blackstone Irrigation Scheme and Becks Flat part of OIS Omakau Irrigation Scheme.
			Sub-total	**29,500**	
	Below Ophir	MIS & private irrigators	Above Race	200	McArthur Ridge.
			< 40 below races	2,350	Includes some private irrigators who take from the Manuherikia River.
			> 40 m below races, potential pressurised supply	1,500	~ 700 ha on Dunstan Flats and ~800 ha in the Keddell Road, Springvale and Long Gully areas.
		GIS	Pump from river/Manor Burn	950	Includes ~ 230 ha from Manor Burn,
			Sub-total	**5,000**	
	Matakanui Extension			1,600	
			Manuherikia Valley Total(1)	**36,100**	Prefeasibility study estimate 35,744 ha.
Ida Valley (including Crawford Hills)				**19,200**	
			Manuherikia Catchment Total	**55,300**	
Wedderburn area from proposed Mt Ida Dam				**550**	
			Study Area Total	**55,850**	

Notes: (1) Excludes the Dairy Flat command area.

[3] The proposed Mt Ida Dam aims to irrigate 2,000 ha, of which approximately 1,000 ha (50 %) is within the Ida Valley part of the Manuherikia River Catchment near Oturehua. The other 1,000 ha is within the Tairi River Catchment near Wedderburn and the White Sow area.



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TITLE MANUHERIKIA CATCHMENT IRRIGABLE AREAS

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Approximately 29,500 ha of the irrigable area is located above Ophir, a further approximately 5,000 ha is below Ophir with the remaining approximately 1,600 ha within the Matakanui extension. The Matakanui Extension represents an area of irrigable land predominantly in the Chatto Creek and Young Hill Creek sub-catchments in the vicinity of the Moutere Disputed Spur Road. This area is beyond the end of the proposed high race associated with Option 1 (Falls Dam High (27 m) Raise) and is difficult for water distribution. This area is excluded from the five irrigation development options (Section 1.2) but was the subject of a separate assessment (Golder 2014b).

Of the 29,500 ha of irrigable land above Ophir approximately 2,450 ha is above the proposed distribution races (namely the proposed High Race) and would require piping and pumping up from the races. Approximately 12,400 ha is greater than 40 m below the proposed distribution races and has the potential to be supplied with a gravity pressurised, piped network, which would eliminate the need for on-farm pumping. The remaining approximately 14,650 ha is below the proposed distribution races and can be supplied by gravity, but some on-farm pumping would be required. Approximately 7,600 ha of this area is below the OIS Main Race and has been assessed as being supplied from that race. Potentially this area could also be supplied by a gravity pressurised piped network from the proposed new high race, thereby further reducing the need for on-farm pumping.

Of the 5,000 ha of irrigable land below Ophir, approximately 4,050 ha is within or adjacent to the command area of the MIS, with the remaining 950 ha within or adjacent to the command area of the GIS. All but 200 ha (McArthur Ridge) of the 4,050 ha associated with the MIS is below the MIS Main Race and can be supplied by gravity, of which approximately 1,500 ha (including 700 ha on Dunstan Flats) is greater than 40 m below the MIS Main Race. This 1,500 ha has the potential to be supplied with a gravity pressurised piped network that would eliminate the need for on-farm pumping. All 950 ha within or adjacent to the command area of the GIS is greater than 40 m below the MIS Main Race and has the potential to be supplied with a gravity pressurised piped network, which would eliminate the need for any scheme or on-farm pumping.

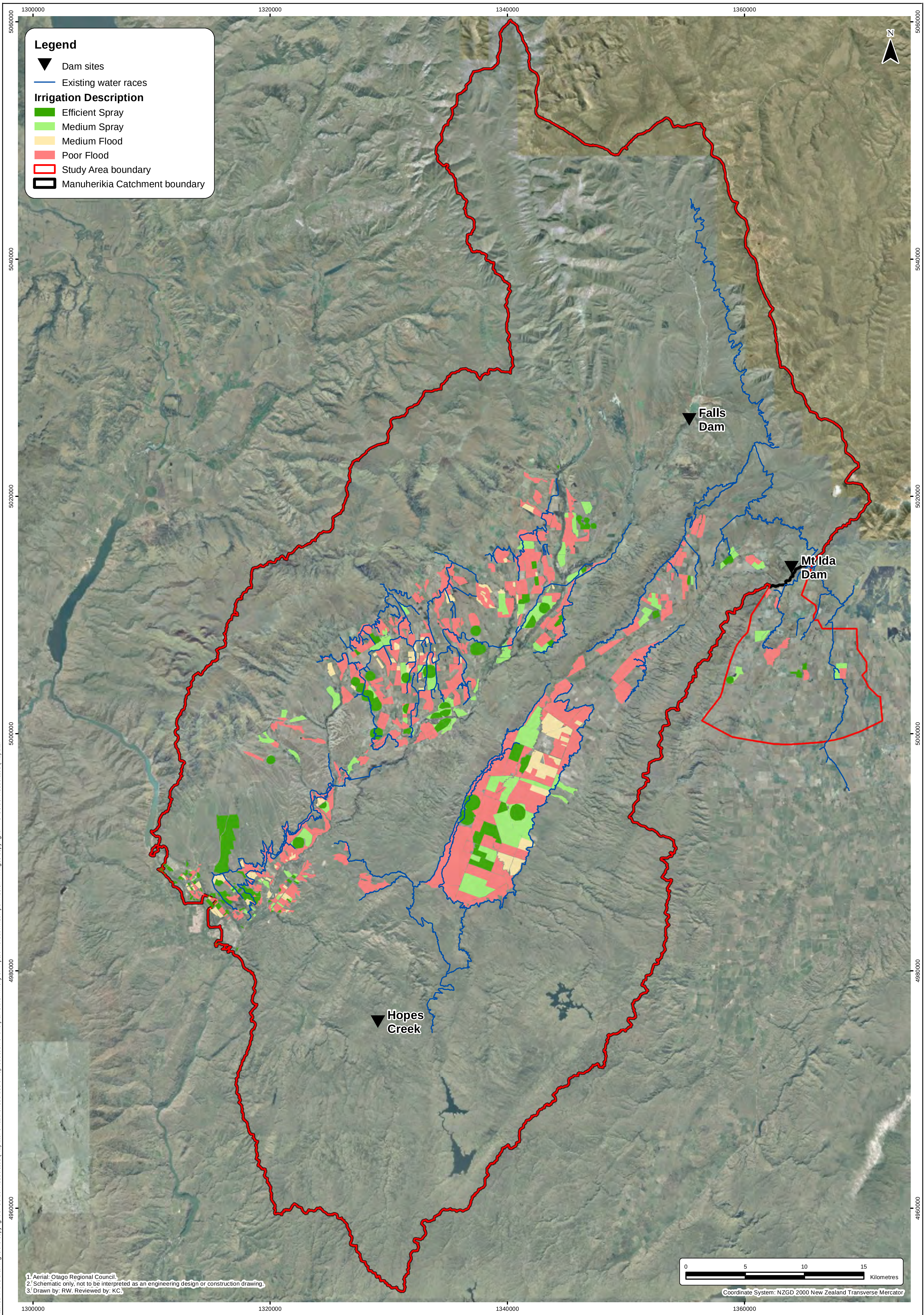
The benefits of gravity pressurised water supplies were summarised in the prefeasibility assessment as:

> *Water delivered under pressure in pipes is the preferred method. The value of the pressure through not having to install and operate pumps is currently equivalent to about $2000 worth of capital expenditure/ha for a typical irrigation system.* (Aqualinc, 2012e).

Option 1 (Falls Dam High (27 m) Raise) involves irrigation of approximately 25,000 ha in the Manuherikia Valley, which equates to approximately 70 % of the irrigable area. Even without increased water storage a move to increased spray irrigation is expected. The following three catchment irrigation maps were produced to assist with visualisation of potential future irrigation changes:

- Current irrigation practices (Figure 4).
- Possible future irrigation practices with no increase in water storage (Figure 5).
- Possible future irrigation practices assuming there is a large increase in storage namely Option 1 (Falls Dam High (27 m) Raise) and Option 5 (Mount Ida Dam) combined (Figure 6).

Conceptual irrigation layouts were also produced for the five case study farms and are included in APPENDIX B.



Golder Associates

TITLE CURRENT IRRIGATION WITHIN THE MANUHERIKIA STUDY AREA

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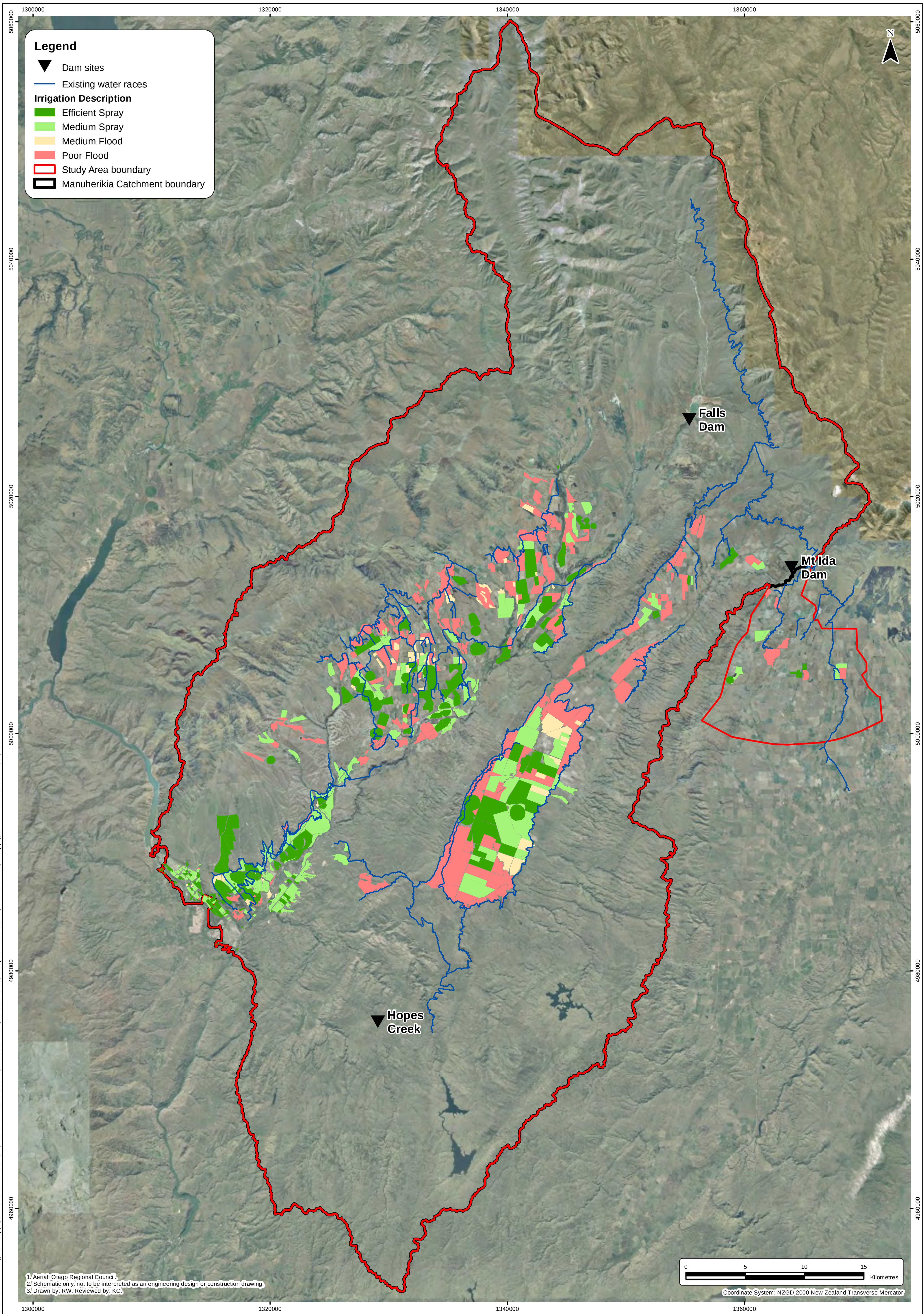

Golder Associates

TITLE POSSIBLE FUTURE IRRIGATION WITHIN THE MANUHERIKIA STUDY AREA
NO INCEASE IN STORAGE

JUNE 2015

PROJECT 1378110270

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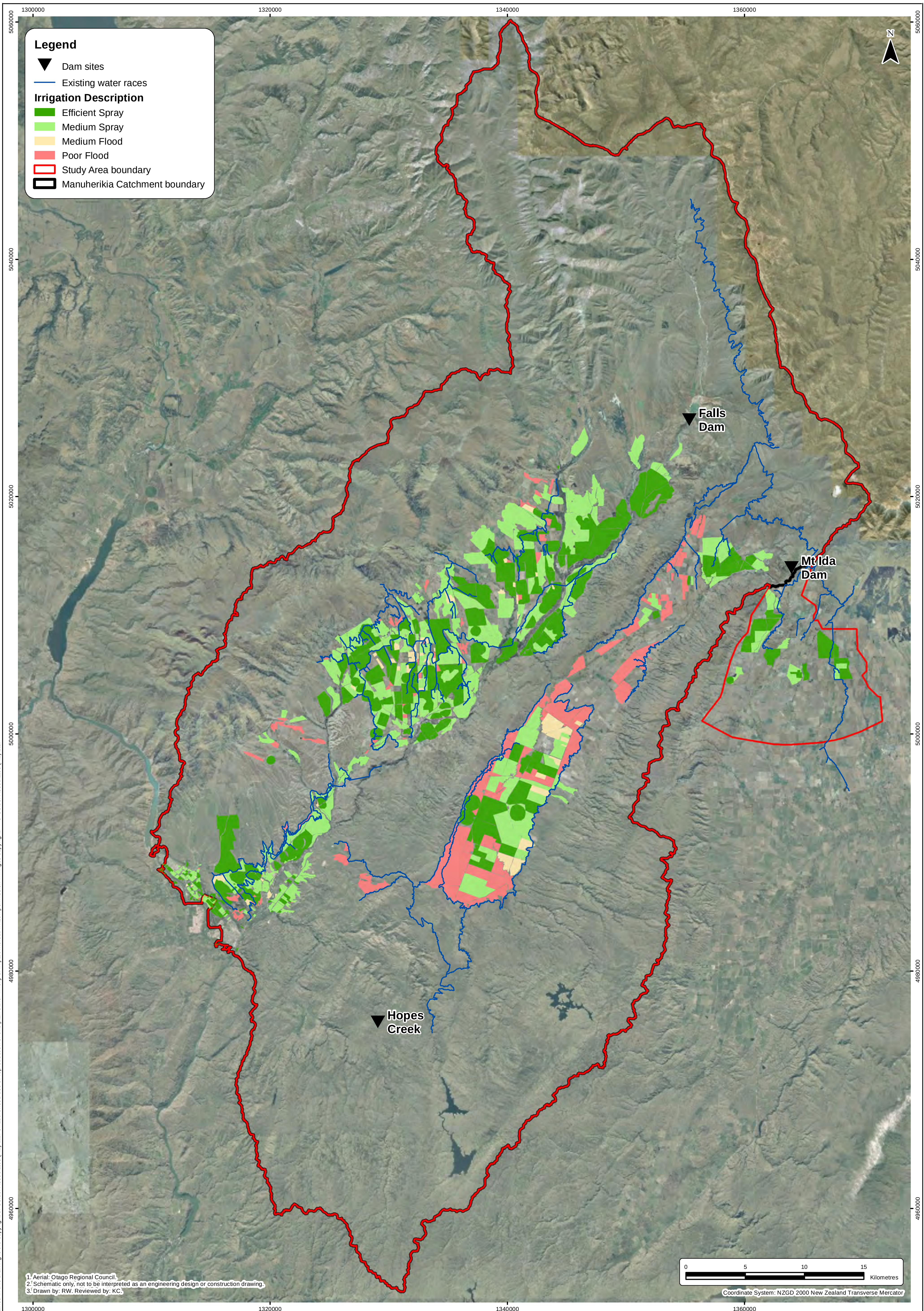

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TITLE Possible Future Irrigation within the Manuherikia Study Area under Option 1 (Falls Dam High Raise) and Option 5 (Mount Ida Dam) combined

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3.0 RESERVOIR STORAGE

3.1 Falls Dam

To improve understanding of the reservoir capacity at Falls Dam and to improve inputs into the hydrological modelling undertaken by Aqualinc (2012f, 2013a and 2014) the stage storage curve for the proposed Falls Dam was revised by Golder. A digital terrain model (DTM) of the reservoir, prepared in AutoCAD using contour information supplied by BTWSouth (2014), was analysed to provide reservoir volume and reservoir surface area curves at two metre elevation intervals for areas above the current full supply level of the existing reservoir. For below the current full supply level the existing reservoir stage storage curve contained in Aqualinc 2012b and Opus 2013 was used. The finalised stage storage curve for Falls Dam is shown in Figure 7.

The contour information was developed using ortho-rectified aerial imagery of the area collected in February and March 2014, with ground control provided by manual survey using RTK GPS with a Total Station. The resulting contours are expected to have an accuracy of ±1m (BTWSouth, 2014).

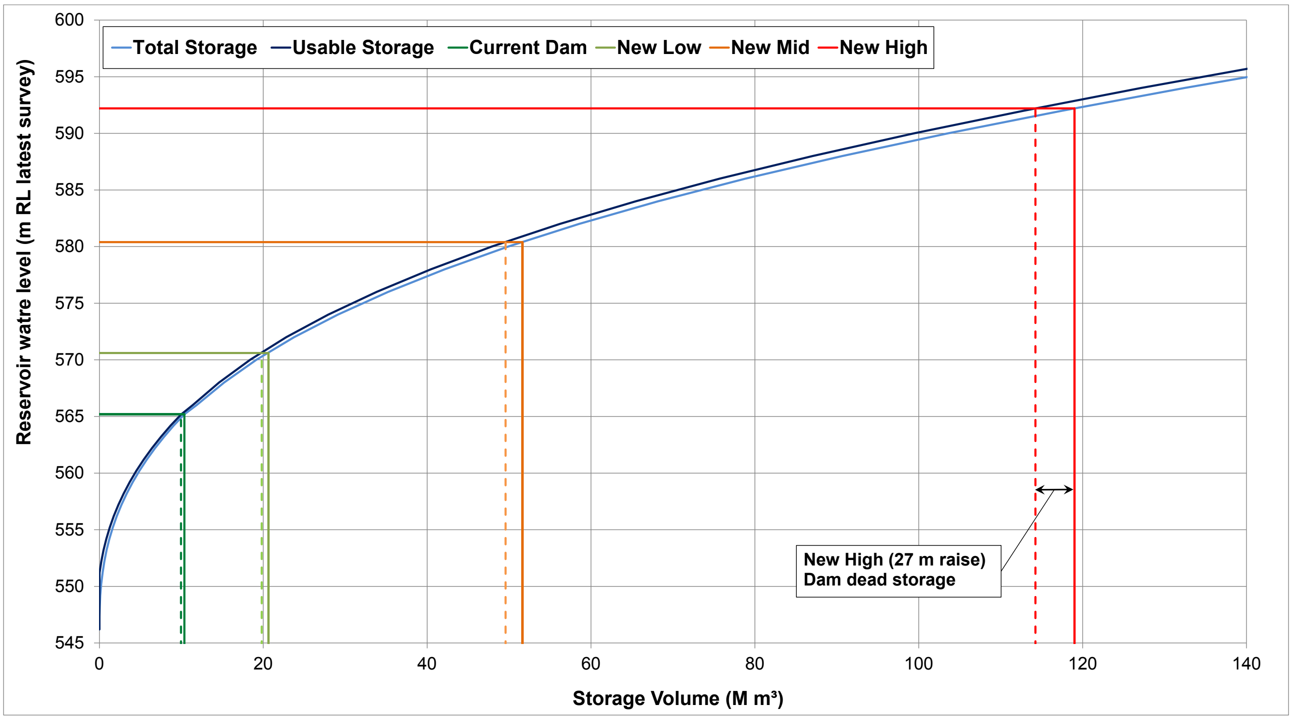
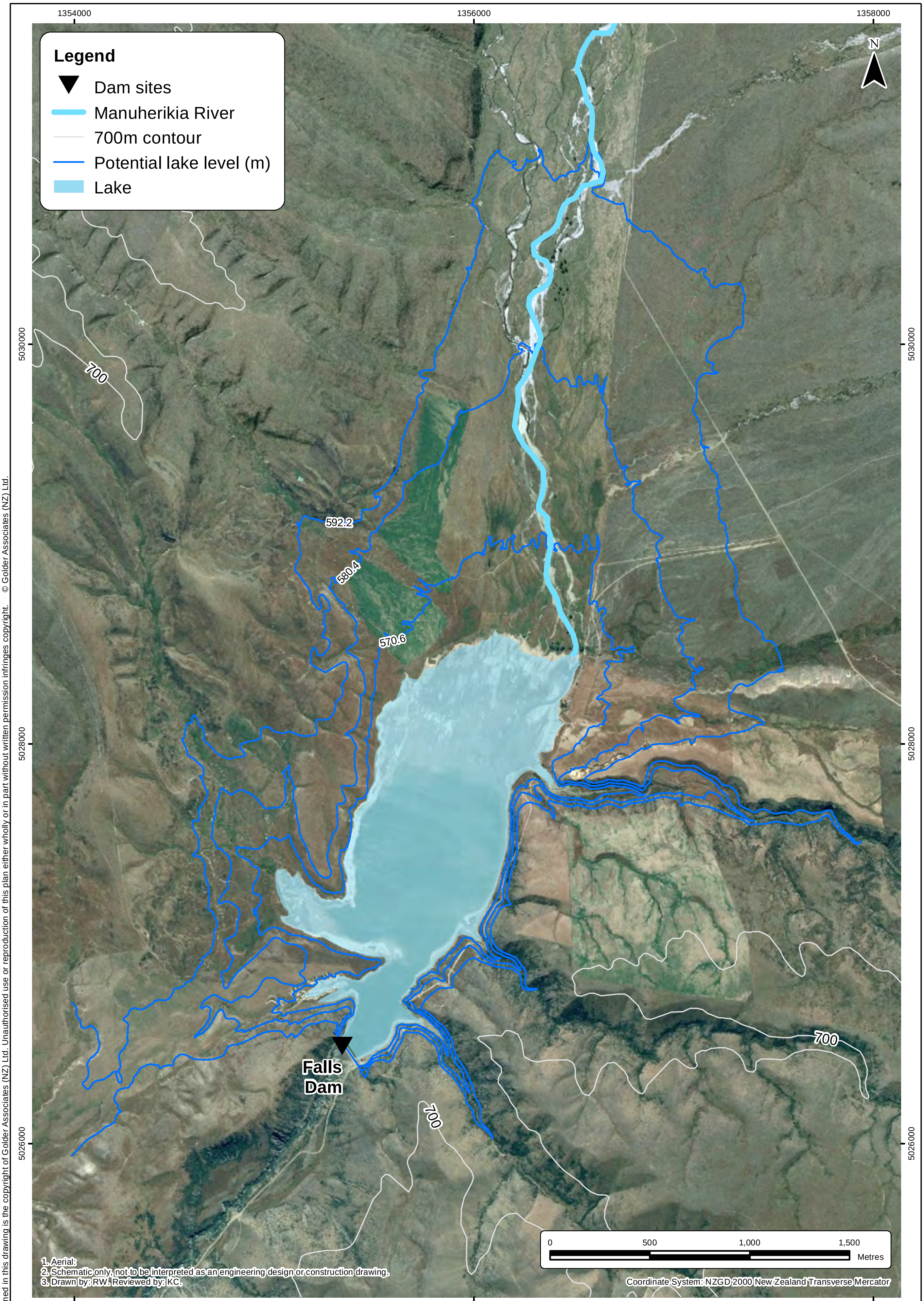


Figure 7: Falls Dam Reservoir Stage Storage Relationship (Dashed Line represents total-usable-storage for all three options).

Table 2 summarises the key variables for the Falls Dam reservoir under Options 1 to 3 and highlights increased usable storage compared to previous estimates used during the prefeasibility assessment. The principal reason for the improvement is an improved stage-storage relationship and a reduction in the allowance for dead storage. The prefeasibility assessment assumed a dead storage ratio for Falls Dam of 10 % of the total storage. Currently Falls Dam has a dead storage ratio of approximately 4 %. During hydrological discussions with the MCWSG it was agreed that future storages should have a similar dead storage ratio (Golder, 2014e). The potential inundation area under Options 1 to 3 is shown in Figure 8.



Golder Associates

TITLE POTENTIAL INUNDATION DUE TO ENLARGED FALLS DAM IMPOUNDMENTS

JUNE 2015

PROJECT 1378110270

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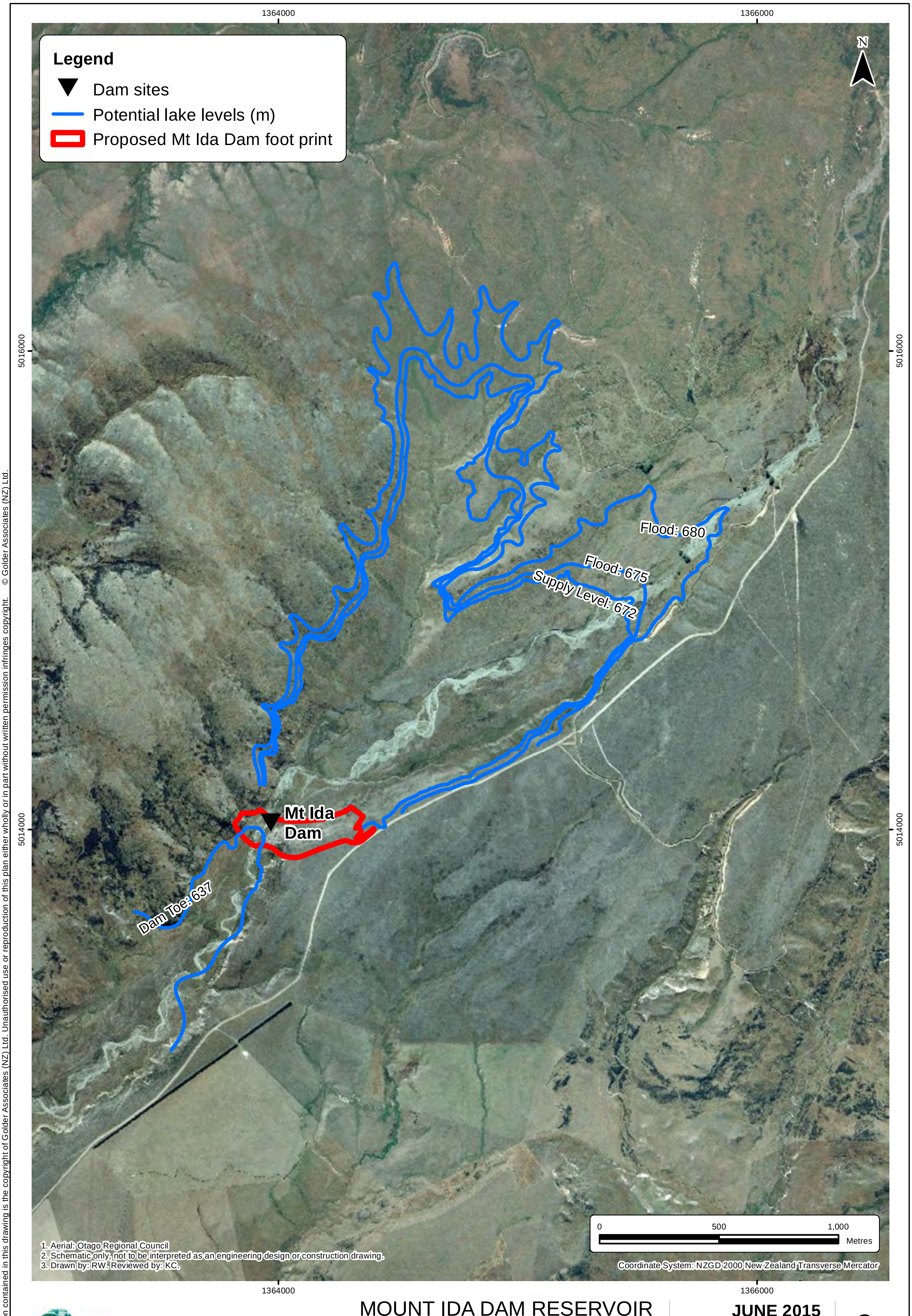
Table 2: Falls Dam reservoir key variables for development Options 1 to 3.

Full supply level (m)	Option and Raise (m)	Total Storage (Mm^3)	Usable storage (Mm^3)	% dead storage	Comment
565.2 m	Current dam	10.4	10.0	3.6 %	Aqualinc 2013 indicates that the current dam (10 Mm^3 of usable storage) with run of river takes can irrigate 6,500 ha above Ophir but there are irrigation restrictions.
570.6 m	**Option 2** (Low) 5.4 m	20.6	19.0	7.9 %	Aqualinc 2013 indicates 19 Mm^3 of usable storage with run of river takes is sufficient to reliably irrigate 7,500 ha above Ophir.
580.4 m	**Option 3** (Mid) 15.2 m	51.6	50.0	3.2 %	Aqualinc 2013 indicates 50 Mm^3 of usable storage with run of river takes is sufficient to reliably irrigate 12,000 ha above Ophir.
592.2 m	**Option 1** (High) 27.0 m	119.0	114.1	4.1 %	Allows reliable irrigation of more than 21,000 ha above Ophir. Requires a more significant structure at Shamrock Gully.

3.2 Mount Ida Dam

No new topographical survey work was undertaken at Mount Ida Dam and the stage storage curve remains as outlined in Hamilton 2006. The potential inundation area associated with the Mount Ida Dam is shown in Figure 9.



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TITLE MOUNT IDA DAM RESERVOIR POTENTIAL INUNDATION AREA

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4.0 DISTRIBUTION ASSESSMENT

4.1 Overview and methodology

4.1.1 Distribution operation and efficiency

Various meetings, site inspections and monitoring visits were undertaken to assess distribution operation, efficiencies and current race leakage in the Hawkdun/Idaburn, Blackstone, Omakau, Manuherikia and Galloway irrigation schemes. The key assessment activities undertaken are outlined in Table 3 below:

Table 3: Distribution assessment activities.

Date	Details	Comments
18 - 21 November 2013	Initial meetings with (Staff /Irrigation Scheme): ■ John Anderson (Manuherikia, Mount Ida Race and general catchment irrigation), ■ Roger Williams (Omakau) and, ■ Keith Campbell (Hawkdun/Idaburn). Inspection of Mount Ida Race.	Background information and inspection of Mount Ida Race from Johnson Weir to Ida Burn.
27 - 31 January 2014	Meetings with: ■ John Anderson (Manuherikia, Mount Ida Race and general), ■ Ralph Hore (Blackstone), ■ Roger Williams (Omakau), ■ Keith Campbell (Hawkdun/Idaburn). Inspection of Blackstone and Omakau. Flow gauging of Mount Ida Race and Omakau Main Race.	Background information, inspection of Blackstone Main Race and parts of Omakau irrigation scheme. Flow gauging of Mount Ida Race (Hut Creek to Pierces Gorge Creek) and Omakau Main Race (Becks Hotel to Lauder siphon).
4 - 9 April 2014	Inspection and flow gauging of Manuherikia (Alex Lawrence), Omakau, Blackstone races and Mount Ida race. Meeting with Aad van Leeuwen (Galloway).	Background information on Galloway irrigation scheme. Inspection and flow gauging of Manuherikia irrigation scheme (Main Race upstream Brassknocker Road to Golden Road Bridge, Borough and some distribution races). Flow gauging of Blackstone main race (intake to bluffs). Flow gauging of Omakau scheme (Main Race intake to Lauder siphon, E Race and Lauder Race). Flow gauging of Mount Ida Race (top end to Shepherds Hut Creek and around Hut Creek pipe).
5 - 6 May 2014	Meeting with Aad van Leeuwan (Galloway). Flow monitoring Mount Ida Race.	Flow gauging of Mount Ida Race (around Hut Creek pipe).

A total of 53 gaugings were completed to assess race leakage, the results of which are summarised in the relevant irrigation scheme sections below. A table summarising all the gauging results is provided in APPENDIX C along with a brief summary of equipment and methodology used.

4.1.2 Future distribution options

An online questionnaire, run by the MCWSG to gain information on current water use in the catchment, and to assess potential future demand, received 68 responses (Table 4) from landowners, who own or represent almost 31,000 ha, of which approximately 7,050 ha is currently irrigated. The landowners considered their current water supply reliability to be relatively poor; 6.2 on a scale of 0 (very unreliable) to 10 (highly reliable). Slightly more than half of the respondents expressed a desire to either upgrade or increase their current irrigation activities, although most indicated that on-farm development would require improved supply reliability. Assuming suitable water supply reliability could be obtained at an affordable cost, the landowners indicated a desire to increase the area irrigated by approximately 50 %.

Table 4: Landowner questionnaire irrigation summary.

Location	Number of respondents	Total area (ha)	Area Irrigated (ha)	Wish to irrigated more land (number)	Area of new irrigation (ha)
Galloway	6	116	35	3	30
Lower Manuherikia below Chatto Creek	25	1,560	585	12	500
Mid Manuherikia Omukau to Lauder	11	2,357	1,214	7	940
Upper Manuherikia Valley Becks – Dunstan	12	20,207	2,209	5	305
Ida Valley	7	3,647	2,230	4	620
Hawkdun Idaburn	5	2,782	517	5	1,070
Other	2	326	165	-	-
Total	68	30,995	6,955	36	3,465

Note: data from BTWSouth 2014a.

The size, location and complexity of an irrigation distribution network are dependent on the irrigators who join the scheme and where the water is required. The landowner questionnaire provided limited information regarding potential irrigator demand or commitment, therefore, conceptual distribution networks were developed. The conceptual distribution networks provide an indication of the potential, size, extent and location of the networks; in order to allow preliminary cost estimation. The focus of the design effort was on the large infrastructure items namely the large intakes, siphons and the main open races, as these will be the major cost items. Simplistic hydraulic designs were completed for the large infrastructure items where necessary. The key design principle used to develop the conceptual distribution networks was to provide gravity pressurised pipe water supply wherever possible in order to facilitate the conversion to spray irrigation and to eliminate or reduce scheme or on-farm pumping. Pipes were sized based on supplying 5 mm/ha/day with average flow velocities in the order of 1 - 1.5 m/s.

Preliminary cost estimates have been prepared for each of the distribution options. The cost estimation process was based on development of a bill of quantities with subsequent pricing using unit rates (Table 1 APPENDIX E).

Unit rates for open races and the large river intakes were supplied by Les Topping of Topping & Associates Limited. Unit rates for six variations of new open race with capacities of 0.5, 1, 2, 3, 4 and 6 m^3/s through both easy (side slopes of 10 %) and difficult (side slopes of 20 %) terrain and with or without clay lining material were provided, based on preliminary design drawings and details provide by Golder (copy included in APPENDIX D). Unit rates for upgrading and doubling the capacity of two variations of existing races (namely expanding from 1 to 2 m^3/s and from 2 to 4 m^3/s) were also provided. Topping and Associates also provided a cost estimate for a new 6 m^3/s river intake based on preliminary design drawings and details provide by Golder (copy included in APPENDIX D). To estimate the cost of smaller intakes the estimate for the 6 m^3/s intake was scaled relative to the intake flow.

Unit rates for supplying and laying polyethylene (PE) pipes of diameters from 100 mm to 1,600 mm were provided by Downer EDI Limited (Downer), based on their current construction of Central Plain Water secondary piped distribution network. Currently there is limited capacity to manufacture larger diameter PE pipes in New Zealand. The conceptual distribution designs require a small number of pipes with diameters larger than 1,600 mm for the larger siphons. In these situations the scheme cost estimates are based on using multiple PE pipes of 1,600 mm diameter or less. During detailed design the use of larger diameter steel pipes for these relatively short lengths should be considered. PE pipes are considered the most appropriate type given their durability, ease of manufacture, transport and installation.

Because of the conceptual nature of the distribution designs, a 35 % allowance is made for un-costed items and contingencies. The detailed cost estimate for each distribution network is presented in APPENDIX E with summary tables presented in the sections below.

Optimisation and design of the distribution networks, particularly the piped sections, will be required to confirm cost estimates, once irrigator support and commitment is confirmed.

The Ida Valley Irrigation Scheme was not included in this assessment as the five irrigation development options, which are the focus of the current feasibility study, do not extend to the command area of the Ida Valley Irrigation Scheme. Should the proposed Hopes Creek Dam progress to feasibility level assessment then the Ida Valley Irrigation Scheme should be assessed at that stage.

The key design concepts, design criteria, conclusions and estimated costs for each of the five assessed irrigation schemes (Hawkdun/Idaburn, Blackstone, Omakau, Manuherikia and Galloway) are summarised in the following sections.

4.2 Galloway

4.2.1 Description

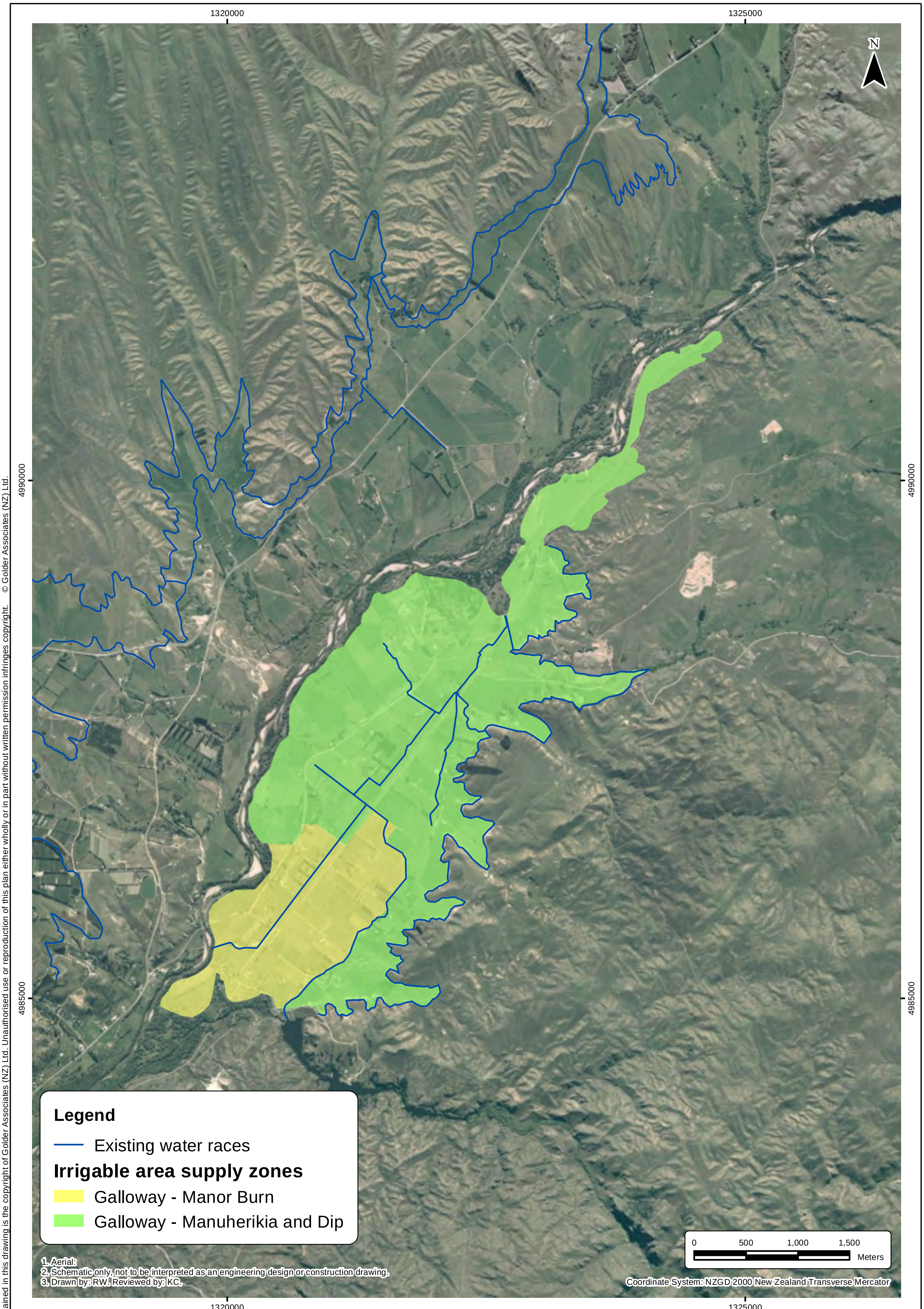
The Galloway Irrigation Scheme (GIS) on the left bank of the lower Manuherikia River, was constructed in the early 1900’s and is one of the oldest schemes in the area. The GIS covers a command area of approximately 800 ha (Aqualinc 2012b) although there is a further approximately 150 ha of adjacent land that is below the GIS’s upper race and is considered irrigable. Approximately 520 ha are currently irrigated within the command area by approximately 70 irrigators. Many of the irrigators are small lifestyle blocks (totalling approximately 380 ha) where maximising production and optimising irrigation practices are often not the principal concern. Approximately 20 of the irrigators have small buffer storage ponds. The scheme is predominantly flood irrigated, although there appears to be a move to spray irrigation, particularly for the irrigators who have buffer storage ponds. Extensive records of the scheme and historic water use are held by Aad van Leeuwen (current irrigator and previous scheme operator).

The command area, surrounding irrigable land and key infrastructure of the GIS is shown in Figure 10.

The scheme has a predominantly open race distribution network with approximately 25 km of open race. The race network consists of three main races: the Upper, Bottom and the Manorburn (Figure 10). The scheme has three water sources: Dip Creek, the Lower Manuherikia River and the Manor Burn via the Lower Manorburn Dam (Figure 10). The total take is authorised via two deemed permits and one RMA permit which expire in 2021. The GIS has a large allocation of approximately 730 L/s, which was set to allow expansion of the irrigated area and is more than sufficient for full spray irrigation of the entire command area.

Dip Creek supply

GIS has an 84 L/s (3 heads) gravity run of river take from Dip Creek. The Dip Creek benefits from bywash and irrigation losses from the Crawford Hills part of the Ida Valley Scheme, although during dry summer periods, flow in Dip Creek is limited and the GIS take becomes unreliable. The Dip Creek take feeds into the Upper Race, which extends to the Lower Manorburn Dam and can supply the Bottom Race via the Chute Race. Over the winter months the Dip Creek take is used to supply the race system with water for stockwater use.



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TITLE GALLOWAY IRRIGATION SCHEME

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Lower Manuherikia River supply

GIS has a 424.5 L/s (15 heads) pumped run of river take from the Lower Manuherikia River. The scheme diverts water from the lower Manuherikia River to a pump station near Olrig Station (Figure 11). The pump station has two pumps and was constructed in the 1950's. The main (Number 2 Pump) 90 kW pump connects to a 320 m long, 380 - 450 mm diameter concrete rising main that supplies the Upper Race. The main pump and rising main lift the water 29.3 m and have a capacity of 184 L/s. A smaller (Number 1 Pump) 22 kW pump connects to a 98 m long, 300 mm diameter concrete rising main that supplies the Bottom Race. The smaller pump and rising main lift the water 6.1 m and have a capacity of 128 L/s. The pumped take supplies irrigation water to approximately 340 ha.

The take from the Lower Manuherikia River benefits from water released from Falls Dam and increased runoff and losses from upstream irrigation. The GIS is a 6 % shareholder of the Falls Dam Company. The GIS also have an agreement with the Fraser River Power Scheme which provides GIS with a fixed amount of free electricity to cover their scheme pumping. GIS usually receive a dividend from the power scheme as they do not use their full entitlement to free electricity. The agreement was signed in 1998 for a period of 50 years.

Figure 11: Galloway Irrigation Scheme Manuherikia pump station.

Lower Manorburn Dam supply

GIS has a 222 L/s (8 heads) gravity supply from the Lower Manorburn Dam (Figure 12). The lower Manorburn Dam provides very limited storage and was built in the 1930's to raise the water to a level where it could be used for irrigation. During dry summer periods, flow in the lower Manor Burn reduces, but rarely results in restrictions for the GIS take.

Flow in the lower Manor Burn is supplemented by losses from the Upper Bonanza Race, which is part of the Ida Valley Irrigation Scheme. Much of the Upper Bonanza Race is cut through schist rock and despite considerable work to seal the race it still leaks. The Upper Bonanza Race has a capacity of 2.15 m^3/s (76 heads) and 10 % leakage is expected (Hamilton 2012).

The proposed Hopes Creek Dam is located within the Manor Burn catchment and its construction would affect downstream flows[4]. A 1.0 m^3/s (approximately 35 heads) capacity distribution race from the Hopes Creek Dam feeding into the Upper Bonanza Race is proposed (Hamilton 2012). The distribution race would

[4] A description of the proposed Hopes Creek Dam is provided in Golder 2014a. Hydrological modelling of the dam and its ability to fill has been completed (Aqualinc 2012i). The hydrological model does not extend below the proposed Hopes Creek Dam and the effect of the dam on flow in the Manor Burn has not been assessed in any detail.

traverse approximately 9.5 km of schist terrain, similar to that traversed by the upper Bonanza Race and would be expected to have a similar 10% leakage rate.

The Lower Manorburn Dam feeds the Manorburn Race, which supplies water to approximately 180 ha. The race runs year round, supplying stockwater over the winter months. The end of the Manorburn Race feeds into the bottom section of the Bottom Race and bywashes to the Lower Manuherikia River approximately 200 m below the Galloway Road Bridge.

Figure 12: The Lower Manorburn Dam.

Scheme infrastructure and operation

The distribution network consists of approximately 25 km of open race and the scheme inventory indicates there are 246 structures, many of which are small pipes and culverts. An inventory undertaken in 2012 indicated that 225 of the structures were in a “Good” condition, 18 were “Fair”, and 3 were “Poor” (GISI 2012). The main scheme infrastructure is the Lower Manorburn Dam, Manuherikia pump station, pumps and the rising mains. The Upper Race was originally benched on the upslope side by the Ministry of Works and Development (MWD) to allow excavators to be used to clean the race. Because of hill slippage below the race, the GIS has subsequently re-benched on the downslope side over 3.5 km of the upper race and a further 3.6 km has been identified as requiring re-benching.

The scheme is run on a roster system, with the pumped take from the Manuherikia River, switched off whenever irrigators do not require water. Aad van Leeuwen has detailed records of pump hours, volume pumped and the volume used by the various irrigators stretching back to the 1965 - 1966 irrigation season. There is clear evidence that GIS does not utilise their full allocation and that there is considerable variation in the quantity of water used by the various irrigators. Some of the irrigators use very limited amounts of water, particular those who irrigate lucerne, but still achieve high levels of production. However, there are other irrigators who use volumes that exceed the annual application depths suggested in Aqualinc 2012a. The construction of approximately 20 buffer storage ponds within the scheme has improved operational flexibility and has reduced the need to bywash water.

4.2.2 Monitoring undertaken and distribution efficiency

Flow and losses in the open races of the GIS are not monitored. Extensive race losses are not expected given the following factors:

- The age of the race network.
- The maintenance and upgrades it has received.
- The relatively small size and low flow rates of the races.

Aqualinc 2012a indicates that most of the command area of the GIS has relatively light soils (i.e., profile available water of 30 - 90 mm). There will be sections of the race network that cross particularly porous soils that may be prone to leakage without sealing or lining. However, the Upper Race traverses around a side slope and there is little evidence of seepage below the race, suggesting that significant leakage is unlikely.

In open race distribution networks, leakage and race losses are most pronounced when the races are “wetted up” immediately after a period of non-use. Drying of races causes sealing silt and clay layers to dry out, crack and potentially be removed through wind erosion. Races that are regularly dried and then re-used tend to leak more than races where a constant flow is maintained. For this reason smaller distribution races tend to leak more, proportionally, than larger main races that are kept full. The desire to reduce pumping costs for the GIS leads to a situation where the pumps are turned off whenever water is not required. This leads to more frequent drying and subsequent “wetting up” of the races, which is expected to result in slightly increased potential for race leakage.

The GIS has a long history of active management, design refinement and operational supervision, which began under the MWD and has continued since. Such management is likely to have identified and rectified any particularly leaky sections of the race. Much of the irrigation water is pumped, which provides a strong economic driver to minimise race leakage, although given the free electricity arrangement, the economic driver is somewhat reduced.

Golder’s assessment indicates that the GIS distribution network is expected to be relatively efficient and race leakage is unlikely to be significant. Race leakage is expected to be less than 10 %, which is considered acceptable for open race networks. The biggest gains in water use efficiency are likely to be associated with improving on-farm irrigation performance and reducing scheme bywash, through increased buffer storage and increased automation and control of the distribution system.

4.2.3 Development scenarios

The current scheme operates effectively at modest cost to the irrigators. The scheme has good records and an established maintenance programme. Given the existing electricity arrangement, the modest cost of the current scheme and the large number of small irrigators (many of which are lifestyle properties who are unlikely to be focused on maximising production), it is expected that it will be difficult to gain widespread support for large-scale changes to the scheme infrastructure. However, some irrigators appreciate that a pressurised supply to the gate would make a substantial improvement to the efficiency and ease of irrigation on their properties and be reflected in property price. Also, consideration must be given to how races will function at lower flows if the amount of take is reduced when the permits are renewed in 2021. The GIS has a sufficient water allocation and good supply reliability to allow considerable expansion of the irrigated area (Aqualinc 2012g). Aqualinc (2012g) identified areas above the Upper Race that are suitable for irrigation expansion. There are also areas on Olrig Station, which are adjacent to the Manuherikia River, but upstream of the current irrigation infrastructure that could be irrigated.

Two development scenarios are considered for the GIS:

1) Maintain current open race system.

2) Convert to a fully piped and pumped supply from the Manuherikia River.

Aqualinc 2012g identified an option for a gravity piped supply from the MIS Main Race. Golder consider this a good engineering option, but obtaining support is expected to be extremely difficult, given the power agreement and the cost associated with the piped network and particularly the siphon under the Manuherikia River. Development scenario 2 is designed so that it could have the Aqualinc gravity supply option connected at a later date if required.

Under both development scenarios stockwater would be derived from the irrigation supply during the irrigation season. Outside of the irrigation season the area could be provided with stockwater through continued operation of the race system using both Dip Creek and the Lower Manor Burn supplies. Costs associated with providing stockwater have been excluded from the cost estimates below.

Scenario 1: Maintain current open race system

The principal maintenance requirements of the current scheme are outlined below along with recommended minor improvements.

- Maintenance of the pumps and cleaning of the screens: New motors were fitted to the pumps in 2010 but the pumps themselves are the original ones from the 1950's. The pumps require maintenance including periodic coating of the impellers. The screens require regular manual cleaning which involves approximately 200 hours per season. It is recommended that an automatic screen cleaner be fitted.
- Replacement of rubber seals: Most of the rubber seals between the concrete rising main pipes were originally fitted in the 1950's. They are old and are at risk of failure. Some of the rings failed in 1997 resulting in disruption to the scheme and requiring a number of pipes/seals to be replaced. The 320 m long rising main from the main pump to the Upper Race will require replacement of the seals, which will require relaying of the pipes. Some of the pipes may also require replacement. This is likely to be an expensive one-off exercise. Planning and budgeting for this work should begin.
- Weed clearance: Significant weed growth occurs in many of the irrigation races throughout the Manuherikia catchment. Regular mechanical clearance of weed from the races is required.
- Re-benching: Re-benching of the upper race, to move the bench to below the race and to reduce the potential for downslope hill slippage should continue and initially target the 3.6 km identified by GIS. This is another expensive one-off exercise. Planning and budgeting for this work should begin.
- Automation: The current scheme has no automation and is controlled manually. To minimise power costs and reduce bywash, consideration should be given to automating the pumps so they can be remotely turned on and off.

Maintaining the current open race system represents the status quo for the GIS. The estimated capital cost[5] for maintaining the current open race system is $410,000, with an estimated annual operation cost[5] of $210,000[6] (Table 5). Spread over the 520 ha currently irrigated the estimates equate to a capital cost of approximately $800/ha and an annual operating cost of approximately $390/ha. The operating costs exclude any on-farm pumping, which would be required for spray irrigation. A breakdown of the costs estimate is provided in APPENDIX E. Golder has not assessed the Lower Manorburn Dam and the estimated costs exclude any maintenance, upgrading or operation costs associated with the Lower Manorburn Dam.

Table 5: Galloway Irrigation Scheme open race cost estimate.

Item	Description	Cost estimate[(1)]
Capital costs	Automation and self cleaning screens	30,000
	Rising main upgrades	54,000
	Benching races	54,000
	Structure upgrades	105,000
	Design, Project Management, Consents, etc.	58,000
	Contingency	105,000
Total Capital Costs Galloway Irrigation Scheme open race		**$410,000**
Total Capital Costs per ha (assuming evenly spread over 520 ha)		**$800/ha**
Annual Operational Costs	Scheme Pumping	60,000
	Operation and Maintenance labour	125,000
	Governance and Administration	20,000
Total Annual Operational Costs Galloway Irrigation Scheme open race		**$210,000**
Total Annual Operational Costs (assuming evenly spread over 520 ha)		**$390/ha**

Notes: (1) Estimated costs are exclusive of GST and are rounded to the nearest $ 1,000, with totals rounded up to nearest $ 10,000, per ha capital costs rounded up to the nearest $100 and per ha operational costs rounded to the nearest $10.

[5] Estimated costs exclude GST.

[6] The operating cost includes scheme pumping.

Scenario 2: Develop a piped and pumped scheme from the Manuherikia River

Piping the GIS would have the following benefits:

- Reduce losses through eliminating bywash.
- Facilitate scheme operation and management.
- Encourage increased spray irrigation, particularly if pressurised water is supplied to the irrigators. It is understood that conversion to spray irrigation is being actively encouraged during consent renewal processes.

GIS's existing 424.5 L/s (15 heads) water take from the Lower Manuherikia River is more than sufficient to supply the 520 ha that is currently irrigated. Assuming a peak spray irrigation demand of 5.0 mm/day[7] the 424.5 L/s is sufficient to irrigate over 730 ha. The pressurised pipe system is based on the existing river diversion, pump station and electricity arrangement.

As identified in Aqualinc 2012g the command area could be served via a simple pressurised pipeline along Galloway Road. Through the command area, Galloway Road drops by approximately 20 m which is more than sufficient to cater for pipe friction losses. The pump station is situated approximately 10 m below the northern end of Galloway Road at an elevation of approximately RL 260 m. At its highest point the Upper Race has an elevation of approximately RL 290 m. Only a small area is irrigated above the Upper Race. Based on providing irrigation water to all existing users with at least 20 m of pressure at the location of their current race offtakes and an expansion of the scheme to 550 ha, an approximately 160 kW pump that can deliver 290 L/s (i.e., 550 ha irrigated at 4.5 mm/day[8]) at 50 m of head will be required.

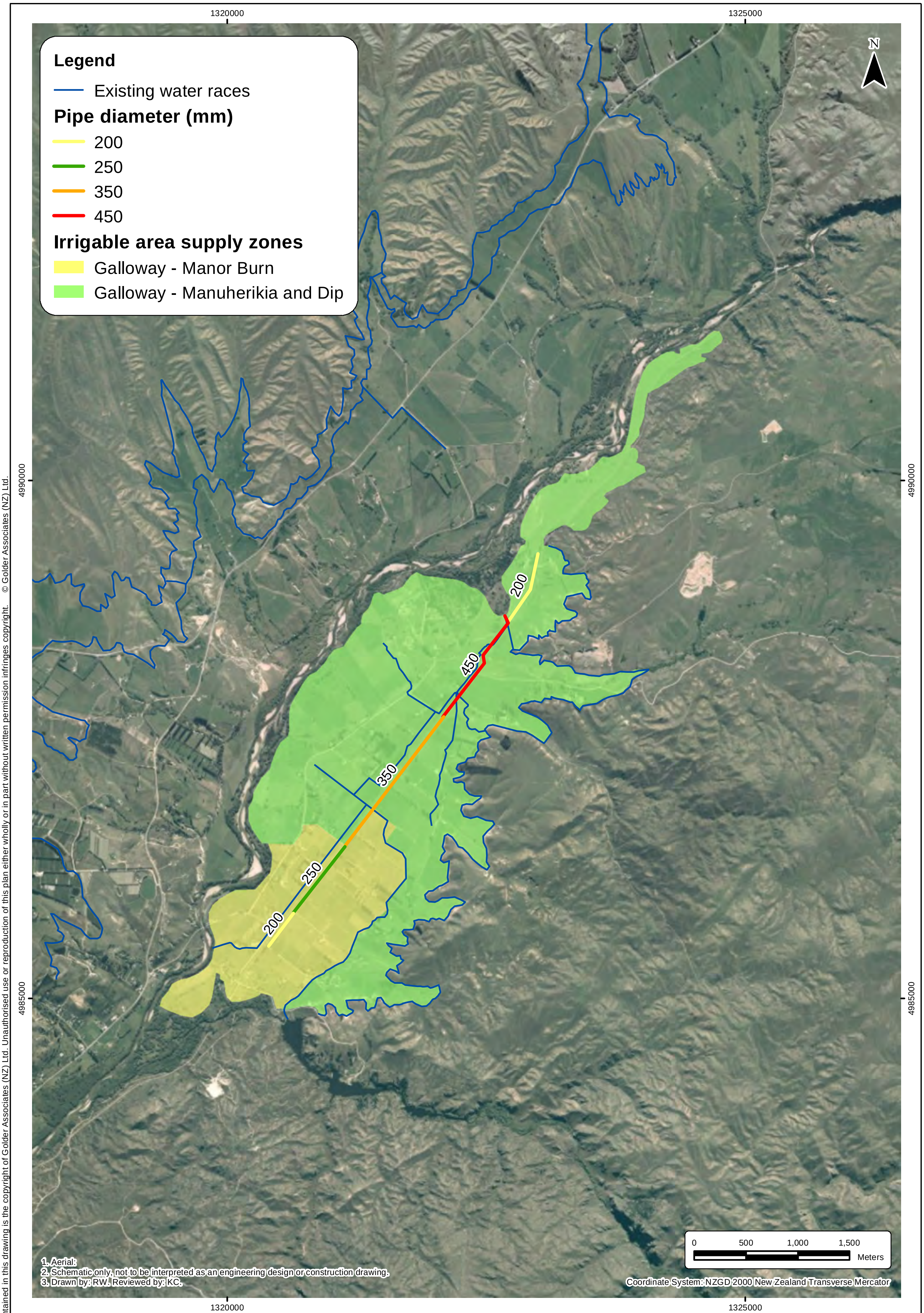
A conceptual distribution pipeline is show in Figure 13 and has been used to provide estimated capital and operational costs Table 8). As most of the currently irrigated land is located east of Galloway Road the pipeline would use the existing crossing (i.e. the existing rising main to the upper race) under the Otago Central Rail Trail (OCRT) and then run down the eastern verge of Galloway Road allowing direct connection to properties east of the road. Properties west of the OCRT would be connected either directly under the OCRT and Galloway Road or via secondary branches down Shennan Road and Clare Road. In developing the conceptual distribution pipeline we have assumed that it will not be overly difficult to have multiple pipe crossings under the OCRT. Given the various trenchless technologies that are available (i.e., pipe boring, jacking etc.) this is considered a reasonable assumption at this stage of the design process. If multiple pipe crossings are not possible then the secondary branches down Shennan Road and Clare Road will need to be more extensive. Should this scenario progress, the detailed design process should commence with consultation with the OCRT Trust and the Department of Conservation (DOC) to confirm the implications of laying pipes under the OCRT.

The estimated capital cost[9] for the proposed pressurized pipe distribution network is $1,930,000 with an estimated annual operation cost[8] of $160,000. Spread over 550 ha the estimates equate to a capital cost of approximately $3,500/ha and an operational cost of approximately $290/ha. Scenario 2 provides pressurised water so no on-farm pumping would be required. It is anticipated that the piped scenario could service a larger area which would potentially reduce the cost per hectare. A breakdown of the cost estimate is provided in APPENDIX E.

[7] Aqualinc 2012a recommends a system capacities of 4.0-5.0 mm/day for 80% efficient irrigation on 120 mm to 60 mm PAW (profile available water) soils in the lower Manuherikia Valley near Alexandra. Aqualinc 2006, suggests maximum daily application rates of 4.3-5.6mm/day for pasture in the Manuherikia Valley on 120 mm to 45 mm PAW soils.

[8] A system capacity of 4.5 mm/day (rather than 5 mm/day) has been used to estimate the peak scheme demand for the piped scenario to allow for some demand diversification (i.e. different crops, irrigation practices and management practices) and to acknowledge there will be limited leakage from a piped system.

[9] Estimated costs exclude GST.



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CONCEPTUAL PIPED SUPPLY

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Table 6: Galloway Irrigation Scheme piped cost estimate.

Item	Description	Cost estimate[1]
Capital costs	Automation and self-cleaning screens new pumps	80,000
	Distribution pipes 6.8 km supply, lay and fittings	611,000
	Road crossings etc.	107,000
	Turnouts	350,000
	Design, Project Management, Consents etc.	276,000
	Contingency	498,000
Total Capital Costs Galloway Irrigation Scheme piped		**$1,930,000**
Total Capital Costs per ha (assuming evenly spread over 550 ha)		**$3,500/ha**
Annual Operational Costs	Scheme Pumping	84,000
	Operation and Maintenance	50,000
	Governance and Administration	20,000
Total Annual Operational Costs Galloway Irrigation Scheme piped		**$160,000**
Total Annual Operational Costs (assuming evenly spread over 550 ha)		**$290/ha**

Notes: (1) Estimated costs are exclusive of GST and are rounded to the nearest $ 1,000, with totals rounded up to nearest $ 10,000, per ha capital costs rounded up to the nearest $100 and per ha operational costs rounded to the nearest $10.

In assessing the piped scenario we assumed no scheme buffer storage. Providing scheme buffer storage may reduce pumping costs by allowing pumping to target night rate power. Should this scenario progress, the inclusion of buffer storage and the potential expansion of the scheme up to approximately 800 ha, should be considered during detailed design.

Other (uncosted) development opportunities

The pumped conceptual distribution scheme shown in Figure 13 could be simply adapted into a piped gravity supply from the MIS Main Race (Aqualinc 2012g) by bringing the siphon under the Manuherikia River to the existing pump station. It is noted that the siphon pipeline could also be used to supply pressurised water to the Keddell Road distribution area of the MIS although this would require a longer siphon length.

A modification of the pumped supply from the Manuherikia River would be to use the Lower Manorburn Dam as the water source. The Lower Manorburn Dam has a crest height of approximately RL 255 m, which is similar to the existing Manuherikia River intake and would result in similar pumping requirements. The Lower Manorburn Dam has very limited storage capacity and the take would be a run of river take from the dam outflow. The current 222 L/s (8 heads) take from the Lower Manorburn Dam held by GIS would need to be increased to 290 L/s. The reliability of this supply would need to be assessed. However, given the leakage from the Upper Bonanza Race, it is anticipated that the take would be relatively reliable, particularly if the Hopes Creek Dam was progressed. The advantage of using the Lower Manorburn Dam is that it would reduce allocation on the Lower Manuherikia River, potentially allowing the allocation to be used further upstream. Should piping the GIS progress, the potential of sourcing water from the Lower Manorburn Dam should be investigated.

4.3 Manuherikia

4.3.1 Description

The Manuherikia Irrigation Scheme (MIS) covers a command area of approximately 5,200 ha on the right bank of the lower Manuherikia River from approximately Chatto Creek to Alexandra. Approximately 2,200 ha are currently irrigated. This irrigated area can be divided into four areas, based on location and irrigator types.

1) Dunstan Flats which consists of approximately 300 ha of predominantly bony soils. Many of the irrigators are small lifestyle blocks where maximising production and optimising irrigation practices are often not the principal concern. There are a number of orchards/vineyards that use water for both irrigation and frost protection. There is an existing private gravity piped scheme that uses a buffer storage pond on the top of the terrace.
2) Various orchards, vineyards, small water users and lifestyle blocks near Alexandra, which are below both the Main and Borough races and which collectively irrigate approximately 400 ha. Many of the irrigators (particularly the orchards and vineyards) have buffer storage dams and utilise water for frost protection.
4) The McArthur Ridge area, which consists of approximately 200 ha of vineyards above the main race. The vineyards pump from the main race and have a number of buffer storage ponds.
5) A relatively small number of larger agricultural properties, which irrigate approximately 1,300 ha and which are predominantly north of Springvale. Much of this area is contour irrigated, however there is a move to increase spray irrigation and a number of gravity piped systems have recently been installed.

The command area and key infrastructure of the MIS is shown in Figure 14.

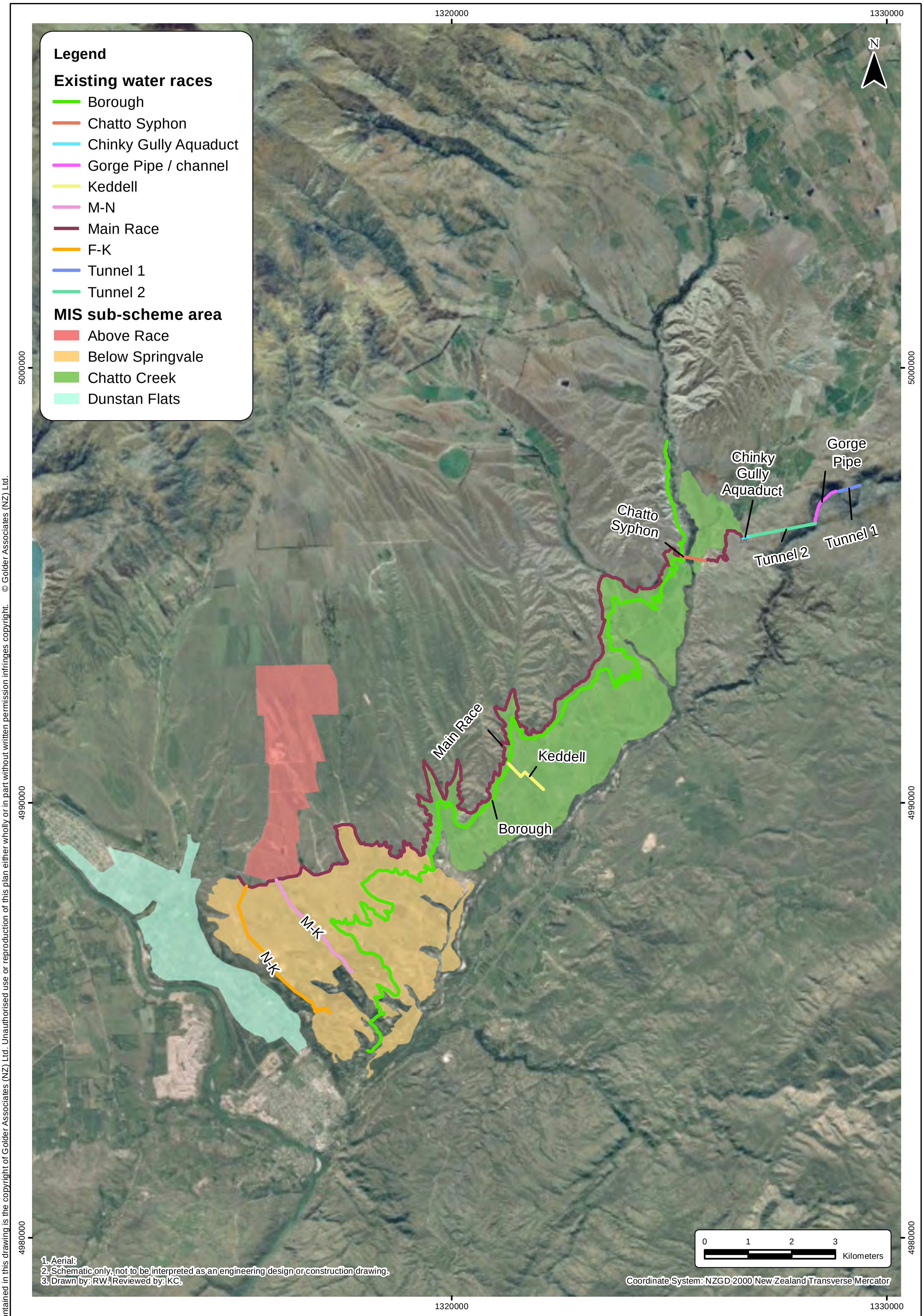
Water Supply

The race network consists of two main races: the Main and Borough Races with various distribution races that feed off the Main Race. The Main Race can supply the Borough Race via various connecting pipes and drop structures. Both races are old. The Main Race was constructed between 1917 and 1922 and was the first race in Central Otago to be constructed specifically for irrigation. The Borough Race was constructed in 1864 as a mining race and was acquired by the Crown in 1922 and incorporated in to the irrigation scheme. On an area basis the scheme is predominantly flood irrigated although there is an increasing move to spray irrigation. The scheme has an extensive distribution network that is approximately 78 km[10] in length of which approximately 73 km is open race (Main Race approximately 30 km, Borough Race approximately 32 km, other distribution races approximately 11 km[6]), approximately 2 km is tunnels and 1.7 km is large concrete channels, siphons or aquaducts. Many of the irrigators, particularly the orchards, vineyards and other spray irrigators, have small buffer storage ponds.

The main water source is the Manuherikia River, but the scheme also takes water from Chatto, Younghill, Brassknocker and McArthurs Creeks, Scrubby Gully and Waipuna Springs. The MIS hold various abstraction consents which in total authorise the abstraction of up to 3,480 L/s (123 heads) the majority of which is from the Manuherikia River (2,830 L/s (100 heads)). The consents are all deemed permits and will expire in 2021. Overall MIS have a large allocation which allows for considerable expansion of the irrigated area. Aqualinc 2012 found that MIS have 2,550 L/s of reliable water of which 1,700 L/s is actually allocated on farm. This suggests that considerable water is bywashed or lost from the scheme. The race system is open ended, in that excess water is bywashed back to natural water courses in a number of locations.

MIS also hold abstraction consent 2002.725.V1 which was granted under the RMA and authorises the abstraction of 4,530 L/s from Lake Dunstan, which is part of the proposed Dairy Creek Scheme. The Dairy Creek Scheme targets areas above the Main Race and is described in Opus 2009 and Opus 2010 and is excluded from the MCWSG feasibility assessments.

[10] Excludes any scheme races on Dunstan Flats.



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Scheme infrastructure and operation

A 1985 scheme inventory from when the MWD operated the scheme indicates there were approximately 120 structures on the Main Race, 220 on the Borough Race and approximately 300 on the numerous distribution races (MWD 1985). The structures range from large tunnels, formed channels, siphons and aqueducts, to relatively small pipes and culverts. The main scheme infrastructure includes the main intake from the Manuherikia River with its associated rock diversion weir, desilter, pipes and tunnels, the Chinky Creek Aquaduct, the Chatto Creek Siphon, the Borough Race Intake on Chatto Creek, and the Steps down to Dunstan Flats. While the scheme is old, it has an active maintenance programme, which is based on the extensive experience of Aqua Irrigation Limited. When structures need replacement or new structures are required, they are built to a very high standard. Overall the scheme is in good condition and of the main infrastructure only the Chinky Gully Aqueduct (Figure 15) and the concrete race/pipe within the Manuherikia River gorge are in need of repair/replacement.

Figure 15: Chinky Gully Aquaduct and associated formed channel.

The scheme is run on a roster system with the takes from the various water sources controlled to match demand. The scheme is operated by Aqua Irrigation Limited (particularly John Anderson and Alex Lawrence) who have extensive experience with the scheme and keep an up to date inventory of the scheme infrastructure. The main intake on the Manuherikia River was automated in 2005, which has greatly facilitated management and operation of the scheme. Records of the volume taken via the main intake are available since 2005. The race network consists of approximately 78 km[11] of open races plus various pipes, siphons, tunnels and viaducts. The main race is approximately 34 km long from the intake to the Steps. Travel time is in the order of 12 - 24 hours, which provides a challenge to management of the scheme. The scheme has benched all of the Main Race (Figure 16) to assist with race maintenance and much of the Borough Race and the various distribution races are readily accessible.

Figure 16: Manuherikia Scheme Main Race showing benching.

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[11] Excludes any scheme races on Dunstan Flats.

The scheme delivers water to its irrigator shareholder based on an allocated roster and charges on a per hectare basis. Shareholders are contracted for an irrigation season supply of 900 mm/ha. In combination with the allocation roster the scheme has records of water supplied to each irrigator. There is considerable variation in the quantity of water used by the various irrigators. Some of the irrigators manage their water use very precisely; particularly the vineyards and orchards where both over-watering and under-watering can significantly damage crop quality. However, there are other irrigators who use volumes that far exceed the annual application depths suggested in Aqualinc 2012a. While the water use data has not been directly compared with the take information it is anticipated that the scheme bywashes considerable volumes. Many of the irrigators have buffer storage, the construction of which has improved operational flexibility and will have reduced the need to bywash water.

4.3.2 Monitoring undertaken and distribution efficiency

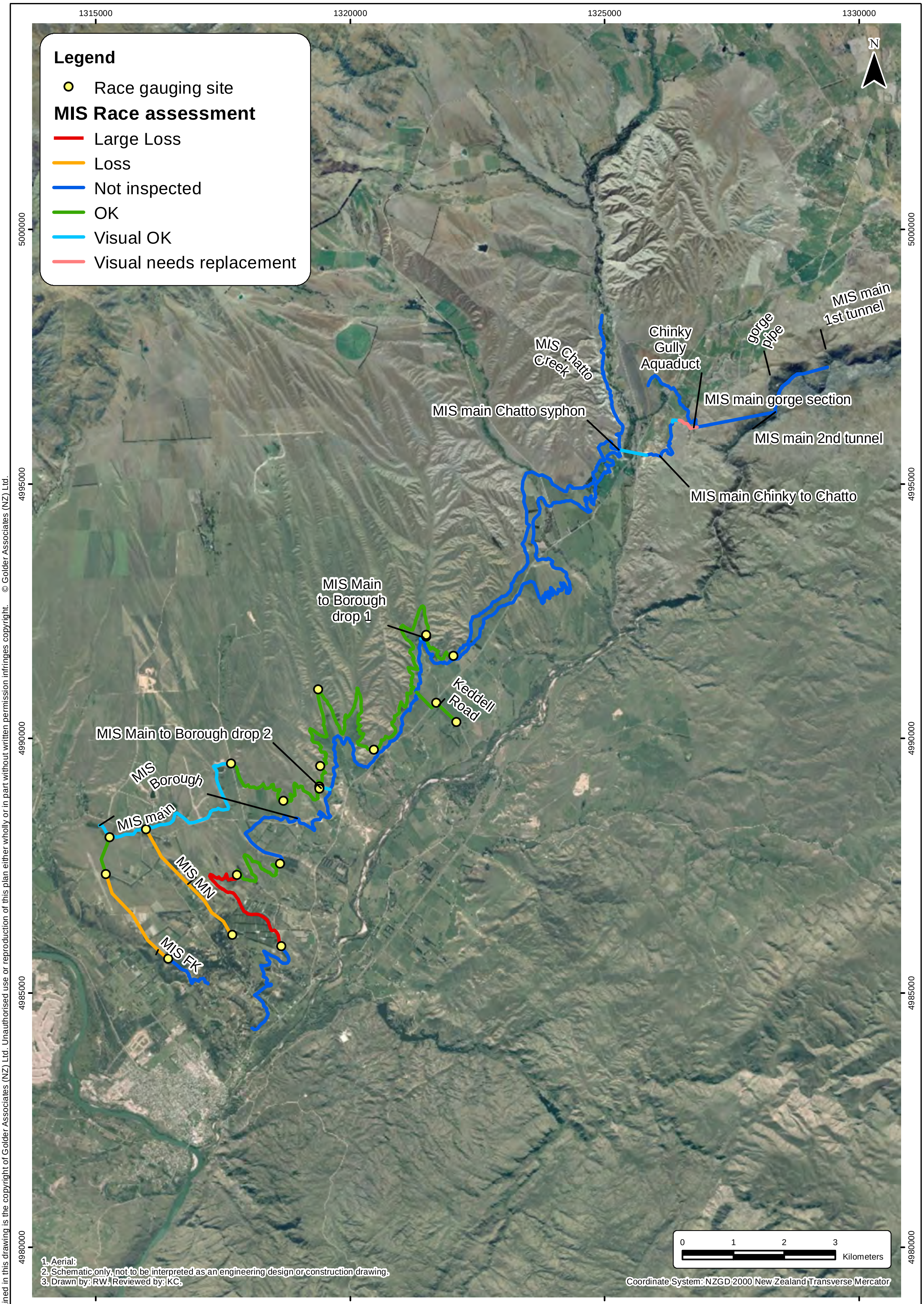
The Main Race and the Borough Race traverse around side slopes for many kilometres and there is little evidence of seepage below the races, indicating there is unlikely to be significant leakage. Aqualinc 2012a indicates that most of the command area of the MIS has relatively light soils (i.e., profile available water of 30 - 90 mm). There will be sections of the race network that cross particularly porous soils (i.e., the Dunstan Flats and the area around Alexandra Airport) and will be prone to leakage. The scheme has a long history of active management, design refinement and operational supervision, which began under the MWD and has continued. Such management effort is likely to have identified and rectified any section of race where leakage is significant.

Flow gauging to assess race losses was completed on the MIS Main Race (upstream of Brassknocker Road to Golden Road Bridge), the lower Borough Race (O'Neill Lane to Rockview Road), the Keddell Road distribution race, the M-N distribution race and the F-K distribution race. The sections of the race that were assessed and the key findings are summarised in Figure 17. Details of the flow gaugings undertaken are provided in APPENDIX C.

The monitored sections of race were selected following discussion with Aqua Irrigation Limited as representative of the overall scheme. The M-N and F-K distribution races were targeted as race operations suggested there were losses occurring in these areas. The flow measurements indicated there is limited leakage (<10 %) from the Main, and Keddell Road races. Greater than 10 % leakage was identified in sections of the Borough, M-N and F-K races.

Golder's assessment is that the distribution network is relatively efficient, with race leakage generally less than 10 %, which is generally considered acceptable for open race networks. Higher leakage rates were identified in short sections of the Borough, M-N and F-K races and it is expected that there will be other short sections of the race network outside the monitored areas where race leakage may be high. The distribution network would benefit from identification and lining of these high leakage sections of race. However, the biggest gains in water use efficiency are likely to be associated with improving on-farm irrigation performance and reducing scheme bywash through increased buffer storage and increased automation and control of the distribution system.

Approximately 300 ha are currently irrigated on Dunstan Flats of which approximately 250 ha is supplied with water via an extensive open race network. The remaining approximately 50 ha is supplied with pressurised water via pipes from small reservoirs on the terrace above Dunstan Flats. There are approximately 20 km of mostly small capacity races on the Dunstan Flats. As part of this study a short familiarisation tour was undertaken of the open race network, but no flow gaugings were completed to assess race losses. Most of the soils on Dunstan Flats are light and bony and leakage from the open race network is suspected to be high (pers. Comm. John Anderson and Alex Lawrence of Aqua Irrigation Limited). As highlighted in Aqualinc 2012g, the Dunstan Flats receive considerable quantities of by-wash from the MIWS main race.



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4.3.3 Development scenario

Aqualinc 2012g found that the MIS scheme has sufficient allocation and water supply reliability to allow expansion of the scheme from the approximately 2,200 ha currently irrigated to 3,600 ha. The high supply reliability is due to a combination of tributary flows below Falls Dam (particularly Dunstan Creek), return water from upstream irrigation and releases from Falls Dam. Future development of the MIS is expected to focus around improving on-farm performance and reducing scheme bywash through increased flow control and piping some of the distribution races. The following development scenario is proposed.

- Replacement of the Chinky Gully Aquaduct and part of the section of race and pipe in the Manuherikia Gorge.
- Increased automation of the scheme.
- Expansion of the area irrigated particularly north of Springvale.
- A move to increased spray irrigation, which will require the scheme to operate on a more continuous supply basis rather than the current roster system.
- Reduce use of the Borough Race and shift the associated take from Chatto Creek to the Main Intake from the Manuherikia River. This will improve flows in the lower sections of Chatto Creek, will simplify the scheme reducing maintenance and operational costs and will maximise the area that can potentially be supplied with pressurised water.
- To provide additional buffer storage at the end of the Main Race to reduce bywash.
- Providing a piped supply to Dustan Flats, utilizing the existing private buffer storage pond and frost fighting pipeline down the terrace.
- Providing piped pressurised supply wherever possible by piping of the distribution races, which have sufficient fall, i.e., the Keddell Road, Springvale and Long Gully areas.

As identified in Aqualinc 2012g the Dunstan Flats area could be served via a gravity pressurised pipe network utilising two reservoirs on the terrace above Dunstan Flats. Aqualinc 2012g proposed an extensive multi-looped mainline to supply irrigation water to approximately 700 ha at 4.5 mm/day. Golder supports the concept of a gravity pressurised pipe network for Dunstan Flats as it will reduce bywash, encourage increased spray irrigation and simplify management of the overall scheme. There are a large number of small irrigators on Dunstan Flats, many of which are lifestyle properties who are unlikely to be focused on maximising production. Much of the area is currently contour irrigated at very limited cost. Given the low cost nature of the current scheme it is expected that it may be difficult to gain widespread support for large-scale changes to the scheme infrastructure. However, some of the irrigators will appreciate that a pressurised supply to the gate would make a substantial improvement to the efficiency and ease of irrigation on their properties and be reflected in property price. Also consideration must be given to how the existing races and contour irrigation will function at lower flows if the amount of take is reduced when the permits are renewed in 2021. On demand, pressurised supplies have the following advantages over rostered open-race systems:

- No on-farm pumping is required, reducing the irrigation infrastructure and associated maintenance needed on-farm. Maintenance requirements tend to shift from on-farm to the scheme.
- Encourages development of spray irrigation, which improves water use efficiency and potentially allows more area and/or a greater variety of crops to be grown. It is understood that conversion to spray irrigation is being actively encouraged during consent renewal processes.
- Water is available on demand whenever required or needed. This eliminates the need for complicated and often inconvenient roster systems.
- Simplifies water metering, allowing charges to better reflect use.

- If the network has some buffer storage it allows unused water to be banked or sold to other users rather than lost to bywash.
- Water supplies can be rapidly and remotely turned on and off facilitating efficient water management.
- Piped distribution networks generally require less maintenance than open race networks as there is no need to clean weed from races.
- The quality of the water received by the irrigators is generally improved due to reduced potential for contamination.

In addition to the above benefits, leakage from the current open race distribution network on the Dunstan Flats is expected to be relatively high and reduction of the leakage through lining the races may be required as part of future consent renewal processes.

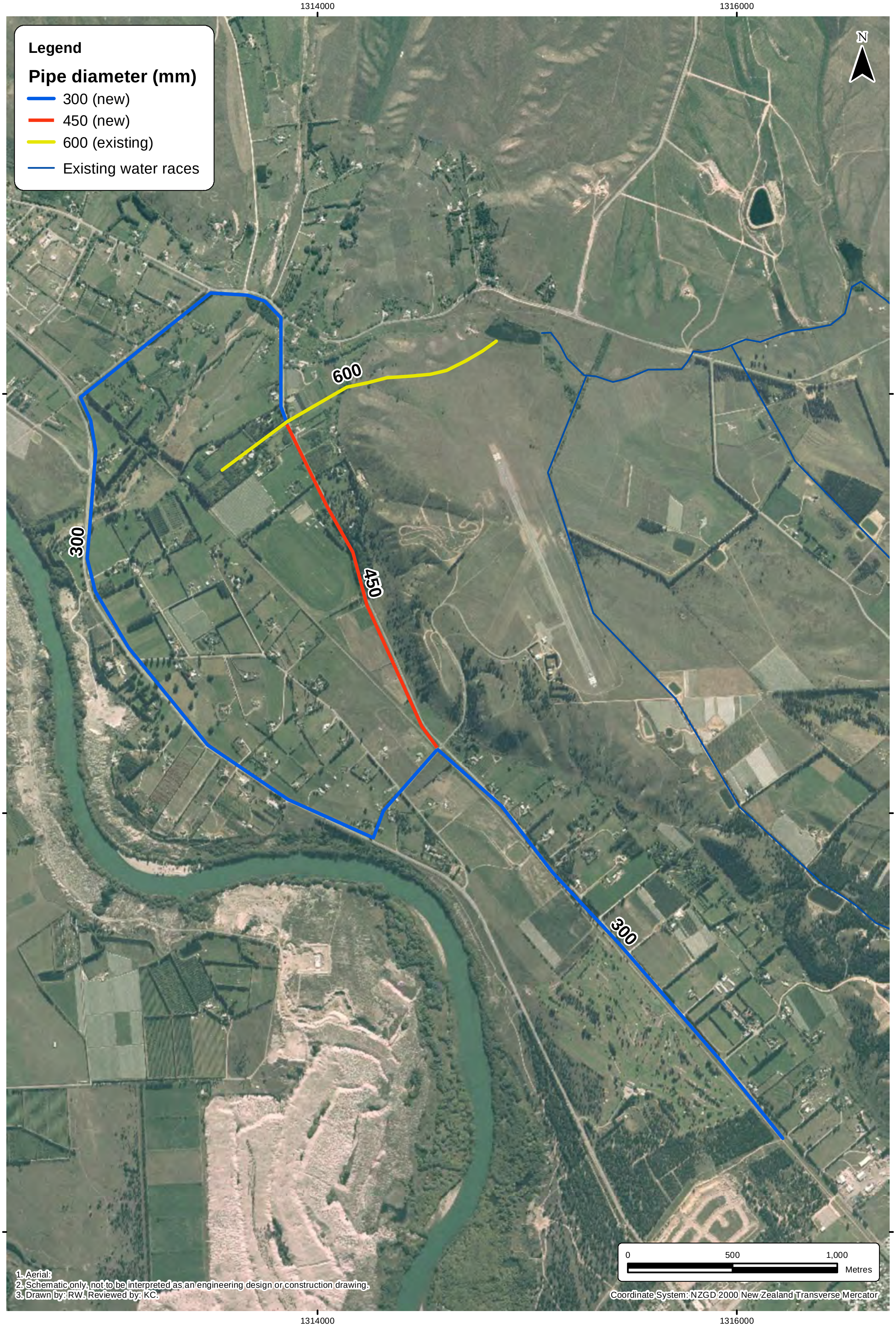
Analysis of current aerial photos of the Dunstan Flats suggests that once riparian, park, industrial and urban areas are removed a realistic irrigation command area is about 700 ha, of which a maximum irrigated area of 500 ha is anticipated once roads, building and other non-irrigated areas are removed. A conceptual distribution pipeline layout, targeting approximately 500 ha on Dunstan Flats, is shown in Figure 18. The proposed pipeline network is less extensive and more simplistic that that proposed by Aqualinc (2012g). It is based on only one buffer storage pond on the terrace (compared to the two suggested by Aqualinc) and utilises the existing pipeline down the terrace from the buffer storage pond, which is understood to comprise an approximately 600 mm diameter concrete pipe.

In addition to the Dunstan Flats there is a further approximately 750 ha of irrigable land that is greater than 40 m below the MIS main race and could potentially be supplied with pressurised water. This land is predominantly located in the Keddell Road, Springvale and Long Gully areas and is primarily contour irrigated. The potential for gravity based pressurised networks in this area was highlighted in Aqualinc 2012g and the landowner immediately north of Keddell Road has recently install a private gravity piped supply from the MIS main race. Once riparian area, roads, building and other non-irrigated area are removed a maximum irrigated area of approximately 600 ha is anticipated, which includes the area north of Keddell Road supplied by the recently installed private gravity pipeline. A conceptual distribution pipeline layout targeting approximately 600 ha in the Keddell Road, Springvale and Long Gully areas is shown in Figure 19.

The conceptual distribution pipeline layouts have been used to provide estimated capital and operational costs (Table 7). As different parts of the scheme will receive differing benefits there is a need to assign costs accordingly. The estimated capital cost[12] for the development that relates to the main race and open race distribution network is $ 3,620,000, with an estimated annual operation cost[8] of $230,000. Spread over the 3,600 ha[13] of irrigation the estimates equate to a capital cost of approximately $1,000/ha and an annual operating cost of approximately $70/ha. The operating costs exclude any on-farm pumping, which would be required for spray irrigation. The estimated capital cost[8] of providing a pressurized piped supply to Dunstan Flats is $ 3,150,000, with an estimated annual operation cost[8] of $70,000. Spread over 500 ha of irrigation the estimates equate to a capital cost of approximately $6,300/ha and an annual operating cost of approximately $140/ha. The estimated capital cost[8] of providing a pressurized piped supply to the Keddell Road, Springvale and Long Gully areas is $ 1,420,000, with an estimated annual operation cost[8] of $70,000. Spread over 600 ha of irrigable land the estimates equate to a capital cost of approximately $2,400/ha and an annual operating cost of approximately $120/ha. For the Dunstan Flats, Keddell Road, Springvale and Long Gully areas, due to the supply of pressurised water, no on-farm pumping would be required. A breakdown of the cost estimates is provided in APPENDIX E.

[12] Estimated costs exclude GST.

[13] As noted in Section 4.3.1 currently there is approximately 2,200 ha irrigated via the MIS but there is potential to increase this by approximately 1,400 ha to approximately 3,600 ha. The costs per hectare assume fully uptake of the approximately 1,400 ha of new irrigated area.



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TITLE MANUHERIKIA IRRIGATION SCHEME: DUNSTAN FLATS PIPE SUPPLY

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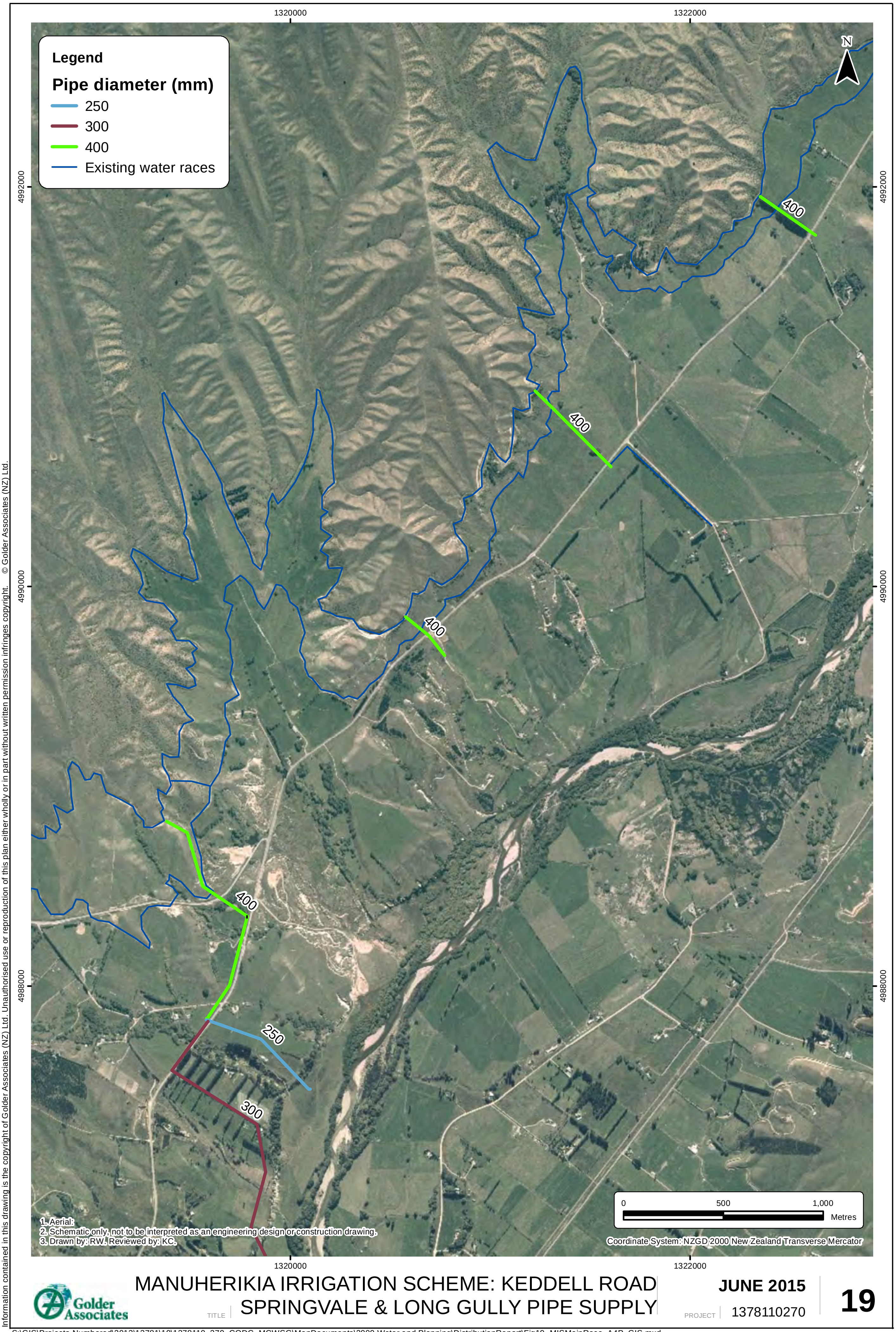

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TITLE MANUHERIKIA IRRIGATION SCHEME: KEDDELL ROAD SPRINGVALE & LONG GULLY PIPE SUPPLY

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Table 7: Manuherikia Irrigation Scheme cost estimates.

Item	Description	Cost estimate(1)
Capital Costs Main Race	Buffer storage pond	1,000,000
	Chinky Gully Siphon	322,000
	Gorge piped section	440,000
	Race upgrades and bywashes etc.	180,000
	Automation of gates, upgrading turnouts and monitoring	220,000
	Design, Project Management, Consents etc.	519,000
	Contingency	938,000
Total Capital Costs Main Race		**$3,620,000**
Total Capital Costs per ha (assuming evenly spread over 3,600 ha)		**$1,000/ha**
Annual Operational Costs	Operation and Maintenance	205,000
	Governance and Administration	20,000
Total Annual Operational Costs Main Race		**$230,000**
Total Annual Operational Costs (assuming evenly spread over 3,600 ha)		**$70/ha**
Capital Costs Dunstan Flats Piped	Distribution pipes 11.3 km supply, lay and fittings	1,103,000
	Road crossings etc.	274,000
	Turnouts	500,000
	Design, Project Management, Consents etc.	451,000
	Contingency	815,000
Total Capital Costs Dunstan Flats		**$3,150,000**
Total Capital Costs per ha (assuming evenly spread over 500 ha)		**$6,300/ha**
Annual Operational Costs	Operation and Maintenance	50,000
	Governance and Administration	20,000
Total Annual Operational Costs Dunstan Flats		**$ 70,000**
Total Annual Operational Costs (assuming evenly spread over 500 ha)		**$140/ha**
Capital Costs Keddell Road, Springvale and Long Gully Piped	Distribution pipes 5.9 km supply, lay and fittings	531,000
	Road crossings etc.	114,000
	Turnouts	150,000
	Design, Project Management, Consents etc.	203,000
	Contingency	367,000
Total Capital Costs Keddell Road, Springvale and Long Gully Piped		**$1,420,000**
Total Capital Costs per ha (assuming evenly spread over 600 ha)		**$2,400/ha**
Annual Operational Costs	Operation and Maintenance	50,000
	Governance and Administration	20,000
Total Annual Operational Costs Keddell Road, Springvale and Long Gully		**$ 70,000**
Total Annual Operational Costs (assuming evenly spread over 600 ha)		**$120/ha**

Notes: (1) Estimated costs are exclusive of GST and are rounded to the nearest $ 1,000, with totals rounded up to nearest $ 10,000, per ha capital costs rounded to the nearest $100 and per ha operational costs rounded to the nearest $10.

4.3.4 Stock and domestic water

The Dunstan Flats, Keddell Road and Springvale areas do not have a rural water supply scheme, with most landowners relying on rainwater collection (very limited), springs, stock water ponds and shallow bores, some of which are likely to rely on recharge from contour flooding. There is a rural water supply scheme in the Long Gully area that supplies domestic and stock water to approximately 40 properties. The Central Otago District Council (CODC) are currently assessing various water supply options for Alexandra and its surrounds[14]. In developing a pressurised pipe network the implications of increased spray irrigation, both in terms of potential increased stock water demand and reduced recharge to shallow groundwater, must be considered. Irrigation systems are generally not compatible with stock and particularly domestic water supplies due to different water quality and supply reliability (i.e., irrigation systems tend to shut down over winter) requirements. Within an irrigated area stock and particularly domestic water demand is small in comparison to irrigation demand. Piped irrigation schemes usually provide stock water over the irrigation season, but irrigators often have to revert to individual stock water supplies (creeks, springs, stock water ponds and shallow groundwater) outside of the irrigation season. Domestic supplies could be provided in a similar fashion, but would require water treatment at either a scheme (would require a separate piped distribution system for the treated domestic water) or at a household level (would require inline or under bench treatment or more likely water tank treatment prior to supply to the dwelling).

The proposed piped irrigation networks for the Dunstan Flats, Keddell Road and Springvale areas are all supplied from the MIS Main Race, which is not operated over winter. Buffer storage is proposed for the Dunstan Flats network, the size of which is more than sufficient to cover domestic and stock water needs over the winter. Much of the area covered by the Keddell Road and Springvale proposed piped networks are close to Brassknocker Creek, Springvale Creek or the Manuherikia River. Creeks, local springs, stock water ponds and shallow groundwater currently provide stockwater outside of the irrigation season and would be expected to cover any increased demand due to future irrigation developments. As such, dedicated stockwater and domestic water supply schemes have not been designed or costed as part of this study.

4.4 Blackstone

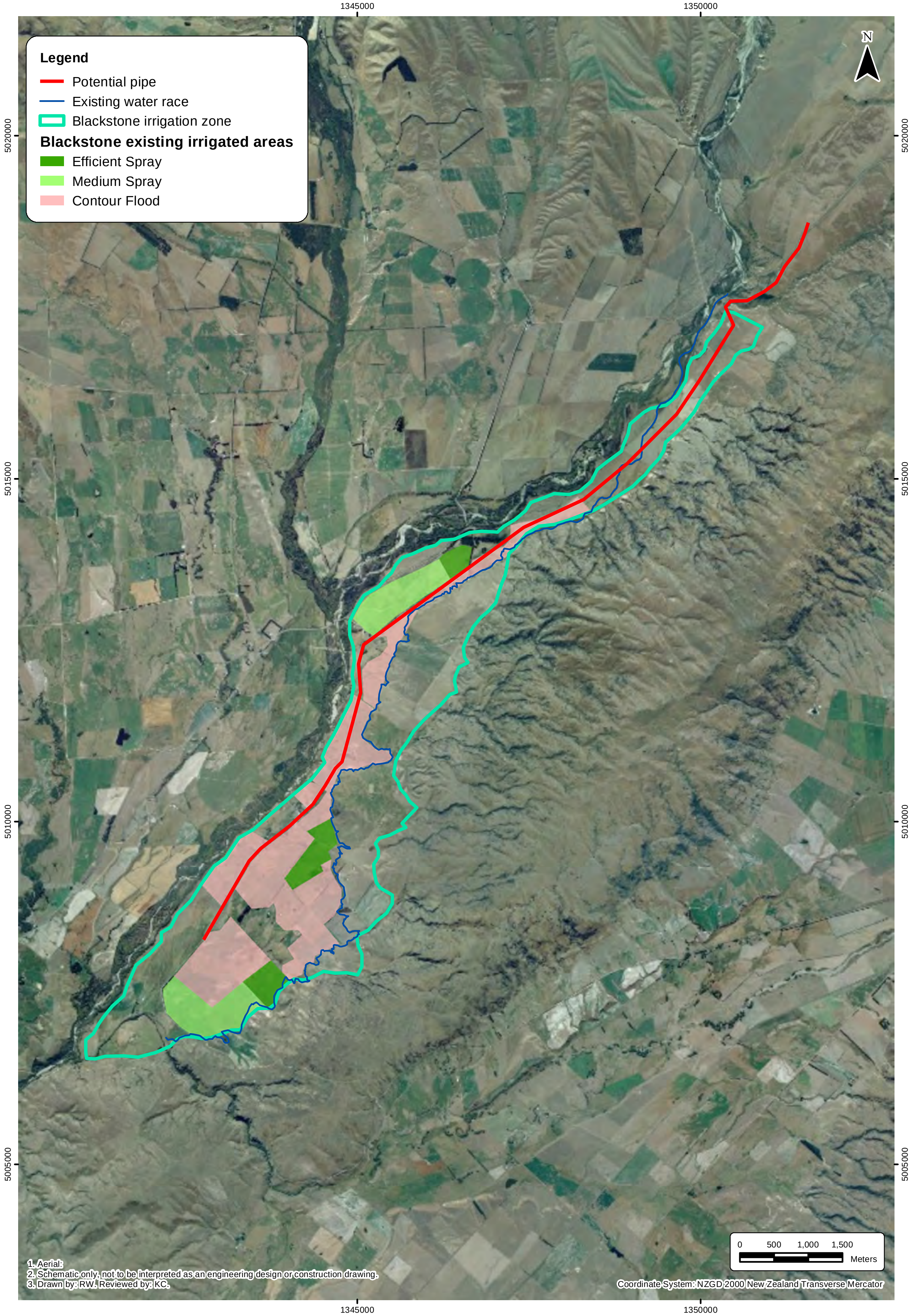
4.4.1 Description

The Blackstone Irrigation Scheme (BIS) on the left bank of the middle reaches of the Manuherikia River (Figure 20) was constructed in the early 1900’s and is one of the oldest schemes in the area. The scheme has always been maintained and operated by the irrigators with the MWD only assisting with maintenance of the Manuherikia River intake. The BIS covers a command area of approximately 1,400 ha, of which approximately 660 ha are currently irrigated by four large pastoral irrigators. The scheme area is elongated adjacent to the Manuherikia River with an approximately 20 km long open race traversing the length of the scheme. The scheme is predominantly flood irrigated (~ 70 %) although there is a move to spray irrigation.

4.4.2 Water Supply

The scheme sources water from the Manuherikia River upstream of the Washpan Creek confluence. The intake is a simple gated diversion with a gravel groyne (Figure 21). Regular maintenance of the groyne is required, particularly after floods and during low flows, to ensure water is continuously directed towards the intake. The BIS intake is the most upstream intake on the main stem of the Manuherikia River and there is currently no irrigation upstream of the intake. Approximately 400 m downstream of the intake, there is a simple flow control structure which directs water into the race and discharges excess water back to the river (Figure 22). The flow control structure has two rectangular weirs, the lower and narrower of which directs water into the race, while the upper and wider weir directs excess water back to the river. The principal function of the weir is to prevent flood flows from entering the race. To reduce flows in the race, manual operation of the intake gate is required. A continuous water level recorder was fitted to the weir in 2010 providing a continuous record of the flow directed into the race. The scheme provides both irrigation water and stockwater and the race has run continuously since the early 1900s. The race is open ended and bywashes (Figure 23) to the lower reaches of the Ida Burn below ORC’s Cob Cottage flow recorder.

[14] Information on the COD’s investigations can be found at http://www.codc.govt.nz/services/water-services/Pages/default.aspx



TITLE BLACKSTONE HILL IRRIGATION SCHEME

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Figure 21: Blackstone Hill Irrigation Scheme River Intake.

Figure 22: Blackstone Hill Irrigation Scheme Flow Control Weir.

Figure 23: Blackstone Hill Irrigation Scheme: duel race section (left), typical race and farm crossing (middle) and race at Thurlow Road above bywash to Ida Burn (right).

BIS are authorised to take a maximum of 536 L/s from the river which is sufficient to spray irrigate approximately 1,030 ha at 4.5 mm/day. The take is authorised via two deemed permits and one resource consent, which expire in 2021 and 2015 respectively. The take from the Manuherikia River benefits from water released from Falls Dam and BIS is a 6 % shareholder of the Falls Dam Company. BIS is very reliant on flow released from Falls Dam as there are no significant tributary inflows between Falls Dam and the BIS intake. Aqualinc 2012b found that at least 325 L/s (11.5 head) is available to BIS for 90 % of the irrigation season.

4.4.3 Scheme infrastructure and operation

The distribution network consists of a single race, which is approximately 20 km long running from the intake near Washpan Stream to the bywash to the Ida Burn, approximately 1 km above it confluence with the Manuherikia River. The race is relatively steep, dropping approximately 100 m over approximately 20 km length, which results in fairly rapid water velocities. In 2010 the upstream irrigator realigned part of the upper race (near the bluffs) in order to install a pumping turbine and to increase the potential to gravity irrigate from the race. There is now a dual race through this section. The race system is very simplistic with relatively few structures consisting of mainly water turnouts, farm crossings and two road crossings (Figure 23). A 1985 MWD scheme inventory of the upper 650m of the race identifies five structures (MWD 1985b). There is no formal inventory of the complete scheme although it is well understood by the four shareholder irrigators.

The scheme provides both irrigation water and stockwater and the race has run continuously since the early 1900's. The scheme is run by the four irrigators on an informal roster system. Maintenance is undertaken on an as required basis and scheme operation and administration costs are very low.

BIS irrigators have indicated that water supply reliability is their biggest challenge and is restricting further development of spray irrigation.

4.4.4 Monitoring undertaken and distribution efficiency

Two gaugings were undertaken on the Blackstone irrigation scheme on 9 April 2014 (Table 8). The first site was located immediately downstream of the intake from the Manuherikia River, and the second site was located before the race splits in two (Figure 23). The gaugings did not identify any significant flow gains or losses indicating that the Blackstone Hills Race is fairly well sealed and does not leak significantly. Given the age of the race and that it is operated continuously we would expect it to be well sealed.

Table 8: Blackstone Hills Irrigation Scheme race loss assessment.

Gauging location	Distance downstream from intake (~ km)	Date Time	Flow (L/s)	Calculated loss	Comments
Downstream of intake	0.7	9/4/2014 7:18	204 ± 3 %		Fast flowing steep gradient.
Upstream of race split	4.3	9/4/2014 8:06	216 ± 2 %	-12 L/s (6 % gain which is within accuracy of flow measurements).	Slower flowing, significant weed.

4.4.5 Development scenarios

The current scheme operates effectively at very little cost to the irrigators. BIS has a sufficient water allocation to allow considerable expansion of the irrigated area, however the scheme suffers from relatively poor supply reliability which is restricting further development of spray irrigation.

Two distribution development scenarios are considered for the BIS:

1) Maintain current open race system, i.e., the status quo.
2) Convert to a gravity piped supply from a new high race associated with increased storage at Falls Dam.

Under the status quo development scenario stockwater would be derived from the open race as is currently the case. Under the piped development scenario stockwater would be provided as part of the irrigation supply during the irrigation season. Outside of the irrigation season the area could be provided with stockwater through continued operation of the open race system or by including a small amount of strategic buffer storage into the piped system. Costs associated with providing stockwater have been excluded from the cost estimates below.

Scenario 1: Maintain current open race system

The principal maintenance requirements of the current scheme are outlined below along with recommended minor improvements.

- The current scheme has no automation and is controlled manually. Automation of the intake gate would facilitate scheme management and reduce bywash.
- Maintenance and upgrading of the race is required in a number of locations to prevent overtopping. Similarly a number of structures need repair or replacement.
- Formation of a buffer storage pond near the end of the race would reduce bywash.
- Upgrading the turnouts to the individual irrigators and monitoring water use would facilitate scheme management and water charging and is likely to lead to improvements in on-farm water use.
- Weed clearance: Significant weed growth occurs in many of the irrigation races throughout the Manuherikia catchment. Regular mechanical clearance of weed from the races is required.

Maintaining the current open race system represents the status quo for the BIS. The estimated capital cost[15] for maintaining the current open race system is $410,000, with an estimated annual operation cost[3] of $70,000[16] (Table 9). Spread over the 660 ha currently irrigated the estimates equate to a capital cost of approximately $600/ha and an annual operating cost of approximately $110/ha. The operating costs exclude any on-farm pumping, which would be required for spray irrigation. A breakdown of the cost estimate is provided in APPENDIX E.

Table 9: Blackstone Hills Irrigation Scheme open race cost estimate.

Item	Description	Cost estimate[(1)]
Capital costs	Automation of intake	50,000
	Race and structure upgrades	43,000
	Buffer storage	100,000
	Upgrading turnouts and increased monitoring	50,000
	Design, Project Management, Consents etc.	58,000
	Contingency	105,600
Total Capital Costs Blackstone Hills open race		**$410,000**
Total Capital Costs per ha (assuming evenly spread over 660 ha)		**$600/ha**
Annual Operational Costs	Operation and Maintenance labour	30,000
	Race cleaning, diversion maintenance and maintenance of structures	30,000
	Governance and Administration	10,000
Total Annual Operational Costs Blackstone Hills open race		**$70,000**
Total Annual Operational Costs (assuming evenly spread over 660 ha)		**$110/ha**

Notes: (1) Estimated costs are exclusive of GST and are rounded to the nearest $ 1,000, with totals rounded up to nearest $ 10,000, per ha capital costs rounded up to the nearest $100 and per ha operational costs rounded to the nearest $10.

15 Estimated costs exclude GST.

16 The operating cost includes scheme pumping.

Scenario 2: Develop a gravity pressurised piped scheme from a new high race

Piping the BIS would have the following benefits:

- Reduce losses through eliminating bywash.
- Facilitate scheme operation and management.
- Encourage increased spray irrigation, particularly as pressurised water would be supplied to the irrigators.

Development of a gravity pressurised piped scheme for BIS relies on the construction of a new high race as proposed under irrigation development Option 1 (Falls Dam High (27 m) Raise) and Option 2 (Falls Dam Mid (15 m) Raise). A new high race would enter the Manuherikia siphon at an elevation of approximately 520 m amsl. There are approximately 1,600 ha of irrigable land adjacent to or within the command area of BIS, all of which is at an elevation of 480 m amsl or lower. As such all the irrigable area could be supplied with gravity pressurised water from the new high race. BIS existing allocation of 536 L/s is sufficient to spray irrigate approximately 1,030 ha at 4.5 mm/day. BIS would require additional allocation to spray irrigate all 1,600 ha that is potentially irrigable. Discussions with BIS irrigators suggest a realistic maximum irrigated area of approximately 1,200 ha. The general shape of the BIS command area (long and skinny) does not readily suit a piped network, in that long pipes are required, but the potential to provide pressurized water and therefore eliminate on-farm pumping will partially compensate for the longer pipe lengths.

The 1,600 ha of command area could be served via a simple pressurised pipeline from the new high race down through the command area. The pipeline would initially follow SH85 and then along Blackstone Hill Runs Road. There is a considerable elevation drop (in the order of 100 m) over the command area, which allows the use of smaller diameter pipes with higher friction losses. A conceptual distribution pipeline is show in Figure 20 and has been used to provide estimated capital and operational costs. The estimated capital cost for the proposed pressurised pipe distribution network is $6,480,000 with an estimated annual operation cost of $50,000 (Table 10). Spread over 1,200 ha the estimates equate to a capital cost of approximately $5,400/ha and an operational cost of approximately $40/ha. The piped network would provide pressurised water eliminating on-farm pumping. There is potential for the piped network to service a larger area which would potentially reduce the cost per hectare. A breakdown of the cost estimate is provided in APPENDIX E.

Table 10: Blackstone Hills Irrigation Scheme piped cost estimate.

Item	Description	Cost estimate(1)
Capital Cost	Distribution pipes 14 km of 350 mm - 700mm diameter PE pipe, supply, lay and fittings	3,661,000
	Road crossings etc.	46,000
	Turnouts	162,500
	Design, Project Management, Consents etc.	929,000
	Contingency	1,679,000
Total Capital Costs Blackstone Hills pipe		**$6,480,000**
Total Capital Costs per ha (assuming evenly spread over 1,200 ha)		**$5,400/ha**
Annual Operational Costs	Operation and Maintenance	40,000
	Governance and Administration	10,000
Total Annual Operational Costs Blackstone Hills pipe		**$50,000**
Total Annual Operational Costs (assuming evenly spread over 1,200 ha)		**$40/ha**

Notes: (1) Estimated costs are exclusive of GST and are rounded to the nearest $ 1,000, with totals rounded up to nearest $ 10,000, per ha capital costs rounded up to the nearest $100 and per ha operational costs rounded to the nearest $10.

Other (uncosted) development opportunities

A modification of the proposed piped network would be to pipe from the existing intake, however this would significantly reduce the ability to provide pressurised water and would save less than 1 km of pipe.

There is potential to possibly replace part of the suggested piped network for BIS with a higher race that would traverse past the Carlowie homestead and then sidle along the western flanks of the Blackstone Hill at approximately the 500 m to 460 m RL contour. Such a race would allow gravity piped supply down to the BIS and potentially could be extended through the Ida Burn gorge to supply water into the Ida Valley. If a large increase in storage at Falls Dam is progressed we recommend that a high race with piped secondary distribution to BIS be investigated.

4.5 Omakau

4.5.1 Description and water source

Omakau Irrigation Scheme (OIS) covers a command area of approximately 21,000 ha on the right bank of the Manuherikia River above Ophir. The OIS supply irrigation water to 5,842 ha although individual irrigators tend to spread their water over a larger area. This irrigated area can be divided into five sub-areas based on water source and location.

1) Main Race – The Main Race takes water from a weir (Figure 24) on the Manuherikia River upstream of its confluence with Dunstan Creek. Approximately 500 m downstream of the intake weir there is a large flow control structure, which bywashes excess water back to the Manuherikia River (Figure 24). OIS have recently automated the Main Race intake allowing remote flow monitoring and operation of the intake gates. The Main Race crosses the Manuherikia River downstream of the SH85 bridge, passes Becks and then passes Omakau to the west and ends with a bywash back to the Manuherikia River near Ophir. Numerous distribution races feed off the Main Race, including a small pumped lift over to the Tiger Hills area. In a number of locations natural channels are utilised to distribute irrigation water or bywash excess water. OIS supply records indicate that 3,759 ha are supplied with irrigation water from the Main Race (including Tiger Hills and the Clearwater Race). Contour irrigation is the dominant method of irrigation although recently there has been quite a shift to spray irrigation with numerous pivot systems installed. OIS hold a consent to take 1,981 L/s from the Manuherikia River via their intake to the Main Race. The Main Race benefits from water released for Falls Dam and OIS is a significant shareholder of the Falls Dam Company. There are no significant tributary inflows between Falls Dam and the OIS Main Race intake and the Main Race part of the OIS is heavily reliant on flow released from Falls Dam. Modelling of the status quo situation (Aqualinc 2014) indicates that the Main Race has a high supply reliability with only 52 days of incomplete water supply in the 40 year period between1 June 1973 and 31 May 2013. The 52 days were spread over 4 years (4 days in April 1976, 7 days in February/March 1998, 31 days in February/March 1999 and 10 days in January 2004). Irrigators have indicated that supply restrictions occur more frequently.
2) Dunstan – The Dunstan part of the OIS takes water from a weir on Dunstan Creek (Figure 25) immediately downstream of the Donald Stuart Creek confluence. The intake gates are automated allowing remote operation (Figure 25) and flow monitoring. Approximately 500 m downstream of the intake weir there is a flow control structure which bywashes excess water back to Dunstan Creek (Figure 25). The Dunstan Race extends toward Lauder Creek. Numerous distribution races feed off the Dunstan Race and supply water to the area around Becks School Road. OIS supply records indicate that 844 ha are supplied with irrigation water from the Dunstan Race. Contour irrigation is the dominant method of irrigation although recently a number of spray systems have been installed. The Dunstan Race relies on flows in Dunstan Creek and can suffer from reduced supply reliability. OIS hold a consent to take 424.5 L/s from Dunstan Creek. Aqualinc 2014 found that mean flow in Dunstan Creek at the Gorge site between 1 June 1973 and 31 May 2013 was 2.35 m^3/s and that seven day mean annual low flow (7d MALF) was 0.62 m^3/s. During the 15 September to 30 April irrigation season median flow was 1.61 m^3/s and flow was less than 0.65 m^3/s 10 % of the time.
3) Lauder – The Lauder part of the OIS takes water from a weir on Lauder Creek (Figure 26) as it exits the Dunstan Mountains and begins to flow across the Manuherikia Valley floor. The Lauder Race extends

toward Thomsons Creek. Three main distribution races feed off the Lauder Race and supply water to the area either side of Muddy Creek Road. OIS supply records indicate that 453 ha are supplied with irrigation water from the Lauder Race. Contour irrigation is the dominant method of irrigation with very limited spray irrigation. The Lauder Race relies on flows in Lauder Creek and can suffer from reduced supply reliability. OIS hold a consent to take 424.5 L/s from Lauder Creek. Aqualinc 2014 found that mean flow in Lauder Creek at the Cattle Yards site between 1 June 1973 and 31 May 2013 was 1.11 m^3/s and 7d MALF was 0.23 m^3/s. During the 15 September to 30 April irrigation season median flow was 0.67 m^3/s and flow was less than 0.24 m^3/s 10 % of the time.

4) Matakanui – The Matakanui part of the OIS takes water from a weir on Thomsons Creek (Figure 27) as it exits the Dunstan Mountains and begins to flow across the Manuherikia Valley floor. Immediately downstream of the weir there is a flow control structure, which both bywashes excess water back to Thomsons Creek and includes flow monitoring. The Matakanui Race extends south and west though the Tinker Diggings and on toward Devonshire Road. A small amount of water is also siphoned back under Thomsons Creek to the left bank. Numerous distribution races feed off the Matakanui Race and supply water to the area either side of Wallington Road. OIS supply records indicate that 556 ha are supplied with irrigation water from the Matakanui Race. Contour irrigation is the dominant method of irrigation although recently a number of spray systems have been installed. The Matakanui Race relies on flows in Thomsons Creek and can suffer from reduced supply reliability. OIS hold consent to take 424.5 L/s from Thomsons Creek. Aqualinc 2014 found that mean flow in Thomsons Creek at the Diversion Weir site between 1 June 1973 and 31 May 2013 was 0.73 m^3/s 7d MALF was 0.17 m^3/s. During the 15 September to 30 April irrigation season median flow was 0.47 m^3/s and flow was less than 0.18 m^3/s 10 % of the time.

5) County - The County part of the OIS takes water from four small creeks (Middle Creek, Coal Creek, Scotts Creek and Devonshire Creek) via various small weirs and diversions. The main County Race runs east from Middle Creek and ends near Devonshire Road. OIS supply records indicate that 231 ha are supplied with irrigation water from the County Race system. Contour irrigation is the dominant method of irrigation with limited spray irrigation. The Country Race system relies on flows in its various feeder creeks and suffers from reduced supply reliability during the height of the irrigation season. OIS hold consent to take a combined 198.1 L/s from the four creeks.

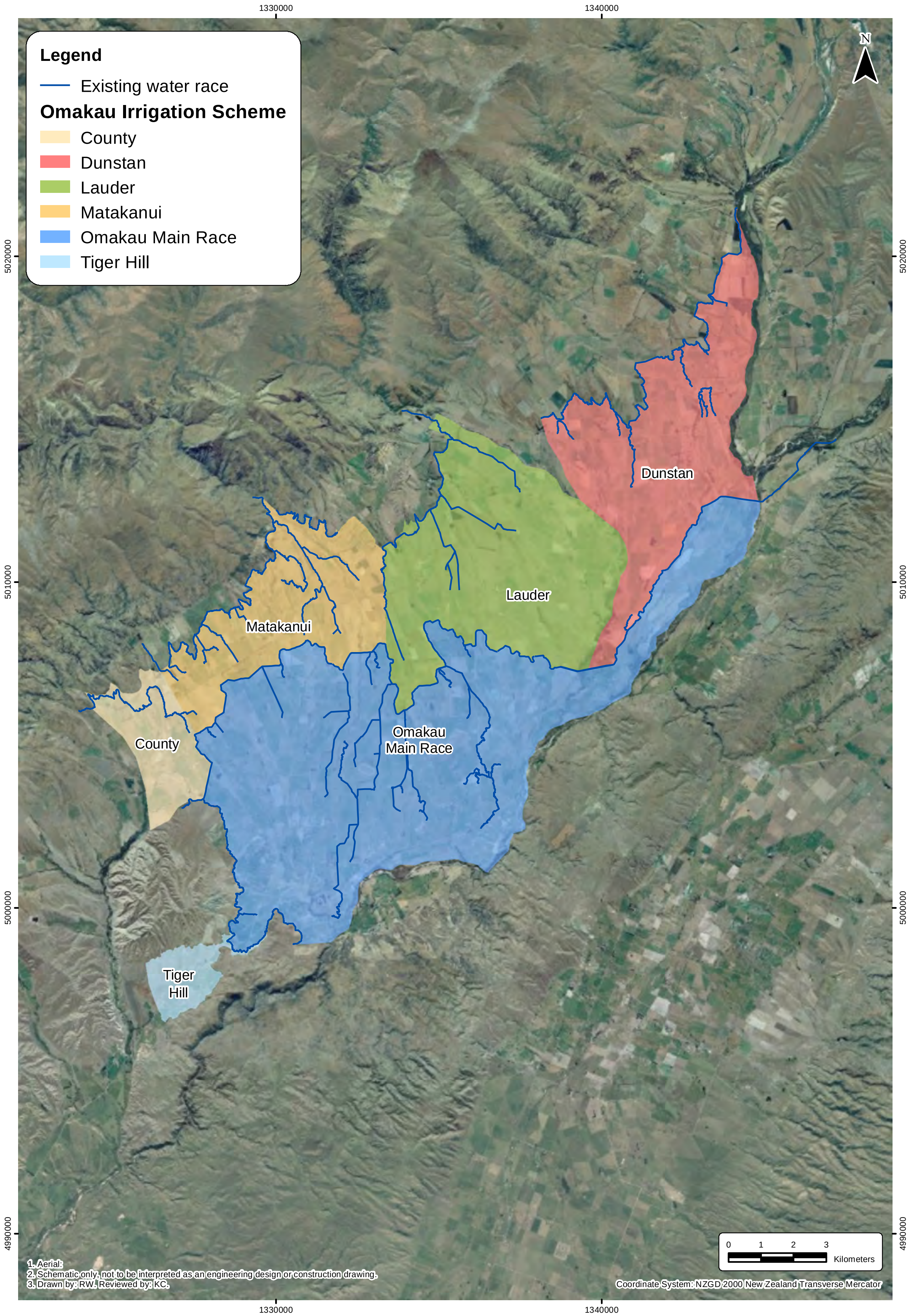
The command area and key infrastructure of the OIS is shown in Figure 28.

Figure 24: Omakau Irrigation Scheme - Main Race intake weir and flow control structure.

Figure 25: Omakau Irrigation Scheme – Dunstan Creek intake weir and flow control structure.

Figure 26: Omakau Irrigation Scheme – Lauder Creek weir.

Figure 27: Omakau Irrigation Scheme – Thomsons Creek intake.



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TITLE OMAKAU IRRIGATION SCHEME

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4.5.2 Scheme infrastructure and operation

The OIS race system is extensive and consists of approximately 200 km of open races, pipes, siphons, tunnels and viaducts. The main race is approximately 50 km long from the intake to the Tiger Hills pump station. Travel time is in to order of 12 - 24 hours which provides a challenge to management of the scheme. The scheme has benched all of the large races (Figure 29) to assist with race maintenance and most of the races are readily assessable. Most of the races are unfenced, allowing stock access. OIS have an on-going programme of race maintenance including weed spraying, clearance of aquatic weeds during the irrigation season and re-battering of side slopes where needed.

Figure 29: Omakau Irrigation Scheme typical races sections (left and right) and Becks Siphon (middle).

A 1985 scheme inventory completed by MWD indicates that the scheme has over 1,100 structures (MWD 1985b). There are approximately 250 structures on the OIS Main Race and a further approximately 370 structures on distribution races (including the Clearwater race system) that feed off the Main Race. There are approximately 160 structures on each of the Dunstan and Matakanui race networks, approximately 120 structures on the Lauder Race network and approximately 50 on the County Race network. The structures range from large tunnels, siphons, aqueducts and bridges to relatively small pipes, culverts and farm crossings. The main scheme infrastructure includes the main intakes and associated flow control structures from the Manuherikia River (Figure 24), Dunstan Creek (Figure 25), Lauder Creek (Figure 26) and Thomsons Creek (Figure 27), the large siphons (Becks (Figure 29), Lauder and Huddlestone), the tunnels on the Main Race, the Tiger Hills pump station, various bywash structures and road bridges. While the scheme is old, much of the infrastructure is robust, although some upgrading and maintenance is required. The OIS operates and maintains the distribution network itself, mostly through the extensive experience of Roger Williams. Mr Williams has both an extensive photographic record of the scheme including pictures of the main infrastructure and an on-going maintenance programme. The site visit revealed that when structures need replacement or new structures are required, they are built to a high standard. Overall the scheme is in a fair condition although as much of the scheme infrastructure is old increased maintenance is required. Of the main infrastructure elements the Lauder siphon and the Dunstan Creek intake weir are the most in need of repair/replacement.

The scheme is run on a roster system with the takes from the various water sources controlled to match demand. Flow monitoring has recently been installed at all the main intakes together with automation of the intake gates at the Main Race intake on the Manuherikia River and the Dunstan Creek intake. The flow monitoring and automation has greatly facilitated efficient management and operation of the scheme. Historically all the area was flood irrigated (contour and border strips) which fitted with a roster system. More recently there has been a move to spray irrigation, which requires continuous water supply and which poses challenges for a predominantly flood irrigated roster system. To help overcome this, a number of the irrigators who have converted to spray irrigation have installed buffer storage. The buffer storages improve supply reliability for the irrigators and provide the scheme operators with increased operational flexibility and will have reduced the need to bywash water.

The scheme charges users on the volume of water used and has records of water supplied to each irrigator. While the water use data has not been directly compared with the take information it is anticipated that the scheme bywashes considerable volumes.

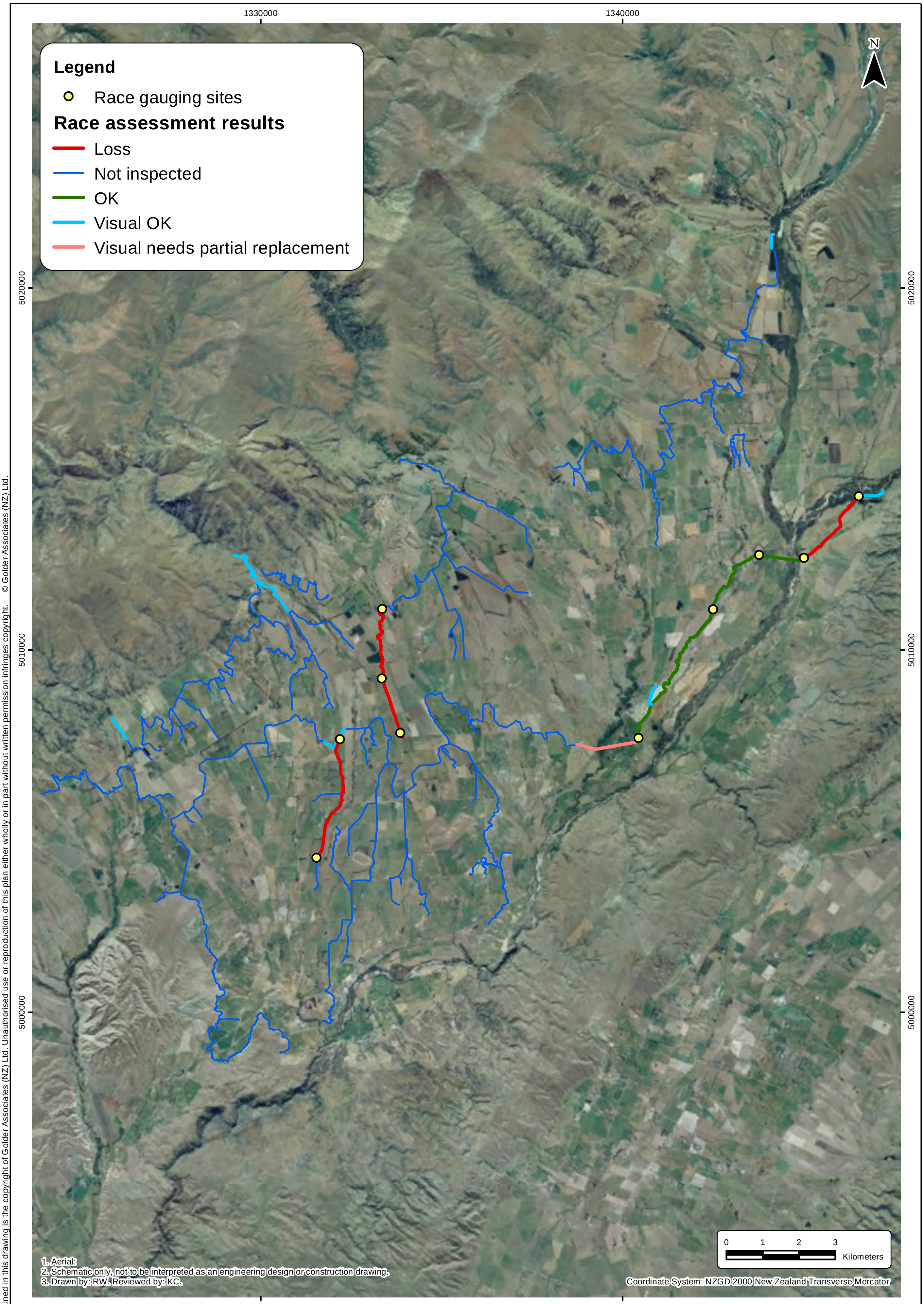
4.5.3 Monitoring undertaken and distribution efficiency

Given the age of the race network, the regular maintenance and upgrades it has received (particularly when it was operated by the MWD), the relatively small size and low flow rates of the many of the races, extensive race losses are not expected. Many sections of race traverse around side slopes for many kilometres and there is generally little evidence of seepage below the races indicating there is unlikely to be significant leakage. Rushes and green vegetation was observed under some small sections of race (i.e., Main Race between Becks and the Lauder siphon (Figure 30), County Race near Coal Creek and Dunstan Race from Loop Road) indicating some potential race leakage. There will be sections of the race network that cross particularly porous soils and will be prone to leakage. Given the age of the scheme any particularly leaky section of race will have been identified and rectified.

Figure 30: Omakau Irrigation Scheme photos indicating potential race leakage.

Flow gauging to assess race losses was completed on the OIS Main Race (intake to Lauder siphon), the E distribution race and the Lauder Race (Glassford Road to Huddleston Road). The sections of the race that were assessed were selected following discussion with Roger Williams as those thought to be most prone to race leakage. The assessed sections and the key findings are shown in Figure 31. Details of the flow gaugings undertaken are provided in APPENDIX C.

Golder’s assessment of the overall OIS distribution network is that it is relatively efficient, with race leakage generally less than 10 %, which is generally considered acceptable for open race networks. Higher leakage rates were identified in short sections of race and it is expected that there will be other sections of the race network outside of the areas monitored where race leakage will be high. The distribution network would benefit from identification and lining of these high leakage sections of race. However, the biggest gains in water use efficiency are likely to be associated with improving on-farm irrigation performance and reducing scheme bywash through increased buffer storage and increased automation and control of the distribution system.



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OMAKAU IRRIGATION SCHEME
RACE LEAKAGE ASSESSMENT

JUNE 2015

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4.5.4 Development scenarios

The current scheme operates effectively at little cost to the irrigators. OIS has a relatively large consented allocation of 3.85 m^3/s of water, which at 5 mm/day, is sufficient to irrigate approximately 6,650 ha. However, relatively poor water supply reliability (particularly for the Dunstan, Lauder, Matakanui and County parts of the scheme) prevents expansion of the irrigated area. This feasibility study is investigating 5 irrigation development options for the Manuherikia Catchment (refer Section 1.2) three of which (Options 1, 2 and 3 (Falls Dam high (27 m), low (5.4 m) and mid (15 m) raises respectively)) would affect the OIS. Options 1 and 3 (Falls Dam high (27 m) and mid (15 m) raises) include potential development of a new "High Race" which would service part of the OIS command area. The new High Race is discussed separately in Section 4.6. The following three distribution development scenarios are considered for the OIS:

1) Maintain current open race system, i.e., the status quo, which equates to irrigation development Option 2 (Falls Dam Low (5.4 m) Raise). This scenario is focused on the current OIS irrigators and does not consider private irrigators.
2) Development of a gravity piped distribution network from the Blackstone Race, which would supply the upper parts of OIS Main Race command area (namely the river flats below and east of Becks).
3) Expansion of the OIS Main Race to allow spray irrigation of 6,000 ha.

Currently stockwater requirements above Ophir are met from a combination of irrigation races (mainly during the irrigation season although some races run continuously), creeks, springs, stock water ponds and shallow groundwater. Moving from flood to spray irrigation and intensifying land use (through both more efficient irrigation and expansion of the irrigated area) will lead to increased stock numbers and greater stockwater demand. During the irrigation season stockwater would be provided as part of the irrigation supply. Outside of the irrigation season stockwater would need to be sourced from creeks, springs, stock water ponds and shallow groundwater. Costs associated with providing stockwater have been excluded from the cost estimates below.

Scenario 1: Maintain current open race system

The principal maintenance requirements of the current scheme are outlined below along with recommended minor improvements.

- The OIS has recently installed flow recorders on their main intakes and have automated the intake gates for both the Main Race and Dunstan Race. Further automation of the other intake gates and some of the larger distribution off takes would facilitate scheme management and reduce bywash.
- Replacement of the first section of the Lauder Siphon. It is understood that this activity has already been identified by OIS and they have previously replaced the remainder of the siphon.
- Upgrade or replace the Dunstan Creek intake weir. The existing sheet pile weir leaks and its rock rip rap protection has degraded.
- Maintenance and upgrading of the race network is required in a number of locations to reduce leakage and prevent overtopping. Similarly a number of structures need repair or replacement.
- Formation of a buffer storage pond near the end of the four race networks would reduce bywash.
- Upgrading the turnouts to the individual irrigators and monitoring of water use would facilitate scheme management and water charging and is likely to lead to improvements in on-farm water use.
- Weed clearance: Significant weed growth occurs in many of the irrigation races throughout the Manuherikia catchment. Regular mechanical clearance of weed from the races is required.

Maintaining the current open race system represents the status quo for the OIS. The estimated capital cost for maintaining the current open race system is $6,150,000 ($3,830,000 for the OIS Main Race and $2,320,000 for the Dunstan, Lauder, Matakanui and County parts of the OIS), with an estimated annual operation cost of $440,000 ($160,000 for the OIS Main Race and $280,000 for the Dunstan, Lauder, Matakanui and County parts of the OIS), (Table 11). Spread evenly over the 5,842 ha currently irrigated (3,759 ha for the OIS Main Race and 2,083 ha for the Dunstan, Lauder, Matakanui and County parts of the

OIS) the estimates equate to a capital cost of approximately $1,100/ha and an annual operating cost of approximately $80/ha. The operating costs exclude any on-farm pumping, which would be required for spray irrigation. A breakdown of the costs estimate is provided in APPENDIX E.

Table 11: Omakau Irrigation Scheme cost estimates.

Item	Description	Cost estimate[1]
Capital Costs Main Race Scheme	Lauder Siphon	1,147,000
	Buffer storage for Main Race	500,000
	Upgrading of races and sealing leaks	355,000
	Automation of distribution offtakes	180,000
	Upgrading turnouts and increased monitoring	100,000
	Design, Project Management, Consents etc.	548,000
	Contingency	991,000
Total Capital Costs Main Race		**$3,830,000**
Total Capital Costs per ha (assuming evenly spread over 3,759 ha)		**$1,000/ha**
Annual Operational Costs	Operation and Maintenance labour	60,000
	Race cleaning, intake and structure maintenance	80,000
	Governance and Administration	20,000
Total Annual Operational Costs Main Race		**$160,000**
Total Annual Operational Costs (assuming evenly spread over 3,759 ha)		**$40/ha**
Capital Costs Dunstan, Lauder, Matakanui and County Schemes	Automation of intakes	200,000
	Dunstan Intake Weir	150,000
	Buffer storage	300,000
	Upgrading of races and sealing leaks	200,000
	Automation of distribution offtakes	180,000
	Upgrading of other structures	200,000
	Upgrading turnouts and increased monitoring	150,000
	Design, Project Management, Consents etc.	331,000
	Contingency	599,000
Total Capital Costs Dunstan, Lauder, Matakanui and County		**$2,320,000**
Total Capital Costs per ha (assuming evenly spread over 2,083 ha)		**$1,100/ha**
Annual Operational Costs	Operation and Maintenance labour	120,000
	Race cleaning, intake and structure maintenance	140,000
	Governance and Administration	20,000
Total Annual Operational Costs Dunstan, Lauder, Matakanui and County		**$280,000**
Total Annual Operational Costs (assuming evenly spread over 2,083 ha)		**$130/ha**

Notes: (1) Estimated costs are exclusive of GST and are rounded to the nearest $ 1,000, with totals rounded up to nearest $ 10,000, per ha capital costs rounded to the nearest $100 and per ha operational costs rounded to the nearest $10.

Scenario 2: Piped network from Blackstone Race to Becks Flats

In assessing the current OIS the potential to supply the upper parts of Main Race command area (namely the river flats below and east of Becks) with pressurised water from the Blackstone Race was identified. Approximately 600 ha of irrigable land on the Beck Flats above Lauder Creek is greater than 40 m below the Blackstone Race and could potential be supplied with pressurised water. This would require some upgrading and possibly slight realignment of the Blackstone Race and development of a piped network from the Blackstone Race under the Manuherikia River. To irrigate the 600 ha at 5 mm/day approximately 350 L/s is required. To minimise pipe friction losses an approximately 600 mm diameter pipe would be required. A new piped supply to Becks Flats would also free up capacity within the rest of the Main Race system and if associated with an increase in storage at Falls Dam could potentially allow some expansion of the area irrigated.

An estimated capital cost for the piped network is $2,790,000, with an estimated annual operational cost of $10,000 (Table 12). The estimates exclude any capital or operational costs associated with upgrading the Blackstone intake and race to cater for the increased flow rate. Spread over the 600 ha currently irrigated the estimates equate to a capital cost of approximately $4,700/ha and an annual operating cost of approximately $20/ha. The piped network would provide pressurised water eliminating the need for on-farm pumping. There is potential for this piped network to service a larger area, which would potentially reduce the cost per hectare. A breakdown of the costs estimate is provided in APPENDIX E.

Table 12: Omakau Irrigation Scheme piped network from Blackstone Race to Becks Flats.

Item	Description	Cost estimate(1)
Capital Cost	Distribution pipes 6 km of 450 mm- 600mm diameter PE pipe, supply, lay and fittings	1,215,000
	Turnout from Blackstone Race and Manuherikia River crossing	350,000
	Farm Turnouts	100,000
	Design, Project Management, Consents etc.	400,000
	Contingency	722,000
Total Capital Costs Blackstone Race to Becks Flats pipe		**$2,790,000**
Total Capital Costs per ha (assuming evenly spread over 600 ha)		**$4,700/ha**
Annual Operational Costs	Operation and Maintenance	10,000
	Governance and Administration already included in general OIS costs	
Total Annual Operational Costs Blackstone Race to Becks Flats pipe		**$10,000**
Total Annual Operational Costs (assuming evenly spread over 600 ha)		**$20/ha**

Notes: (1) Estimated costs are exclusive of GST and are rounded to the nearest $1,000, with totals rounded up to nearest $10,000, per ha capital costs rounded up to the nearest $100 and per ha operational costs rounded to the nearest $10.

Scenario 3: Expansion of Omakau Main Race

There are approximately 8,600 ha of irrigable land below the OIS Main Race. OIS supply records indicate that 3,759 ha are supplied with irrigation water although it is understood that the water is spread over a larger area. OIS are authorised to take up to 1,981 L/s via the Main Race intake, at 4.5 mm/day this is sufficient to spray irrigated 3,800 ha which is similar to the area currently supplied. Without increased allocation there is no ability to increase the area irrigated under the OIS Main Race.

Any increase in storage at Falls Dam has the potential to provide additional allocation to the OIS Main Race and allow expansion of the area irrigated. While there are approximately 8,600 ha of irrigable land below the OIS Main Race, irrigation of more than approximately 6,000 ha (~ 70 %) is considered unlikely. Approximately 3,150 L/s is required to irrigate 6,000 ha at 4.5 mm/day. The OIS Main Race was constructed to have a capacity of approximately 2,080 L/s (MWD 1985b). Increasing the capacity up to approximately 3,150 L/s will require expansion of the race and many of the structures. Extensive expansion or upgrading of the main intake weir and flow control structure is not expected to be required given the large size and robust nature of both structures. Not all the structures will require replacement as many of the smaller ones will be able to handle a higher flow rate, albeit with increased head loss. The principal expansion works are likely to be restricted to a general expansion of the open races and replacement of the Becks and Lauder siphons. As the Huddleston siphon is near the end of the OIS Main Race it is not expected to require full replacement.

An estimated capital cost for increasing the capacity of the OIS Main Race up to approximately 3,150 L/s is $10,670,000, with an estimated annual operational cost of $160,000 (Table 13). Spread over 6,000 ha the estimates equate to a capital cost of approximately $1,800/ha and an annual operating cost of approximately $30/ha. The operating costs exclude any on-farm pumping, which would be required for spray irrigation. A breakdown of the cost estimate is provided in APPENDIX E.

Table 13: Omakau Irrigation Scheme cost estimates.

Item	Description	Cost estimate(1)
Capital Costs Main Race	Upgrade of Automation of Main Race intake to cater for higher flows	50,000
	Upgrade Lauder Siphon	2,371,000
	Upgrade Becks Siphon	2,028,000
	Buffer storage for Main Race	500,000
	Upgrading of main race and sealing leaks	450,000
	Upgrading other structures	500,000
	Upgrading of distribution races and sealing leaks	190,000
	Automation of distribution offtakes	180,000
	Upgrading turnouts and increased monitoring	100,000
	Design, Project Management, Consents etc.	1,529,000
	Contingency	2,764,000
Total Capital Costs Main Race		**$10,670,000**
Total Capital Costs per ha (assuming evenly spread over 6,000 ha)		**$1,800/ha**
Annual Operational Costs	Operation and Maintenance labour	60,000
	Race cleaning, intake and structure maintenance	80,000
	Governance and Administration	20,000
Total Annual Operational Costs Main Race		**$160,000**
Total Annual Operational Costs (assuming evenly spread over 6,000 ha)		**$30/ha**

Notes: (1) Estimated costs are exclusive of GST and are rounded to the nearest $ 1,000, with totals rounded up to nearest $ 10,000, per ha capital costs rounded up to the nearest $100 and per ha operational costs rounded to the nearest $10.

Other (uncosted) development opportunities

The OIS Main Race from the intake down to the Becks Siphon is very steep and contains a number of drop structures. The potential to realign the race and utilise the head loss via small scale hydro should be investigated.

4.6 New High Race

The prefeasibility investigations (Aqualinc 2012c and 2012h) and earlier MWD investigations (MWD 1984) identified the potential for a “High Race” along the western edge of the Manuherikia Valley. The race could potentially supply water to a large proportion of the irrigable land above Ophir. Development of a High Race requires increased storage at Falls Dam to ensure suitable water supply reliability.

4.6.1 High Race Alignment

Aqualinc 2012h and MWD 1984 developed fairly similar alignments for the proposed race. Both assessments proposed to start the High Race above Loop Road to initially run down the true left bank of the Manuherikia River, before siphoning back under the river. It is understood that the principal reason for starting the race above Loop Road was to avoid the gorge section of the Manuherikia River, which extends from Falls Dam down to near Loop Road and thereby ensuring that this section of river retains higher flows through the transportation of irrigation water. Aqualinc (2012h) proposed a race slightly steeper (average fall of approximately 1.5 m/km) than the earlier MWD (1984) assessment (average fall of approximately 1.0 m/km). Steepening the race causes slightly higher flow velocities, which allows smaller and therefore cheaper race cross sections to be used. However, steepening the race results in a lower end point and a lower alignment overall. The proposed MWD 1984 High Race extended to the lower Manuherikia Valley near Strath Clyde and could have potentially supplied water to most of the irrigable land within the Manuherikia Valley. Aqualinc (2012h) ended their proposed High Race at the Matakanui Station boundary.

We have reassessed the High Race alignment and particularly if it was worth extending it right up to the proposed new Falls Dam. The race alignment favoured by this assessment, together with the approximate alignments proposed in Aqualinc 2012h and MWD 1984, are shown in Figure 32.

In developing our preferred High Race alignment our key considerations were:

- To quickly identify areas that are difficult and warrant special attention, i.e., river crossings and steep broken terrain, and to develop potential solutions for these areas.
- Keeping the race as high as possible so as to maximise the potential for providing pressurised water supply.
- Utilise existing infrastructure where possible, particularly river intakes and existing large races. Enlarging existing infrastructure, particularly races, will be significantly cheaper than constructing new infrastructure.

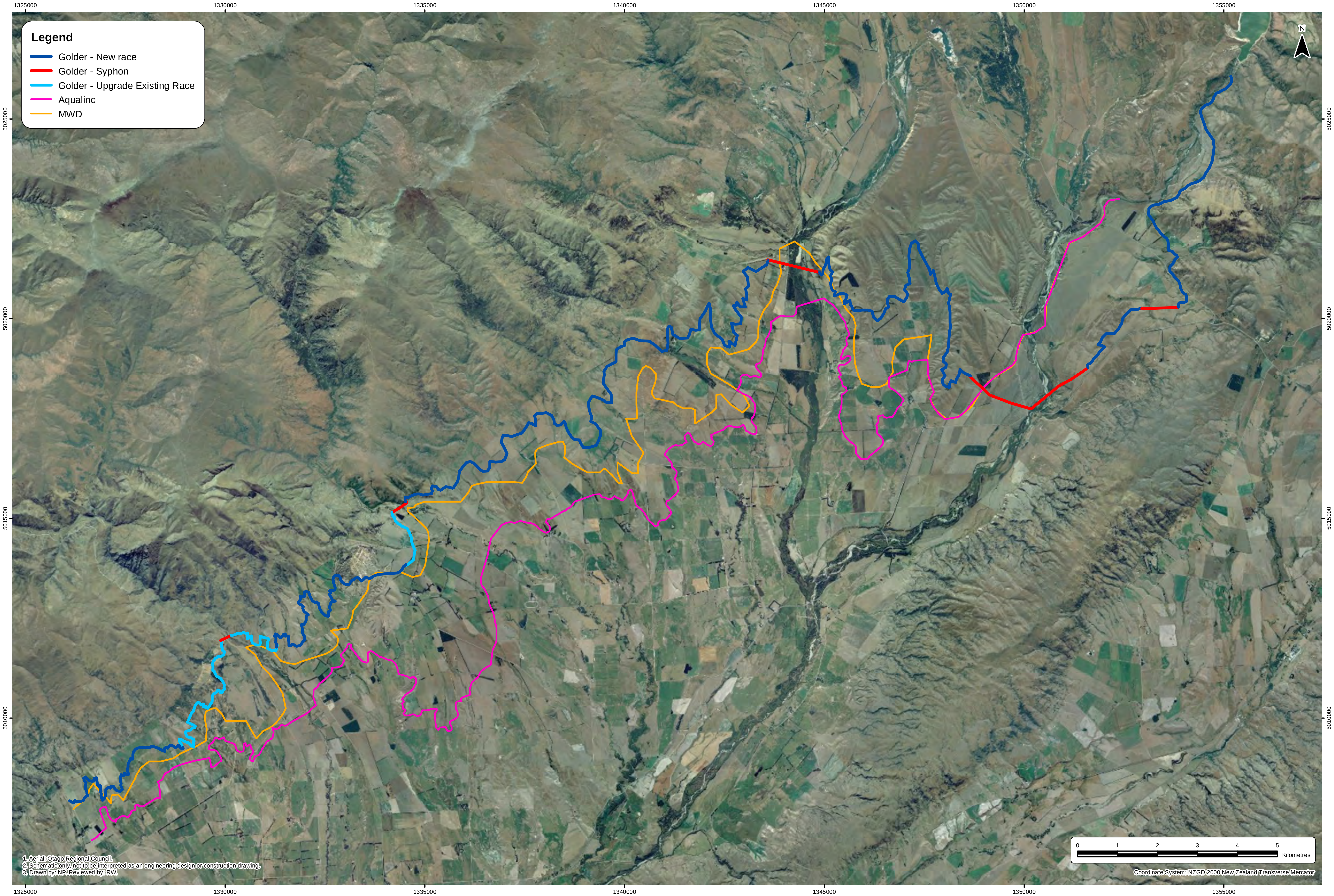
A key factor in the design of any irrigation distribution system is to determine where the water is needed. There is very limited information regarding potential irrigator demand or commitment to the proposed high race. Under irrigation development Option 1 (Falls Dam High (27 m) Raise) Golder were instructed that the high race was to extend to the boundary of Matakanui Station as per the prefeasibility investigations (Aqualinc 2012h). The terrain beyond Matakanui is more broken making race construction more difficult, particularly if a lower alignment is used. Discussions with landowners in the Matakanui area (Golder 2014b) revealed that the higher MWD alignment was preferred as it gave more potential for both extending the scheme and supplying pressurised water.

When assessing the overall Manuherikia Valley and potential race alignments five areas stand out as being potentially difficult and requiring careful consideration.

1) The start of the race and the intake requirements. The Manuherikia River is a large river that experiences significant flood flows any intakes will need to be very robust structures. Starting the race at a new or enlarged Falls Dam would eliminate the need for a downstream intake structure.

2) Crossing the Manuherikia River. The Manuherikia River between Loop Road and St Bathans Downs Road has a wide often braided riverbed with steep and often actively eroding terrace faces.

3) Crossing Dunstan Creek. Dunstan Creek also has a relatively wide riverbed with steep terrace faces.



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TITLE MANUHERIKIA VALLEY PROPOSED HIGH RACE ALIGNMENT

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4) The Drybread Diggings between Lauder Creek and Thomsons Creek where the topography is very broken and areas have been disturbed by historic mining activity, which will make forming a race very difficult. The MWD 1984 alignment goes through the Drybread Diggings, whereas the prefeasibility alignment (Aqualinc 2012) skirts round below them.

5) The Tinker Diggings in the Matakanui area, which are similar to the Drybread Diggings and where forming a race will be difficult. The Matakanui Race runs through the Tinker Diggings providing a potential alignment through this difficult area.

Aerial photos and topographic maps were used initially to develop a suggested high race alignment (Figure 32), which was field verified and checked in a number of locations. To confirm the alignment, topographic information, further design assessment and site walk overs are required. The preferred High Race alignment starts directly at Falls Dam, which eliminates the need for a downstream intake and allows a higher overall alignment. This significantly increases the potential to supply pressurised water. The preferred High Race alignment has the following characteristics relative to the prefeasibility alignment.

- The race feeds directly from Falls Dam. This eliminates the need for a downstream intake but slightly reduces the hydroelectric generation potential at Falls Dam. The topography of the Falls Dam site favours a spillway on the centre right and an off-take structure on left (western side). A race below Falls Dam would preferably be on the river terraces on the right (eastern) side of river (i.e., essentially follow Fiddler Flat Road). To feed the race, water from the outlet would need to be piped across Manuherikia River, immediately below Falls Dam. Construction of a large new Falls Dam is likely to require an access bridge over the Manuherikia River near the dam site (Golder 2015a). Following construction the access bridge, or part of it, could be used to support a pipe or formed channel over the river. Supplying the race directly from the dam will reduce flow in the Manuherikia River from the dam to approximately Loop Road as this section of the river will not be used to transfer High Race irrigation water as was proposed in the prefeasibility alignment.

- The preferred High Race alignment is higher than both the prefeasibility alignment (Aqualinc 2012h) and the MWD 1984 alignment. There are approximately 12,000 ha of irrigable land which is greater than 40 m below the proposed higher alignment and which could potentially be supplied with pressurised water (Figure 33). There is also significant, less irrigable land, above the higher alignment, which would reduce the need for pumping up from the race. Reducing future pumping costs is a significant benefit of the higher alignment and is expected to exceed the higher construction costs.

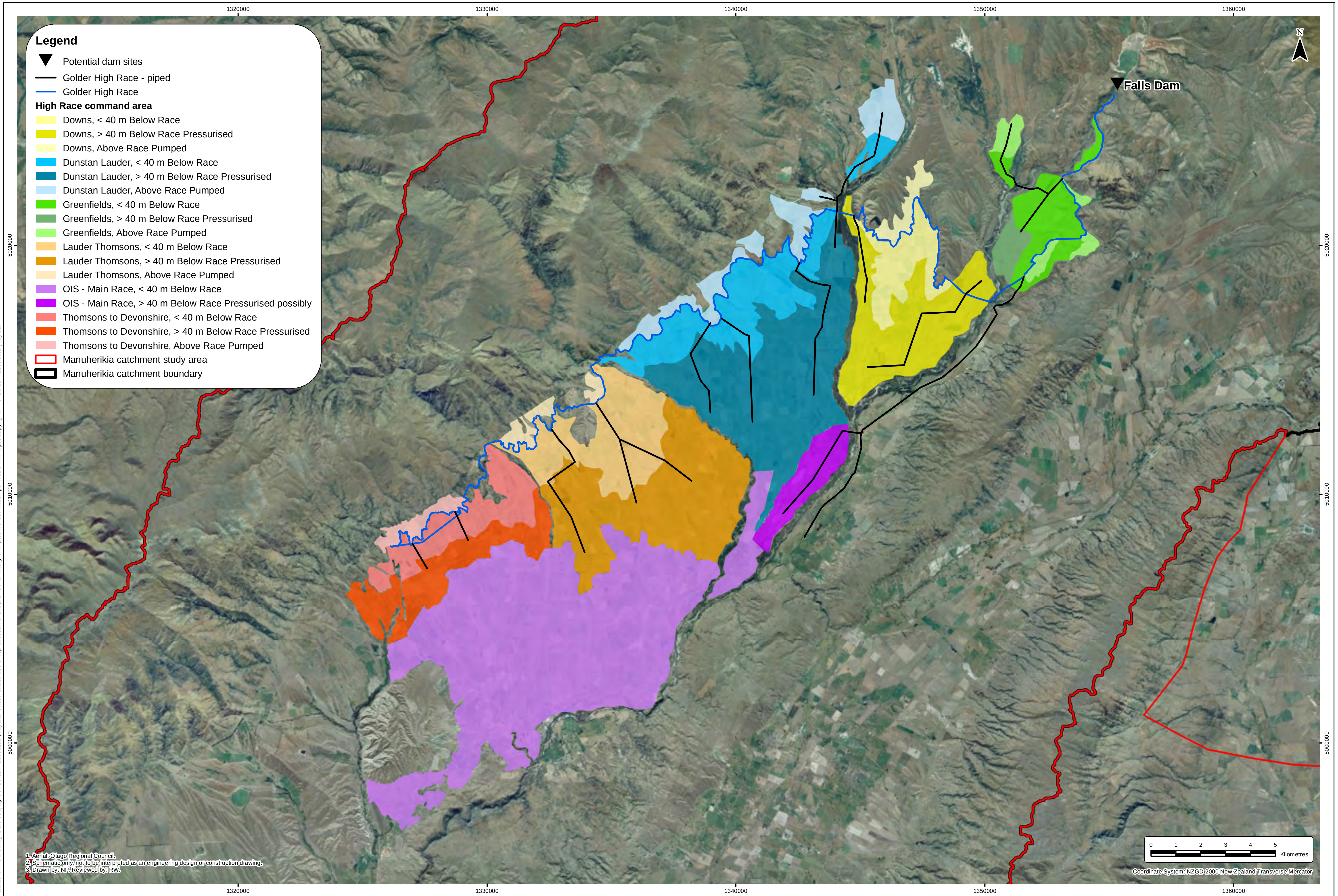
- The higher alignment uses the Matakanui Race, which simplifies the alignment through the Tinkers Diggings and allows the existing Thomsons Gorge intake and the numerous existing small storages off the Matakanui Race, to be simply incorporated into the expanded scheme.

- The preferred High Race alignment has an average slope of approximately 1.5 m/km (the same as the prefeasibility), which is considered a reasonable balance between maintaining elevation and minimising race cross sectional area.

- The elevation of the end of the race coincides roughly with the MWD 1984 alignment, which is preferred by landowners in the Matakanui area and would facilitate any potential extension of the race past the Matakanui Station Boundary.

- The preferred alignment is longer and therefore more expensive: approximately 72.1 km compared with approximately 59.9 km for the prefeasibility alignment and approximately 56.8 km for the MWD 1984 alignment. The 72.1 km preferred alignment consists of 56.2 km of new race, 9.3 km of upgraded race and 6.6 km of siphons. The siphon lengths required to cross Thomsons and Lauder Creeks are less than that required for the prefeasibility alignment, but the siphon lengths required to cross Dunstan Creek and the Manuherikia River are significantly longer and a new low pressure siphon is required at Greenfields.

- The alignment traverses through, rather than around, the Drybread Diggings, thereby reducing the length of race between Lauder and Thomsons Creeks. Race construction is expected to be difficult through this area and some piping maybe required and has been allowed for in the cost estimates. Site inspection and further design is required to confirm the alignment through the Drybread Diggings.



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TITLE MANUHERIKIA VALLEY PROPOSED HIGH RACE COMMAND AREA AND SECONDARY PIPED DISTRIBUTION NETWORK

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- The alignment is slightly above the OIS intake on Lauder Creek and the OIS and Downs intakes on Dunstan Creek. Allowing the High Race to supply water to those schemes is needed, although it is more difficult to feed water (particularly from Dunstan Creek) into the High Race.
- The preferred alignment traverses through the Beattie Road saddle, which is consistent with the alignment preferred by local farmers and significantly increases the irrigation potential in the Downs area.
- The higher alignment potentially allows water to be supplied (without excessive pumping) up Hawkdun Run Road and to the Johnson's property, thereby providing the landowners most affected by the raising of Falls Dam with some irrigation water.

There is potential to realign the upper sections of the proposed high race and to potentially cross the Manuherikia River up at Fiddlers Flat. This would significantly reduce the syphon length across the Manuherikia River but would require the race to traverse some very difficult and unstable terrain down the right bank of the river particularly upstream and downstream of Loop Road. A right bank alignment would require a long syphon under Station and Mata Creeks and a race would still be needed down the left bank to supply the Greenfields area. There are a number of potential alignments for the high race involving various syphon, pipe and canal lengths. Should a medium or high raise of the Falls Dam impoundment be progressed we recommend that detailed design commence with an optimisation process to confirm the preferred alignment of the high race.

4.6.2 High Race Capacity

Following development of the alignment the required race capacity was determined, based on expected irrigation demand derived from Aqualinc's hydraulic model, where two High Race scenarios were sized.

1) A High Race extending to the Matakanui Station boundary (as requested by the MCWSG) and having an end flow of 1 m^3/s. An end flow of 1 m^3/s is conservative because it is approximately double the flow required to supply the approximately 1,000 ha of irrigable land on Matakanui Station and will lead to higher race construct cost estimates. Conservatively sizing the High Race is considered appropriate at this stage in the design process, given there is considerable uncertainty over where the irrigation water is required.

2) A High Race extending to Lauder Creek with an end flow of 0.2 m^3/s. This High Race scenario is related to a 'mid raise' of Falls Dam (i.e., irrigation development Option 3) and the request that the 'mid raise' improves supply reliability to as many existing irrigators as possible, hence the desire to be able to supplement flows in Lauder Creek. An end flow of 0.2 m^3/s equates to approximately 90 % of the 7d MALF for Lauder Creek at the Cattle Yards site and approximates the suggested minimum flow requirements for Lauder Creek (Golder 2014e).

For both scenarios the required capacity of the High Race was determined from bottom to top as follows.

a) The command area supplied by the High Race under the two scenarios was determined and then separated into various supply zones based on five location zones (Greenfields, Downs, Dunstan-Lauder, Lauder-Thomsons, Thomsons-Matakanui) and three elevation categories (above the race, less than 40 m elevation below the race and greater than 40 m elevation below the race). Irrigable land greater than 40 m elevation below the race has the potential to be supplied with gravity pressurised water and simplistic, conceptual piped secondary distribution networks were developed for these areas. Irrigable areas above and below the race were assumed to take directly from the race, with take locations positioned at the downstream end of the zone or at key race infrastructure (i.e., prior to siphons or secondary piped distribution off takes). The flow requirements for each of the supply zones was then determined based on the area irrigated and assuming a supply rate of 5 mm/day. In completing this it was assumed that all the command area would be irrigated from the High Race. Working up from the end of the race the flow requirement at key locations along the High Race was then determined.

b) It was assumed that the High Race would receive inflow from the three main tributaries; Dunstan, Lauder and Thomsons Creeks and that the overall system would operate by prioritising run of river abstraction, which would then be supplemented by storage releases when required. Prioritising run of river abstraction minimises the storage requirements. The capacity of the race upstream of each of the three inflow points was reduced by the reliable tributary inflow. Reliable inflow from the three tributaries was assumed to be the flow exceeded 90 % of the time during the irrigation season, as determined by the hydrological model (Aqualinc 2014). The capacity of the race downstream of the inflow points was also checked to ensure it was sufficient to handle the total consented takes from each of the tributaries, thereby ensuring that the High Race size did not restrict run of river harvesting from the tributaries.

4.6.3 Estimated costs

Once the capacity of each section of the race was determined, aerial photos and topographic maps were used to assess construction difficulty. Each sized section of race was separated into areas of gentle or steep side slope and areas expected to require lining. This size and construction difficulty breakdown, together with unit construction costs, were used to develop a cost estimate for the two High Race scenarios, which are summarised in Table 14 (to Matakanui Station boundary) and Table 15 (to Lauder Creek). A breakdown of the cost estimates is provided in APPENDIX E.

Costs associated with providing stockwater have been excluded from the cost estimates below, but are not expected to be significant as the irrigation supply will easily cater for stockwater demand over the irrigation season and the existing on-farm systems, which use creeks, springs, stock water ponds and shallow groundwater, are likely to be sufficient over the winter months. If required, many of the existing irrigation races could potentially be used to provide additional stockwater over winter.

Table 14: New High Race to Matakanui Station boundary cost estimate.

Item	Description	Cost estimate[1]
Capital Cost	Buffer storage	$300,000
	Dunstan intake	$1,789,000
	High Race	$7,162,000
	Greenfields Siphon	$2,400,000
	Manuherikia Siphon	$9,763,000
	Dunstan Siphon	$5,599,000
	Other siphons	$2,895,000
	Main Race structures and crossings	$1,069,000
	Secondary Piped Distribution pipes	$8,444,000
	Distribution structures	$477,000
	Farm Turnouts	$750,000
	Automation and monitoring	$510,000
	Design, Project Management, Consents etc.	$9,158,000
	Uncosted and contingency	$16,561,000.00
Total Capital Costs High Race to Matakanui Station boundary		**$63,880,000**
Total Capital Costs per ha (assuming evenly spread over 14,100 ha)		**$4,500/ha**
Annual Operational Costs	Operation and Maintenance Labour	$120,000
	Race Maintenance	$40,000
	Structure Maintenance	$50,000
	Governance and Administration	$20,000
Total Annual Operational Costs High Race to Matakanui Station boundary		**$230,000**
Total Annual Operational Costs (assuming evenly spread over 14,100 ha)		**$20/ha**

Notes: (1) Estimated costs are exclusive of GST and are rounded to the nearest $1,000, with totals rounded up to nearest $10,000, per ha capital costs rounded up to the nearest $100 and per ha operational costs rounded to the nearest $10.

Table 15: New High Race to Lauder Creek cost estimate.

Item	Description	Cost estimate[1]
Capital Cost	Buffer storage	$300,000
	Dunstan intake	$1,789,000
	High Race	$3,299,000
	Greenfields Siphon	$928,000
	Manuherikia Siphon	$4,037,000
	Dunstan Siphon	$1,095,000
	Other siphons	$1,292,000
	Main Race structures and crossings	$524,000
	Secondary Piped Distribution pipes	$5,213,000
	Distribution structures	$356,000
	Farm Turnouts	$450,000
	Automation and monitoring	$240,000
	Design, Project Management, Consents etc.	$4,686,000
	Uncosted and contingency	$8,473,000
Total Capital Costs High Race to Lauder Creek		**$32,680,000**
Total Capital Costs per ha (assuming evenly spread over 6,500 ha)		**$5,000 ha**
Annual Operational Costs	Operation and Maintenance Labour	$120,000
	Race Maintenance	$40,000
	Structure Maintenance	$50,000
	Governance and Administration	$20,000
Total Annual Operational Costs High Race to Lauder Creek		**$230,000**
Total Annual Operational Costs (assuming evenly spread over 6,500 ha)		**$40/ha**

Notes: (1) Estimated costs are exclusive of GST and are rounded to the nearest $1,000, with totals rounded up to nearest $10,000, per ha capital costs rounded up to the nearest $100 and per ha operational costs rounded to the nearest $10.

Loop Road Intake and Fiddlers Road Race estimated cost comparison

To further assess the benefits of extending the High Race to Falls Dam, rather than commencing it at Loop Road, the estimated cost of an intake at Loop Road was compared to the cost of extending the race up to Falls Dam. A preliminary design and bill of quantities for an intake at Loop Road was prepared (APPENDIX D) and then costed (Table 16). Extending the race up to Falls Dam requires approximately 4.8 km of extra race up Fiddlers Flat Road to the dam and approximately 350 m of pipe to convey the irrigation water from the dam outlet on the left abutment (western) to the start of the race on the river terraces on the right (eastern) side of the Manuherikia River. The pipe would run over the access bridge required during construction of the dam (Golder 2015a). Of the approximately 4.8 km of extra race, 1.2 km is considered to be over difficult terrain and the remaining 3.6 km over gentle terrain. Estimated capital costs for the pipe and the extra race are summarised in Table 16. Operational costs not been estimated, but are likely to be higher for the Loop Road intake, as the intake will require regular inspection and maintenance. A breakdown of the costs estimates is provided in APPENDIX E.

Constructing an intake at Loop Road is a substantial undertaking and a cost comparison indicates that extending the High Race up to Falls Dam is expected to cost less than constructing the Loop Road intake (Table 16).

Table 16: High Race commencing at Falls Dam or Loop Road estimated costs comparison.

Item	Description	Cost estimate(1)
Capital Costs Main Race to Falls Dam	350 m of duel 1.6 m diameter PE pipe.	$1,233,000
	3.6 km of 6m³/s capacity race over gentle terrain.	$315,000
	3.6 km of 6m³/s capacity race over gentle terrain.	$224,000
	Design, Project Management, Consents etc.	$301,000
	Uncosted and contingency	$725,000
Total Capital Costs Main Race to Falls Dam		**$2,800,000**
Capital Costs Intake at Loop Road	River weir	$3,312,000
	Intake structure, gates and flow control	$705,000
	Design, Project Management, Consents etc.	$683,000
	Uncosted and contingency	$1,645,000
Total Capital Costs Intake at Loop Road		**$6,350,000**

Notes: (1) Estimated costs are exclusive of GST and are rounded to the nearest $1,000, with totals rounded up to nearest $10,000 , per ha capital costs rounded to the nearest $100 and per ha operational costs rounded to the nearest $10.

4.7 Hawkdun/Idaburn

4.7.1 Description

The Hawkdun/Idaburn Irrigation Scheme (HIIS) is described in detail in Hamilton 2006 with only a short summary provided below. The scheme spans the Manuherikia and Taieri catchments and has a command area of approximately 23,200 ha, of which approximately 7,400 ha are within the Manuherikia catchment. The HIIS has agreements to supply water to 3,585 ha on 70 properties, although individual irrigators tend to spread their water over a larger area. The scheme is predominantly a run of river scheme, but has three small reservoirs (West Eweburn, Idaburn and Paisley's) and more recently a number of individual irrigators have constructed on-farm storage dams. Most of the scheme water is sourced from the 108 km long Mount Ida Water Race, which traverses the western flanks of the Hawkdun Range, harvesting run of river water from numerous small catchments. The Mount Ida Water Race was originally constructed in the late 1800s for mining purposes and was subsequently enlarged for irrigation. The Hawkdun Idaburn Irrigation Company Limited (HIIC) hold RMA consents to take a combined maximum of 3,498 L/s from 25 catchments, which feed into the Mount Ida Race. The consents were granted by the ORC in 2002 and expire in 2037.

The HIIS has long been recognised as water short and HIIC have been investigating options for obtaining more reliable water for many years. Feasibility assessments (Hamilton 2006, Pickens 2005 and Raineffects 2006) proposed a new dam (Mount Ida Dam) with a 34 m high earth embankment on the upper Ida Burn, near Seagull Hill. The Mount Ida Dam is estimated to store approximately 15.6 Mm^3 of which approximately 14.6 Mm^3 would be potentially useable (Hamilton 2006). The dam *"maximises the storage that can be achieved at the site"* (Hamilton 2006) and would harvest water from its upstream catchment with inflows supplemented by the Mount Ida Race. To improve the dam's ability to refill, enlargement of the current Mount Ida Race from the upper Ida Burn to Hills Creek was proposed. Water balance assessments indicate that 14.6 Mm^3 of usable storage is sufficient to reliably irrigate about 2,000 ha of land in the Oturehua, Wedderburn and White Sow areas (Hamilton 2006 and Aqualinc 2013b). To distribute the irrigation water both a piped and an open race network are being considered.

The proposed Mount Ida Dam is being reassessed by the MCWSG as part of this feasibility assessment. In regard to this distribution assessment the following has been completed for the proposed Mt Ida Dam.

- Technical review of the two water balance assessments (Hamilton 2006 and Aqualinc 2013b) that have been undertaken for the proposed Mount Ida Dam and which assess the ability to refill the dam and to determine the potential area that could be irrigated. The findings of the review were documented in Golder 2014d. The review found that there was uncertainty regarding the functioning of the Mount Ida Race and potential race losses.

- An assessment of the efficiency of the Mount Ida Race from it its start point on Johnstons Creek to the siphon under the Ida Burn upstream of the proposed Mount Ida Dam was undertaken and is documented below.
- Maintenance and upgrade costs for the Mt Ida Race up to the siphon under the Ida Burn have been estimated and are documented below.

Due to concerns regarding the design and potential cost of the proposed Mount Ida Dam potential distribution networks from the dam have not been assessed. The Mount Ida Race the proposed Mt Ida Dam and the potential command area for the proposed dam are shown in Figure 34.

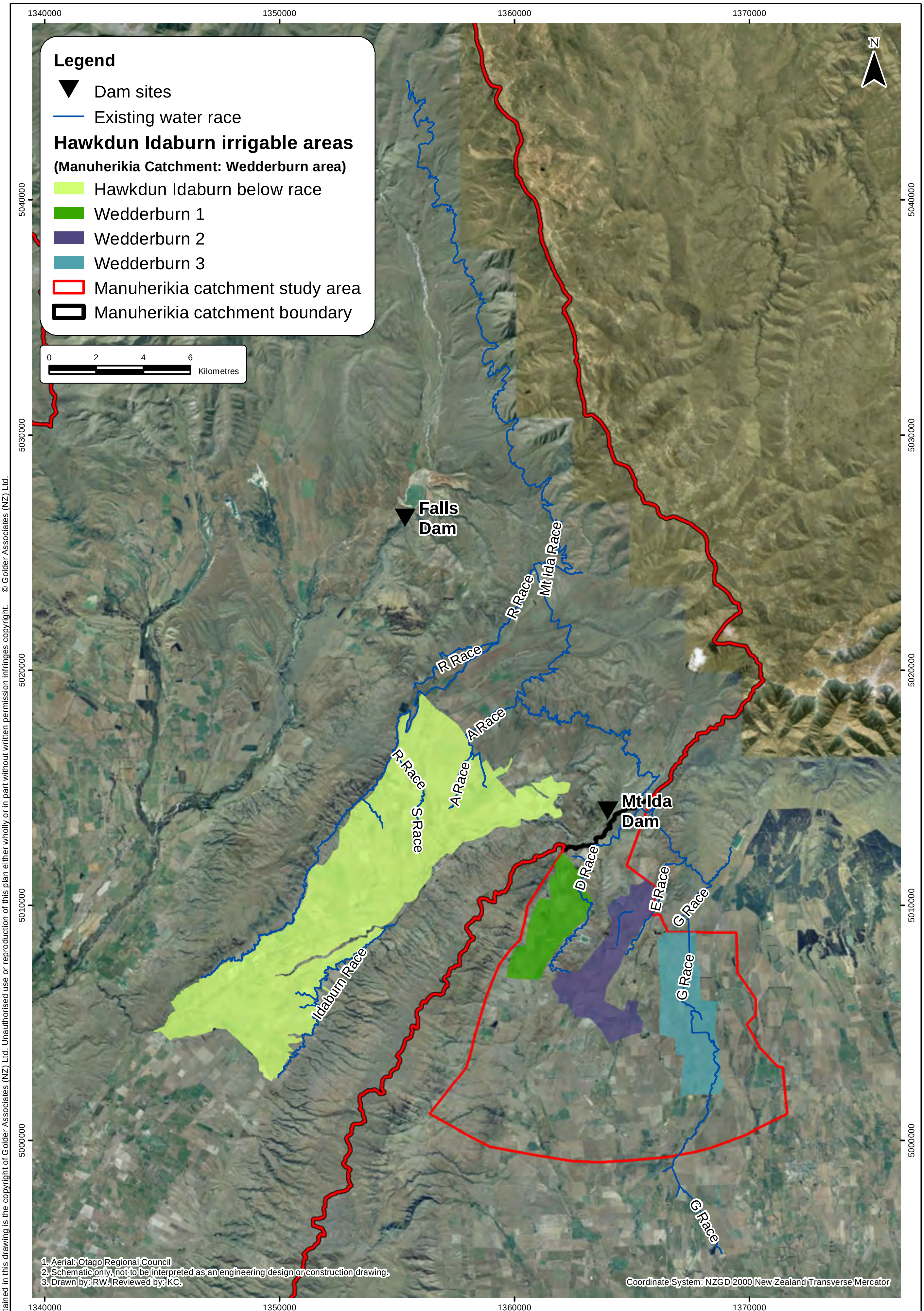
4.7.2 Scheme infrastructure and operation

The Mount Ida Race traverses a fairly high and harsh alpine environment, which experiences intense rainfall events. The Mount Ida Race intercepts overland flow from all up-gradient catchments, unless there is specific infrastructure (e.g., culverts, siphons, pipes, or flumes) that prevents the overland flow entering the race. The various creeks and waterways that either feed into the race or are crossed by the race (either via aquaduct or siphon), experience very large flood events resulting in a need for very robust structures and a high level of maintenance. The race system has experienced a number of events that have caused extensive damage to parts of the race and/or the associated infrastructure. Significant repair and upgrading of the race and infrastructure have occurred during its history, improving the robustness of the overall race system. The race has numerous bywashes along its length to control flow and to prevent overtopping.

While the scheme is old, it has an active maintenance programme that is based on the extensive experience of Aqua Irrigation Limited (particularly John Anderson and Keith Campbell). When structures need replacement or new structures are required, they are built to a very high standard. Essentially the entire race is benched on the downslope side allowing easy access. Overall the scheme is in a fair to good condition and, of the main infrastructure, only Johnstons Creek (top end) intake weir (Figure 35), Kirkwood Creek Siphon (Figure 35), the pipe upstream of Hut Creek (Figure 36) and Scotts Flume (Figure 36) are in need of repair/replacement. Some replacement of the rock rip rap protection is required for a number of the other siphons (Figure 37), although this is unlikely to be a large task, provided suitably sized rock can be sourced locally.

The HIIC has a detailed inventory of the Mount Ida Race which includes photographs of the major infrastructure including all abstraction and discharge points. It is understood that the inventory was created to support consenting of the scheme in 2002. During this study most of the Mount Ida Race between the top end (Johnstons Creek) and the Ida Burn was inspection and the scheme inventory was found to be accurate.

The scheme is run on a roster system with the takes from the various creeks that feed the Mount Ida Race controlled to match demand. The scheme is operated by Aqua Irrigation Limited (particularly Keith Campbell) who have extensive experience with the scheme. Water level sensors are installed on the Johnstone Creek and East Eweburn weirs and continuous flow data from both sites is available since 2007, which has greatly facilitated management and operation of the scheme. The scheme has no other automation and all intakes to and offtakes from the Mount Ida Race are manually controlled. Upstream of the Ida Burn there are two offtakes from the Mount Ida Race, R Race and A Race.



Golder Associates

TITLE HAWKDUN IDABURN IRRIGATION

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Figure 35: Mount Ida Race: Johnstons Creek (top end) intake weir and Kirkwood Creek Siphon.

Figure 36: Mount Ida Race: Hut Creek Pipe, pipe leakage and Scotts Flume.

Figure 37: Mount Ida Race: Healeys Creek Siphon, Hills Creek Siphon and Johnstones flow monitoring weir.

4.7.3 Mount Ida Race distribution efficiency

Sections of the Mount Ida Race upstream of the Ida Burn were inspected on three main occasions (Table 17). Flow gauging to assess race losses and take effectiveness in the section from the top end (Johnstons Creek) to Shepherds Hut Creek and from Hut Creek to Pierces Gorge Creek. The assessed sections and the key findings are shown in Table 17 and Figure 38. Details of the flow gaugings undertaken are provided in APPENDIX C.

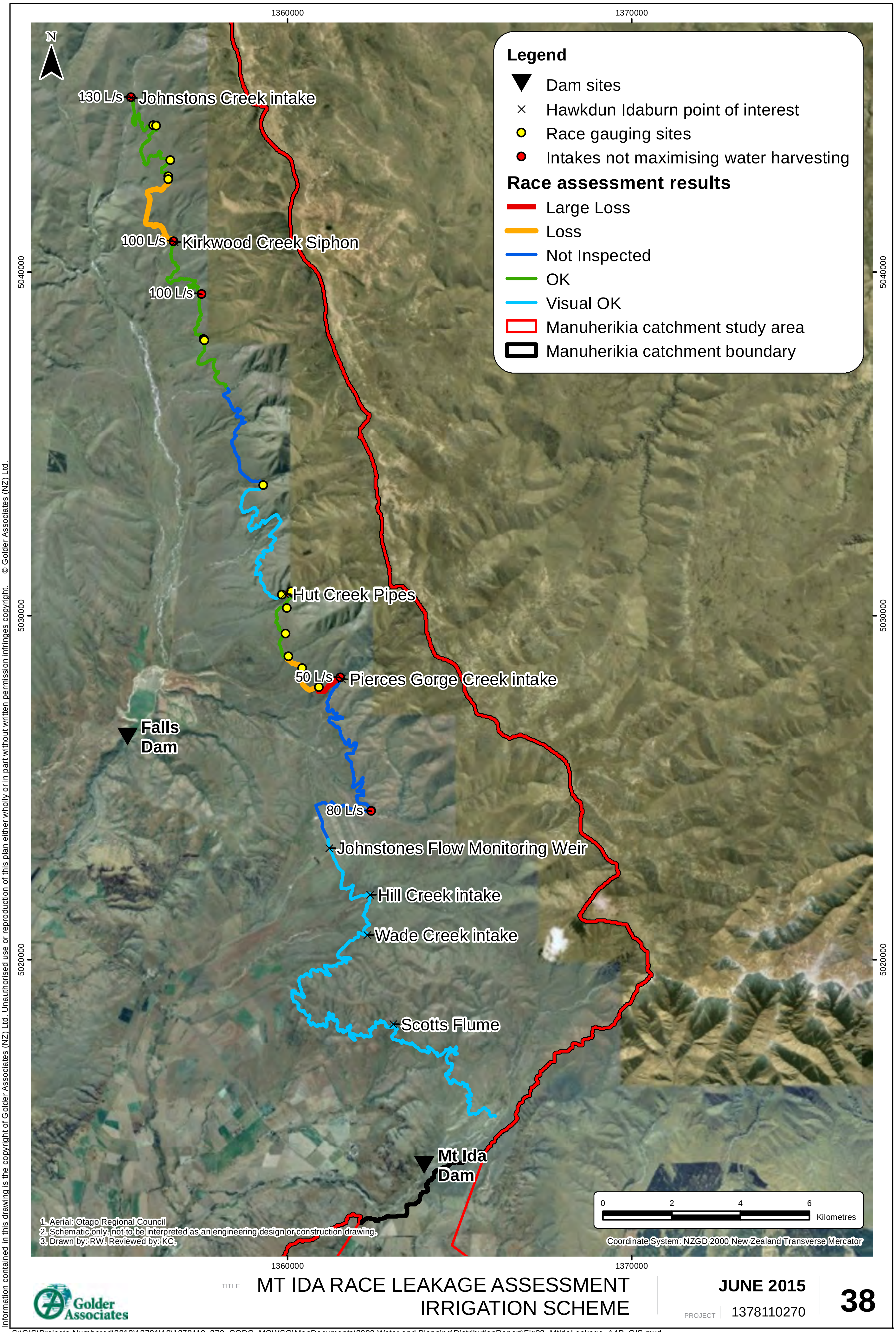
Table 17: Mount Ida Race inspections.

Date	Details	Comments
21 November 2013	Inspection of Mount Ida Race upstream from Ida Burn to Johnsones Weir.	Initial inspection of race with Keith Campbell (Aqua Irrigation Limited) by Ian Lloyd and Jeff Fraser (Golder) and Les Topping (Topping and Associates).
30 January 2014	Flow gauging of Mount Ida Race, upstream from Pierces Gorge Creek to Hut Creek pipe.	Race inspection and flow gauging to assess race losses by Ian Lloyd (Golder).
8 April 2014	Inspection and flow gauging of Mount Ida Race, downstream from top end (Johnstons Creek) to Shepherds Hut Creek and around Hut Creek pipe.	Race inspection with Keith Campbell (Aqua Irrigation Limited) and flow gauging to assess race losses by Sophie South and Ian Lloyd (Golder).
6 May 2014	Flow gauging of Mount Ida Race around Hut Creek pipe.	Flow gauging to assess race losses by Ian Lloyd (Golder).

Given the age of the race, the regular maintenance and upgrades it has received, its relatively small size and the fact that it flow continuously for long periods, extensive race losses were not expected. The race traverses around side slopes for many kilometres and there is generally limited evidence of seepage below the races, indicating there is unlikely to be significant leakage. An exception was the area below Hut Creek pipe where extensive seepage, rushes and green vegetation was observed (Figure 36). There will be sections of the race network that cross particularly porous soils and will be prone to leakage. However, given the age of the race we would expect any particularly leaky section of race to have already been identified and rectified.

Golder's assessment of the Mount Ida Race above the Ida Burn is that it is relatively efficient, with race leakage generally less than 10 %, which is generally considered acceptable for open race networks. Higher leakage rates were identified in short sections of race (Figure 38) and it is expected that there will be other sections of the race network, outside of the monitored areas, where race leakage will be high. The distribution network would benefit from identification and lining of these high leakage sections of race.

The RMA abstraction consents held by HIIC for operation of the scheme require small residual flows (14-28 L/s) to be maintained in five (Johnstons, Manuka, Big German, Pierces Gorge and Johnstones Creeks) of the 25 creeks that the Mount Ida Race harvests water from. In the other 20 catchments there is no residual flow requirement. The creeks can experience periods of very low flow over summer punctuated by large flood events. Creating intakes that are both sensitive enough to harvest the low flows, but are robust enough to handle flood events and prevent excess water entering the race system during flood events, is very difficult. Most of the race is isolated and it is not a simple task to check or adjust the intakes. The creeks at the intake sites are generally very steep with active beds of large boulders. During the site inspections it was observed that most of the intakes were not fully harvesting all of the flow that was both available and authorised to be taken. Gallery type intakes, particularly buried perforated pipes within or adjacent to the riverbed, which are suitably protected against flood flows, may provide a better means of harvesting low flows.



Golder Associates

TITLE MT IDA RACE LEAKAGE ASSESSMENT IRRIGATION SCHEME

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4.7.4 Development scenario

The current HIIS operates effectively at little cost to the irrigators. HIIS has a relatively large consented allocation of 3.498 m^3/s, which at 4.5 mm/day is sufficient to irrigate approximately 6,700 ha. However, poor water supply reliability prevents either expansion of the irrigated area or significant scheme development. The proposed Mount Ida Dam aims to improve supply reliability to at least part of the HIIS. As part of the Mount Ida Dam proposal, enlargement of the current Mount Ida Race from the Hills Creek intake to the upper Ida Burn is required to assist with refilling of the reservoir. Enlarging the race from its current approximately 0.9 m^3/s capacity to a capacity of either 1.5 m^3/s or 2.2 m^3/s has been suggested, as has enlarging the race back to the Pierces Gorge Creek intake.

The principal maintenance requirements of the current Mount Ida Race up to the Ida Burn are outlined below along with recommended minor improvements.

- Repair the damaged intake weir at Johnstons Creek and install perforated piped gallery intake to ensure capture of low flow flows.
- Replace Kirkwood Creek siphon.
- Relay pipe upstream of Hut Creek and replace seals.
- Replace Scotts Flume with a siphon. Note a larger siphon is required if the Mount Ida Dam progresses.
- Install perforated piped gallery intake to ensure capture of low flow flows at the three largest intakes (Johnstones Creek, Big Bremner Creek and Kirkwoods Creek.
- The current scheme has no automation and is controlled manually. Automation of the larger intakes (Johnstones Creek, Big Bremner Creek and Kirkwoods Creek) and the R Race offtake gates would facilitate scheme management.
- Maintenance and upgrading of the race is required in a number of locations to prevent overtopping or reduce leakage. Similarly a number of structures need minor repair.
- Upgrading the turnouts to the individual irrigators and monitoring of water use would facilitate scheme management and water charging and is likely to lead to improvements in on-farm water use.
- Weed clearance: Significant weed growth occurs in the race over summer. Periodic mechanical clearance of weed is required from sections of the race.

The above items represent the status quo for the HIIS. Should the Mount Ida Dam be progressed, the race from at least Hills Creek intake to the upper Ida Burn needs to be expanded. Associated structures such as the intakes from Hills Creek, North Branch Ida Burn, Wade Creek and Pig Gully, bywashes/flow controls at Ida Burn, Dillions Gorge and the above intakes, a larger siphon to replace Scotts Flume, and a small number of stock access culverts/bridges will require enlargement. The enlargement of the race back to Pierces Gorge Creek intake has also been suggested although this would require enlargement and/or modification of a number of additional structures, particularly the piped crossing of Johnstones Creek.

Enlarging the race is relatively straightforward and will involve cutting back the upslope bank to allow widening and slight deepening of the race. Removed material would be side cast, slightly widening the current access bench. Most of the race between Hills Creek and the Ida Burn is through relatively gentle topography although some cutback of steeper slopes and excavation of some small areas of rock will be required. Extensive excavation through solid rock or blasting is not expected. The excavation costs are expected to be time dependant rather than volume dependant and there is expected to be little cost difference between the two suggested enlargement scenarios (0.9 to 1.5 m^3/s, or 0.9 to 2.2 m^3/s). The race is approximately 22.7 km long between the Hills Creek intake and the Ida Burn. Enlarging the race back to Johnstones Creek involves an extra 6.2 km and to Pierces Gorge Creek a further 8.9 km.

The estimated capital cost for maintaining the Mount Ida Race is $1,260,000 with an estimated annual operation cost of $90,000 (Table 18). The estimated capital cost of enlarging the race between the Hills Creek intake and the Ida Burn is $2,290,000. The operating costs exclude both the rest of the HIIS and any on-farm pumping that would be required for spray irrigation. A breakdown of the cost estimate is provided in APPENDIX E.

Table 18: Hawkdun/Idaburn Irrigation Scheme cost estimate.

Item	Description	Cost estimate(1)
Capital costs of maintaining Mt Ida Race above Ida Burn	Automation of intakes/offtakes and increased monitoring.	$120,000
	Race and structure upgrades (particularly Johnstons intake weir, Kirkwood Creek Siphon, Hut Creek Pipes and Scotts Flume)	$627,000
	Design, Project Management, Consents etc.	$179,000
	Uncosted and contingency	$324,000.00
Total Capital Costs Maintain Mt Ida Race		**$ 1,260,000**
Total Capital Costs per ha (assuming evenly spread over 3,585 ha)		**$ 400/ha**
Annual Operational Costs	Operation and Maintenance labour	30,000
	Race cleaning and maintenance of structures particularly intakes	50,000
	Governance and Administration	10,000
Total Annual Operational Costs Maintain Mt Ida Race		**$ 90,000**
Total Annual Operational Costs (assuming evenly spread over 3,585 ha)		**$ 30/ha**
Capital costs of enlarging Mt Ida Race from Hills Creek to Ida Burn	Enlargement of Race (37.8 km)	$869,000
	Larger Siphon at Scotts Flume	$98,000
	Enlargement/modification of intakes and other structures.	$400,000
	Design, Project Management, Consents etc.	$328,000
	Uncosted and contingency	$593,000
Total Capital Costs Enlarge Mt Ida Race		**$ 2,290,000**
Total Capital Costs per ha (assuming evenly spread over 2,000 ha that benefits from proposed Mount Ida Dam)		**$ 1,200/ha**

Notes: (1) Estimated costs are exclusive of GST and are rounded to the nearest $1,000, with totals rounded up to nearest $10,000, per ha capital costs rounded up to the nearest $100 and per ha operational costs rounded to the nearest $10.

Other (uncosted) development opportunities

In addition to reducing leakage losses from the Mount Ida Race and upgrading the various intakes, to ensuring all authorised water is taken, we suggest (as highlighted in Golder 2014f) that the HIIC investigate the following two additional water supply solutions..

1) The potential to harvest water into the Mount Ida Race from additional catchments such as the East Manuherikia River (near its confluence with Camp Creek) and or Mutton Creek should be investigated.

2) Increasing the storage within Falls Dam and pumping part of this extra storage over Home Hills Saddle to supplement flows in R race and inflows into Idaburn Dam.

5.0 CATCHMENT CONSIDERATIONS

The MCWSG feasibility study is focused on five main irrigation development options (Falls Dam, Mount Ida Dam and improved irrigation efficiency) and one preliminary storage option (Hopes Creek Dam). For each of the five main options this distribution assessment has identified various potential distribution scenarios, which are discussed on a scheme by scheme basis in Section 4.0. The irrigation development options and associated distribution networks will have a cross scheme effect. Table 19 briefly summarises the influence the five options will have on irrigation within the Manuherikia River catchment and highlights areas where further investigations are considered warranted.

Irrigation in the catchment is currently characterised by an extensive open race distribution network, which is operated on a roster system and which supplies water to predominantly on-farm flood irrigation. On a catchment level the irrigation is very efficient in terms of both scheme distribution efficiency and catchment water use.

Inspection and monitoring of the open race network has indicated limited race leakage. Race leakage is generally limited and within the 10 % which is considered acceptable for open race based distribution networks. All distribution networks leak to some extent and it is not possible to have zero leakage. Any new races that are constructed (i.e. the proposed High Race) should target a leakage rate of less than 10 %.

Throughout the catchment irrigation water is spread very thinly and often recaptured and reused down gradient, both of which result in water use being very efficient at a catchment level. However, on an individual paddock or farm basis water use efficiency is often poor. The large application depths and infrequent watering associated with flood irrigation leads to significant runoff and deep drainage of irrigation water during irrigation events and the development of large soil moisture deficits between irrigation events, which limit production. Improving irrigation efficiency at a farm or paddock level essentially represents a move from the flood irrigation, which currently dominates, to spray irrigation. However, converting to spray irrigation has significant implications at a scheme and catchment level. Under a spray dominated regime there is significantly reduced potential for runoff and/or deep drainage of irrigation water, limiting the ability to recapture and reuse irrigation water down gradient. Spray irrigation requires water constantly on demand, requiring a shift away from rostered supplies. For larger supply networks the conversion of a few properties to spray can usually be accommodated within a predominantly roster based supply system, particularly if some buffer storage is available. However, as more properties convert to spray and require a continuous supply, there comes a tipping point where schemes have to convert totally to continuous supply, and continued flood irrigation using large flow rates for short periods can only be accommodated through on-farm buffer storage. As such, on-farm conversion to spray irrigation will have significant operational implications for the schemes.

Conversion to spray provides production benefits but is expensive ranging from $2,000/ha to $10,000/ha (Aqualinc 2012e). To justify the conversion costs a reliable water supply is required. The spray conversions that have occurred within the catchment have been on properties with one or more of the following: reliable high priority water rights; a large quota; access to water from scheme storage reservoirs (i.e. Falls Dam) and on-farm buffer storage. Much of the irrigation in the Manuherikia Valley above Ophir and in the Ida Valley suffers from poor water supply reliability. Future irrigation development in this area needs to focus on improving water supply reliability, prior to considering extensive upgrades or improvements to the distribution network. For the lower Manuherikia Valley below Ophir, the hydrological model results indicate that irrigation water supply is sufficiently reliable to justify upgrades or improvements to the distribution network and on-farm conversion to spray irrigation. In this area, upgrading and improvement of the distribution networks should focus on activities that reduce bywash, assist efficient water management and simplify operation of the distribution networks, and encourage on-farm conversion to spray irrigation.

Table 19: Catchment summary of expected distribution scenarios.

Irrigation Scheme(1)	Distribution scenarios	Irrigated area (ha)	Capital Cost ($)	Annual Operational Cost(2) ($)	Reliant on increased storage	Relevant Irrigation development option	Comments(3)
Galloway (GIS)	Pumped Open Race (Status Quo unpressurised supply)	520	410,000 (800/ha)	210,000(4) (390/ha)	No	Status Quo	Current supply reliability is sufficient to support on-farm spray irrigation and distribution development. Given the existing power arrangement, a move to pumped piped supply from the Manuherikia River is supported. If Keddell Road pipe goes ahead as part of MIS developments then investigate the potential of gravity supply from MIS main race. If Hopes Creek Dam goes ahead investigate shifting supply to the Lower Manorburn Dam. Costs exclude consideration of the Lower Manorburn Dam.
	Pumped piped pressurised supply from Manuherikia	550 (potentially more)	1,930,000 (3,500/ha)	160,000(4) (290/ha)	No	4 (Efficient Distribution)	
Manuherikia (MIS)	Open Race (Status Quo)	3,600	3,620,000 (1,000/ha)	230,000 (70/ha)	No	Status Quo	Current supply reliability sufficient to support on-farm spray irrigation and distribution development. Development of a gravity piped supply to Dunstan Flats, Keddell Road, Springvale and Long Gully areas is supported. Investigate the potential to tie the Keddell Road pipeline in with a gravity supply to the GIS. Reduced use of the Borough Race and transfer of the take to the main intake from the Manuherikia River should be investigated as it will simplify scheme operation, reduce maintenance and maximise the area that can be supplied with gravity pressurised water.
	Gravity pipe Dunstan Flats	500	3,150,000 (6,300/ha)	70,000 (140/ha)	No	4 (Efficient Distribution)	
	Gravity pipe Keddell Road, Springvale etc	600	1,420,000 (2,400/ha)	70,000 (120/ha)	No	4 (Efficient Distribution)	
Blackstone (BIS)	Open Race (Status Quo unpressurised supply)	660	410,000 (600/ha)	70,000 (110ha)	No	Status Quo & 2 (Falls Dam low raise)	Current supply reliability is relatively poor which will limit development of spray irrigation to the area with secure peak of season water supply. Falls Dam High, Mid and Low raises increase supply reliability allowing increased spray irrigation. A gravity piped supply is possible but expensive. Focus development on-farm initially then on improving supply reliability.
	Gravity pressurised pipe supply from new High Race	1,200 (potentially more)	6,480,000 (5,400/ha)	50,000 (40/ha)	Yes	1 and 3 (Falls Dam mid and high raise)	
Omakau (OIS)	Main Race status quo (unpressurised supply)	3,759	3,830,000 (1,000/ha)	160,000 (40/ha)	No	Status Quo & 2 (Falls Dam low raise)	Current supply reliability is relatively poor (particularly for the Lauder, Matakanui and County parts of the OIS) which will limit development of spray irrigation to the area with secure peak of season water supply. Development of spray irrigation on-farm only for areas with secure peak of season water supply. Falls Dam High, Mid and Low raises increase supply reliability allowing increased spray irrigation. A gravity piped supply to the Becks Flat area from the Blackstone Race is possible and should be investigated further. Focus development on-farm initially then on improving supply reliability. Investigate potential to supply Matakanui extension area from expanded OIS main race.
	Dunstan, Lauder, Matakanui and County status quo (unpressurised supply)	2,083	2,320,000 (1,100/ha)	280,000 (130/ha)	No	Status Quo	
	Main Race expanded capacity (unpressurised supply)	6,000(5)	10,670,000 (1,800/ha)	160,000 (30/ha)	Yes	1 and 3 (Falls Dam mid and high raise)	
	Gravity pipe to Becks Flats	600	2,790,000 (4,700/ha)	10,000 (20/ha)	No	Status Quo	
High Race	High Race to Matakanui Station Boundary piped secondary distribution.	14,100(5) (~ 8,000(5) pressurised supply)	63,880,000 (4,500/ha)	230,000 (20/ha)	Yes	1 (Falls Dam high raise)	High race associated with Falls Dam Mid and High raises, would increase supply reliability allowing increased spray irrigation. Falls Dam High raise allows High Race to replace all irrigation from Dunstan, Lauder, Thomsons Creeks and associated tributaries. Falls Dam Mid raise allows High Race to replace all irrigation from Dunstan Creek and suppliants current takes from Lauder Creek. There is a large potential for gravity pressurised supply and development should focus on these areas. Focusing development closer to Falls Dam will reduce distribution costs.
	High Race to Lauder Creek piped secondary distribution.	6,500(5) (~ 4,000(5) pressurised supply)	32,680,000 (5,000/ha)	230,000 (40/ha)	Yes	3 (Falls Dam mid raise)	
Hawkdun Idaburn (HIIC)	Upgrade Mt Ida Race, gravity unpressurised supply	3,585	1,260,000 (400/ha)	90,000 (30/ha)	No	Status Quo	Current supply reliability very poor. Development of spray irrigation on-farm only for areas with secure peak of season water supply. There is potential to increase water harvesting by the Mt Ida Race through reducing leakage, upgrading intakes and potentially harvesting from additional sub-catchments, all of which should be investigated further. The proposed Mt Ida Dam improves supply reliability allowing increased spray irrigation. With Falls Dam High Raise the potential to pump over Home Hills Saddle to suppliant R race should be investigated.
	Expand Mt Ida Race	2,000	2,290,000 (1,200/ha)	Included in above	Yes	5 (Mt Ida Dam)	
Private irrigators	Development focused on-farm	Total area unknown	n/a	n/a	No	Status Quo	For irrigators who take from the Manuherikia River, current supply reliability is sufficient to support conversion to spray irrigation. For many of the irrigators who take from the tributaries current supply reliability is relatively poor and on-farm development of spray irrigation will be limited to those areas with secure water supply during the peak of the irrigation season.

Notes: (1) The Ida Valley Irrigation Scheme (IVIS) was not assessed as it is not influenced by any of the 5 development options covered by the Feasibility Study.
(2) Unless stated annual operational costs exclude any scheme or on farm pumping.
(3) Supply reliability comments are based on hydrological model results (Aqualinc 2012f, 2013a and 2014).
(4) Operational costs for the Galloway scenarios include scheme pumping.
(5) Area is indicative only and based on assessment of current areas irrigated and potential increases suggested by the hydrological model results (Aqualinc 2012f, 2013a and 2014).

Shaded scenarios represent either full (dark grey) or partial (light grey) provision of pressurised (>30 m pressure) water to the farm gate. Unshaded scenarios require on-farm pumping for spray irrigation.

The six main irrigation schemes in the catchment (Omakau, Blackstone, Hawkdun/Idaburn, Ida Valley, Manuherikia and Galloway) and the numerous private irrigators with rights to abstract water for irrigation purposes tend to operate in a somewhat independent and isolated manner. The Falls Dam Company and the priority associated with the various abstraction consents ensure a degree of co-operation. Irrigation development within the catchment will require a high level of co-operation and interactive management to ensure the optimum water supply and distribution solutions are identified and progressed. Similarly, re-consenting of the existing irrigation activities when the deemed permits expire in 2021, is likely to be facilitated if a catchment wide approach is adopted.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The MCWSG feasibility assessment is focused on five options, and for each development option this distribution assessment has identified various potential distribution scenarios. The size, location and complexity of an irrigation distribution network are dependent on the irrigators who join the scheme and where the water is required. There is limited information regarding potential irrigator demand or commitment, and as such the distribution networks contained in this report are conceptual and are aimed at providing an indication of the potential, size, extent and location of the networks to assist with preliminary cost estimation.

The benefits of gravity pressurised water supplies are significant and were summarised in the prefeasibility study as:

> *Water delivered under pressure in pipes is the preferred method. The value of the pressure through not having to install and operate pumps is currently equivalent to about $2,000 worth of capital expenditure/ha for a typical irrigation system.* (Aqualinc, 2012e).

Because of these benefits a key design principle used to develop the conceptual distribution networks outlined in this report was to provide gravity pressurised pipe water supply wherever possible in order to: simplify scheme operation and management, facilitate the conversion to spray irrigation and eliminate or reduce scheme or on-farm pumping.

Future irrigation development in the Manuherikia catchment (particularly in the Manuherikia Valley above Ophir and in the Ida Valley) needs to focus on improving water supply reliability and on-farm performance, prior to considering extensive upgrades or improvements to the distribution network. Improving supply reliability relies on increased water harvesting and storage. Improving on-farm performance essentially means converting from the flood irrigation that currently dominates to spray irrigation. As highlighted in the prefeasibility assessments there are limited opportunities for increasing storage (Falls Dam, Mount Ida Dam and Hopes Creek Dam) within the catchment. There is considerably more flexibility in potential distribution scenarios, as well as the ability to stagger distribution development. There is considerable existing distribution infrastructure throughout the catchment (namely the extensive open race network) that is not fully utilised during the peak of the irrigation season due to insufficient water supply. Distribution scenarios that focus on improving supply reliability, to ensure that the existing distribution infrastructure is fully utilised at the peak of the irrigation season, and improving on-farm performance (through increased spray irrigation), will significantly improve irrigation performance and is likely to have limited distribution cost implications. Longer term distribution upgrades should focus on providing gravity pressurised piped water supply where possible. The proposed High Race alignment shown in Figure 32 maximises the area that can potentially be supplied with pressurised water (Figure 33).

In assessing the various irrigation development scenarios, current and potential irrigators need to consider the development as a whole, including: storage, distribution, on-farm development, water management and scheme operation. The various distribution scenarios outlined in this report provide differing levels of service, particularly in regard to the provision of pressurised versus non-pressurised water. In comparing the various distribution scenarios we recommend the full life of asset costs be the principal means of comparison.

Following selection of the preferred scheme, particularly the preferred water storage details, further design work is required to optimise the distribution networks and confirm estimated distribution costs. This work would include: confirmation of supply areas and design flows, detailed hydraulic design of key infrastructure (particularly the siphons and intakes) and alignment walkovers (particularly for the proposed High Race alignment through the Drybread Diggings).

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APPENDIX A

Report Limitations

Report Limitations

This Report/Document has been provided by Golder Associates (NZ) Limited ("Golder") subject to the following limitations:

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APPENDIX B

Case Study Farms – Conceptual Irrigation Layouts

1. Aerial: Otago Regional Council.
2. Schematic only, not to be interpreted as an engineering design or construction drawing.
3. Drawn by: NP, Reviewed by: RW.

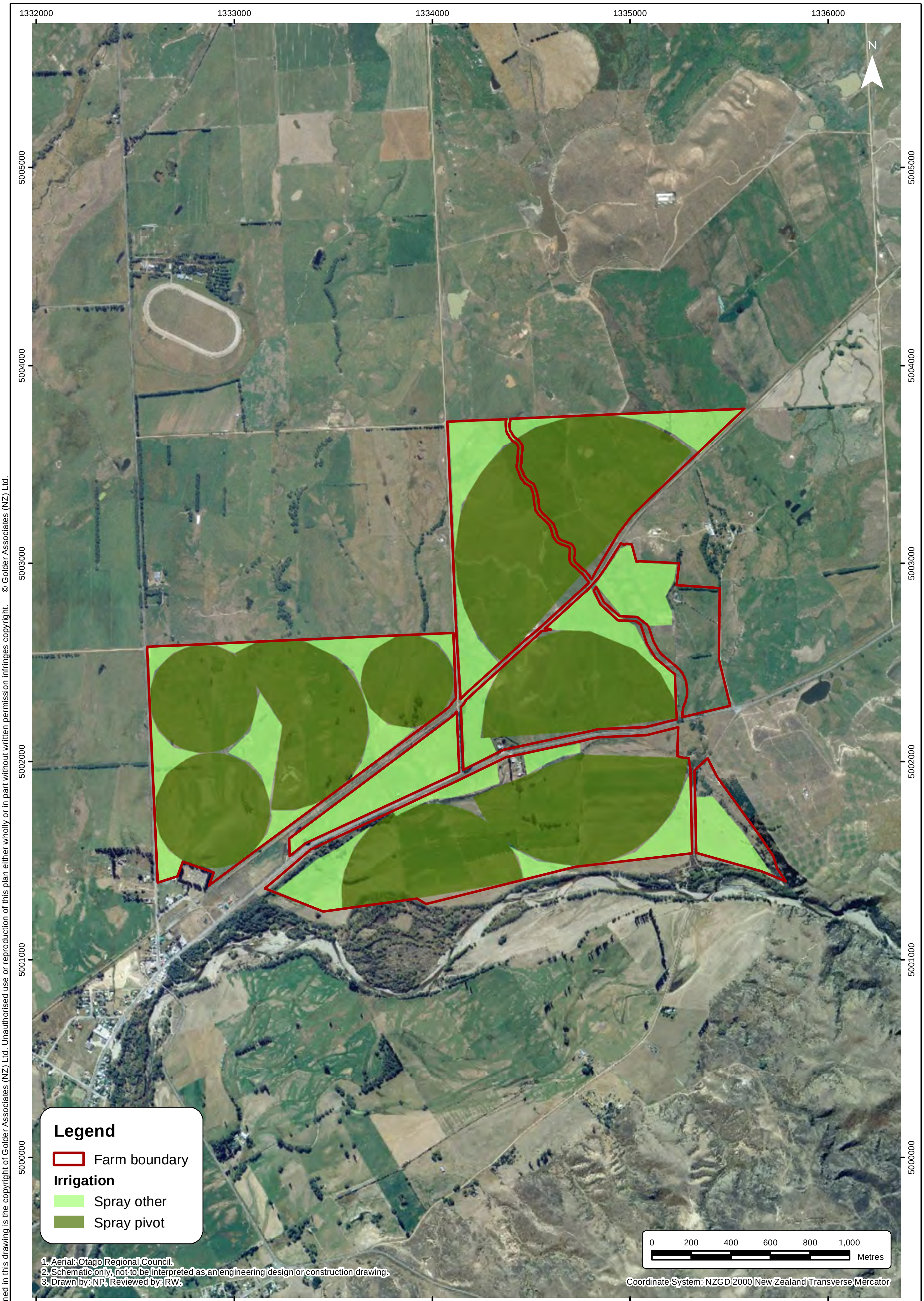
Golder Associates

TITLE CASE STUDY FARM
HAWKDUN - FUTURE IRRIGATION

JUNE 2015

PROJECT 1378110270

B1



Golder Associates

TITLE
CASE STUDY FARM
OMAKAU DAIRY - FUTURE IRRIGATION

JUNE 2015

PROJECT 1378110270

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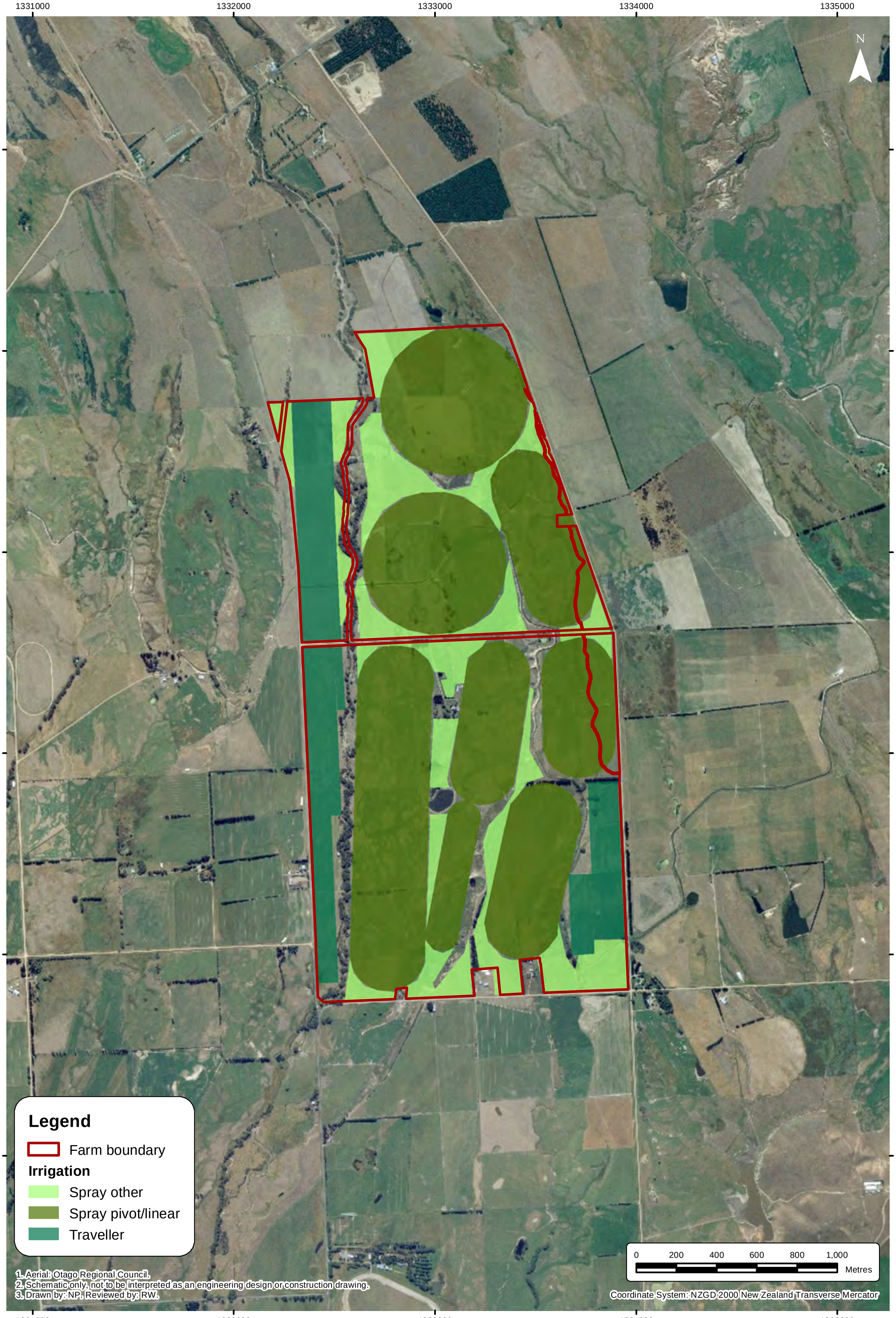

1. Aerial: Otago Regional Council.
2. Schematic only, not to be interpreted as an engineering design or construction drawing.
3. Drawn by: NP. Reviewed by: RW.

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TITLE CASE STUDY FARM
OMAKAU MAWHINNEY - FUTURE IRRIGATION

JUNE 2015

PROJECT 1378110270

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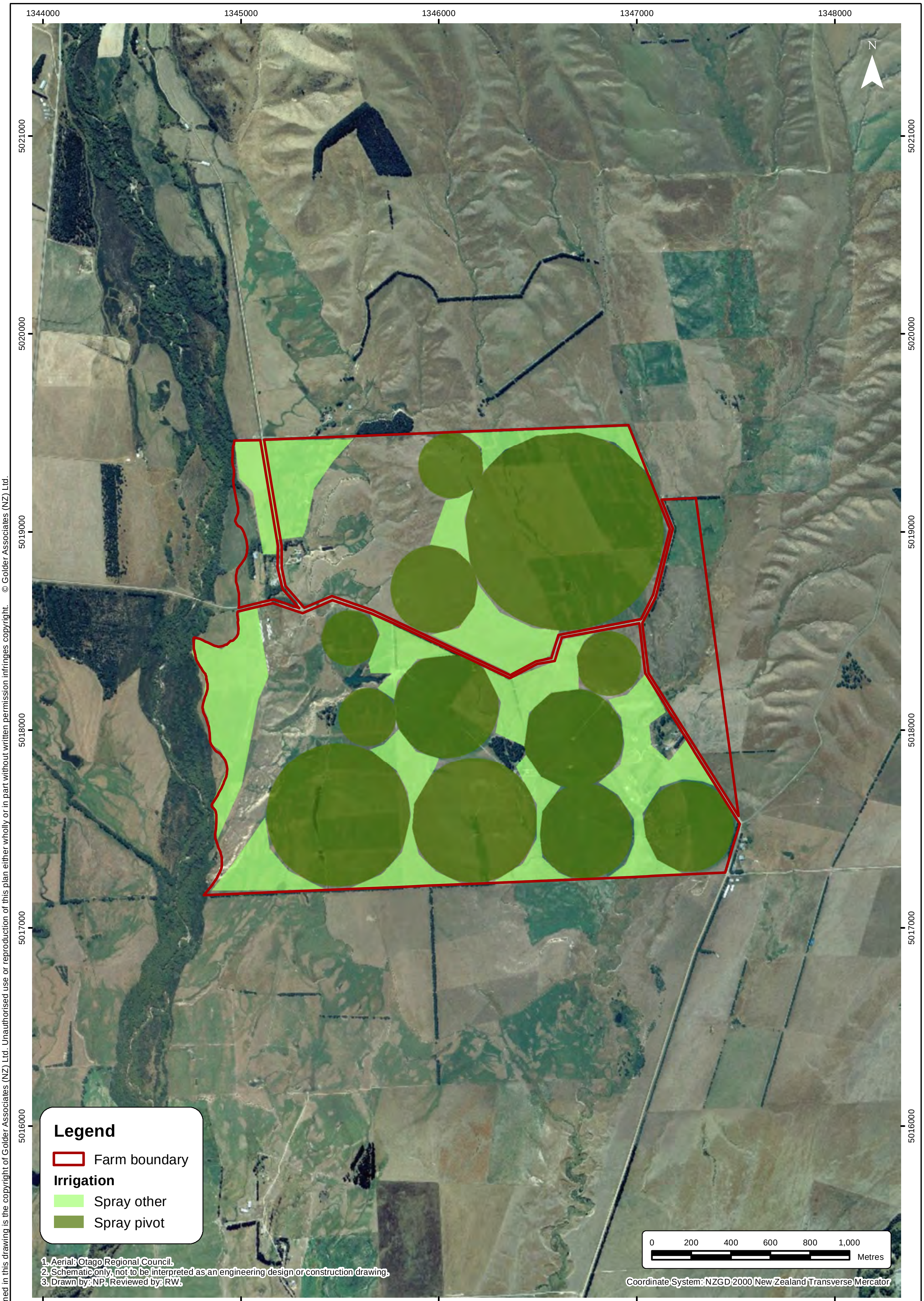

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TITLE CASE STUDY FARM DOWNS - FUTURE IRRIGATION

JUNE 2015

PROJECT 1378110270

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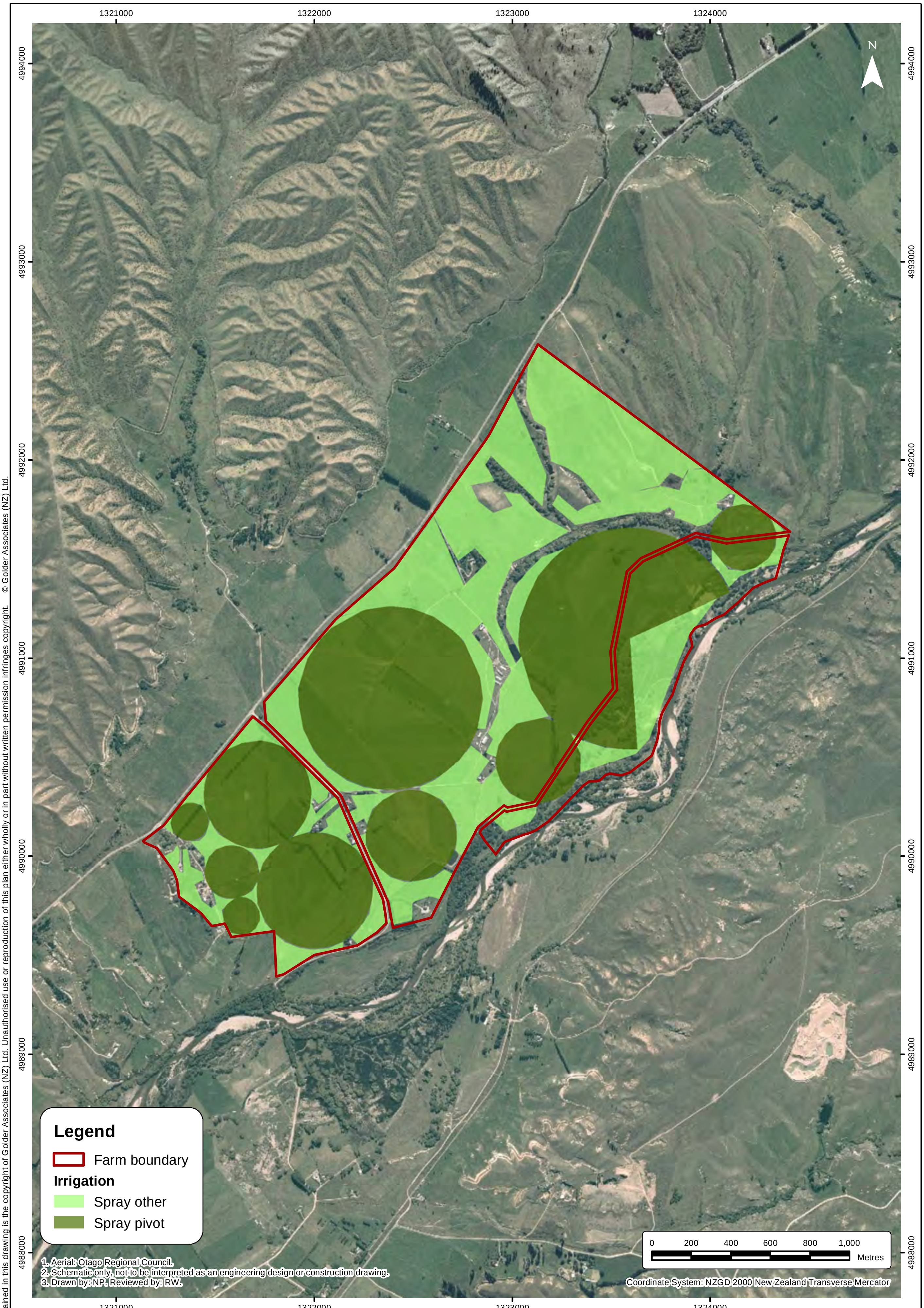

Golder Associates

TITLE CASE STUDY FARM
KEDDEL ROAD - FUTURE IRRIGATION

JUNE 2015

PROJECT 1378110270

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APPENDIX C
Flow Gauging Details

Race leakage assessment methodology:

Assessment of race leakage and distribution efficiency was completed through the following two stage process:

1) Stage 1 – Initial investigations. Initial discussions were held with the relevant race operators. This was followed by a general inspection of the races with the race operators. Race operators were asked to identify relevant sections of race for subsequent flow monitoring.

2) Stage 2 – Flow monitoring. A series of concurrent flow gaugings were undertaken on the identified sections of race. A Sontek FlowTracker was the primary flow measurement device, which operates using the Acoustic Doppler Velocimeter (ADV) technology. Additional and supplementary gaugings were performed using a small Ott current propeller meter.

   Standard flow monitoring field techniques were utilised as outlined in NIWA (1994). Concurrent gaugings were generally conducted in a downstream direction during stable flow conditions and when discharges to or takes from the races were known and recorded. The 0.6 depth method was used with sufficient verticals measured to ensure that no more than 10 % of the flow occurred between successive verticals. Gauged flows were compared to assess race gains and losses.

Many of the races have flow control and hydraulic structures (i.e., irrigation boxes or weirs) that allow race operators to assess flow. Flow over standard hydraulic structures is well understood having been tested in numerous hydraulic testing facilities. Provided standard hydraulic structure designs are used and the structures are appropriately installed and maintained, they provide an accurate means of assessing flow. Most of the structures (particularly the irrigation boxes, weirs and flow control structures) within the open race distribution network were constructed by either the MWD or Aqua Irrigation Limited and are standard robust structures whose flow characteristics are well understood. Where possible, the concurrent gaugings were compared to flow estimated from neighbouring hydraulic structures.

Table C.1: Manuherikia catchment Flow Gaugings

Scheme	Race	Site	Date	Flow (L/s)	Mean velocity (m/s)	Maximum velocity (m/s)	Width (m)	Maximum depth (m)	Comments
Lower Manuherikia	Main Race	MR1	6/4/2014	1,323	0.464	0.557	4.95	0.79	
		MR2	6/4/2014	1,370	0.498	0.624	4.95	0.76	
		MR3	6/4/2014	1,149	0.499	0.641	4.85	0.65	
		MR4	6/4/2014	1,099	0.291	0.379	5.00	0.96	
		MR5	6/4/2014	1,077	0.489	0.647	4.25	0.66	
		MR6	6/4/2014	968	0.321	0.470	4.60	0.83	
		MR7	6/4/2014	960	0.598	0.682	2.10	0.82	Uniform flat-bottomed channel
	Borough Race	BOR1	7/4/2014	111	0.206	0.351	2.20	0.32	
		BOR2	7/4/2014	109	0.221	0.371	2.40	0.26	
		BOR3	7/4/2014	82	0.085	0.192	2.00	0.61	
	Keddell Road Distribution Race	KEL T	6/4/2014	127	0.460	0.638	1.25	0.26	
		KEL B	6/4/2014	116	0.470	0.532	0.63	0.40	
	M-N Distribution Race	LET T	6/4/2014	68	0.148	0.224	1.90	0.32	
		MN BENNIE	7/4/2014	52	0.080	0.116	1.90	0.40	
	F-K Distribution Race	FK T	6/4/2014	80	0.149	0.195	2.80	0.27	
		FK M	6/4/2014	79	0.282	0.366	1.21	0.24	
Blackstone	Blackstone	BLACK1	9/4/2014	204	0.417	0.634	2.10	0.33	
		BLACK2	9/4/2014	216	0.198	0.325	2.40	0.57	

Scheme	Race	Site	Date	Flow (L/s)	Mean velocity (m/s)	Maximum velocity (m/s)	Width (m)	Maximum depth (m)	Comments
Mt Ida	Mt Ida Race	MR1	8/4/2014	86	0.216	0.399	1.80	0.30	Johnston's Creek. Approximately 133 L/s not captured.
		MR2	8/4/2014	104	0.172	0.256	2.20	0.44	
		MR3	8/4/2014	181	0.367	0.442	1.45	0.34	
		MR4	8/4/2014	215	0.399	0.574	2.00	0.34	
		MR5	8/4/2014	248	0.317	0.464	2.65	0.37	
		MR6	8/4/2014	309	0.527	0.827	1.80	0.48	
		MR7	8/4/2014	221	0.308	0.676	1.60	0.56	
		MR8	8/4/2014	404	0.564	0.721	2.40	0.38	
		MR10	8/4/2014	419	0.637	0.755	2.30	0.42	
		MR9 ILPIP	8/4/2014	417	0.559	0.723	2.30	0.42	
		HUTUP	6/5/2014	532	0.556	0.626	2.40	0.54	
		HUTDOWN2	6/5/2014	456	0.515	0.710	2.40	0.50	
Omakau	Omakau Main Race	OMR1	9/4/2014	1,283	0.705	0.869	4.50	0.45	
		OMR2	9/4/2014	1,141	0.728	0.853	4.30	0.48	
		OMR3	9/4/2014	1,276	0.947	1.095	4.40	0.36	
		OMR4	9/4/2014	1,188	0.553	0.640	4.80	0.70	
		OMR5	9/4/2014	1,164	0.674	0.813	4.65	0.48	
	E Race	E1	9/4/2014	111	0.434	0.562	1.50	0.20	
		E2	9/4/2014	94	0.559	0.664	1.00	0.21	
	Lauder Main Race	LAD1	9/4/2014	128	0.384	0.522	1.40	0.27	
		LAD2	9/4/2014	115	0.369	0.551	1.60	0.22	
		LAD3	9/4/2014	102	0.425	0.661	1.10	0.32	

APPENDIX D

Distribution network design plans and details for cost estimation.

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CONSULTANT
Golder Associates

PROJECT
MANUHERIKIA CATCHMENT FEASIBILITY STUDY

TITLE
IRRIGATION WATER DISTRIBUTION
RIVER INTAKE LOCATION

PROJECT No.	Rev.	FIGURE
1378110270	A	1

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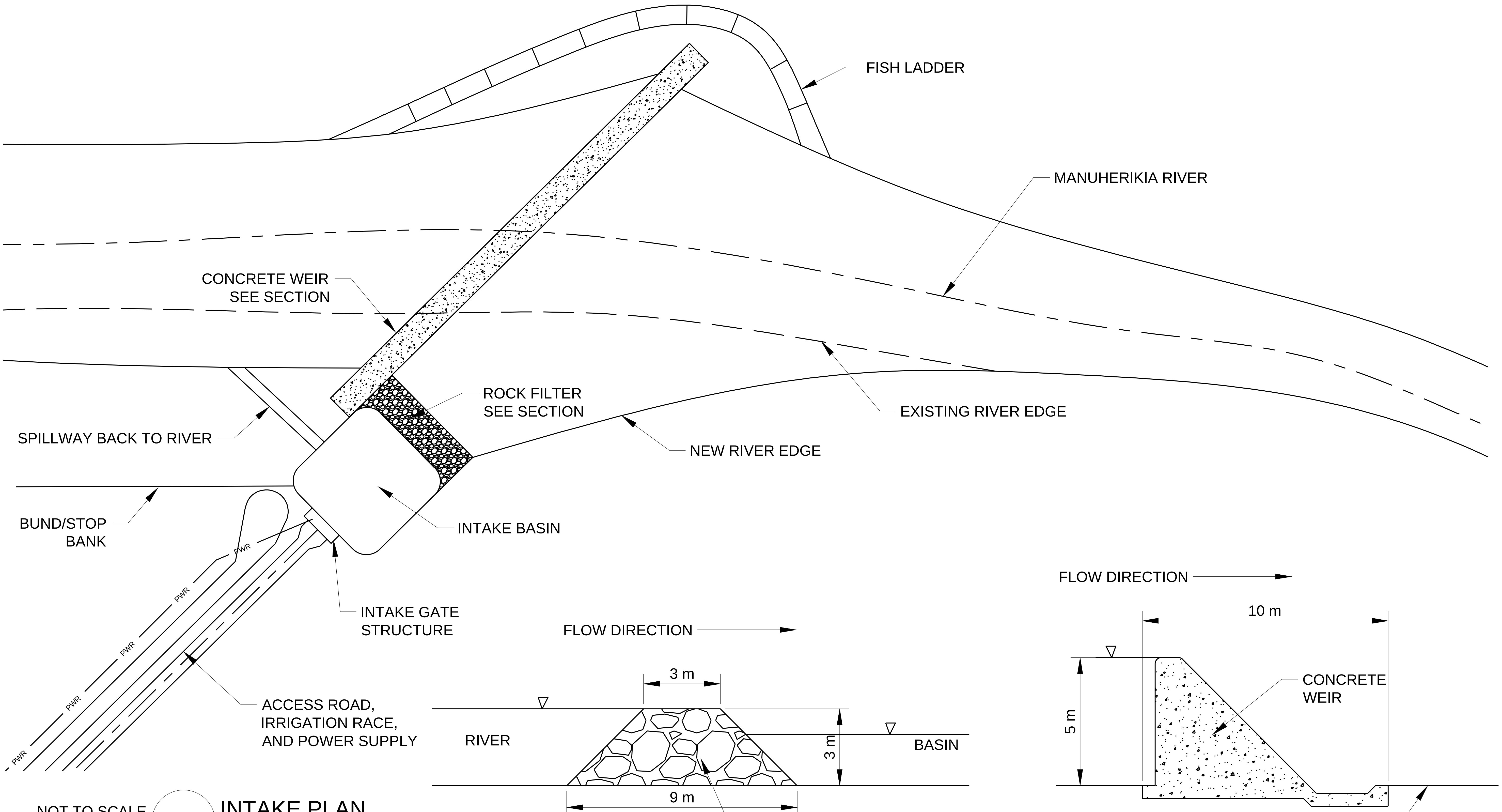

NOT TO SCALE A INTAKE PLAN

NOT TO SCALE B TYPICAL SECTIONS

NOTES:
1. ALL DIMENSIONS AND QUANTITIES ARE APPROXIMATE AND ARE SOLELY INTENDED FOR INDICATIVE COSTING.

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MANUHERIKIA CATCHMENT WATER STRATEGY GROUP

PROJECT
MANUHERIKIA CATCHMENT FEASIBILITY STUDY

CONSULTANT
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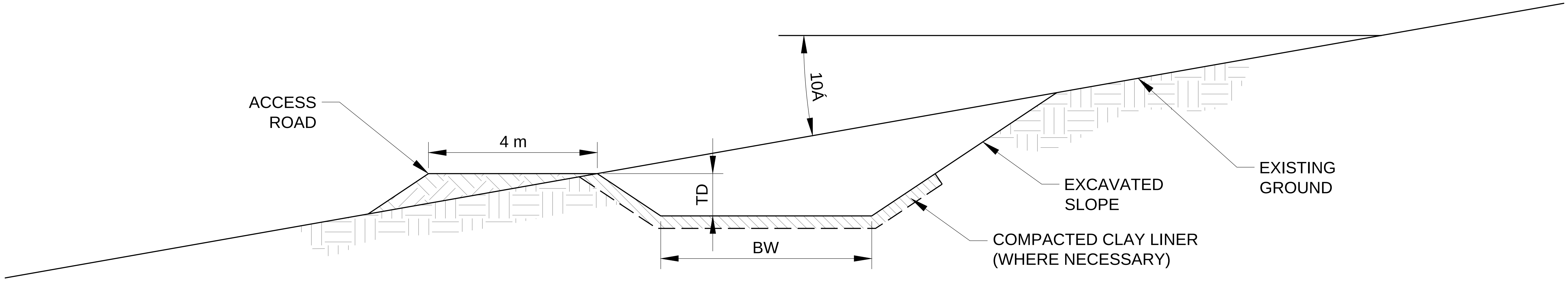
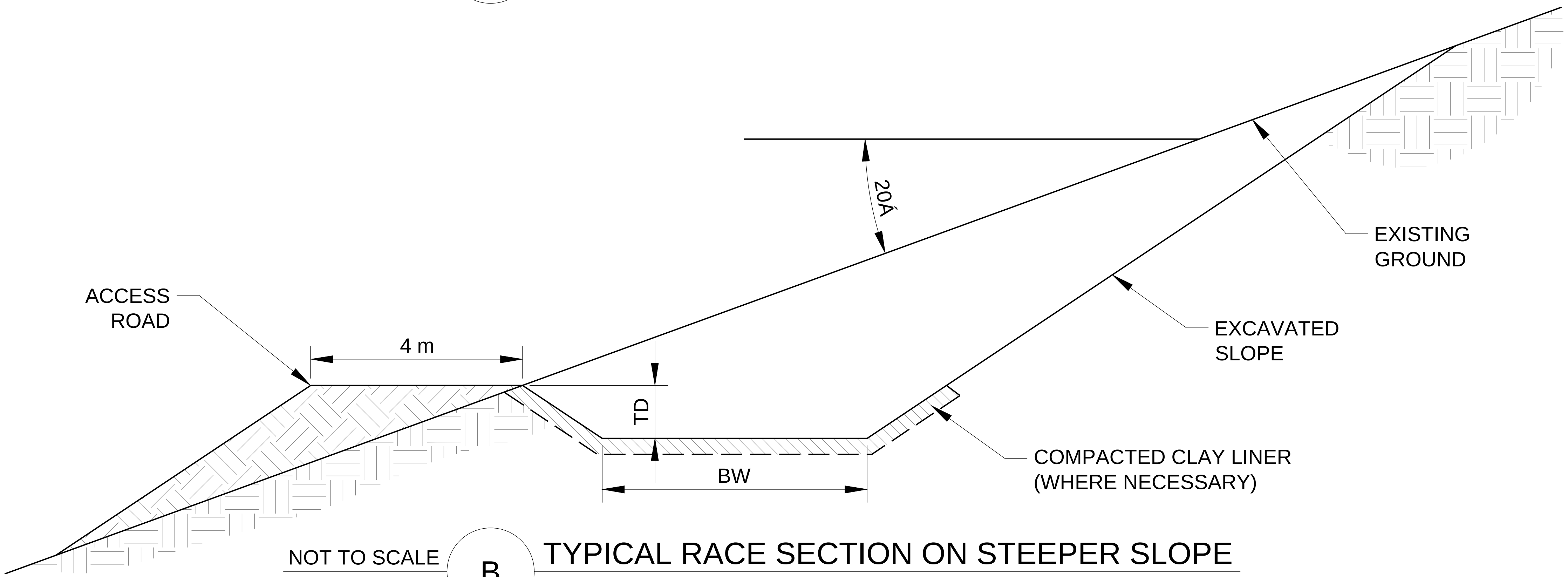
TITLE
IRRIGATION WATER DISTRIBUTION
RIVER INTAKE PLAN

PROJECT No.	Rev.	FIGURE
1378110270	A	2



NOT TO SCALE **A** TYPICAL RACE SECTION ON FLATTER SLOPE



NOT TO SCALE **B** TYPICAL RACE SECTION ON STEEPER SLOPE

SCHEDULE OF TYPICAL RACE SECTIONS

TYPE	BOTTOM WIDTH, BW (m)	TOTAL DEPTH, TD (m)	CROSS SECTIONAL AREA ON FLATTER SLOPE (m2)	CROSS SECTIONAL AREA ON STEEPER SLOPE (m2)
1	5.0	1.3	19	41
2	4.0	1.1	13	28
3	4.0	1.4	17	36
4	3.0	1.2	11	23
5	2.5	1.0	8	16
6	2.0	0.9	6	12

NOTES:
1. ALL CUT SLOPES ARE 1.5H:1V.
2. EXCAVATED MATERIAL TO BE SIDECAST AND COMPACTED TO CREATE 4m WIDE ACCESS ROAD.
3. ALL DIMENSIONS AND QUANTITIES ARE APPROXIMATE AND ARE SOLELY INTENDED FOR INDICATIVE COSTING.

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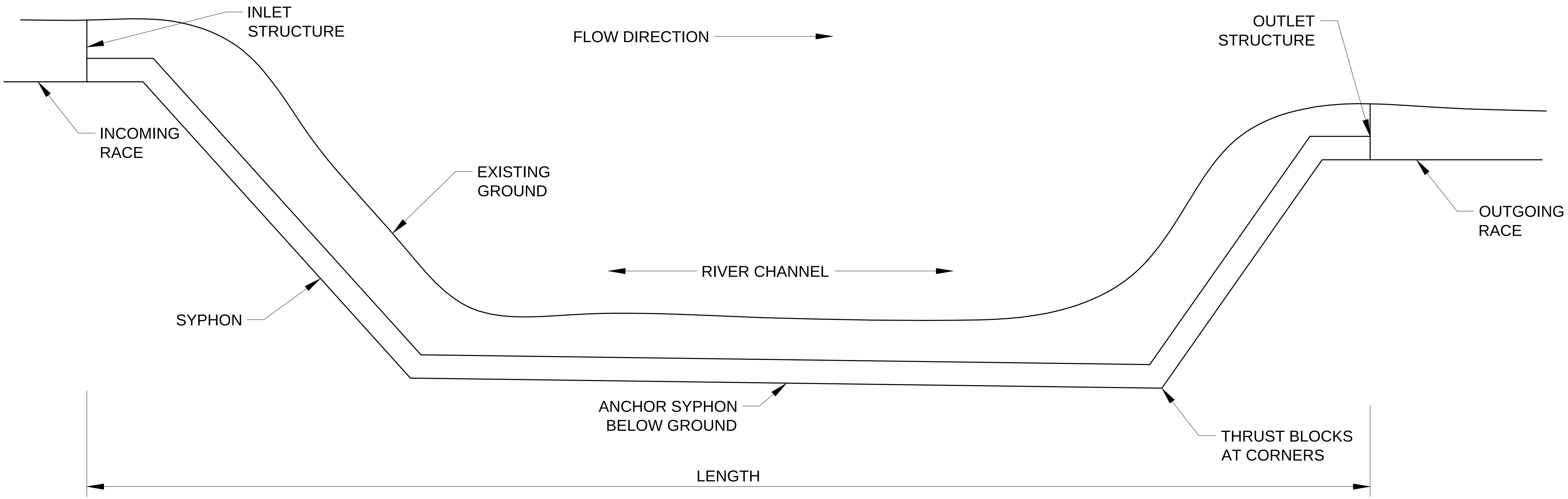
MANUHERIKIA CATCHMENT WATER STRATEGY GROUP

PROJECT
MANUHERIKIA CATCHMENT FEASIBILITY STUDY

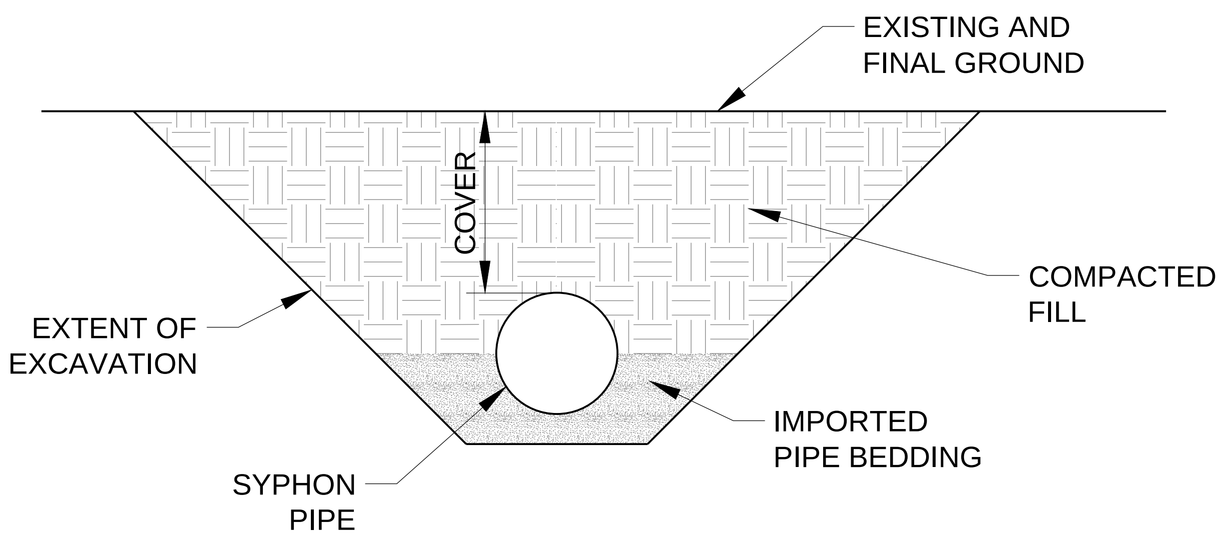
CONSULTANT
Golder Associates

TITLE
DISTRIBUTION DESIGN
TYPICAL IRRIGATION RACE SECTIONS

PROJECT No. 1378110270 | Rev. A | FIGURE 3



NOT TO SCALE A TYPICAL SYPHON PROFILE



NOT TO SCALE B TYPICAL SYPHON INSTALL

SCHEDULE OF SYPHONS				
TYPE	FLOW (m3/s)	LENGTH (m)	DIAMETER (m)	PRESSURE CLASS
LONG	6.0	3500	2.2	PN9
LONG	2.0	3500	1.4	PN9
MEDIUM	4.0	1300	1.8	PN6
MEDIUM	1.0	1300	1.0	PN6
SHORT	0.5	500	0.6	PN3

NOTES:
1. ALL DIMENSIONS AND QUANTITIES ARE APPROXIMATE AND ARE SOLELY INTENDED FOR INDICATIVE COSTING.

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CLIENT
MANUHERIKIA CATCHMENT WATER STRATEGY GROUP

PROJECT
MANUHERIKIA CATCHMENT FEASIBILITY STUDY

CONSULTANT
Golder Associates

TITLE
IRRIGATION WATER DISTRIBUTION
SYPHON CONCEPT DESIGN

PROJECT No. 1378110270
Rev. A
FIGURE 4

APPENDIX E

Distribution networks cost estimation breakdown tables.

MANUHERIKIA CATCHMENT FEASIBILITY STUDY
IRRIGATION WATER DISTRIBUTION UNIT COST TABLE

Item No.	Description	Unit	Unit Rate	Comments	Assumptions	Estimate Source
1	**Project Management**	**Unit**	**Unit Rate**	**Comments**	**Assumptions**	**Estimate Source**
1.1	Construction Management	%	7%	Percent of BCS		Golder / Topping & Associates
1.2	Engineering and Design	%	10%	Percent of BCS		Golder / Topping & Associates
2	**Consents and Permits**	**Unit**	**Unit Rate**	**Comments**	**Assumptions**	**Estimate Source**
2.1	Consenting	%	2%	Percent of BCS		Golder / Topping & Associates
2.2	Bonds and Insurance	%	5%	Percent of BCS		Golder / Topping & Associates
3	**New 6m^3/s Intake**	**Unit**	**Unit Rate**	**Comments**	**Assumptions**	**Estimate Source**
3.1	Power Supply	m	$ 175	Three phase power to the site via overhead power lines.	Run communication wiring alongside (if not via radio).Assume 11kV overhead and stepdown transformer to 400V and 240 V ($100/mx800=$80k+ tran LS $60k= $140k/800=$175/m	Topping & Associates
3.2	Site Preparation	ha	$ 8,000	Clearing and grubbing, survey, erosion and sediment controls, etc. on river bank	Allow 2 days with small excavator, 20hrs @$200=$4000+survey LS=$4,000	Topping & Associates
3.3	Intake Gate Structure	ea	$ 165,000	Construct 10m long x 4m wide x 10m tall reinforced cast-in-place concrete structure. Lower wet well allows water flow and houses gates. Shafts extend into upper level that houses motors, and electrical gear, providing human access.	110m^3 reinforced concrete @ $1500/$m^3$=$165000 excluding mechanical and electrical works	Topping & Associates
3.4	Gates	ea	$ 65,000	Supply and install automated, electric motor-driven vertical gates. 3m high x 2m wide.	Allow 3000kg per gate @$15000/t=$45000 ea+ram+motor$20,000	Topping & Associates
3.5	Electrical Equipment	LS	$ 50,000	Supply and install 480V MCC with starter buckets to drive gates, PLC for control, remote monitoring gear, low voltage equipment for lights, outlets, etc.	Allow PS = $50,000	Golder / Topping & Associates
3.6	Security Fence	LS	$ 6,000	With gate for site security around intake structure	Allow 50lm x 2m high security fence (150x100+gatex$1000)	Topping & Associates
3.7	Intake Basin	m^3	$ 20	30m x 30m x 3m deep unlined basin excavated into ground. Spoils used on site for grading and bunding.		Topping & Associates
3.8	Spillway Back to River	m	$ 50	3m wide x 3m deep unlined channel excavated into ground.		Topping & Associates
3.9	Rock Filter	m^3	$ 120	3m tall well sorted, large diameter, trapezoidal shaped rock pile	Imported material	Topping & Associates
3.10	Water Management	ea	$ 10,000	River water management (coffer dam and river diversion, dewatering, etc.) to install weir and rock filter on bank	Channel river using small excavator	Topping & Associates
3.11	Site Preparation	ha	$ 33,000	Within river banks. Removal of boulders and gravel from weir footprint area in preparation of concrete weir construction, general grading within river bank to promote flow toward rock filter and fish ladder. Material wasted on site.	Boulders/gravels in river to be removed are 1m thick (2,500 m^3)	Topping & Associates
3.12	Concrete Weir	m	$ 23,000	Construction of reinforced concrete weir from bank to bank. 5m tall, vertical upstream face, sloping downstream face with energy dissipator (23m2 cross section). Base tied into rock.	5m height is enough to found the structure on competent rock. Pour in 10m sections, form both faces, allow $1,000/$m^3$	Topping & Associates
3.13	Fish Ladder	m	$ 1,700	5m wide channel lined with cemented rock	allow 2m^3/m@$850	Topping & Associates
4	**Upgrade Existing Intakes**	**Unit**	**Unit Rate**	**Comments**	**Assumptions**	**Estimate Source**
4.1	2 m^3/s Intake	%	33%	Replace existing intake with upgraded intake	Cost can be represented by a flow ratio of Item 3.0	Golder
4.2	1m^3/s Intake	%	17%	Replace existing intake with upgraded intake	Cost can be represented by a flow ratio of Item 3.0	Golder
5	**Irrigation Races**	**Unit**	**Unit Rate**	**Comments**	**Assumptions**	**Estimate Source**
5.1a	Main Race - Type 1 - capacity 6 m^3/s steep	km	$ 87,400	6 m^3/s, 0.3% bed slope in easy terrain. Excavation volume of 19 m^3/m. See figure.	Race length quantity is indicative. Excavator bulk and trim; $4.60/$m^3$; 500$m^3$/day or 26 lm/day	Topping & Associates
5.1b	Main Race - Type 1 - capacity 6 m^3/s steep	km	$ 151,700	6 m^3/s, 0.3% bed slope in difficult terrain. Excavation volume of 41 m^3/m. See figure.	Race length quantity is indicative. Dozer bulk push and excavator trim;$3.70/3, 1500$m^3$/day; 36 lm/day	Topping & Associates
5.1c	Main Race - Type 1 - capacity 6 m^3/s steep	km	$ 34,800	Additional cost to line Item 5.1b with 300mm of compacted clay (9.7m wetted perimeter, 2.9 m^3 of clay per metre of race).	Clay imported within 5km. Race length quantity is indicative. Allow $7.50 to import, place and compact $4.50/$m^3$x2.9mx1000=$34800	Topping & Associates
5.2a	Main Race - Type 2 - capacity 3 m^3/s steep	km	$ 65,000	3 m^3/s, 0.3% bed slope in easy terrain. Excavation volume of 13 m^3/m. See figure.	Race length quantity is indicative.	Topping & Associates
5.2b	Main Race - Type 2 - capacity 3 m^3/s steep	km	$ 114,800	3 m^3/s, 0.3% bed slope in difficult terrain. Excavation volume of 28 m^3/m. See figure.	Race length quantity is indicative.	Topping & Associates
5.2c	Main Race - Type 2 - capacity 3 m^3/s steep	km	$ 28,800	Additional cost to line Item 5.2b with 300mm of compacted clay (8.0m wetted perimeter, 2.4 m^3 of clay per metre of race).	Clay imported within 5km. Race length quantity is indicative.	Topping & Associates
5.3a	Main Race - Type 3 - capacity 4 m^3/s	km	$ 74,800	4 m^3/s, 0.15% bed slope in easy terrain. Excavation volume of 17 m^3/m. See figure	Race length quantity is indicative.	Topping & Associates
5.3b	Main Race - Type 3 - capacity 4 m^3/s	km	$ 140,400	4 m^3/s, 0.15% bed slope in difficult terrain. Excavation volume of 36 m^3/m. See figure.	Race length quantity is indicative.	Topping & Associates
5.3c	Main Race - Type 3 - capacity 4 m^3/s	km	$ 32,400	Additional cost to line Item 5.3b with 300mm of compacted clay (9.0m wetted perimeter, 2.7 m^3 of clay per metre of race).	Clay imported within 5km. Race length quantity is indicative.	Topping & Associates
5.4a	Main Race - Type 4 - capacity 2 m^3/s	km	$ 57,200	2 m^3/s, 0.15% bed slope in easy terrain. Excavation volume of 11 m^3/m. See figure	Race length quantity is indicative.	Topping & Associates
5.4b	Main Race - Type 4 - capacity 2 m^3/s	km	$ 96,600	2 m^3/s, 0.15% bed slope in difficult terrain. Excavation volume of 23 m^3/m. See figure.	Race length quantity is indicative.	Topping & Associates
5.4c	Main Race - Type 4 - capacity 2 m^3/s	km	$ 26,400	Additional cost to line Item 5.4b with 300mm of compacted clay (7.3m wetted perimeter, 2.2 m^3 of clay per metre of race).	Clay imported within 5km. Race length quantity is indicative.	Topping & Associates
5.5a	Main Race - Type 5 - capacity 1 m^3/s	km	$ 44,000	1 m^3/s, 0.15% bed slope in easy terrain. Excavation volume of 8 m^3/m. See figure	Race length quantity is indicative.	Topping & Associates
5.5b	Main Race - Type 5 - capacity 1 m^3/s	km	$ 70,400	1 m^3/s, 0.15% bed slope in difficult terrain. Excavation volume of 16 m^3/m. See figure.	Race length quantity is indicative.	Topping & Associates
5.5c	Main Race - Type 5 - capacity 1 m^3/s	km	$ 21,600	Additional cost to line Item 5.5b with 300mm of compacted clay (6.1m wetted perimeter, 1.8 m^3 of clay per metre of race).	Clay imported within 5km. Race length quantity is indicative.	Topping & Associates
5.6a	Main Race - Type 6 - capacity 0.5 m^3/s	km	$ 34,200	0.5 m^3/s, 0.15% bed slope in easy terrain. Excavation volume of 6 m^3/m. See figure.	Race length quantity is indicative.	Topping & Associates
5.6b	Main Race - Type 6 - capacity 0.5 m^3/s	km	$ 62,400	0.5 m^3/s, 0.15% bed slope in difficult terrain. Excavation volume of 12 m^3/m. See figure.	Race length quantity is indicative.	Topping & Associates
5.6c	Main Race - Type 6 - capacity 0.5 m^3/s	km	$ 19,200	Additional cost to line Item 5.6b with 300mm of compacted clay (5.2m wetted perimeter, 1.6 m^3 of clay per metre of race).	Clay imported within 5km. Race length quantity is indicative.	Topping & Associates
5.7a	Existing Race - upgrade from 1 to 2 m^3/s	km	$ 13,800	Excavate existing race to be 200mm deeper and 0.5m wider, sidecast without compaction alongside existing access road, gentle terrain excavate 3 m^3/m	Race length quantity is indicative. Excavator at $230/hr, capacity 50$m^3$/hr=$4.6/m^3. $4.6/$m^3$x3$m^3$/mx1000=$13,800/ km.	Topping & Associates
5.7b	Existing Race - upgrade from 1 to 2 m^3/s	km	$ 32,200	Excavate existing race to be 200mm deeper and 0.5m wider, sidecast without compaction alongside existing access road, steep terrain excavate 7 m^3/m	Race length quantity is indicative. Excavator at $230/hr, capacity 50$m^3$/hr=$4.6/m^3. $4.6/$m^3$x7$m^3$/mx1000=$32,200/ km.	Topping & Associates
5.8a	Existing Race - upgrade from 2 to 4 m^3/s	km	$ 27,600	Excavate existing race to be 200mm deeper and 1m wider, sidecast without compaction alongside existing access road, gentle terrain excavate 6 m^3/m	Race length quantity is indicative. Excavator at $230/hr, capacity 50$m^3$/hr=$4.6/m^3. $4.6/$m^3$x6$m^3$/mx1000=$27,600/ km.	Topping & Associates
5.8b	Existing Race - upgrade from 2 to 4 m^3/s	km	$ 59,800	Excavate existing race to be 200mm deeper and 1m wider, sidecast without compaction alongside existing access road, steep terrain excavate 13 m^3/m	Race length quantity is indicative. Excavator at $230/hr, capacity 50$m^3$/hr=$4.6/m^3. $4.6/$m^3$x13$m^3$/mx1000=$59,800/ km.	Topping & Associates
5.9	Bywashes	ea	$ 6,000	5m wide concrete weir in race bank and across access road to discharge excess water into nearby drainage	Race length quantity is indicative. Formed in concrete 5m^3 @ $1200=$6000ea	Topping & Associates
5.10a	Main Race - Type 7 - capacity 5 m^3/s	km	$ 73,500	5 m^3/s, 0.15% bed slope in easy terrain. Excavation volume of 19 m^3/m.	Race length quantity is indicative.	Golder scaled from 5.3a
5.10b	Main Race - Type 7 - capacity 5 m^3/s	km	$ 130,600	5 m^3/s, 0.15% bed slope in difficult terrain. Excavation volume of 40 m^3/m.	Race length quantity is indicative.	Golder scaled from 5.3b
5.10c	Main Race - Type 7 - capacity 5 m^3/s	km	$ 30,000	Additional cost to line Item 5.10b with 300mm of compacted clay (9.4m wetted perimeter, 2.8 m^3 of clay per metre of race).	Clay imported within 5km. Race length quantity is indicative.	Golder scaled from 5.3c
5.11a	Main Race - Type 8 - capacity 3.5 m^3/s	km	$ 65,100	3.5 m^3/s, 0.15% bed slope in easy terrain. Excavation volume of 15 m^3/m.	Race length quantity is indicative.	Golder scaled from 5.3a and 5.4a
5.11b	Main Race - Type 8 - capacity 3.5 m^3/s	km	$ 113,500	3.5 m^3/s, 0.15% bed slope in difficult terrain. Excavation volume of 33 m^3/m.	Race length quantity is indicative.	Golder scaled from 5.3b and 5.4b
5.11c	Main Race - Type 8 - capacity 3.5 m^3/s	km	$ 28,700	Additional cost to line Item 5.11b with 300mm of compacted clay (8.7m wetted perimeter, 2.6 m^3 of clay per metre of race).	Clay imported within 5km. Race length quantity is indicative.	Golder scaled from 5.3c and 5.4c
5.12a	Main Race - Type 9 - capacity 3 m^3/s	km	$ 63,900	3 m^3/s, 0.15% bed slope in easy terrain. Excavation volume of 14 m^3/m.	Race length quantity is indicative.	Golder scaled from 5.3a and 5.4a
5.12b	Main Race - Type 9 - capacity 3 m^3/s	km	$ 110,200	3 m^3/s, 0.15% bed slope in difficult terrain. Excavation volume of 30 m^3/m.	Race length quantity is indicative.	Golder scaled from 5.3b and 5.4b
5.12c	Main Race - Type 9 - capacity 3 m^3/s	km	$ 28,300	Additional cost to line Item 5.12b with 300mm of compacted clay (8.4m wetted perimeter, 2.5 m^3 of clay per metre of race).	Clay imported within 5km. Race length quantity is indicative.	Golder scaled from 5.3c and 5.4c
5.13a	Main Race - Type 10 - capacity 1.5 m^3/s	km	$ 51,400	1.5 m^3/s, 0.15% bed slope in easy terrain. Excavation volume of 9 m^3/m.	Race length quantity is indicative.	Golder scaled from 5.4a and 5.5a
5.13b	Main Race - Type 10 - capacity 1.5 m^3/s	km	$ 84,100	1.5 m^3/s, 0.15% bed slope in difficult terrain. Excavation volume of 20 m^3/m.	Race length quantity is indicative.	Golder scaled from 5.4b and 5.5b
5.13c	Main Race - Type 10 - capacity 1.5 m^3/s	km	$ 24,100	Additional cost to line Item 5.13b with 300mm of compacted clay (6.7m wetted perimeter, 2.0 m^3 of clay per metre of race).	Clay imported within 5km. Race length quantity is indicative.	Golder scaled from 5.4c and 5.5c
5.14a	Main Race - Type 11 - capacity 0.25 m^3/s	km	$ 28,400	0.25 m^3/s, 0.15% bed slope in easy terrain. Excavation volume of 5 m^3/m.	Race length quantity is indicative.	Golder scaled from 5.6a
5.14b	Main Race - Type 11 - capacity 0.25 m^3/s	km	$ 52,100	0.25 m^3/s, 0.15% bed slope in difficult terrain. Excavation volume of 10 m^3/m.	Race length quantity is indicative.	Golder scaled from 5.6b
5.14c	Main Race - Type 11 - capacity 0.25 m^3/s	km	$ 17,800	Additional cost to line Item 5.14b with 300mm of compacted clay (4.9m wetted perimeter, 1.5 m^3 of clay per metre of race).	Clay imported within 5km. Race length quantity is indicative.	Golder scaled from 5.6c
5.15	Fencing of new races, one side only.	m	$ 20	7 wire post and batten fence, assume medium terrain and access but numerous corners.	Large volume order to reduce costs	Golder
5.16	Upgrade and automation of main intake gates / controls and increased monitoring - large intake	ea	$ 150,000	To improve operation automation of intake gates for the main intakes and integration into the existing automated management system.	Assume large gates which can be operated using hydraulic power and reticulated power electricity supply is not required.	Golder
5.17	Upgrade and automation of main intake gates / controls and increased monitoring - medium small intake	ea	$ 50,000	To improve operation automation of intake gates for the main intakes and integration into the existing automated management system.	Assume relatively small gate which can be operated on battery (solar), or hydraulic power and reticulated power electricity supply is not required.	Golder
5.18	Automation of secondary distribution race off takes	ea	$ 30,000	To improve operation and reduce bywash automation of gates on the larger secondary distribution races/pipes with integration into an automated management system.	Assume relatively small gate which can be operated on battery (solar), or hydraulic power and reticulated power electricity supply is not required.	Golder

MANUHERIKIA CATCHMENT FEASIBILITY STUDY
IRRIGATION WATER DISTRIBUTION UNIT COST TABLE

6	Siphons & Road Crossings	Unit	Unit Rate	Comments	Assumptions	Estimate Source
6.1	Long Siphon - 6 m³/s	m	$ 2,667	Supply and install 2 x 1.6m diameter welded polyethylene (PE) pipe (PN9), buried below existing ground, thrust blocks at corners, river diversion for installation, anchored and protected with concrete below river channel, concrete inlet and outlet structures, access manholes every 500m	Pipe bedding material imported within 10km. Quantity is indicative.	Downer (pipe supply and normal laying costs)
6.2	Long Siphon - 2 m³/s	m	$ 1,031	Supply and install 1.4m diameter welded PE pipe (PN9), buried below existing ground, thrust blocks at corners, river diversion for installation, anchored and protected with concrete below river channel, concrete inlet and outlet structures, access manholes every 500m	Pipe bedding material imported within 10km. Quantity is indicative.	Downer (pipe supply and normal laying costs)
6.3	Medium Siphon - 4 m³/s	m	$ 1,802	Supply and install 2 x 1.3m diameter welded polyethylene (PE) pipe (PN6), buried below existing ground, thrust blocks at corners, river diversion for installation, anchored and protected with concrete below river channel, concrete inlet and outlet structures, access manholes every 500m	Pipe bedding material imported within 10km. Quantity is indicative.	Downer (pipe supply and normal laying costs)
6.4	Medium Siphon - 1 m³/s	m	$ 645	Supply and install 1.0m diameter welded PE pipe (PN6), buried below existing ground, thrust blocks at corners, river diversion for installation, anchored and protected with concrete below river channel, concrete inlet and outlet structures, access manholes every 500m	Pipe bedding material imported within 10km. Quantity is indicative.	Downer (pipe supply and normal laying costs)
6.5	Short Siphon - 0.5 m³/s	m	$ 269	Supply and install 0.6m diameter welded PE pipe (PN3), buried below existing ground, thrust blocks at corners, river diversion for installation, anchored and protected with concrete below river channel, concrete inlet and outlet structures.	Pipe bedding material imported within 10km. Quantity is indicative.	Downer (pipe supply and normal laying costs)
6.6	Extra siphon laying costs and protection works for river sections	m	$ 855	Extra burial depth (2m below surface) across river section with concrete anchors and rock rip wrap protection. Include river diversion for installation.	Pipe bedding and protection material imported from within 10km at excavation and placement costs. Allows 10 x normal laying cost for crossing river.	Golder
6.7	Main Road Crossing	ea	$ 50,000	Supply and install 1m high by 5m wide by 12m long precast concrete box culvert for two lane sealed road crossings.	Quantity is indicative	Golder
6.8	Race rural road and farm access crossings	ea	$ 20,000	Supply and install 12m long 1.6m diameter PE pipe for rural roads and farm track crossings.	Quantity is indicative	Downer (pipe supply and normal laying costs), rounded up by Golder to account for wing walls etc.
7	**Secondary distribution**	**Unit**	**Unit Rate**	**Comments**	**Assumptions**	**Estimate Source**
7.1	Main Race Turnout	ea	$ 12,500	Concrete headwall with 500mm pipe penetration through bank and under access road.	Excludes gates and automation as covered elsewhere.	Downer
7.2a	On Farm Turnouts - piped, high pressure, large	ea	$ 15,000	Flow and pressure control, flow meter (local readout) and manual gate valve in simple housing at farm turnout. Large turnout assume 250mm diameter pipe.	Excludes automation, data recording or telemetry.	Golder
7.2b	On Farm Turnouts - piped, high pressure, small	ea	$ 10,000	Flow and pressure control, flow meter (local readout) and manual gate valve in simple housing at farm turnout. Small turnout assume 100m diameter pipe.	Excludes automation, data recording or telemetry.	Golder
7.2c	On Farm Turnouts - low pressure or open race	ea	$ 5,000	Flow control, flow meter (local readout) and manual gate valve in simple housing at farm turnout.	Excludes automation, data recording or telemetry.	Golder
7.2d	On Farm Turnouts - upgrade existing simple turnout and/or automation	ea	$ 5,000	Simple upgrading or flow monitoring data recording or telemetry.	Assume part of large automation network therefore unit rates are low	Golder
7.3	Pipe - 100mm PN6 supply	m	7.00	Supply pipe	Large volume order to reduce costs	Downer
7.4	Pipe - 100mm PN6 lay	m	26.00	Install pipe, buried 0.5m below ground (rolling terrain) using re-compacted in-situ material	Quantity is indicative	Downer
7.5	Pipe - 150mm PN6 supply	m	14.00	Supply pipe	Large volume order to reduce costs	Downer
7.6	Pipe - 150mm PN6 lay	m	29.00	Install pipe, buried 0.5m below ground (rolling terrain) using re-compacted in-situ material	Quantity is indicative	Downer
7.7	Pipe - 200mm PN6 supply	m	19.00	Supply pipe	Large volume order to reduce costs	Downer
7.8	Pipe - 200mm PN6 lay	m	29.00	Install pipe, buried 0.5m below ground (rolling terrain) using re-compacted in-situ material	Quantity is indicative	Downer
7.9	Pipe - 250mm PN6 supply	m	29.00	Supply pipe	Large volume order to reduce costs	Downer
7.10	Pipe - 250mm PN6 lay	m	39.00	Install pipe, buried 0.5m below ground (rolling terrain) using re-compacted in-situ material	Quantity is indicative	Downer
7.11	Pipe - 300mm PN6 supply	m	46.00	Supply pipe	Large volume order to reduce costs	Downer
7.12	Pipe - 300mm PN6 lay	m	43.00	Install pipe, buried 0.5m below ground (rolling terrain) using re-compacted in-situ material	Quantity is indicative	Downer
7.13	Pipe - 350mm PN6 supply	m	58.00	Supply pipe	Large volume order to reduce costs	Downer
7.14	Pipe - 350mm PN6 lay	m	45.00	Install pipe, buried 0.5m below ground (rolling terrain) using re-compacted in-situ material	Quantity is indicative	Downer
7.15	Pipe - 400mm PN6 supply	m	74.00	Supply pipe	Large volume order to reduce costs	Downer
7.16	Pipe - 400mm PN6 lay	m	49.00	Install pipe, buried 0.5m below ground (rolling terrain) using re-compacted in-situ material	Quantity is indicative	Downer
7.17	Pipe - 450mm PN6 supply	m	103.00	Supply pipe, includes costs of fittings	Large volume order to reduce costs	Downer
7.18	Pipe - 450mm PN6 lay	m	54.00	Install pipe, buried 0.5m below ground (rolling terrain) using re-compacted in-situ material	Quantity is indicative	Downer
7.19	Pipe - 500mm PN6 supply	m	142.00	Supply pipe	Large volume order to reduce costs	Downer
7.20	Pipe - 500mm PN6 lay	m	63.00	Install pipe, buried 0.5m below ground (rolling terrain) using re-compacted in-situ material	Quantity is indicative	Downer
7.21	Pipe - 550mm PN6 supply	m	160.00	Supply pipe, includes costs of fittings	Large volume order to reduce costs	Downer
7.22	Pipe - 550mm PN6 lay	m	65.00	Install pipe, buried 0.5m below ground (rolling terrain) using re-compacted in-situ material	Quantity is indicative	Downer
7.23	Pipe - 600mm PN6 supply	m	184.00	Supply pipe	Large volume order to reduce costs	Downer
7.24	Pipe - 600mm PN6 lay	m	67.00	Install pipe, buried 0.5m below ground (rolling terrain) using re-compacted in-situ material	Quantity is indicative	Downer
7.25	Pipe - 700mm PN6 supply	m	233.00	Supply pipe	Large volume order to reduce costs	Downer
7.26	Pipe - 700mm PN6 lay	m	82.00	Install pipe, buried 0.5m below ground (rolling terrain) using re-compacted in-situ material	Quantity is indicative	Downer
7.27	Pipe - 800mm PN6 supply	m	296.00	Supply pipe	Large volume order to reduce costs	Downer
7.28	Pipe - 800mm PN6 lay	m	89.00	Install pipe, buried 0.5m below ground (rolling terrain) using re-compacted in-situ material	Quantity is indicative	Downer
7.29	Pipe - 900mm PN6 supply	m	388.00	Supply pipe	Large volume order to reduce costs	Downer
7.30	Pipe - 900mm PN6 lay	m	114.00	Install pipe, buried 0.5m below ground (rolling terrain) using re-compacted in-situ material	Quantity is indicative	Downer
7.31	Pipe - 1000mm PN6 supply	m	462.00	Supply pipe	Large volume order to reduce costs	Downer
7.32	Pipe - 1000mm PN6 lay	m	137.00	Install pipe, buried 0.5m below ground (rolling terrain) using re-compacted in-situ material	Quantity is indicative	Downer
7.33	Pipe - 1200mm PN6 supply	m	657.00	Supply pipe	Large volume order to reduce costs	Downer
7.34	Pipe - 1200mm PN6 lay	m	165.00	Install pipe, buried 0.5m below ground (rolling terrain) using re-compacted in-situ material	Quantity is indicative	Downer
7.35	Pipe - 1300mm PN6 supply	m	749.00	Supply pipe	Large volume order to reduce costs	Downer
7.36	Pipe - 1300mm PN6 lay	m	77.00	Install pipe, buried 0.5m below ground (rolling terrain) using re-compacted in-situ material	Quantity is indicative	Downer
7.37	Pipe - 1400mm PN6 supply	m	862.00	Supply pipe	Large volume order to reduce costs	Downer
7.38	Pipe - 1400mm PN6 lay	m	83.00	Install pipe, buried 0.5m below ground (rolling terrain) using re-compacted in-situ material	Quantity is indicative	Downer
7.39	Pipe - 1500mm PN6 supply	m	994.00	Supply pipe	Large volume order to reduce costs	Downer
7.40	Pipe - 1500mm PN6 lay	m	89.00	Install pipe, buried 0.5m below ground (rolling terrain) using re-compacted in-situ material	Quantity is indicative	Downer
7.41	Pipe - 1600mm PN6 supply	m	1,126.00	Supply pipe	Large volume order to reduce costs	Downer
7.42	Pipe - 1600mm PN6 lay	m	95.00	Install pipe, buried 0.5m below ground (rolling terrain) using re-compacted in-situ material	Quantity is indicative	Downer
7.43	Distribution Main Road Crossings	ea	$ 15,000	Include appropriate backfilling, compaction and resurfacing	Traffic control required as fairly busy roads.	Golder
7.44	Distribution rural road and farm access crossings	ea	$ 5,000	Include appropriate backfilling, compaction and resurfacing	Limited traffic control and rural roads	Golder
7.45	Manholes	ea	$ 2,000	Includes a port for inspection and air relief valve	Every 500m of pipe length	Golder
7.46	Reinstatement of fences etc.	LS	$ 2,000	Nominal estimate based on approximately 1 weeks work by a fencing contractor to repair existing fences.		Golder
7.47	Pipe to Farm Turnouts	m	$ 50	Nominal length estimated based on number of irrigators and size of surround properties. Assumes average of 200mm diameter PE pipe	Assume most properties can access the main race or distributions.	Golder using Downer pipe prices
7.48	Road / Driveway Crossing for turnouts	ea	$ 3,000	Include appropriate backfilling, compaction and resurfacing	Allows crossing of various rural roads	Golder
			Item 7 Costs			
8	**Other items**	**Unit**	**Unit Rate**	**Comments**	**Assumptions**	**Estimate Source**
8.1	Buffer Pond	m³	$ 10	30,000m³ pond, small compacted embankment in farm gully using on-site soils, piped connection from main race and to secondary distribution pipe		Golder
8.2	Large excavator	hr	$ 230	Hire of large excavator and driver for race cleaning and upgrading.	Assume 2 week period and locally supplied so limited mobilisation costs.	Golder / Topping & Associates
8.3	Replacement of existing small structures	ea	$ 5,000	Assume relatively small structures like is distribution race culverts.		Golder
			Item 8 Costs			
			BCS Cost			
			DCS Cost			
9	**Contingencies**	**Unit**	**Unit Rate**	**Comments**	**Assumptions**	**Estimate Source**
9.1	Contingency	%	35%	Percent of DCS		Golder / Topping & Associates
			Preliminary Project Cost	BCS+DCS+Contingency		

*Base construction cost (BCS) excludes Items 1 and 2
**Direct construction cost (DCS) includes all items except contingency

MANUHERIKIA CATCHMENT FEASIBILITY STUDY
IRRIGATION WATER DISTRIBUTION COST TABLE
GALLOWAY SCHEME

Option A - Open Race Option

Item No.	Description	Unit	Quantity	Unit Rate	Amount	Comments	Assumptions
1	**Project Management**						
1.1	Construction Management	%	1	7%	$ 16,978	Percent of Capital Cost	
1.2	Engineering and Design	%	1	10%	$ 24,254	Percent of Capital Cost	
				Item 1 Costs	**$ 41,231**		
2	**Consents and Permits**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
2.1	Consenting	%	1	2%	$ 4,851	Percent of Capital Cost	
2.2	Bonds and Insurance	%	1	5%	$ 12,127	Percent of Capital Cost	
				Item 2 Costs	**$ 16,978**		
3	**Capital Cost**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
3.1	Installation of self cleaning screens and automation	LS	1	$ 30,000	$ 30,000	Automate pumps to allow remote operation, install self cleaning screens.	Assume no capital works to diversion required.
3.2	Replacement of seals in raising main	m	320	$ 167	$ 53,536	Costed as if concrete raising main replaced with 450mm diameter welded PE pipe.	
3.3	Benching of races	m	3600	$ 15	$ 54,000	Construct drivable bench below the existing upper race. Target the 3.6 km identified by GIS. Cost allows for 1 month with a large excavator ($230/hr) and assumes simple sidecasting and no relining of the canal.	
3.4	Structure up-grades	ea	21	$ 5,000	$ 105,000	Replace the 18 structures where condition is assessed as "fair " and the 3 assessed as "poor". The structure have not been visited by Golder and a nominal amount has been assumed per structure assuming the structures are relatively small.	
				Item 3 Costs	**$ 242,536**		
4	Contingency	%	1	35%	$ 105,261	Percent of Items 1, 2, and 3	
	Galloway Scheme Open Race Option Total Capital Cost				**$ 406,005**		
	Galloway Scheme Open Race Option Capital Cost (Rounded)				**$ 410,000**		
5	**Annual Operational Cost**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
5.1	Scheme pumping	$/hr	3500	$ 17	$ 59,500	Assume 15c / kWh, 112 kW pump operated for 3500 hr per year	Understood to be subsidised from power agreement.
5.2	Operation and Management	LS	1	$ 60,000	$ 60,000	Nominal estimate based on approximately a person half time plus vehicle	
5.3	Race clearing and diversion maintenance.	LS	1	$ 25,000	$ 25,000	Nominal estimate based on clearing the 25 km of race once a season allows for a excavator ($230/hr) for approximately 2-3 weeks.	
5.4	Governance and Administration	LS	1	$ 20,000	$ 20,000	Nominal estimate	
5.5	Maintenance of pumps and structures	LS	1	$ 40,000	$ 40,000	Nominal estimate allows $10,000 for pump and pump shed maintenance and 6 structures (2% by number) to be replaced annually.	
	Galloway Scheme Open Race Option Operational Cost				**$ 204,500**		
	Galloway Scheme Open Race Option Operational Cost (Rounded)				**$ 210,000**		

Option B - Piped Option

Item No.	Description	Unit	Quantity	Unit Rate	Amount	Comments	Assumptions
1	**Project Management**						
1.1	Construction Management	%	1	7%	$ 80,391	Percent of Capital Cost	
1.2	Engineering and Design	%	1	10%	$ 114,844	Percent of Capital Cost	
				Item 1 Costs	**$ 195,235**		
2	**Consents and Permits**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
2.1	Consenting	%	1	2%	$ 22,969	Percent of Capital Cost	
2.2	Bonds and Insurance	%	1	5%	$ 57,422	Percent of Capital Cost	
				Item 2 Costs	**$ 80,391**		
3	**Capital Cost**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
3.1	Pumps	LS	1	$ 80,000	$ 80,000	Upgrade pumps for increased duty, require 160 kW pump that can deliver 290 L/s (i.e., 550 ha irrigated at 4.5 mm/day) at 50 m of head. Upgrade associated valves and inlet/outlet pipe. New self cleaning screens included.	Assume 3 pumps 1 @ 50L/s with VSD drive, 1 @ 120 L/s with VSD and one @ 120 L/s direct drive. Assume current pump house and power supply to building sufficient, but allow for replacement of in-shed electrics and automation. Assume no capital works to diversion required.
3.2	PVC pipe - 450mm PN6	m	1200	$ 167	$ 200,760	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.3	PVC pipe - 350mm PN6	m	1600	$ 109	$ 174,080	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	For install assume pipe buried 0.5m below ground (flat terrain and good access) using re-compacted in-situ material. No special bedding
3.4	PVC pipe - 250mm PN6	m	800	$ 71	$ 56,720	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.5	PVC pipe - 200mm PN6	m	1200	$ 50	$ 59,880	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.6	Sealed Road Crossing	ea	1	$ 15,000	$ 15,000	Include appropriate backfilling, compaction and resurfacing	Nominal traffic control required as rural road.
3.7	Manholes	ea	10	$ 2,000	$ 20,000	Includes a port for inspection and air relief valve	Every 500m of pipe length
3.8	Gravel Road / Driveway Crossing	ea	12	$ 5,000	$ 60,000	Include appropriate backfilling, compaction and resurfacing	
3.9	Reinstatement of fences etc.	week	1	$ 2,000	$ 2,000	Nominal estimate based on approximately 1 weeks work by a fencing contractor to repair existing fences no new fences.	
3.10	Pipe to Farm Turnouts	m	2000	$ 50	$ 100,000	Nominal length estimated based on number of irrigators and size of surround properties.	Assume approximately 1/2 the properties can access the mainline.
3.11	Road / Driveway Crossing for turnouts	ea	10	$ 3,000	$ 30,000	Include appropriate backfilling, compaction and resurfacing	
3.12	Farm Turnouts	ea	70	$ 5,000	$ 350,000	Flow and pressure meter (local readout) and manual gate valve in simple housing. Sized for average irrigator of 10 ha assume 100m diameter and low pressure.	
				Item 3 Costs	**$ 1,148,440**		
4	Contingency	%	1	35%	$ 498,423	Percent of Items 1, 2, and 3	
	Galloway Scheme Piped Option Total Capital Cost				**$ 1,922,489**		
	Galloway Scheme Piped Option Capital Cost (Rounded)				**$ 1,930,000**		
5	**Annual Operational Cost**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
5.1	Scheme pumping	$/hr	3500	$ 24	$ 84,000	Assume 15c / kWh, 160 kW pump operated for 3500 hr per year	Understood to be subsidised from power agreement. Would replace the need for current on-farm pumping.
5.2	Operation and Management	LS	1	$ 30,000	$ 30,000	Nominal estimate based on approximately a person quarter time plus vehicle	
5.3	Governance and Administration	LS	1	$ 20,000	$ 20,000	Nominal estimate	
5.4	Maintenance (diversion and pumps mainly)	LS	1	$ 20,000	$ 20,000	Nominal estimate	Assumes minimal maintenance required on the new pipe system.
	Galloway Scheme Piped Option Operational Cost				**$ 154,000**		
	Galloway Scheme Piped Option Operational Cost (Rounded)				**$ 160,000**		

Notes:
Galloway Scheme options exclude costs associated with Lower Manorburn Dam

MANUHERIKIA CATCHMENT FEASIBILITY STUDY
IRRIGATION WATER DISTRIBUTION COST TABLE
MANUHERIKIA IRRIGATION SCHEME

Part A - Main Race and open race network

Item No.	Description	Unit	Quantity	Unit Rate	Amount	Comments	Assumptions
1	**Project Management**						
1.1	Construction Management	%	1	7%	$ 151,354	Percent of Capital Cost	
1.2	Engineering and Design	%	1	10%	$ 216,220	Percent of Capital Cost	
				Item 1 Costs	**$ 367,574**		
2	**Consents and Permits**	Unit	Quantity	Unit Rate	Amount	Comments	Assumptions
2.1	Consenting	%	1	2%	$ 43,244	Percent of Capital Cost	
2.2	Bonds and Insurance	%	1	5%	$ 108,110	Percent of Capital Cost	
				Item 2 Costs	**$ 151,354**		
3	**Capital Costs**	Unit	Quantity	Unit Rate	Amount	Comments	Assumptions
3.1	Buffer storage pond at end of Main Race	m3	100000	$ 10	$ 1,000,000	Buffer storage pond in combination with existing pond to reduce bywash from the end of the main race and to provide storage for irrigation and frost fighting on Dunstan Flats. Main race approximately 35km long with a capacity in the order of 60,000 m^3. 500 ha to be irrigated on Dunstan Flats at 5 mm/day equates to 25,000m^3. 100,000 m^3 of buffer storage provides 4 days of irrigation water or approximately 1-2 nights of frost fighting in addition to current storage.	Existing agreement allows for an approximately 200m by 200m buffer storage pond. Assume 5 m deep and lined.
3.2	Chinky Gully Aqueduct replaced with syphon 2m3/s capacity	m	200	$ 1,182	$ 321,980	Supply and install 1.5m diameter welded polyethylene (PE) pipe (PN6), buried below existing ground, thrust blocks at corners, anchored and protected, concrete inlet and outlet structures.	Pipe bedding material imported within 10km at excavation placement costs. Allow for increased laying cost for stream crossing and to cater fro joining into tunnel etc (100m).
3.3	Automation of Gates / Controls and increased monitoring	ea	4	$ 30,000	$ 120,000	To improve operation and reduce bywash. Note 2 main intakes are already automated. Remaining gates would be on secondary races or piped distributions. Nominal estimate based on 4 additional sites (F-K race, M-N race, Drop from Main to Borough Race plus one other) to be feed into existing automated management system.	Assume relatively small gates which can be operated on battery (solar), or hydraulic power and reticulated power electricity supply is not required.
3.4	Gorge Piping	m	300	$ 1,182	$ 440,220	It is understood that approximately 300m (the 150m lidded section of concretechannel and the first 150m downstream from the desilter) of the Gorge section of the main distribution network requires upgrading. This section was not visited by Golder we have costed replacing the 300m section with a buried 1.5m diameter welded polyethylene (PE) pipe.	Allow for increased laying costs to cater for expected rocky conditions and joining into tunnel etc (100m).
3.5	Upgrading on Main Race and sealing leaks	LS	1	$ -	$ -	Monitoring and inspection of the main race indicates it is in a good state of repair and no major leaks were identified. Not all the race was inspected so some upgrading is expected, however it is expected that this could be included within the scheme's current annual non-routine maintenance budget, hence no specific allowance is made.	
3.6	Distribution race lining and upgrading	LS	1	$ 150,000	$ 150,000	Monitoring and inspection of parts of the secondary distribution races identified some leakage particularly on the Borough, M-N and F-K races. Not all the secondary distribution races was inspected so a nominal estimate has been made assuming approximately 2 km of the secondary distribution race is upgraded and/or lined and 2 crossing are installed or upgraded.	Assumes a move to reducing use of the Borough Race and transferring the various tributary takes to the Main Race and taking from the Manuherikia River only.
3.7	Upgrade Dunstan Flats bywash	LM	1	$ 30,000	$ 30,000	Nominal estimate to cover upgrade of bywash as required.	It is understood the current bywash requires some upgrades through a small gully. Under the proposed developments bywashes will reduce and therefore the need for the upgrade may reduce
3.8	Turnout upgrades and monitoring	ea	20	$ 5,000	$ 100,000	To allow improved measurement and recording of water use upgrades and monitoring of the larger turnouts will be required. Nominal estimate has been included to cover approximately 20 off-takes.	
				Item 3 Costs	**$ 2,162,200**		
4	Contingency	%	1	35%	$ 938,395	Percent of Items 1, 2, and 3	
	Manuherikia Scheme Main Race Total Capital Cost				**$ 3,619,523**		
	Manuherikia Scheme Main Race Capital Cost (Rounded)				**$ 3,620,000**		
The main intake, the desilter, the two tunnels and the Chatto Creek siphon were not inspected by Golder and the above costs exclude any maintenance or upgrades of these structures.							
5	**Annual Operational Cost**	Unit	Quantity	Unit Rate	Amount	Comments	Assumptions
5.1	Operation and Management	LS	1	$ 60,000	$ 60,000	Nominal estimate based on approximately a person half time plus vehicle	
5.2	Governance and Administration	LS	1	$ 20,000	$ 20,000	Nominal estimate	
5.3	Maintenance costs as per current budget	LS	1	$ 145,000	$ 145,000	Based on current maintenance budget	Excludes Falls Dam operation and maintenance costs
	Manuherikia Scheme Main Race Operational Cost				**$ 225,000**		
	Manuherikia Scheme Main Race Operational Cost (Rounded)				**$ 230,000**		

Part B - Dunstan Flats

Item No.	Description	Unit	Quantity	Unit Rate	Amount	Comments	Assumptions
1	**Project Management**						
1.1	Construction Management	%	1	7%	$ 131,400	Percent of Capital Cost	
1.2	Engineering and Design	%	1	10%	$ 187,714	Percent of Capital Cost	
				Item 1 Costs	**$ 319,114**		
2	**Consents and Permits**	Unit	Quantity	Unit Rate	Amount	Comments	Assumptions
2.1	Consenting	%	1	2%	$ 37,543	Percent of Capital Cost	
2.2	Bonds and Insurance	%	1	5%	$ 93,857	Percent of Capital Cost	
				Item 2 Costs	**$ 131,400**		
3	**Capital Costs**	Unit	Quantity	Unit Rate	Amount	Comments	Assumptions
3.1	PVC pipe - 450mm PN6	m	1800	$ 167	$ 301,140	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	For install assume pipe buried 0.5m below ground (flat terrain and
3.2	PVC pipe - 300mm PN6	m	7500	$ 94	$ 702,000	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	good access) using re-compacted in-situ material. No special
3.3	Sealed Road Crossing	ea	6	$ 15,000	$ 90,000	Include appropriate backfilling, compaction and resurfacing	Traffic control required as semi urban roads.
3.4	Gravel Road / Driveway Crossing	ea	30	$ 5,000	$ 150,000	Include appropriate backfilling, compaction and resurfacing	
3.5	Reinstatement of fences etc.	week	2	$ 2,000	$ 4,000	Nominal estimate based on approximately 2 weeks work by a fencing contractor to repair existing fences no new fences.	
3.6	Pipe to Farm Turnouts	m	2000	$ 50	$ 100,000	Nominal estimate	Assume approximately 1/2 the properties can access the mainline.
3.7	Road / Driveway Crossing for turnouts	ea	10	$ 3,000	$ 30,000	Include appropriate backfilling, compaction and resurfacing	
3.8	Farm Turnouts	ea	50	$ 10,000	$ 500,000	Flow and pressure meter (local readout) and manual gate valve in simple housing. Sized for average irrigator of 10 ha assume 100m diameter.	
				Item 3 Costs	**$ 1,877,140**		
4	Contingency	%	1	35%	$ 814,679	Percent of Items 1, 2, and 3	
	Manuherikia Dunstan Flat Total Capital Cost				**$ 3,142,332**		
	Manuherikia Dunstan Flat Capital Cost (Rounded)				**$ 3,150,000**		
4	**Annual Operational Cost**	Unit	Quantity	Unit Rate	Amount	Comments	Assumptions
4.1	Operation and Management	LS	1	$ 30,000	$ 30,000	Nominal estimate based on approximately a person quarter time plus vehicle	
4.2	Governance and Administration	LS	1	$ 20,000	$ 20,000	Nominal estimate	
4.3	Maintenance	LS	1	$ 20,000	$ 20,000	Nominal estimate	
	Manuherikia Dunstan Flats Operational Cost				**$ 70,000**		
	Manuherikia Dunstan Flats Operational Cost (Rounded)				**$ 70,000**		

MANUHERIKIA CATCHMENT FEASIBILITY STUDY
IRRIGATION WATER DISTRIBUTION COST TABLE
MANUHERIKIA IRRIGATION SCHEME

Part C - Piped Distribution

Item No.	Description	Unit	Quantity	Unit Rate	Amount	Comments	Assumptions
1	**Project Management**						
1.1	Construction Management	%	1	7%	$ 59,155	Percent of Capital Cost	
1.2	Engineering and Design	%	1	10%	$ 84,507	Percent of Capital Cost	
				Item 1 Costs	**$ 143,662**		
2	**Consents and Permits**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
2.1	Consenting	%	1	2%	$ 16,901	Percent of Capital Cost	
2.2	Bonds and Insurance	%	1	5%	$ 42,254	Percent of Capital Cost	
				Item 2 Costs	**$ 59,155**		
3	**Capital Costs**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
3.1	PVC pipe - 400mm PN6	m	2400	$ 130	$ 312,960	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	For install assume pipe buried 0.5m below ground (flat terrain and good access) using re-compacted in-situ material. No special
3.2	PVC pipe - 300mm PN6	m	1800	$ 94	$ 168,480	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.2	PVC pipe - 250mm PN6	m	700	$ 71	$ 49,630	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.3	Sealed Road Crossing	ea	5	$ 15,000	$ 75,000	Include appropriate backfilling, compaction and resurfacing	Traffic control required as state highways.
3.4	Gravel Road / Driveway Crossing	ea	5	$ 5,000	$ 25,000	Include appropriate backfilling, compaction and resurfacing	
3.5	Reinstatement of fences etc.	LS	1	$ 2,000	$ 2,000	Nominal estimate based on approximately 1 weeks work by a fencing contractor.	
3.6	Pipe to Farm Turnouts	m	1000	$ 50	$ 50,000		Assume approximately 1/2 the properties can access the mainline.
3.7	Road / Driveway Crossing for turnouts	ea	4	$ 3,000	$ 12,000	Include appropriate backfilling, compaction and resurfacing	
3.8	Farm Turnouts	ea	15	$ 10,000	$ 150,000	Flow and pressure meter (local readout) and manual gate valve in simple housing. Sized for average irrigator of 50 ha assume 150m diameter.	
				Item 3 Costs	**$ 845,070**		
4	Contingency	%	1	35%	$ 366,760	Percent of Items 1, 2, and 3	
	Manuherikia Piped Total Capital Cost				**$ 1,414,647**		
	Manuherikia Piped Capital Cost (Rounded)				**$ 1,420,000**		
5	**Annual Operational Cost**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
5.1	Operation and Management	LS	1	$ 30,000	$ 30,000	Nominal estimate based on approximately a person quarter time plus vehicle	
5.2	Governance and Administration	LS	1	$ 20,000	$ 20,000	Nominal estimate	
5.3	Maintenance	LS	1	$ 20,000	$ 20,000	Nominal estimate	Assumes minimal maintenance required on the new pipe system.
	Manuherikia Piped Distribution Operational Cost				**$ 70,000**		
	Manuherikia Piped Distribution Operational Cost (Rounded)				**$ 70,000**		

MANUHERIKIA CATCHMENT FEASIBILITY STUDY
IRRIGATION WATER DISTRIBUTION COST TABLE
BLACKSTONE SCHEME

Option A - Open Race Option - Low raise of Falls Dam

Item No.	Description	Unit	Quantity	Unit Rate	Amount	Comments	Assumptions
1	**Project Management**						
1.1	Construction Management	%	1	7%	$ 17,038	Percent of Capital Cost	
1.2	Engineering and Design	%	1	10%	$ 24,340	Percent of Capital Cost	
				Item 1 Costs	**$ 41,378**		
2	**Consents and Permits**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
2.1	Consenting	%	1	2%	$ 4,868	Percent of Capital Cost	
2.2	Bonds and Insurance	%	1	5%	$ 12,170	Percent of Capital Cost	
				Item 2 Costs	**$ 17,038**		
3	**Capital Cost**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
3.1	Automation of Intake Gate / Controls and increased monitoring	LS	1	$ 50,000	$ 50,000	To improve operation and reduce bywash. Nominal estimate based on upgrading and automating the existing intake to be feed into existing (i.e. the Omakau) automated management system.	Assume relatively small gate which can be operated on battery (solar), or hydraulic power and reticulated power electricity supply is not required.
3.2	Upgrading on Race and sealing leaks	LS	1	$ 43,400	$ 43,400	Monitoring and inspection of the race indicates it requires maintenance but no major leaks were identified. Not all the race was inspected so some upgrading is expected. A nominal allowance has been made to upgrade the race which provides for approximately 2 weeks with an excavator ($230/hr) and replacement of 5 minor structures (farm crossings) at $5,000 each.	
3.3	Buffer storage pond at end of Race	m3	10000	$ 10	$ 100,000	Buffer storage pond to reduce bywash from the end of the race system and to assist in capturing rainfall runoff that enters the race during rainfall events. Note main race approximately 20km long with a capacity in the order of 10,000 m^3.	Assume pond is lined.
3.4	Turnout upgrades and monitoring	ea	10	$ 5,000	$ 50,000	To allow improved measurement and recording of water use from the larger turnouts. Nominal estimate has been included to cover approximately 10 off-takes.	
				Item 3 Costs	**$ 243,400**		
4	Contingency	%	1	35%	$ 105,636	Percent of Items 1, 2, and 3	
	Blackstone Scheme Open Race Option Total Capital Cost				**$ 407,452**		
	Blackstone Scheme Open Race Option Capital Cost (Rounded)				**$ 410,000**		
5	**Annual Operational Cost**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
5.1	Operation and Management	LS	1	$ 30,000	$ 30,000	Nominal estimate based on approximately a person quarter time plus vehicle	
5.2	Race clearing and diversion maintenance	LS	1	$ 20,000	$ 20,000	Nominal estimate based on clearing the approximately 20 km of race once a season allows for a excavator ($230/hr) for approximately 2 weeks.	
5.3	Governance and Administration	LS	1	$ 10,000	$ 10,000	Nominal estimate	
5.4	Maintenance structures	LS	1	$ 10,000	$ 10,000	Nominal estimate allows for maintenance of the river diversion and structures.	
	Blackstone Scheme Open Race Option Operational Cost				**$ 70,000**		
	Blackstone Scheme Open Race Option Operational Cost (Rounded)				**$ 70,000**		

Option B - Piped Option - Mid and High raises of Falls Dam

Item No.	Description	Unit	Quantity	Unit Rate	Amount	Comments	Assumptions
1	**Project Management**						
1.1	Construction Management	%	1	7%	$ 270,886	Percent of Capital Cost	
1.2	Engineering and Design	%	1	10%	$ 386,980	Percent of Capital Cost	
				Item 1 Costs	**$ 657,866**		
2	**Consents and Permits**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
2.1	Consenting	%	1	2%	$ 77,396	Percent of Capital Cost	
2.2	Bonds and Insurance	%	1	5%	$ 193,490	Percent of Capital Cost	
				Item 2 Costs	**$ 270,886**		
3	**Capital Cost**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
3.1	Turnout from main race	ea	1	$ 12,500	$ 12,500	Precast concrete headwall with pipe penetration through canal bank and under access road.	
3.2	PE pipe - 700mm	m	7000	$ 338	$ 2,368,100	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	For install assume pipe buried 0.5m below ground
3.3	PE pipe - 500mm	m	4000	$ 219	$ 876,800	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	For install assume pipe buried 0.5m below ground
3.4	PE pipe - 350mm	m	3000	$ 109	$ 326,400	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	For install assume pipe buried 0.5m below ground
3.5	Sealed Road Crossing	ea	1	$ 15,000	$ 15,000	Include appropriate backfilling, compaction and resurfacing	Traffic control required as SH.
3.6	Manholes	ea	20	$ 2,000	$ 40,000	Includes a port for inspection and air relief valve	Every 500m of pipe length
3.7	Gravel Road / Driveway Crossing	ea	4	$ 5,000	$ 20,000	Include appropriate backfilling, compaction and resurfacing	
3.8	Reinstatement of fences etc.	LS	1	$ 2,000	$ 2,000	Nominal estimate based on approximately 1 weeks work by a fencing contractor to repair existing fences no new fences.	
3.9	Pipe to Farm Turnouts	m	1000	$ 50	$ 50,000	Nominal length estimated based on number of irrigators and size of surround properties.	Assume most properties can access the mainline.
3.10	Road / Driveway Crossing for turnouts	ea	3	$ 3,000	$ 9,000	Include appropriate backfilling, compaction and resurfacing	Allows crossing of Blackstone Hill Run Road
3.11	Farm Turnouts	ea	10	$ 15,000	$ 150,000	Flow and pressure meter (local readout) and manual gate valve in simple housing. Sized for average irrigator of 100 ha assume 200mm diameter.	
				Item 3 Costs	**$ 3,869,800**		
4	Contingency	%	1	35%	$ 1,679,493	Percent of Items 1, 2, and 3	
	Blackstone Scheme Piped Option Total Capital Cost				**$ 6,478,045**		
	Blackstone Scheme Piped Option Capital Cost (Rounded)				**$ 6,480,000**		
5	**Annual Operational Cost**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
5.1	Operation and Management	LS	1	$ 30,000	$ 30,000	Nominal estimate based on approximately a person quarter time plus vehicle	
5.2	Governance and Administration	LS	1	$ 10,000	$ 10,000	Nominal estimate	
5.3	Maintenance (diversion mainly)	LS	1	$ 10,000	$ 10,000	Nominal estimate	Assumes minimal maintenance required on the new pipe system.
	Blackstone Scheme Piped Option Operational Cost				**$ 50,000**		
	Blackstone Scheme Piped Option Operational Cost (Rounded)				**$ 50,000**		

Notes:
Blackstone Scheme options exclude costs associated with Falls Dam

MANUHERIKIA CATCHMENT FEASIBILITY STUDY
IRRIGATION WATER DISTRIBUTION COST TABLE
OMAKAU SCHEME - MAIN RACE

Option A - Low - Medium raise of Falls Dam

Item No.	Description	Unit	Quantity	Unit Rate	Amount	Comments	Assumptions
1	**Project Management**						
1.1	Construction Management	%	1	7%	$ 159,773	Percent of Capital Cost	
1.2	Engineering and Design	%	1	10%	$ 228,247	Percent of Capital Cost	
				Item 1 Costs	**$ 388,020**		
2	**Consents and Permits**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
2.1	Consenting	%	1	2%	$ 45,649	Percent of Capital Cost	
2.2	Bonds and Insurance	%	1	5%	$ 114,124	Percent of Capital Cost	
				Item 2 Costs	**$ 159,773**		
3	**Capital Cost**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
3.1	Buffer storage pond at end of Main Race	m3	50000	$ 10	$ 500,000	Buffer storage pond to reduce bywash from the main race. Main race including siphon etc is approximately 45km long with a capacity in the order of 50,000 m^3.	Assume a lined turkey nest structure.
3.2	Lauder Siphon 2m3/s capacity	m	1100	$ 888	$ 1,147,470	Supply and install 1.2m diameter welded PE pipe (PN6), buried below existing ground, thrust blocks at corners, river diversion for installation, anchored and protected with concrete below river channel, concrete inlet and outlet structures, access manhole and drain in the middle.	understood to be already planned. Pipe bedding material imported within 10km at excavation placement costs. Allows for increased laying cost for crossing river (200m).
3.3	Automation of main intake gates / controls and increased monitoring	ea	0	$ 150,000	$ -	To improve operation automation of main gates and integration into the existing automated management system. It is understood that this has been completed.	Expected to have required power supply to the site, but understood to not have.
3.4	Automation of secondary distribution race off takes	ea	6	$ 30,000	$ 180,000	To improve operation and reduce bywash. To improve operation automation of gates to six main secondary distribution races (B, C, D, E, F and Clearwater) and integration into the existing automated management system. Nominal estimate based on upgrading and automating the existing intake to be feed into existing (i.e. the Omakau) automated management system.	Assume relatively small gate which can be operated on battery (solar), or hydraulic power and reticulated power electricity supply is not required.
3.5	Upgrading of Main Race and sealing leaks	LS	1	$ 165,000	$ 165,000	Monitoring and inspection of the Main Race indicates that it is in a good state of repair and no major leaks were identified. Not all the approximately 39 Km of actual race was inspected so some upgrading and lining is expected. An allowance for one month with an excavator ($230/hr) and lining of 5 km ($25/m) is included.	Assume clay material for lining is available locally at excavation costs only.
3.6	Distribution race lining and upgrading	LS	1	$ 190,000	$ 190,000	Monitoring and inspection of parts of the secondary distribution races (E Race) identified some leakage. Not all the 50 km of secondary distribution races were inspected. An allowance for one month with an excavator ($230/hr), lining of 5 km ($20/m) and replacement/upgrade of 10 minor structures (farm crossings) at $5,000 each.	
3.7	Turnout upgrades and monitoring	ea	20	$ 5,000	$ 100,000	To allow improved measurement and recording of water use from the larger turnouts. Nominal estimate has been included to cover approximately 20 off-takes.	
				Item 3 Costs	**$ 2,282,470**		
4	Contingency	%	1	35%	$ 990,592	Percent of Items 1, 2, and 3	
	Omakau Scheme Main Race Total Capital Cost				**$ 3,820,855**		
	Omakau Scheme Main Race Capital Cost (Rounded)				**$ 3,830,000**		
5	**Annual Operational Cost**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
5.1	Operation and Management	LS	1	$ 60,000	$ 60,000	Nominal estimate based on approximately one person half time plus vehicle	
5.2	Race clearing and diversion maintenance	LS	1	$ 30,000	$ 30,000	Nominal estimate based on clearing approximately 30 km of race once a season allows for a excavator ($230/hr) for approximately three weeks.	
5.3	Governance and Administration	LS	1	$ 20,000	$ 20,000	Nominal estimate	
5.4	Maintenance structures	LS	1	$ 50,000	$ 50,000	Nominal estimate allows for maintenance of the river diversion and structures.	
	Omakau Scheme Main Race Operational Cost				**$ 160,000**		
	Omakau Scheme Main Race Operational Cost (Rounded)				**$ 160,000**		

Option B - High raise of Falls Dam

Item No.	Description	Unit	Quantity	Unit Rate	Amount	Comments	Assumptions
1	**Project Management**						
1.1	Construction Management	%	1	7%	$ 445,848	Percent of Capital Cost	
1.2	Engineering and Design	%	1	10%	$ 636,926	Percent of Capital Cost	
				Item 1 Costs	**$ 1,082,774**		
2	**Consents and Permits**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
2.1	Consenting	%	1	2%	$ 127,385	Percent of Capital Cost	
2.2	Bonds and Insurance	%	1	5%	$ 318,463	Percent of Capital Cost	
				Item 2 Costs	**$ 445,848**		
3	**Capital Cost**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
3.1	Buffer storage pond at end of Main Race	m3	50000	$ 10	$ 500,000	Buffer storage pond to reduce bywash from the main race. Main race including siphon etc is approximately 45km long with a capacity in the order of 50,000 m^3.	Assume a lined turkey nest structure.
3.2	Lauder Siphon 2.5m3/s capacity	m	1650	$ 1,334	$ 2,371,440	Supply and install 1.6m diameter PE pipe (PN6), buried below existing ground, thrust blocks at corners, river diversion for installation, anchored and protected with concrete below river channel, concrete inlet and outlet structures, access manhole and drain in the middle.	Assume total replacement of existing siphon. Pipe bedding material imported within 10km at excavation placement costs. Allows for increased laying cost for crossing river (200m).
3.3	Upgrade automation of main intake gates / controls and increased monitoring	LS	1	$ 50,000	$ 50,000	Recently installed automation of main gates will need to be modified to cater for high flow.	Assume will require power supply to the site.
3.4	Automation of secondary distribution race off takes	ea	6	$ 30,000	$ 180,000	To improve operation and reduce bywash. To improve operation automation of gates to six main secondary distribution races (B, C, D, E, F and Clearwater) and integration into the existing automated management system. Nominal estimate based on upgrading and automating the existing intake to be feed into existing (i.e. the Omakau) automated management system.	Assume relatively small gate which can be operated on battery (solar), or hydraulic power and reticulated power electricity supply is not required.
3.5	Upgrading of Main Race and sealing leaks	LS	1	$ 450,000	$ 450,000	Monitoring and inspection of the Main Race indicates that it is in a good state of repair and no major leaks were identified. Not all the approximately 39 Km of actual race was inspected. Race to be expanded to cater for increased capacity (capacity to approximately double). An allowance for approximately five months (0.25km/day) with an excavator ($230/hr) and lining of 5 km ($30/m) is included.	Assume clay material for lining is available locally at excavation costs only.
3.6	Upgrading Becks (Manuherikia Syphon) 2.5m3/s capacity	m	1200	$ 1,334	$ 2,027,820	Supply and install 1.6m diameter PE pipe (PN6), buried below existing ground, thrust blocks at corners, river diversion for installation, anchored and protected with concrete below river channel, concrete inlet and outlet structures, access manhole and drain in the middle.	Construct new syphon leave existing one in place. Assume can reuse inlet and outlet works. Allows for increased laying cost for crossing river (500m).
3.7	Upgrading other structures for increased capacity	LS	1	$ 500,000	$ 500,000	Upgrade extend replace other structures as required. A nominal about has been estimated.	Assume most structures can handle increased capacity through accepting increased headloss and some regrading of the race.
3.8	Distribution race lining and upgrading	LS	1	$ 190,000	$ 190,000	Monitoring and inspection of parts of the secondary distribution races (E Race) identified some leakage. Not all the 50 km of secondary distribution races were inspected. An allowance for one month with an excavator ($230/hr), lining of 5 km ($20/m) and replacement/upgrade of 10 minor structures (farm crossings) at $5,000 each.	
3.9	Turnout upgrades and monitoring	ea	20	$ 5,000	$ 100,000	To allow improved measurement and recording of water use from the larger turnouts. Nominal estimate has been included to cover approximately 20 off-takes.	
				Item 3 Costs	**$ 6,369,260**		
4	Contingency	%	1	35%	$ 2,764,259	Percent of Items 1, 2, and 3	
	Omakau Scheme Main Race Total Capital Cost				**$ 10,662,141**		
	Omakau Scheme Main Race Capital Cost (Rounded)				**$ 10,670,000**		
5	**Annual Operational Cost**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
5.1	Operation and Management	LS	1	$ 60,000	$ 60,000	Nominal estimate based on approximately one person half time plus vehicle	
5.2	Race clearing and diversion maintenance	LS	1	$ 30,000	$ 30,000	Nominal estimate based on clearing approximately 30 km of race once a season allows for a excavator ($230/hr) for approximately three weeks.	
5.3	Governance and Administration	LS	1	$ 20,000	$ 20,000	Nominal estimate	
5.4	Maintenance structures	LS	1	$ 50,000	$ 50,000	Nominal estimate allows for maintenance of the river diversion and structures.	
	Omakau Scheme Main Race Operational Cost				**$ 160,000**		
	Omakau Scheme Main Race Operational Cost (Rounded)				**$ 160,000**		

MANUHERIKIA CATCHMENT FEASIBILITY STUDY
IRRIGATION WATER DISTRIBUTION COST TABLE
OMAKAU SCHEME - MAIN RACE

Option C - Piped Option for Beck Flats from Blackstone Race

Item No.	Description	Unit	Quantity	Unit Rate	Amount	Comments	Assumptions
1	**Project Management**						
1.1	Construction Management	%	1	7%	$ 116,523	Percent of Capital Cost	
1.2	Engineering and Design	%	1	10%	$ 166,462	Percent of Capital Cost	
				Item 1 Costs	**$ 282,985**		
2	**Consents and Permits**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
2.1	Consenting	%	1	2%	$ 33,292	Percent of Capital Cost	
2.2	Bonds and Insurance	%	1	5%	$ 83,231	Percent of Capital Cost	
				Item 2 Costs	**$ 116,523**		
3	**Capital Cost**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
3.1	Turnout from Blackstone Race	ea	1	$ 12,500	$ 12,500	Precast concrete headwall with pipe penetration through canal bank and under access road.	
3.2	PE pipe - 600mm	m	3000	$ 269	$ 808,200	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	For install assume pipe buried 0.5m below ground (flat terrain and good access) using re-compacted in-situ material. No special bedding
3.3	PE pipe - 450mm	m	2000	$ 167	$ 334,600	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	For install assume pipe buried 0.5m below ground (flat terrain and good access) using re-compacted in-situ material. No special bedding
3.4	New Becks (Manuherikia Crossing) 0.6m3/s capacity	m	300	$ 1,124	$ 337,320	Supply and install 0.6m diameter PE pipe (PN6), buried below existing ground, thrust blocks at corners, river diversion for installation, anchored and protected with concrete below river channel, concrete inlet and outlet structures, access manhole and drain in the middle.	Allows for increased laying cost for crossing river (fully 300m length). If high option goes ahead could use existing siphon to save cost.
3.5	Manholes	ea	10	$ 2,000	$ 20,000	Includes a port for inspection and air relief valve	Every 500m of pipe length
3.6	Reinstatement of fences etc.	week	1	$ 2,000	$ 2,000	Nominal estimate based on approximately 1 weeks work by a fencing contractor to repair existing fences no new fences.	
3.7	Pipe to Farm Turnouts	m	1000	$ 50	$ 50,000	Nominal length estimated based on number of irrigators and size of surround properties.	Assume most properties can access the mainline.
3.8	Farm Turnouts	ea	10	$ 10,000	$ 100,000	Flow and pressure meter (local readout) and manual gate valve in simple housing. Sized for average irrigator of 100 ha assume 200mm diameter.	
				Item 3 Costs	**$ 1,664,620**		
4	Contingency	%	1	35%	$ 722,445	Percent of Items 1, 2, and 3	
	Beck Flats from Blackstone Piped Option Total Capital Cost				**$ 2,786,574**		
	Beck Flats from Blackstone Piped Capital Cost (Rounded)				**$ 2,790,000**		
5	**Annual Operational Cost**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
5.1	Operation and Management	LS	1	$ -	$ -	Included above	
5.2	Governance and Administration	LS	1	$ -	$ -	Included above	
5.3	Maintenance (intake and turnouts mainly)	LS	1	$ 10,000	$ 10,000	Nominal estimate	Assumes minimal maintence required on the new pipe system.
	Beck Flats from Blackstone Piped Option Operational Cost				**$ 10,000**		
	Beck Flats from Blackstone Operational Cost (Rounded)				**$ 10,000**		

Notes:
Omakau Main Race Scheme Options exclude costs associated with Falls Dam

MANUHERIKIA CATCHMENT FEASIBILITY STUDY
IRRIGATION WATER DISTRIBUTION COST TABLE
HIGH RACE (includes current Dunstan, Lauder, Matakanui and County races)

Option A - Low raise of Falls Dam (Status Quo)

Item No.	Description	Unit	Quantity	Unit Rate	Amount	Comments	Assumptions
1	**Project Management**						
1.1	Construction Management	%	1	7%	$ 96,600	Percent of Capital Cost	
1.2	Engineering and Design	%	1	10%	$ 138,000	Percent of Capital Cost	
				Item 1 Costs	**$ 234,600**		
2	**Consents and Permits**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
2.1	Consenting	%	1	2%	$ 27,600	Percent of Capital Cost	
2.2	Bonds and Insurance	%	1	5%	$ 69,000	Percent of Capital Cost	
				Item 2 Costs	**$ 96,600**		
3	**Capital Cost**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
3.1	Buffer storage pond at end of race systems.	m3	30000	$ 10	$ 300,000	Buffer storage pond to reduce bywash from the race systems. The OIS's Lauder, Dunstan, Matakanui and County races have a combined length of approximately 90km and have an estimated capacity of 10,000 m3. An estimated three new storages each of 10,000 m3 are proposed.	Assume lined turkey nest structures.
3.2	Dunstan intake weir upgrade	LS	1	$ 150,000	$ 150,000	The existing OIS weir on Dunstan Creek has automated gates but the existing sheet pile weir requires maintenance and upgrading, particularly the placement of large rock rip rap protection immediately downstream. A nominal amount has been estimated to up grade the weir.	Note at some stage it is expected that the whole intake will need replacement bu this has not been included in the estimate.
3.3	Upgrade and automation of main intake gates / controls and increased monitoring	ea	4	$ 50,000	$ 200,000	To improve operation automation of intake gates for the main takes (ie Lauder Creek, Dunstan Creek, Thomsons Creek plus allowance for one other) and integration into the existing automated management system.	Assume relatively small gate which can be operated on battery (solar), or hydraulic power and reticulated power electricity supply is not required.
3.4	Automation of secondary distribution race offtakes	ea	6	$ 30,000	$ 180,000	To improve operation and reduce bywash automation of gates on the larger secondary distributio races is required with integration into the existing automated management system. Nominal estimate based on upgrading and automating six gates.	Assume relatively small gate which can be operated on battery (solar), or hydraulic power and reticulated power electricity supply is not required.
3.5	Upgrading of races and sealing leaks	LS	1	$ 200,000	$ 200,000	Monitoring and inspection of parts of the race system identified some leaks and locations where mainteence/upgrade is required. A limited length of the approximately 90 Km of actual race was inspected but some mainteence and upgrading is expected. Some of the races have poor water supply reliability which will limit the viability of extensive upgrades and lining. An allowance for tw months with an excavator ($230/hr) and lining of 5 km ($25/m) is included. It is noted that this will not fully upgrade the network and there will still be areas where the races leaks and upgrades are required.	Assume clay material for lining is available locally at excavation and placement costs only.
3.6	Turnout upgrades and monitoring	ea	30	$ 5,000	$ 150,000	To allow improved measurement and recording of water use from the larger turnouts. Nominal estimate has been included to cover approximately 30 off-takes.	
3.70	Upgrading other structures	LS	1	$ 200,000	$ 200,000	Upgrade replace other structures as required. A nominal about has been estimated.	Assume most structures are in a reasonable state of repair.
				Item 3 Costs	**$ 1,380,000**		
4	Contingency	%	1	35%	$ 598,920	Percent of Items 1, 2, and 3	
	Dunstan, Lauder, Matakanui and County Races Status Quo Total Capital Cost				**$ 2,310,120**		
	Dunstan, Lauder, Matakanui and County Races Status Quo Capital Cost (Rounded)				**$ 2,320,000**		
5	**Annual Operational Cost**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
5.1	Operation and Management	LS	1	$ 120,000	$ 120,000	Nominal estimate based on approximately one person full time plus vehicle	
5.2	Race clearing and diversion maintenance	LS	1	$ 40,000	$ 40,000	Nominal estimate based on clearing approximately 40 km of race once a season allows for a excavator ($230/hr) for approximately four weeks.	
5.3	Governance and Administration	LS	1	$ 20,000	$ 20,000	Nominal estimate	
5.4	Maintenance structures	LS	1	$ 100,000	$ 100,000	Nominal estimate allows for maintenance of the various river diversions and structures.	
	Dunstan, Lauder, Matakanui and County Races Status Quo Operational Cost				**$ 280,000**		
	Dunstan, Lauder, Matakanui and County Races Status Quo Operational Cost (Rounded)				**$ 280,000**		

MANUHERIKIA CATCHMENT FEASIBILITY STUDY
IRRIGATION WATER DISTRIBUTION COST TABLE
HIGH RACE (includes current Dunstan, Lauder, Matakanui and County races)

Option B - Mid raise of Falls Dam and irrigation of 6,500 ha from a new high race. Lauder, Matakanui and County Races Status Quo

Item No.	Description	Unit	Quantity	Unit Rate	Amount	Comments	Assumptions
6	**Project Management**						
6.1	Construction Management	%	1	7%	$ 1,408,285	Percent of Capital Cost	
6.2	Engineering and Design	%	1	10%	$ 2,011,835	Percent of Capital Cost	
				Item 1 Costs	**$ 3,420,120**		
7	**Consents and Permits**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
7.1	Consenting	%	1	2%	$ 402,367.07	Percent of Capital Cost	
7.2	Bonds and Insurance	%	1	5%	$ 1,005,918	Percent of Capital Cost	
				Item 2 Costs	**$ 1,408,285**		
3	**Capital Cost**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
3.1	Buffer storage pond at end of race systems.	m3	30000	$ 10	$ 300,000	Buffer storage pond to reduce bywash from the race systems. New High Race replaces Dunstan races; OIS's Lauder, Matakanui and County races continue to operate. An estimated three new storages each of 10,000 m3 are proposed.	Assume lined turkey nest structures.
3.2	New Dunstan intake weir	LS	1	$ 1,789,433	$ 1,789,433	New Dunstan Creek intake that feeds into the high race will be required. A nominal amount has been estimated for a 2 m³/s intake based on the costing for Loop road intake structure plus 5 km o 2 m³/s feeder race, 50% of which is in difficult terrain and requires lining.	
3.3	High Race - Open race 3 m3/s capacity gentle terrain. Dam to Greenstreet turnout	km	3.6	$ 65,000	$ 234,000	0.3% bed slope in easy terrain. Excavation volume of 13 m3/m. Unlined	
3.4	High Race - Open race 3 m3/s capacity difficult terrain. Dam to Greenstreet turnout	km	1.2	$ 143,600	$ 172,320	0.3% bed slope in difficult terrain. Excavation volume of 28 m3/m. Clay lined.	Clay lining imported within 5km.
3.5	High Race - Open race 2 m3/s capacity gentle terrain. Greenstreet turnout to Manuherikia Siphon.	km	3.6	$ 57,200	$ 205,920	0.15% bed slope in easy terrain. Excavation volume of 11 m3/m. Unlined	
3.6	High Race - Open race 2 m3/s capacity difficult terrain. Greenstreet turnout to Manuherikia Siphon.	km	1.2	$ 123,000	$ 147,600	0.15% bed slope in difficult terrain. Excavation volume of 23 m3/m. Clay lined.	Clay lining imported within 5km.
3.7	High Race - Open race 1 m3/s capacity gentle terrain. Downs - Manuherikia Siphon to Dunstan Siphon.	km	7.3	$ 44,000	$ 321,200	0.15% bed slope in easy terrain. Excavation volume of 8 m3/m. Unlined	
3.8	High Race - Open race 1 m3/s capacity difficult terrain. Downs - Manuherikia Siphon to Dunstan Siphon.	km	4.7	$ 92,000	$ 432,400	0.15% bed slope in difficult terrain. Excavation volume of 16m3/m. Clay lined.	Clay lining imported within 5km.
3.9	High Race - Open race 1 m3/s capacity gentle terrain. Dunstan Lauder - Dunstan Siphon to first distrib.	km	3.1	$ 44,000	$ 136,400	0.15% bed slope in easy terrain. Excavation volume of 8 m3/m. Unlined	
3.10	High Race - Open race 1 m3/s capacity difficult terrain. Dunstan Lauder - Dunstan Siphon to first distrib.	km	1	$ 92,000	$ 92,000	0.15% bed slope in difficult terrain. Excavation volume of 16m3/m. Clay lined.	Clay lining imported within 5km.
3.11	High Race - Open race 0.5 m3/s capacity gentle terrain. Dunstan Lauder - first to second distribs.	km	6.3	$ 34,200	$ 215,460	0.15% bed slope in easy terrain. Excavation volume of 6 m3/m. Unlined	
3.12	High Race - Open race 0.5 m3/s capacity difficult terrain. Dunstan Lauder - first to second distribs.	km	2.2	$ 81,600	$ 179,520	0.15% bed slope in difficult terrain. Excavation volume of 12m3/m. Clay lined.	Clay lining imported within 5km.
3.13	High Race - Open race 0.25 m3/s capacity gentle terrain. Dunstan Lauder - second distrib to Lauder Creek.	km	5.8	$ 28,400	$ 164,720	0.15% bed slope in easy terrain. Excavation volume of 5 m3/m. Unlined	
3.14	High Race - Open race 0.25 m3/s capacity difficult terrain. Dunstan Lauder - second distrib to Lauder Creek.	km	2.2	$ 69,900	$ 153,780	0.15% bed slope in difficult terrain. Excavation volume of 10m3/m. Clay lined.	Clay lining imported within 5km.
3.15	Fencing new race	m	42200	$ 20	$ 844,000	7 wire post and batten fence, assume medium terrain and access but numerous corners.	
3.16	Race Bywashes	ea	4	$ 6,000	$ 24,000	5m wide concrete weir in race bank and across access road to discharge excess water into nearby drainage. A nominal amount has been included to cover 4 bywash structures.	
3.17	Race Main Road Crossings	LS	1	$ 50,000	$ 50,000	Supply and install 1m high by 5m wide by 12m long precast concrete box culvert for two lane sealed road crossings.	
3.18	Race rural road and farm access crossings	ea	20	$ 20,000	$ 400,000	Supply and install 12m long 1.6m diameter PE pipe for rural roads and farm track crossings.	
3.19	Main Race turnouts to secondary distribution network	ea	4	$ 12,500	$ 50,000	Concrete headwall with 500mm pipe penetration through bank and under access road	Excludes gates and automation as covered elsewhere.
3.20	Pipe from Dam Off take to start of race	m	500	$ 1,886	$ 943,100	Supply and install 1.4m diameter welded PE pipe (PN6), buried below existing ground, thrust block at corners, anchored and protected, concrete inlet and outlet structures.	Pipe bedding material imported within 10km at excavation placement costs. Assume crosses dam construction access bridge. Allows for extra laying cost for whole length.
3.21	Greenstreet siphon 2 m3/s capacity.	m	900	$ 1,031	$ 928,080	Supply and install 1.4m diameter welded PE pipe (PN3), buried below existing ground, thrust block at corners, anchored and protected, concrete inlet and outlet structures, access manholes every 500m.	Pipe bedding material imported within 10km at excavation placement costs.
3.22	Manuherikia siphon 1.6 m3/s capacity.	m	3500	$ 1,031	$ 4,036,700	Supply and install 1.4m diameter welded PE pipe (PN9), buried below existing ground, thrust block at corners, river diversion for installation, anchored and protected with concrete below river channel, concrete inlet and outlet structures, access manholes every 500m.	Pipe bedding material imported within 10km at excavation placement costs. Allow for increased laying cost for crossing river (500m).
3.23	Dunstan siphon 0.7 m3/s capacity.	m	1300	$ 645	$ 1,095,260	Supply and install 1.0m diameter welded PE pipe (PN6), buried below existing ground, thrust block at corners, river diversion for installation, anchored and protected with concrete below river channel, concrete inlet and outlet structures, access manholes every 500m.	Pipe bedding material imported within 10km at excavation placement costs. Allow for increased laying cost for crossing river (300m)
3.24	Other small siphons	m	500	$ 269	$ 348,450	Supply and install 0.6m diameter welded PE pipe (PN3), buried below existing ground, thrust block at corners, river diversion for installation, anchored and protected with concrete below river channel, concrete inlet and outlet structures. Assume nominal combined length of 500m.	Pipe bedding material imported within 10km at excavation placement costs. Allow for increased laying cost for crossing river (250m)
3.25	Secondary distribution - Greenstreet PE pipe - 600mm dia PN6	m	800	$ 269	$ 215,520	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	For install assume pipe buried 0.5m below ground (flat terrain and good access) using re-compacted in-situ material. No special bedding
3.26	Secondary distribution - Greenstreet PE pipe - 450mm dia PN6	m	4500	$ 167	$ 752,850	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.27	Secondary distribution - Greenstreet PE pipe - 250mm dia PN6	m	1500	$ 71	$ 106,350	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.28	Secondary distribution - Downs 1 PE pipe - 450mm dia PN6	m	3300	$ 167	$ 552,090	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.29	Secondary distribution - Downs 1 PE pipe - 400mm dia PN6	m	1500	$ 130	$ 195,600	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.30	Secondary distribution - Downs 1 PE pipe - 300mm dia PN6	m	1000	$ 94	$ 93,600	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.31	Secondary distribution - Downs 1 PE pipe - 250mm dia PN6	m	800	$ 71	$ 56,720	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.32	Secondary distribution - Downs 2 PE pipe - 450mm dia PN6	m	1800	$ 167	$ 301,140	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.33	Secondary distribution - Downs 2 PE pipe - 400mm dia PN6	m	1200	$ 130	$ 156,480	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.34	Secondary distribution - Downs 2 PE pipe - 300mm dia PN6	m	500	$ 94	$ 46,800	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.35	Secondary distribution - Dunstan Creek PE pipe - 450mm dia PN6	m	2200	$ 167	$ 368,060	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.36	Secondary distribution - Dunstan Creek 2 PE pipe - 400mm dia PN6	m	2100	$ 130	$ 273,840	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.37	Secondary distribution - Dunstan Creek PE pipe - 300mm dia PN6	m	2500	$ 94	$ 234,000	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.38	Secondary distribution - Dunstan Lauder 1 PE pipe - 550mm dia PN6	m	1000	$ 241	$ 241,000	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.39	Secondary distribution - Dunstan Lauder 1 PE pipe - 450mm dia PN6	m	2000	$ 167	$ 334,600	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.40	Secondary distribution - Dunstan Lauder 1 PE pipe - 400mm dia PN6	m	2000	$ 130	$ 260,800	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.41	Secondary distribution - Dunstan Lauder 1 PE pipe - 300mm dia PN6	m	1400	$ 94	$ 131,040	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.42	Secondary distribution - Dunstan Lauder 2 PE pipe - 450mm dia PN6	m	2000	$ 167	$ 334,600	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.43	Secondary distribution - Dunstan Lauder 2 PE pipe - 400mm dia PN6	m	1500	$ 130	$ 195,600	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.44	Secondary distribution - Dunstan Lauder 2 PE pipe - 300mm dia PN6	m	1200	$ 94	$ 112,320	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.45	Distribution Main Road Crossings	ea	2	$ 15,000	$ 30,000	Include appropriate backfilling, compaction and resurfacing	Traffic control required as fairly busy roads.
3.46	Distribution rural road and farm access crossings	ea	30	$ 5,000	$ 150,000	Include appropriate backfilling, compaction and resurfacing	Limited traffic control and rural roads
3.47	Manholes	ea	70	$ 2,000	$ 140,000	Includes a port for inspection and air relief valve	Every 500m of pipe length
3.48	Reinstatement of fences etc.	week	3	$ 2,000	$ 6,000	Nominal estimate based on approximately 3 weeks work by a fencing contractor to repair existing fences no new fences.	
3.49	Pipe to Farm Turnouts	m	5000	$ 50	$ 250,000	Nominal length estimated based on number of irrigators and size of surround properties.	Assume most properties can access the main race or distributions.
3.50	Road / Driveway Crossing for turnouts	ea	10	$ 3,000	$ 30,000	Include appropriate backfilling, compaction and resurfacing	Allows crossing of various rural roads
3.51	Farm Turnouts	ea	30	$ 15,000	$ 450,000	Flow and pressure meter (local readout) and manual gate valve in simple housing. Sized for average irrigator of 200 ha assume 250mm diameter.	

MANUHERIKIA CATCHMENT FEASIBILITY STUDY
IRRIGATION WATER DISTRIBUTION COST TABLE
HIGH RACE (includes current Dunstan, Lauder, Matakanui and County races)

3.52	Upgrade and automation of main intake gates / controls and increased monitoring	ea	3	$ 50,000	$ 150,000	To improve operation automation of intake gates for the main intakes (ie Lauder Creek, Thomsons Creek plus allowance for one other) and integration into the existing automated management system.	Assume relatively small gate which can be operated on battery (solar), or hydraulic power and reticulated power electricity supply is not required.
3.53	Automation of secondary distribution race off takes	ea	3	$ 30,000	$ 90,000	To improve operation and reduce bywash automation of gates on the larger secondary distribution races is required with integration into the existing automated management system. Nominal estimate based on upgrading and automating three gates.	Assume relatively small gate which can be operated on battery (solar), or hydraulic power and reticulated power electricity supply is not required.
3.54	Upgrading of races and sealing leaks (Lauder, Matakanui and County races)	LS	1	$ 120,000	$ 120,000	Monitoring and inspection of parts of the race system identified some leaks and locations where mainteence/upgrade is required. A limited length of the approximately 65 Km of actual race was inspected but some mainteence and upgrading is expected. Some of the races have poor water supply reliability which will limit the viability of extensive upgrades and lining. An allowance for on month with an excavator ($230/hr) and lining of 3 km ($25/m) is included. It is noted that this will not fully upgrade the network and there will still be areas where the races leaks and upgrades are required.	Assume clay material for lining is available locally at excavation and placement costs only.
3.55	Turnout upgrades and monitoring	ea	15	$ 5,000	$ 75,000	To allow improved measurement and recording of water use from the larger turnouts. Nominal estimate has been included to cover approximately 15 off-takes.	
3.56	Upgrading other structures	LS	1	$ 400,000	$ 400,000	Upgrade extend replace other structures as required. A nominal about has been estimated.	Assume most structures can handle increased capacity through accepting increased headloss and some regrading of the race.
				Item 3 Costs	**$ 20,118,353**		
4	Contingency	%	1	35%	8,731,365	Percent of Items 1, 2, and 3	
	Mid Raise Falls, Lauder, Matakanui and County Races Status Quo Total Capital Cost				**$ 33,678,123**		
	Mid Raise Falls, Lauder, Matakanui and County Races Status Quo Total Cost (Rounded)				**$ 33,680,000**		
5	**Annual Operational Cost**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
5.1	Operation and Management	LS	1	$ 120,000	$ 120,000	Nominal estimate based on approximately one person full time plus vehicle	
5.2	Race clearing and diversion maintenance	LS	1	$ 40,000	$ 40,000	Nominal estimate based on clearing approximately 40 km of race once a season allows for a excavator ($230/hr) for approximately four weeks.	
5.3	Governance and Administration	LS	1	$ 20,000	$ 20,000	Nominal estimate	
5.4	Maintenance structures	LS	1	$ 50,000	$ 50,000	Nominal estimate allows for minor maintenance of structures.	Assumes minimal maintenance required on the new pipe system.
	Mid Raise Falls, Lauder, Matakanui and County Races Status Quo Operational Cost				**$ 230,000**		
	Mid Raise Falls, Lauder, Matakanui and County Races Status Quo Operational Cost (Rounded)				**$ 230,000**		

MANUHERIKIA CATCHMENT FEASIBILITY STUDY
IRRIGATION WATER DISTRIBUTION COST TABLE
HIGH RACE (includes current Dunstan, Lauder, Matakanui and County races)

Option C - High raise of Falls Dam and irrigation of 14,100 ha from a new high race.

Item No.	Description	Unit	Quantity	Unit Rate	Amount	Comments	Assumptions
1	**Project Management**						
1.1	Construction Management	%	1	7%	$ 2,671,061	Percent of Capital Cost	
1.2	Engineering and Design	%	1	10%	$ 3,815,801	Percent of Capital Cost	
				Item 1 Costs	**$ 6,486,862**		
2	**Consents and Permits**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
2.1	Consenting	%	1	2%	$ 763,160	Percent of Capital Cost	
2.2	Bonds and Insurance	%	1	5%	$ 1,907,901	Percent of Capital Cost	
				Item 2 Costs	**$ 2,671,061**		
3	**Capital Cost**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
3.1	Buffer storage pond at end of race systems.	m3	30000	$ 10	$ 300,000	Buffer storage pond to reduce bywash from the race systems. New High Race replaces Dunstan, Lauder, Matakanui and County races. An estimated three new storages each of 10,000 m3 are proposed.	Assume lined turkey nest structures.
3.2	New Dunstan intake weir	LS	1	$ 1,789,433	$ 1,789,433	New Dunstan Creek intake that feeds into the high race will be required. A nominal amount has been estimated for a 2 m³/s intake based on the costing for Loop road intake structure plus 5 km of 2 m³/s feeder race, 50% of which is in difficult terrain and requires lining.	
3.2	High Race - Open race 6 m3/s capacity gentle terrain. Dam to Greenstreet turnout	km	3.6	$ 87,400	$ 314,640	0.3% bed slope in easy terrain. Excavation volume of 19 m3/m. Unlined	
3.3	High Race - Open race 6 m3/s capacity difficult terrain. Dam to Greenstreet turnout	km	1.2	$ 186,500	$ 223,800	0.3% bed slope in difficult terrain. Excavation volume of 41 m3/m. Clay lined.	Clay lining imported within 5km.
3.4	High Race - Open race 5 m3/s capacity gentle terrain. Greenstreet turnout to Manuherikia Siphon.	km	3.6	$ 73,500	$ 264,600	0.15% bed slope in easy terrain. Excavation volume of 18 m3/m. Unlined	
3.5	High Race - Open race 5 m3/s capacity difficult terrain. Greenstreet turnout to Manuherikia Siphon.	km	1.2	$ 160,600	$ 192,720	0.15% bed slope in difficult terrain. Excavation volume of 39 m3/m. Clay lined.	Clay lining imported within 5km.
3.6	High Race - Open race 4 m3/s capacity gentle terrain. Downs - Manuherikia Siphon to Dunstan Siphon.	km	7.3	$ 74,800	$ 546,040	0.15% bed slope in easy terrain. Excavation volume of 17 m3/m. Unlined	
3.7	High Race - Open race 4 m3/s capacity difficult terrain. Downs - Manuherikia Siphon to Dunstan Siphon.	km	4.7	$ 172,800	$ 812,160	0.15% bed slope in difficult terrain. Excavation volume of 36 m3/m. Clay lined.	Clay lining imported within 5km.
3.8	High Race - Open race 4 m3/s capacity gentle terrain. Dunstan Lauder - Dunstan Siphon to first distrib.	km	3.1	$ 74,800	$ 231,880	0.15% bed slope in easy terrain. Excavation volume of 17 m3/m. Unlined	
3.9	High Race - Open race 4 m3/s capacity difficult terrain. Dunstan Lauder - Dunstan Siphon to first distrib.	km	1	$ 172,800	$ 172,800	0.15% bed slope in difficult terrain. Excavation volume of 36 m3/m. Clay lined.	Clay lining imported within 5km.
3.10	High Race - Open race 3.5 m3/s capacity gentle terrain. Dunstan Lauder - first to second and third distribs.	km	6.3	$ 65,100	$ 410,130	0.15% bed slope in easy terrain. Excavation volume of 16 m3/m. Unlined	
3.11	High Race - Open race 3.5 m3/s capacity difficult terrain. Dunstan Lauder - first to second and third distribs.	km	2.2	$ 142,200	$ 312,840	0.15% bed slope in difficult terrain. Excavation volume of 33m3/m. Clay lined.	Clay lining imported within 5km.
3.12	High Race - Open race 3.0 m3/s capacity gentle terrain. Dunstan Lauder - third distrib to Lauder siphon.	km	5.8	$ 63,900	$ 370,620	0.15% bed slope in easy terrain. Excavation volume of 14 m3/m. Unlined	
3.13	High Race - Open race 3.0 m3/s capacity difficult terrain. Dunstan Lauder - third distrib to Lauder siphon.	km	2.2	$ 138,500	$ 304,700	0.15% bed slope in difficult terrain. Excavation volume of 30m3/m. Clay lined.	Clay lining imported within 5km.
3.14	High Race - Open race upgrade 1.6 km of existing race to 3.0 m3/s. Lauder Thomsons - Lauder Siphon to Lauder Thomsons distrib 1.	LS	1	$ 30,000	$ 30,000	Race to be expanded to cater for significantly increased capacity. An allowance for approximately 1 week (0.3km/day) with an excavator ($230/hr) and lining of 0.5 km ($30/m) is included.	Assume clay material for lining is available locally at excavation costs only.
3.15	High Race - Open race 2.0 m3/s capacity gentle terrain. Lauder Thomsons - Lauder Thomsons distrib 1 to distrib 2.	km	1.6	$ 57,200	$ 91,520	0.15% bed slope in easy terrain. Excavation volume of 11 m3/m. Unlined	
3.16	High Race - Open race 2.0 m3/s capacity difficult terrain. Lauder Thomsons - Lauder Thomsons distrib 1 to distrib 2.	km	1.8	$ 123,000	$ 221,400	0.15% bed slope in difficult terrain. Excavation volume of 23 m3/m. Clay lined.	Clay lining imported within 5km.
3.17	High Race - Open race 1.5 m3/s capacity gentle terrain. Lauder Thomsons - Lauder Thomsons distrib 2 to regrade section.	km	10.5	$ 51,400	$ 539,700	0.15% bed slope in easy terrain. Excavation volume of 10 m3/m. Unlined	
3.18	High Race - Open race 1.5 m3/s capacity difficult terrain. Lauder Thomsons - Lauder Thomsons distrib 2 to regrade section.	km	0.7	$ 108,200	$ 75,740	0.15% bed slope in difficult terrain. Excavation volume of 20m3/m. Clay lined.	Clay lining imported within 5km.
3.19	High Race - Open race regrade and upgrade 2.1 km of existing race to 1.5 m3/s. Lauder Thomsons - Lauder Thomsons distrib 2 to Thomsons Siphon.	LS	1	$ 35,000	$ 35,000	Race to be expanded to cater for significantly increased capacity. An allowance for approximately 2 weeks (0.2km/day) with an excavator ($230/hr) and lining of 0.5 km ($30/m) is included.	Assume clay material for lining is available locally at excavation costs only.
3.20	High Race - Open race upgrade 5.0 km of existing Matakanui race to 1.5 m3/s. Thomsons Matakanui Station - Thomsons siphon to distrib 1.	LS	1	$ 35,000	$ 35,000	Race to be expanded to cater for significantly increased capacity. An allowance for approximately 2 weeks (0.5km/day) with an excavator ($230/hr) and lining of 0.5 km ($30/m) is included.	Assume clay material for lining is available locally at excavation costs only.
3.21	High Race - Open race 1.5 m3/s capacity gentle terrain. Thomsons Matakanui Station - distrib 1 to distrib 2.	km	3.6	$ 51,400	$ 185,040	0.15% bed slope in easy terrain. Excavation volume of 10 m3/m. Unlined	
3.22	High Race - Open race 1.0 m3/s capacity gentle terrain. Thomsons Matakanui Station - distrib 2 to Matakanui Station.	km	5.2	$ 44,000	$ 228,800	0.15% bed slope in easy terrain. Excavation volume of 8 m3/m. Unlined	
3.23	High Race - Open race 1.0 m3/s capacity difficult terrain. Lauder Thomsons - distrib 2 to Matakanui Station.	km	1.7	$ 92,000	$ 156,400	0.15% bed slope in difficult terrain. Excavation volume of 16m3/m. Clay lined.	Clay lining imported within 5km.
3.24	Fencing new race	m	70300	$ 20	$ 1,406,000	7 wire post and batten fence, assume medium terrain and access but numerous corners.	
3.25	Devonshire Diggings pipe 0.9 m3/s capacity.	m	500	$ 541	$ 270,400	Supply (includes costs of fittings 10% of pipe cost) and install 900 mm diameter welded PE pipe (PN3), buried below existing ground, access manholes every 500m.	For install assume pipe buried 0.5m below ground (flat terrain and good access) using re-compacted in-situ material. No special bedding
3.26	Race Bywashes	ea	6	$ 6,000	$ 36,000	5m wide concrete weir in race bank and across access road to discharge excess water into nearby drainage. A nominal amount has been included to cover 4 bywash structures.	
3.27	Race Main Road Crossings	LS	1	$ 50,000	$ 50,000	Supply and install 1m high by 5m wide by 12m long precast concrete box culvert for two lane sealed road crossings.	
3.28	Race rural road and farm access crossings	ea	30	$ 20,000	$ 600,000	Supply and install 12m long 1.6m diameter PE pipe for rural roads and farm track crossings.	
3.29	Main Race turnouts to secondary distribution network	ea	9	$ 12,500	$ 112,500	Concrete headwall with 500mm pipe penetration through bank and under access road	Excludes gates and automation as covered elsewhere.
3.30	Pipe from Dam Off take to start of race	m	350	$ 3,522	$ 1,232,770	Supply and install 2 x 1.6m diameter welded polyethylene (PE) pipe (PN9), buried below existing ground, thrust blocks at corners, river diversion for installation, anchored and protected with concrete below river channel, concrete inlet and outlet structures.	Pipe bedding material imported within 10km at excavation placement costs. Assume crosses dam construction access bridge. Allows for extra laying cost for whole length.
3.30	Greenstreet siphon 6 m3/s capacity.	m	900	$ 2,667	$ 2,400,480	Supply and install 2 x 1.6m diameter welded polyethylene (PE) pipe (PN9), buried below existing ground, thrust blocks at corners, river diversion for installation, anchored and protected with concrete below river channel, concrete inlet and outlet structures, access manholes every 500m	Pipe bedding material imported within 10km at excavation placement costs.
3.31	Manuherikia siphon 6 m3/s capacity.	m	3500	$ 2,667	$ 9,762,700	Supply and install 2 x 1.6m diameter welded polyethylene (PE) pipe (PN9), buried below existing ground, thrust blocks at corners, river diversion for installation, anchored and protected with concrete below river channel, concrete inlet and outlet structures, access manholes every 500m	Pipe bedding and protection material imported from within 10km at excavation and placement costs. Allows 10 x normal laying cost for crossing river (500m).
3.32	Dunstan siphon 4 m3/s capacity.	m	1300	$ 1,802	$ 2,598,840	Supply and install 2 x 1.3m diameter welded polyethylene (PE) pipe (PN6), buried below existing ground, thrust blocks at corners, river diversion for installation, anchored and protected with concrete below river channel, concrete inlet and outlet structures, access manholes every 500m	Pipe bedding material imported within 10km at excavation placement costs. Allows 10 x normal laying cost for crossing river (300m)
3.33	Lauder siphon 3 m3/s capacity.	m	500	$ 1,031	$ 686,600	Supply and install 1.4m diameter welded PE pipe (PN6), buried below existing ground, thrust block at corners, river diversion for installation, anchored and protected with concrete below river channel, concrete inlet and outlet structures.	Pipe bedding material imported within 10km at excavation placement costs. Allows 10 x normal laying cost for crossing river (200m)
3.34	Thomsons siphon 1.5 m3/s capacity.	m	300	$ 645	$ 279,060	Supply and install 1.0m diameter welded PE pipe (PN6), buried below existing ground, thrust block at corners, river diversion for installation, anchored and protected with concrete below river channel, concrete inlet and outlet structures.	Pipe bedding material imported within 10km at excavation placement costs. Allows 10 x normal laying cost for crossing river (100m)
3.35	Other small siphons	m	1000	$ 269	$ 696,900	Supply and install 0.6m diameter welded PE pipe (PN3), buried below existing ground, thrust block at corners, river diversion for installation, anchored and protected with concrete below river channel, concrete inlet and outlet structures. Assume nominal combined river length of 500m.	Pipe bedding material imported within 10km at excavation placement costs. Allows 10 x normal laying cost for crossing river (500m)
3.36	Secondary distribution - Greenstreet PE pipe - 600mm dia PN6	m	800	$ 269	$ 215,520	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	For install assume pipe buried 0.5m below ground (flat terrain and good access) using re-compacted in-situ material. No special bedding
3.37	Secondary distribution - Greenstreet PE pipe - 450mm dia PN6	m	4500	$ 167	$ 752,850	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.38	Secondary distribution - Greenstreet PE pipe - 250mm dia PN6	m	1500	$ 71	$ 106,350	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.39	Secondary distribution - Downs 1 PE pipe - 450mm dia PN6	m	3300	$ 167	$ 552,090	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.40	Secondary distribution - Downs 1 PE pipe - 400mm dia PN6	m	1500	$ 130	$ 195,600	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.41	Secondary distribution - Downs 1 PE pipe - 300mm dia PN6	m	1000	$ 94	$ 93,600	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.42	Secondary distribution - Downs 1 PE pipe - 250mm dia PN6	m	800	$ 71	$ 56,720	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.43	Secondary distribution - Downs 2 PE pipe - 450mm dia PN6	m	1800	$ 167	$ 301,140	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	

MANUHERIKIA CATCHMENT FEASIBILITY STUDY
IRRIGATION WATER DISTRIBUTION COST TABLE
HIGH RACE (includes current Dunstan, Lauder, Matakanui and County races)

3.44	Secondary distribution - Downs 2 PE pipe - 400mm dia PN6	m	1200	$ 130	$ 156,480	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.45	Secondary distribution - Downs 2 PE pipe - 300mm dia PN6	m	500	$ 94	$ 46,800	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.46	Secondary distribution - Dunstan Creek PE pipe - 450mm dia PN6	m	2200	$ 167	$ 368,060	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.47	Secondary distribution - Dunstan Creek 2 PE pipe - 400mm dia PN6	m	2100	$ 130	$ 273,840	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.48	Secondary distribution - Dunstan Creek PE pipe - 300mm dia PN6	m	2500	$ 94	$ 234,000	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.49	Secondary distribution - Dunstan Lauder 1 PE pipe - 550mm dia PN6	m	1000	$ 241	$ 241,000	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.50	Secondary distribution - Dunstan Lauder 1 PE pipe - 450mm dia PN6	m	2000	$ 167	$ 334,600	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.51	Secondary distribution - Dunstan Lauder 1 PE pipe - 400mm dia PN6	m	2000	$ 130	$ 260,800	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.52	Secondary distribution - Dunstan Lauder 1 PE pipe - 300mm dia PN6	m	1400	$ 94	$ 131,040	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.53	Secondary distribution - Dunstan Lauder 2 PE pipe - 450mm dia PN6	m	2000	$ 167	$ 334,600	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.54	Secondary distribution - Dunstan Lauder 2 PE pipe - 400mm dia PN6	m	1500	$ 130	$ 195,600	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.55	Secondary distribution - Dunstan Lauder 2 PE pipe - 300mm dia PN6	m	1200	$ 94	$ 112,320	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.56	Secondary distribution - Dunstan Lauder 3 PE pipe - 450mm dia PN6	m	1500	$ 167	$ 250,950	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.57	Secondary distribution - Dunstan Lauder 3 PE pipe - 400mm dia PN6	m	1500	$ 130	$ 195,600	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.58	Secondary distribution - Dunstan Lauder 3 PE pipe - 300mm dia PN6	m	1000	$ 94	$ 93,600	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.59	Secondary distribution - Greenstreet PE pipe - 600mm dia PN6	m	1700	$ 269	$ 457,980	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.60	Secondary distribution - Lauder Thomsons 1 PE pipe - 450mm dia PN6	m	5600	$ 167	$ 936,880	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.61	Secondary distribution - Lauder Thomsons 1 PE pipe - 400mm dia PN6	m	400	$ 130	$ 52,160	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.62	Secondary distribution - Lauder Thomsons 2 PE pipe - 450mm dia PN6	m	1700	$ 167	$ 284,410	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.63	Secondary distribution - Lauder Thomsons 2 PE pipe - 400mm dia PN6	m	3000	$ 130	$ 391,200	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.64	Secondary distribution - Lauder Thomsons 2 PE pipe - 300mm dia PN6	m	1600	$ 94	$ 149,760	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.65	Secondary distribution - Thomsons Matakanui 1 PE pipe - 450mm dia PN6	m	1300	$ 167	$ 217,490	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.66	Secondary distribution - Thomsons Matakanui 2 PE pipe - 450mm dia PN6	m	1200	$ 167	$ 200,760	Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	
3.67	Distribution Main Road Crossings	LS	1	$ 15,000	$ 15,000	Include appropriate backfilling, compaction and resurfacing	Traffic control required as fairly busy roads.
3.68	Distribution rural road and farm access crossings	ea	30	$ 5,000	$ 150,000	Include appropriate backfilling, compaction and resurfacing	Limited traffic control and rural roads
3.69	Manholes	ea	120	$ 2,000	$ 240,000	Includes a port for inspection and air relief valve	Every 500m of pipe length
3.70	Reinstatement of fences etc.	week	6	$ 2,000	$ 12,000	Nominal estimate based on approximately 6 weeks work by a fencing contractor to repair existing fences no new fences.	
3.71	Pipe to Farm Turnouts	m	5000	$ 50	$ 250,000	Nominal length estimated based on number of irrigators and size of surround properties.	Assume most properties can access the main race or distributions.
3.72	Road / Driveway Crossing for turnouts	ea	20	$ 3,000	$ 60,000	Include appropriate backfilling, compaction and resurfacing	Allows crossing of various rural roads
3.73	Farm Turnouts	ea	50	$ 15,000	$ 750,000	Flow and pressure meter (local readout) and manual gate valve in simple housing. Sized for average irrigator of 200 ha assume 250mm diameter.	
3.74	Upgrade and automation of main intake gates / controls and increased monitoring	ea	3	$ 50,000	$ 150,000	To improve operation automation of intake gates for the main intakes (ie Lauder, Thomsons Creeks plus allowance for one other) and integration into the existing automated management system.	Assume relatively small gate which can be operated on battery (solar), or hydraulic power and reticulated power electricity supply is not required.
3.75	Automation of secondary distribution race off takes	ea	12	$ 30,000	$ 360,000	To improve operation and reduce bywash automation of gates on the larger secondary distribution races is required with integration into the existing automated management system. Nominal estimate based on upgrading and automating twelve gates.	Assume relatively small gate which can be operated on battery (solar), or hydraulic power and reticulated power electricity supply is not required.
				Item 3 Costs	**$ 38,158,013**		
4	Contingency	%	1	35%	$ 16,560,578	Percent of Items 1, 2, and 3	
				High Raise Falls Total Capital Cost	**$ 63,876,514**		
				High Raise Falls Capital Cost (Rounded)	**$ 63,880,000**		
5	**Annual Operational Cost**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
5.1	Operation and Management	LS	1	$ 120,000	$ 120,000	Nominal estimate based on approximately one person full time plus vehicle	
5.2	Race clearing and diversion maintenance	LS	1	$ 40,000	$ 40,000	Nominal estimate based on clearing approximately 40 km of race once a season allows for a excavator ($230/hr) for approximately four weeks.	
5.3	Governance and Administration	LS	1	$ 20,000	$ 20,000	Nominal estimate	
5.4	Maintenance structures	LS	1	$ 50,000	$ 50,000	Nominal estimate allows for minor maintenance of structures.	Assumes minimal maintenance required on the new pipe system.
				High Raise Falls Total Operational Cost	**$ 230,000**		
				High Raise Falls Operational Cost (Rounded)	**$ 230,000**		

Notes:
Excludes detailed considerations of infrastructure associated with private water rights. Assumes private water right holders join the overall scheme.
Excludes any costs associated with Falls Dam.
Assumes the OIS intakes on Lauder, Thomsons and Coal creeks require minimal upgrading, continue to be operated and can be adjusted to feed in to the new high race.
A new intake on Dunstan Creek is required and a nominal amount allowed for that. Further design work is required to determine if Dunstan Creek water can be fed in to the new high race.
Distribution is conceptual at this stage as details of where the water will go are not confirmed.
Excludes all onfarm costs.

MANUHERIKIA CATCHMENT FEASIBILITY STUDY
IRRIGATION WATER DISTRIBUTION COST TABLE
High Race Intake Comparison.

Open Race Option

Item No.	Description	Unit	Quantity	Unit Rate	Amount	Comments	Assumptions
1	**Capital Cost**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
1.1	Pipe from Falls Dam outlet to start of High Race, 6 m³/s capacity.	m	350	$ 3,522	$ 1,232,770	Supply and install 2 x 1.6m diameter welded polyethylene (PE) pipe (PN9), buried below existing ground, thrust blocks at corners, and anchor blocks over bridge.	Pipe bedding and protection material imported from within 10km at excavation and placement costs. Allows 10 x normal laying cost for this section given expected to be in rock and to allow for bridge crossing.
1.2	High Race - Open race 6 m3/s capacity gentle terrain. Dam to Greenstreet turnout	km	3.6	$ 87,400	$ 314,640	0.3% bed slope in easy terrain. Excavation volume of 19 m3/m. Unlined	
1.3	High Race - Open race 6 m3/s capacity difficult terrain. Dam to Greenstreet turnout	km	1.2	$ 186,500	$ 223,800	0.3% bed slope in difficult terrain. Excavation volume of 41 m3/m. Clay lined.	Clay lining imported within 5km.
					$ 1,771,210	BCS	
2	Project Management and Consents etc	%	1	17%	$ 301,106	Percent of BCS	
					$ 2,072,316	DCS	
3	Uncosted items and Contingency	%	1	35%	$ 725,311	Percent of DCS	
				Total Costs	**$ 2,797,627**		

New Intake Option

Item No.	Description	Unit	Quantity	Unit Rate	Amount	Comments	Assumptions
1	**New Intake (Figure 1 and 2)**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
1.1	Power Supply	m	800	$ 175	$ 140,000	Three phase power to the site via overhead power lines.	Power available from Loop Road. Run communication wiring alongside (if not via radio). Assume 11kV overhead and stepdown transformer to 400V and 240 V ($100/mx800=$80k+ tran LS $60k= $140k/800=$175/m
1.2	Site Preparation	ha	1	$ 8,000	$ 8,000	Clearing and grubbing, survey, erosion and sediment controls, etc. on river bank	Allow 2 days with small excavator, 20hrs @$200=$4000+survey LS=$4,000
1.3	Intake Gate Structure	ea	1	$ 165,000	$ 165,000	Construct 10m long x 4m wide x 10m tall reinforced cast-in-place concrete structure. Lower wet well allows water flow and houses gates. Shafts extend into upper level that houses motors, and electrical gear, providing human access.	110m3 reinforced concrete @ $1500/m3=$165000 excluding mechanical and electrical works
1.4	Gates	ea	3	$ 65,000	$ 195,000	Supply and install automated, electric motor-driven vertical gates. 3m high x 2m wide.	Allow 3000kg per gate @$15000/t=$45000 ea+ram+motor$20,000
1.5	Electrical Equipment	LS	1	$ 50,000	$ 50,000	Supply and install 480V MCC with starter buckets to drive gates, PLC for control, remote monitoring gear, low voltage equipment for lights, outlets, etc.	Allow PS = $50,000
1.6	Fence	LS	1	$ 6,000	$ 16,000	With gate for site security around intake structure	Allow 50lm x 2m high security fence (150x100+gatex$1000)
1.7	Intake Basin	m3	2700	$ 20	$ 54,000	30m x 30m x 3m deep unlined basin excavated into ground. Spoils used on site for grading and bunding.	
1.8	Spillway Back to River	m	50	$ 50	$ 2,500	3m wide x 3m deep unlined channel excavated into ground.	
1.9	Rock Filter	m3	540	$ 120	$ 64,800	3m tall well sorted, large diameter, trapezoidal shaped rock pile	Imported material
1.10	Water Management	ea	1	$ 10,000	$ 10,000	River water management (coffer dam and river diversion, dewatering, etc.) to install weir and rock filter on bank	Channel river using small excavator
1.11	Site Preparation	ha	1.5	$ 33,000	$ 49,500	Within river banks. Removal of boulders and gravel from weir footprint area in preparation of concrete weir construction, general grading within river bank to promote flow toward rock filter and fish ladder. Material wasted on site.	Boulders/gravels in river to be removed are 1m thick (2,500 m3)
1.12	Concrete Weir	m	130	$ 23,000	$ 2,990,000	Construction of reinforced concrete weir from bank to bank. 5m tall, vertical upstream face, sloping downstream face with energy dissipator (23m2 cross section). Base tied into rock.	5m height is enough to found the structure on competent rock. Pour in 10m sections, form both faces, allow $1,000/m3
1.13	Fish Ladder	m	160	$ 1,700	$ 272,000	5m wide channel lined with cemented rock	allow 2m3/m@$850
					$ 4,016,800	BCS	
2	Project Management and Consents etc	%	1	17%	$ 682,856	Percent of BCS	
					$ 4,699,656	DCS	
3	Uncosted items and Contingency	%	1	35%	$ 1,644,880	Percent of DCS	
				Total Costs	**$ 6,344,536**		

MANUHERIKIA CATCHMENT FEASIBILITY STUDY
IRRIGATION WATER DISTRIBUTION COST TABLE
Mt Ida Race upstream of Ida Burn

Maintain / upgrade current Mt Ida Race up to Ida Burn

Item No.	Description	Unit	Quantity	Unit Rate	Amount	Comments	Assumptions
1	**Project Management**						
1.1	Construction Management	%	1	7%	$ 52,285.80	Percent of Capital Cost	
1.2	Engineering and Design	%	1	10%	$ 74,694.00	Percent of Capital Cost	
				Item 1 Costs	**$ 126,980**		
2	**Consents and Permits**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
2.1	Consenting	%	1	2%	$ 14,938.80	Percent of Capital Cost	
2.2	Bonds and Insurance	%	1	5%	$ 37,347.00	Percent of Capital Cost	
				Item 2 Costs	**$ 52,286**		
3	**Capital Cost**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
3.1	Repair upgrade Johnstons Creek intake weir	LS	1	$ 61,310	$ 61,310	Install perforated piped gallery intake (100m long and 400 mm diameter) to ensure capture of low flow flows, and reinstate existing weir. Allow for pipe plus install plus 3 days with an excavator ($230/hr) to reinstated the intake weir.	Allow for extra bedding costs for gallery pipe (50m)
3.2	Replace Kirkwood Creek siphon capacity 0.5 m³/s	m	50	$ 1,124	$ 56,220	Supply and install 0.6m diameter welded PE pipe (PN3), buried below existing ground, thrust blocks at corners, river diversion for installation, anchored and protected with concrete below river channel, concrete inlet and outlet structures.	Pipe bedding and protection material available onsite. Allow for increased laying cost for crossing river full length. Assume can reuse existing concrete inlet and out let structures.
3.3	Relay pipe upstream of Hut Creek capacity 1 m³/s	m	100	$ 541	$ 63,280	Supply and install 0.9m diameter welded PE pipe (PN3), buried below existing ground, thrust blocks at corners, concrete inlet and outlet structures. Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	Assume pipe bedding material available onsite. Assume can reuse existing concrete inlet and out let structures. Note pipes may be able to relayed rather than replaced. Access is difficult, allow extra 5 days with excavator $230/hr).
3.4	Replace Scotts Flume with a siphon capacity 1 m³/s	m	200	$ 541	$ 193,660	Supply and install 0.9m diameter welded PE pipe (PN3), buried below existing ground, thrust blocks at corners, concrete inlet and outlet structures. Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	Pipe bedding and protection material available onsite. Allow for increased laying cost for half length (100m), given difficult access, steepness and need for intake and outlet structures.
3.5	Upgrade three largest intakes with perforated piped gallery intakes (Johnstones Creek, Big Bremner Creek and Kirkwoods Creek).	LS	1	$ 209,070	$ 209,070	Install perforated piped gallery intake (3x 100m long and 600 mm diameter) to ensure capture of low flow flows, and reinstate existing weir. Allow for pipe plus install.	Allow for extra bedding costs for gallery pipe (3x50m)
3.6	Automation of Intake Gate / Controls and increased monitoring	LS	4	$ 30,000	$ 120,000	To improve operation and reduce bywash. Nominal estimate based on upgrading and automating the existing intakes at Johnstones Creek, Big Bremner Creek and Kirkwoods Creek and the R Race offtake. Automation to feed into existing (i.e. Hawkdun/Idaburn) flow monitoring system.	Assume relatively small gate which can be operated on battery (solar), or hydraulic power and reticulated power electricity supply is not required.
3.7	Upgrading on Race and sealing leaks	LS	1	$ 43,400	$ 43,400	Monitoring and inspection of the race indicates it requires maintenance but no major leaks were identified. Not all the race was inspected so some upgrading is expected. A nominal allowance has been made to upgrade the race which provides for approximately 2 weeks with an excavator ($230/hr) and replacement of 5 minor structures (farm crossings) at $5,000 each.	
				Item 3 Costs	**$ 746,940**		
4	Contingency	%	1	35%	$ 324,171.96	Percent of Items 1, 2, and 3	
	Maintain / upgrade current Mt Ida Race up to Ida Burn Total Capital Cost				**$ 1,250,378**		
	Maintain / upgrade current Mt Ida Race up to Ida Burn Capital Cost (Rounded)				**$ 1,260,000**		
5	**Annual Operational Cost**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
5.1	Operation and Management	LS	1	$ 30,000	$ 30,000	Nominal estimate based on approximately a person quarter time plus vehicle	
5.2	Race clearing and diversion maintenance	LS	1	$ 20,000	$ 20,000	Nominal estimate based on clearing the approximately 20 km of race once a season allows for a excavator ($230/hr) for approximately 2 weeks.	
5.3	Governance and Administration	LS	1	$ 10,000	$ 10,000	Nominal estimate	
5.4	Maintenance structures	LS	1	$ 30,000	$ 30,000	Nominal estimate allows for maintenance of the river diversion and structures.	
	Maintain / upgrade current Mt Ida Race up to Ida Burn Operational Cost				**$ 90,000**		
	Maintain / upgrade current Mt Ida Race up to Ida Burn Operational Cost (Rounded)				**$ 90,000**		

Extra costs to expand Mt Ida Race from Hills Creek to Ida Burn

Item No.	Description	Unit	Quantity	Unit Rate	Amount	Comments	Assumptions
1	**Project Management**						
1.1	Construction Management	%	1	7%	$ 95,724	Percent of Capital Cost	
1.2	Engineering and Design	%	1	10%	$ 136,748	Percent of Capital Cost	
				Item 1 Costs	**$ 232,472**		
2	**Consents and Permits**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
2.1	Consenting	%	1	2%	$ 27,350	Percent of Capital Cost	
2.2	Bonds and Insurance	%	1	5%	$ 68,374	Percent of Capital Cost	
				Item 2 Costs	**$ 95,724**		
3	**Capital Cost**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
3.1	Replace Scotts Flume with an increased capacity siphon of 2 m³/s rather than 1 m³/s	m	200	$ 490	$ 98,080	Supply and install 1.4m diameter welded PE pipe (PN3), buried below existing ground, thrust blocks at corners, concrete inlet and outlet structures. Supply pipe, includes costs of fittings (10% of pipe cost) plus installation	Pipe laying costs do not change significantly for larger diameter siphon.
3.2	Expand Mt Ida Race from Ida Burn to Hills Creek.	km	22.7	$ 23,000	$ 522,100	Increase capacity from 1 m³/s to 2 m³/s. Assume 50% of length is easy terrain and 50% is steep. Allows for excavator at $230/hr and approximately 0.1 km/day	
3.3	Expand Mt Ida Race from Hills Creek to Johnstones Creek.	km	6.2	$ 23,000	$ 142,600	Increase capacity from 1 m³/s to 2 m³/s. Assume 50% of length is easy terrain and 50% is steep. Allows for excavator at $230/hr and approximately 0.1 km/day	
3.4	Expand Mt Ida Race from Johnstones Creek to Pierces Gorge Creek.	km	8.9	$ 23,000	$ 204,700	Increase capacity from 1 m³/s to 2 m³/s. Assume 50% of length is easy terrain and 50% is steep. Allows for excavator at $230/hr and approximately 0.1 km/day	
3.5	Enlarge other structures	LS	1	$ 400,000	$ 400,000	The intakes at Pierces Gorge Creek, Johnstones Creek, Hills Creek, Wade Creek and Pig Gully Flow will need to expanded as will the siphons over theses creeks. A nominal estimate has been made.	
				Item 3 Costs	**$ 1,367,480**		
4	Contingency	%	1	35%	$ 593,486	Percent of Items 1, 2, and 3	
	Extra costs to expand Mt Ida Race from Hills Creek to Ida Burn Total Capital Cost				**$ 2,289,162**		
	Extra costs to expand Mt Ida Race from Hills Creek to Ida Burn Capital Cost (Rounded)				**$ 2,290,000**		
5	**Annual Operational Cost**	**Unit**	**Quantity**	**Unit Rate**	**Amount**	**Comments**	**Assumptions**
5.1	Expanding the race would not change operational costs significantly.	LS	1	$ -	$ -		
	Extra costs to expand Mt Ida Race from Hills Creek to Ida Burn Operational Cost				**$ -**		
	Extra costs to expand Mt Ida Race from Hills Creek to Ida Burn Operational Cost (Rounded)				**$ -**		

Notes:
Mt Ida Race options exclude costs associated with the proposed Dam or the rest of the scheme past the Ida Burn.

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