June 2015

PRELIMINARY ECOLOGICAL ASSESSMENT

Manuherikia Catchment Feasibility Study

Submitted to:
The Manuherikia Catchment Water Strategy Group

Report Number. 1378110270-4000-R-Rev1-401

REPORT

Golder Associates

Executive Summary

The Manuherikia and Ida valleys are well developed for pastoral activity. Indigenous vegetation and intact indigenous ecosystems are essentially absent from the valley floors. The Land Environment New Zealand (LENZ) threatened environment classification recognises this with the valley floor Level 4 environment ranked as acutely threatened. The areas on the hillslopes and higher altitude areas are progressively less developed and provide larger areas of indigenous vegetation and the associated fauna. The intermontane basin of the upper Manuherikia Valley above Falls Dam is one of the least modified areas of the Manuherikia Valley

The upper Manuherikia River valley supports a significant array of indigenous plants, birds, lizards and fish. The braided river habitat in the upper Manuherikia River valley provides the only habitat for the Manuherikia alpine galaxiid and habitat for a number of threatened braided river birds. Additionally, the Manuherikia River gorge immediately downstream of Falls Dam and gullies to the east of Falls Dam provide good habitat for threatened plants and lizard species.

Saline wetlands in the lower Manuherikia River catchment provide another unique and restricted ecosystem. These saline areas host a range of threatened plants and invertebrates. These sites are currently recognised in the Otago Regional Council (ORC) water plan as regionally significant wetlands.

The highly modified valley floors downstream of the Loop Road Bridge on the Manuherikia River provide little indigenous species habitat. However, any remaining areas of indigenous vegetation are of high value due to their rarity as indicated by the LENZ threatened environment assessment.

Recent studies have shown the current state of the Manuherikia River and its tributaries is varied. In general, the upper catchment has excellent water quality. However, in the lower reaches of the Manuherikia River at Galloway, the water quality has declined to ‘good’ (ORC 2011). In the tributaries, water quality declines downstream as each stream flows across the Manuherikia or Ida valley floor. Current irrigation in the catchment is dominated by flood irrigation practices. Large application depths are applied which cause saturation of the soil profile, runoff and significant drainage of water through the soil profile. Increased runoff leads to sediment and phosphorus being washed into the watercourses while increased drainage results in leaching of nitrogen. There is potential for algal blooms, although this is currently limited by low levels of nitrogen in the streams.

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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 water storage and water management options for water users within the Manuherikia River catchment.

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 2012a). Six main irrigation companies 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, Blackstone Irrigation Company, Hawkdun / Idaburn Irrigation Company, Ida Valley Irrigation Company, Manuherikia Irrigation Company and the Galloway Irrigation Company. 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 used 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 2012 and references within). This was followed by a Prefeasibility Study which assessed potential development options for improved irrigation within the catchment (Aqualinc 2012). 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).

MCWSG have now commissioned a Feasibility Study (of which this report is a part), which is due for completion in early 2015. The Feasibility Study will 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 is focused on five irrigation development options which were identified in the Prefeasibility Study. 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). An overall site map of the project site is presented on Figure 1.

1.2 Purpose of this Report

This report describes the implications for the feasibility of proposed increased water storage and water use (predominantly for expansion of agricultural irrigation) based on the results of an evaluation of the ecological characteristics of the Manuherikia River catchment. It is based on a review of previous ecological investigations (previously documented in Golder, 2014) and new field studies by Golder in summer and autumn 2014. This is one of a series of reports that assess the feasibility of five irrigation development options in the Manuherikia River catchment. This report assembles the existing information available on the environments, terrestrial, aquatic and avian species and habitats that may be affected by the five proposed water development options for the Manuherikia River catchment and uses the available data to assess:

- The type and significance of environments, terrestrial and aquatic values supported in the Manuherikia River catchment;
- The likely nature and magnitude of any effects on the environment and ecology of the Manuherikia River catchment associated with the proposed development options; and
- Appropriate strategies for mitigation, if required, to address any significant adverse ecological effects.
- Where appropriate, knowledge gaps and the potential need for further work are highlighted.

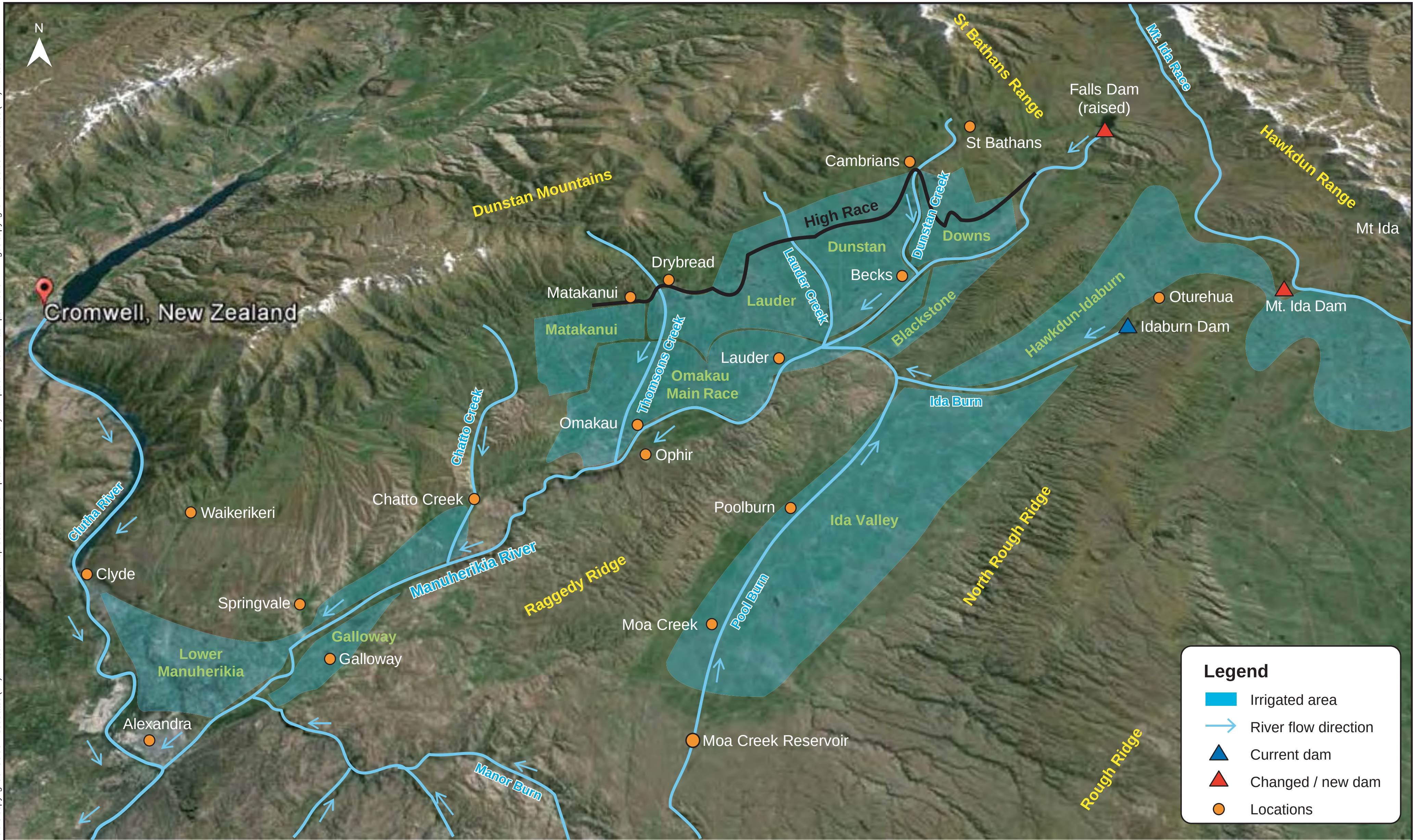
This ecological assessment has relied on the findings of the various other feasibility reports and assessments the most critical of which are outlined below:

- Golder 2015a *Geotechnical Stage Three Report: Fall Dam Preliminary Design and Cost Estimate*. Contains a detailed description of Falls Dam and outlines the proposed construction works associated with the three options for increasing storage at Falls Dam.
- Golder 2015b *Distribution Report:* Contains a description of potential distribution options associated with the five irrigation development options. The distribution report has been used to assess the potential irrigation command area, potential construction works associate with the distribution network and to inundation area associated with the three options for increasing storage at Falls Dam and the Mt Ida Dam.
- Various hydrology reports and letters including Aqualinc 2013a, 2013b and 2014, Golder 2014b, 2014c and 2014d. Two hydrological models have been prepared which allow the hydrological implications of various storage, irrigation and flow regime scenarios to be assessed for both Falls Dam (Aqualinc 2013a) and Mt Ida Dam (Aqualinc 2013b). The Manuherikia Valley model (Aqualinc 2013a) predicts potential changes in flow at various locations down the main stem of the Manuherikia River while the Mt Ida Model is more focused on operation of the dam. The models have been used to determine the potential changes in flow associated with the various irrigation development scenarios. These reports have been used to assess the potential changes in flow that are expected under the five irrigation development scenarios.
- AgResearch 2015 OVERSEER® *Nutrient Budget Modelling in the Manuherikia Catchment.* AgReserach are modelling nutrient loss from various case study farms and the Manuherikia catchment as a whole. Both current nutrient loss and loss under a maximum irrigation development option (i.e., large increase in storage at Falls Dam and construction of the new Mt Ida Dam) are being assessed and will be used to assess potential changes in water quality. At the time of preparing this report the modelling had not been completed. Preliminarily findings indicated that nutrient loss is very dependent on irrigation efficiency and moving from the current predominantly flood based irrigation system to spray irrigation is expected to significantly reduce nutrient loss. Discussion on potential water quality changes will be included in an addendum to this report once the modelling is complete.

This assessment does not consider landscape issues which have been addressed in an associated study (Espie, 2015).

1.3 Report Limitations

Your attention is drawn to the document, “Report Limitations”, as attached in Appendix A. 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, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.



1. AERIAL IMAGE: Google Earth Pro.
2. NOTE: Oblique Basemap – Not to scale.
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TITLE MANUHERIKIA OVERVIEW MAP

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2.0 ECOLOGICAL ASSESSMENT OF THE MANUHERIKIA RIVER CATCHMENT

This section summarises the results of an assessment of the ecological characteristics of the Manuherikia River catchment, including threatened environments and species. A more detailed description of the environments and species present in the catchment is presented in Appendix B.

2.1 Environmental Setting

The Manuherikia River catchment, including both the Manuherikia and Ida valleys, covers an area of approximately 3,000 km^2. The area is surrounded by mountainous terrain with the exception of where it joins the Clutha River / Mata-Au at Alexandra to the south-west. The headwaters lie within the Hawkdun Range. The catchment has two major valleys; the Manuherikia Valley and the Ida Valley which connect via the Pool Burn gorge. The catchment's surrounding terrain and distance from the ocean creates a climate unique in New Zealand that is more "continental" with cold winters, warm summers and high diurnal ranges, (NIWA 2001, ORC 2012). This distinctive combination of climate, topography and geology has led to locally adapted ecosystems and species present in the Manuherikia catchment.

The ecosystems present include:

- Lowland catchment drylands including semi-natural and agricultural landscapes
- Tall tussock and tussock grasslands
- Subalpine and scree slopes
- Grey shrublands
- Wetlands - both upland and lowland
- Lowland cushion/herbfield ecosystems
- Saline ecosystems
- Riverine habitats including some sections of braided river

This broad range of ecosystems also supports a diverse range of indigenous flora and fauna, some of which is unique to Central Otago as described below.

The catchment has a long history of extensive pastoral farming and irrigation which has resulted in the majority of the lowland areas of the catchment being highly modified. Current landuse is dominated by dryland sheep and sheep and beef farming Table 1.

Table 1: Manuherikia Catchment - Current Landuse.

Landuse[1]		**% of Area**
Dryland	Native (including conservation estate, riverbeds and reservoirs)	11.0
	Sheep or Sheep and Beef	76.1
	Beef or Deer	2.8
	Urban areas, Road, Tracks etc.	1.1
	Total dryland	**92.0**
Irrigated	Sheep or Sheep and Beef	6.5
	Beef or Deer	0.5
	Dairy or Dairy support	0.3
	Vineyards, Orchards. Lifestyle Blocks etc.	0.7
	Total Irrigated	**8.0**

Notes: (1) Calculated from Landuse maps used for OVERSEER® modelling (AgResearch 2015 (in Prep)).

2.2 Environment Classification

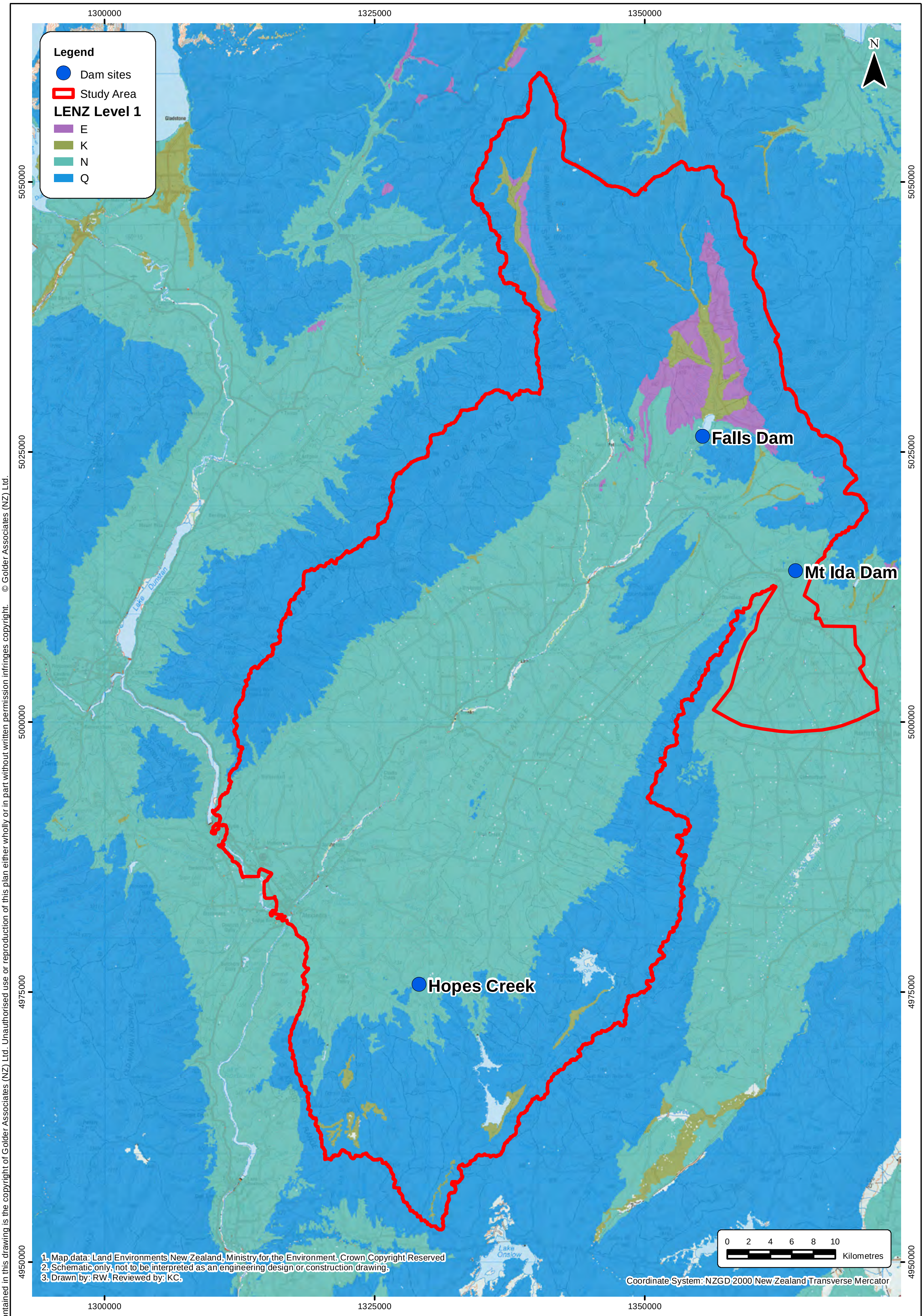
The Land Environment New Zealand (LENZ) environment classification system provides a basis for describing the environments present within the Manuherikia Valley. LENZ uses a range of geologic, climate, soil and geographic (e.g., aspect, elevation) data to cluster land areas with the same or similar attributes into environmental categories (Leathwick et al. 2002, Leathwick et al. 2003). The system has a four tier output that has:

- 20 level 1 broad scale environments useful for national analyses
- 100 level 2 environments useful for national and regional analyses
- 200 level 3 environments useful for regional analyses
- 500 level 4 fine scale environments useful for regional and local analyses

The majority of the Manuherikia Valley and surrounding mountain ranges fall into two Level 1 environments (Figure 2). The valley floors of the Manuherikia and Ida valleys comprise an environment with a cool climate, moderate sunshine and moderate water and vapour deficits. The land is mostly flat and soils are generally alluvial sands and gravels derived from greywacke and schist rocks and these are often overlain by loess. These areas are characterised as 'Environment N – Eastern South Island Plains'. The Dunstan, Saint Bathans and Hawkdun Ranges, parts of the Raggedy Range and Rough Ridge are within Environment Q – Southeastern Hill Country and Mountains. These are areas with a cool climate, low annual and winter solar radiation that lie in the rain shadow of the Southern Alps. This leads to low rainfall and drier conditions than most New Zealand mountain areas. The terrain is often steep although less so in the Manuherikia and Ida valleys and the underlying geology is generally schist or greywacke.

The floor of the upper Manuherikia River valley above Falls Dam comprises a recent flood plain area with alluvial soils derived from greywacke rocks (Environment K – Central Upland Recent Soils). The climate is cool, and water and vapour deficits are low. Rainfall varies from relatively high close to the main divide to low in more eastern areas. The hill slopes at the foot of the Hawkdun and Saint Bathans Ranges comprise gentle hill country with underlying greywacke (Environment E – Central Dry Foothills). The climate is cool and rainfall is low. The Dunstan Creek and Manuherikia River sites for Environment E represent the most southern extent of this environment.

Within each of these Level 1 environments the Manuherikia Valley is divided into one of Level 2, 3, and 4 Environments (Figure 3). Within the Manuherikia Valley 41 level 4 environments are recognised. The distinctive upper Manuherikia River area is again evident at the level 4 classification level.



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TITLE LENZ LEVEL 1 ENVIRONMENTS FOR THE MANUHERIKIA VALLEY

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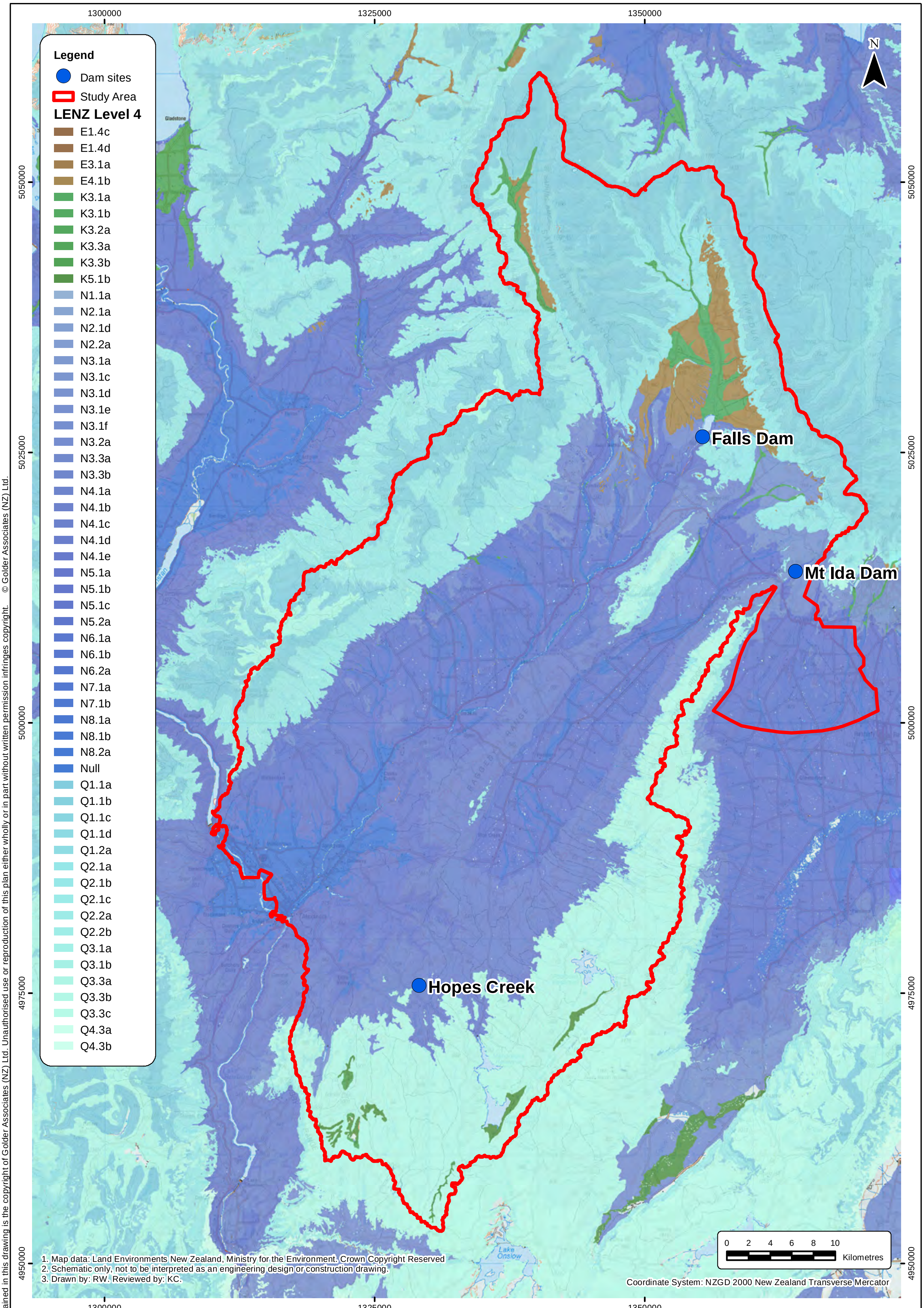

1. Map data: Land Environments New Zealand, Ministry for the Environment, Crown Copyright Reserved
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TITLE LENZ LEVEL 4 ENVIRONMENTS FOR THE MANUHERIKIA VALLEY

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2.2.1 Threatened Environments within the Manuherikia River catchment

LandCare Research and DOC conduct reviews of the threat levels of each level 4 environment using the LENZ level 4 environments, the Land Cover Database (LCBD) and areas of legally protected land (e.g., DOC estate, QE II covenants). A five-tier threat classification is used (Table 2) which provides a measure of both the environmental change that is occurring and the level of protection.

Table 2: LENZ threatened environment classification (Walker et al 2008).

Category	Indigenous vegetation criteria
Acutely threatened	<10 % indigenous cover left
Chronically threatened	10 - 20 % left
At risk	20 - 30 % left
Critically underprotected	>30 % left and <10 % protected
Underprotected	>30 % left and 10 - 20 % protected
Less reduced and better protected	>30 % left and >20 % protected

The current threatened environment classification indicates that all Level 4 environments in the Manuherikia Valley are in the top two categories of the threatened environments with less than10 % (i.e., acutely threatened) or less than 20 % (chronically threatened) of the indigenous vegetation remaining (Figure 4). Areas on the lower hillslopes and in the upper Manuherikia Valley (above Falls Dam) are also threatened or at risk as only up to 30 % remains in indigenous vegetation.

In April 2007, the Minister of Conservation and Minister for the Environment issued a Statement of National Priorities for protecting rare and threatened native biodiversity on private land. The Statement sets the following four priorities:

National Priority 1: To protect indigenous vegetation associated with land environments, (defined by Land Environments of New Zealand at Level IV), that have 20 percent or less remaining in indigenous cover.

National Priority 2: To protect indigenous vegetation associated with sand dunes and wetlands; ecosystem types that have become uncommon due to human activity.

National Priority 3: To protect indigenous vegetation associated with ‘originally rare’ terrestrial ecosystem types not already covered by priorities 1 and 2.

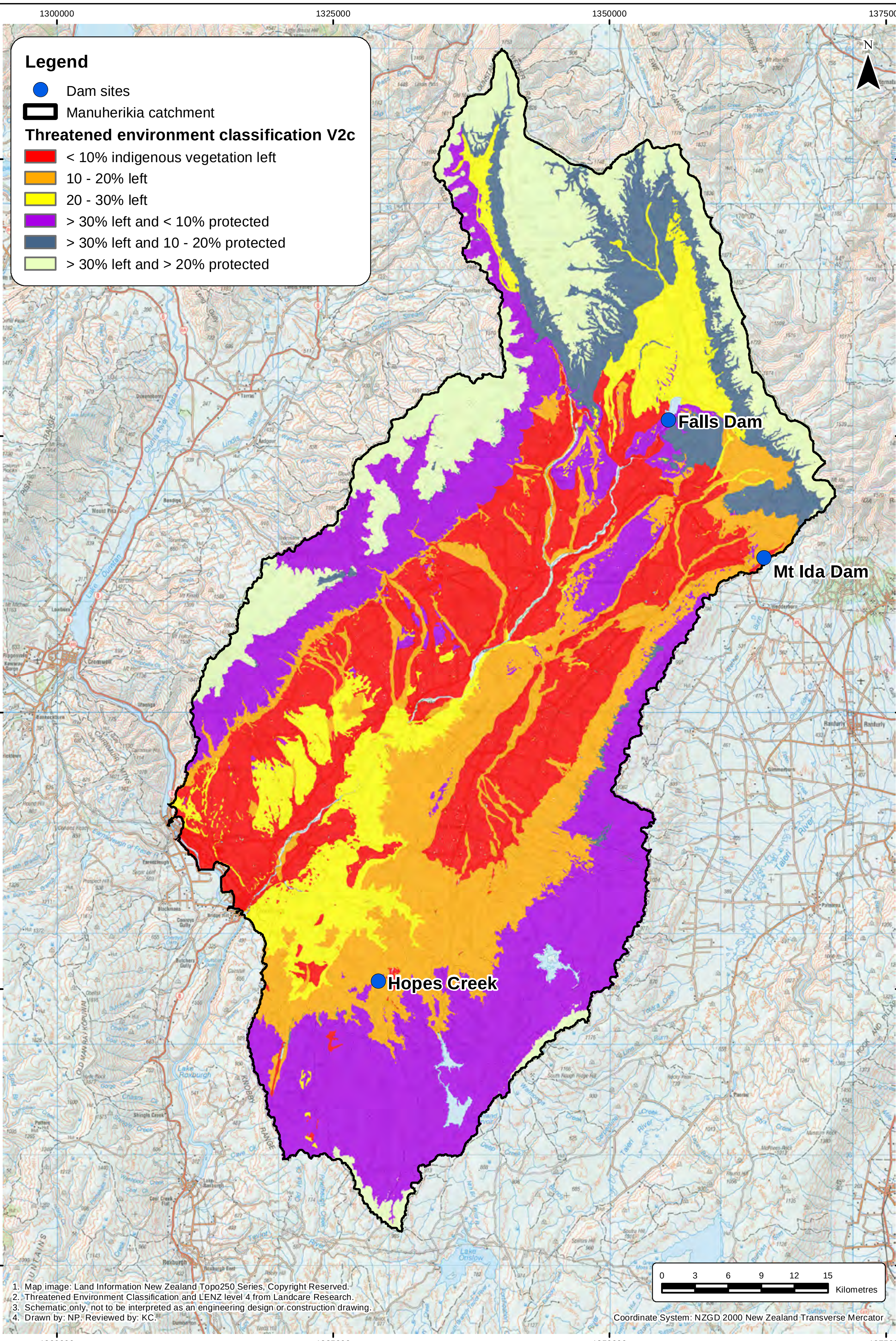
National Priority 4: To protect habitats of acutely and chronically threatened indigenous species.

The valley floors of both the Manuherikia and Ida valleys are highly modified with less than 20 % of their indigenous vegetation remaining (Figure 5) and therefore protection of the remaining indigenous vegetation falls under National Priority 1. Similarly any wetlands within the catchment are covered by National Priority 2. The ‘originally rare’ terrestrial ecosystem types covered by National Priority 3 included inland saline, inland outwash gravels and braided riverbeds which are present within the Manuherikia Catchment.

2.2.2 Threatened species

DOC undertakes a threat ranking process for all native species (flora and fauna) using a standard ranking process (Townsend et al. 2008). This ranking classifies species according to the number of mature individuals and/or the area the species occupies and the rate of decline or increase the species is undergoing. This ranking has three categories for Threatened species: Nationally Critical, Nationally Endangered and National Vulnerable. Additional species are classified as At Risk with a series of qualifiers declining, naturally uncommon, relict and recovering. If insufficient data is available to conduct a ranking for a species it is classified as data deficient. The DOC threat ranking has no legal status and does not convey any protection for the threatened species. However, protection is provided for the majority of indigenous fauna via the Wildlife Act and the Conservation Act.

Table 3 highlights the species from DOC’s treat rankings that are present or likely to be present in the Manuheirkia and Ida valleys.



1. Map image: Land Information New Zealand Topo250 Series, Copyright Reserved.
2. Threatened Environment Classification and LENZ level 4 from Landcare Research.
3. Schematic only, not to be interpreted as an engineering design or construction drawing.
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TITLE THREATENED ENVIRONMENT CLASSIFICATION V2C

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Table 3: Threatened and At Risk species present or likely to be present in the Manuherikia and Ida Valleys

	Number of species present or likely to be present						**Comment**
	Threatened Species			**At Risk Species** (no relict or recovering species were identified)		Data deficient	
	National Critical	Nationally endangered	Nationally Vulnerable	Declining	Naturally uncommon		
Plants	14	10	18	33	47	15	Two of the national critical plant species are only known from Central Otago (de Lange et al. 2013). *Aceana aff rorida* is a small herb that grows in damp areas amongst tussock grasses; this plant has only been recorded from the Pool Burn catchment. Kirk's scurvy grass is restricted to saline areas in Central Otago and currently known from only twelve sites centred on the Galloway and Springvale areas (NZPCN 2014a).
Reptiles			Scree skink	Green skink			Scree skinks occupy steep unstable scree slopes and are found at altitudes greater than 700 m on the southern flanks of the Hawkdun Range at sites above the altitudes potentially affected by the Manuherikia water project.
Birds	Black billed gull (Black Stilt)	Black fronted tern	Banded dotterel, Wrybill	Pied oystercatcher			The Manuherikia River above Falls Dam is the focal point for the six species. Black stilts have been historically reported in the area, but none have been reported for several decades.
Fish	Clutha flathead	Alpine galaxias, Central Otago roundhead galaxiid		Longfin eel, koaro			Of the five species alpine galaxias is the only one restricted to just the Manuherikia River catchment and only occurs upstream of Falls Dam.

2.3 Terrestrial Ecosystems of the Manuherikia Valley

2.3.1 Upper catchment and surrounding ranges

The range crests surrounding the upper catchment are part of an ancient erosion surface that forms one of New Zealand's most extensive and ancient landforms. The Oteake Conservation Park is the largest reserve in this area and centres on the Saint Bathans, Ewe, Hawkdun, Ida and Saint Marys Ranges and includes areas of the upper Manuherikia Basin. The draft Otago Conservation Management Strategy (CMS) (DOC 2013) has identified many of the extensive tussock grasslands, successional shrublands, subalpine grasslands, wetlands and scree slopes within the upper Manuherikia valley and surrounding ranges as priority ecosystem sites for protection (DOC 2013). The intact altitudinal vegetation present on both the Saint Bathans and Hawkdun Ranges provide significant biodiversity values and habitat for threatened species.

2.3.2 Lower catchment drylands

The lower catchment drylands, which include the Manuherikia and Ida valley floors, are characterised by semi-natural and agricultural landscapes and wide open spaces set amongst rolling hills. The rain shadow effect of the main divide and ranges to the east of the main divide creates extremely dry conditions leading to highly adapted plant and animal communities. Schist rock formations (tors) often feature prominently on the ridges in the landscape and can also be refuges for threatened plants and animals.

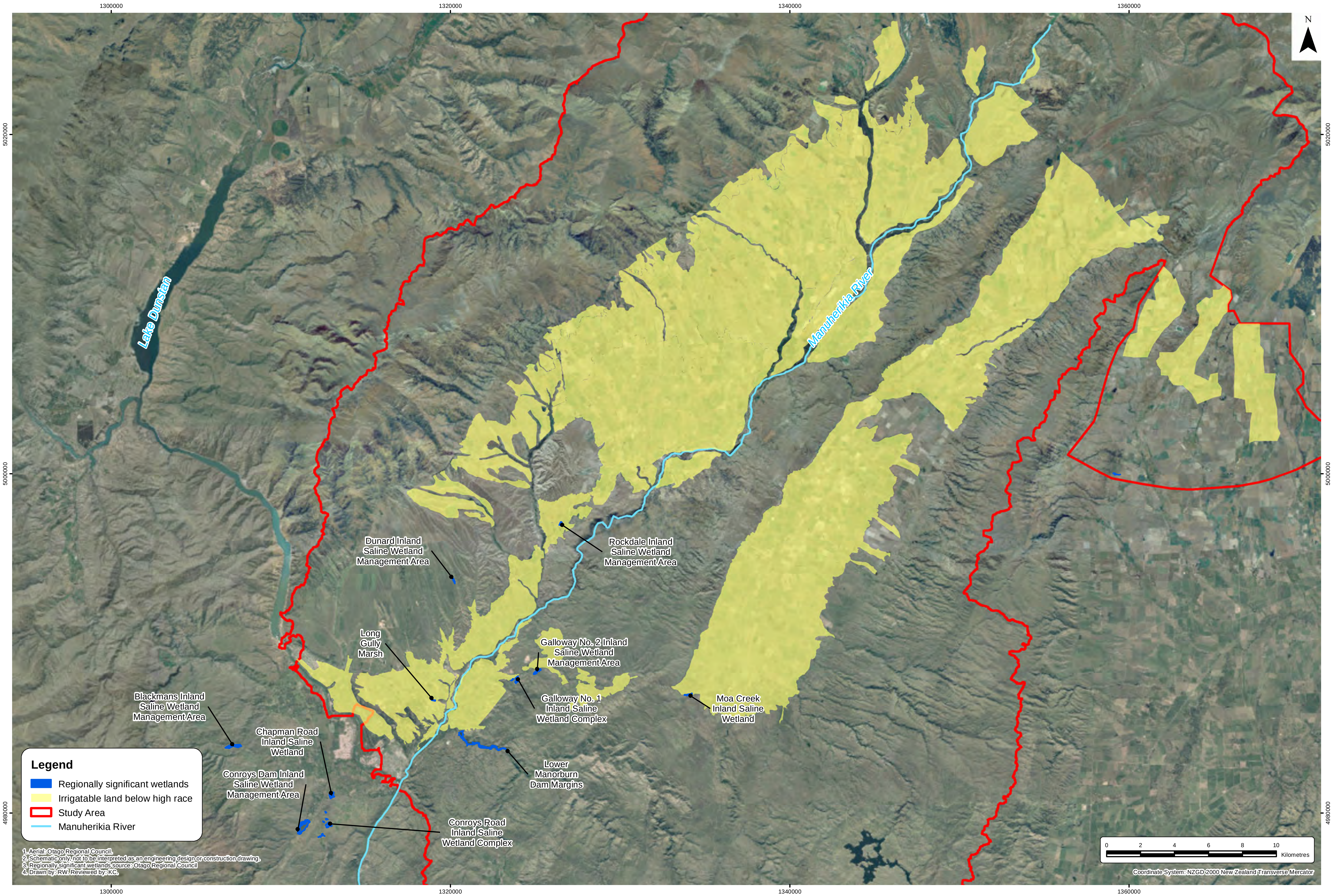
One highly distinctive feature of the drylands is the inland saline ecosystems. These are scattered, small pockets of saline soils and wetlands that contain their own specialised salt-tolerant communities. Five saline sites are recognised in the Manuherikia catchment and these are included in the Otago Regional Plan as regionally significant wetlands. The location of these saline wetland sites is shown relative to the irrigation command area in Figure 5. Four of the five saline wetlands are outside or adjacent to the irrigation command area. The Rockdale saline wetland is located near Chatto Creek near the boundary between the Tiger Hills part of the Omakau Irrigation Scheme and the Manuherikia Irrigation Scheme.

The indigenous ecosystems and landscapes of the drylands have been modified extensively during human settlement. Impacts from gold mining, pastoral farming, weed invasions, fire, pest browsers and more recently cropping, viticulture, horticulture, intensive grazing, dairying, forestry and lifestyle blocks have all lead to widespread loss of the indigenous vegetation. For the indigenous fauna of the lowlands the change in vegetation and land-use coupled with the impacts of introduced predators have led to substantial declines in the range and abundance of many dryland species. However, the Manuherikia catchment does contain some remnant dryland habitats that provide some of the only remaining habitat for some nationally threatened species.

2.3.3 Falls Dam environment

The Home Hills tenure review report (DOC 2006), Grove (1994) and Wildlands (2011) identified a range of terrestrial ecosystems and associated threatened plants in the vicinity of Falls Dam, Fiddlers Flat and along the braided river valley of the upper Manuherikia River Valley. Several of the vegetation communities that are present are now rare nationally and are also home to several declining or threatened species. Figure 6 presents a summary of terrestrial ecosystems in the area around Falls Dam, relative to the potential area of inundation. Areas of bluff rockland and mixed diverse grey shrubland are located within the potential inundation area in the valleys associated with Johnsons Creek and tributaries between Johnsons Creek and Falls Dam.

Browntop (*Agrostis capillaris*) pasture grassland is the dominant vegetation community in the vicinity of the Falls Dam. The development of pasture grassland for grazing has led to vegetation communities dominated by browntop across the Manuherikia riverbed upstream and on the true right bank of the reservoir. Small areas of shrublands and rock bluffs occur on the true left of the Falls Dam reservoir. None of the vegetation communities are restricted to the inundation area with all extending to areas outside the mapped zone.



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TITLE LOCATION OF REGIONALLY SIGNIFICANT WETLAND AREAS IN RELATION TO IRRIGABLE LAND

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Grey shrubland is a feature of the Falls Dam area, being particularly well established on the rocky slopes and gullies on the eastern side of the reservoir and along both sides of the Manuherikia River below the dam wall.

Localised patches of usually low-stature matagouri with golden speargrass and extensive browntop are common on the western side of Falls Dam reservoir. 'At risk' coral broom (*Carmichaelia crassicaulis* subsp. *Crassicaulis,* see photograph in Appendix B) is commonly associated with this shrubland, with a large mixed age population present within a stock exclusion area along a 10 m wide strip of the western shore of Falls Dam reservoir.

Sparsely vegetated scree is present above the reservoir, particularly just upstream of Falls Dam (see photograph in Appendix B). Screes, characterised by large blocky boulders and no interstial soils, are sparsely vegetated (0.2 % cover), but where the scree is more stable with gravel and soil present, vegetation cover may be 5 %.

The Falls Dam area is characterised by the presence of acidic greywacke rock outcrop systems that extend up the tributaries on the east side of the reservoir, as well as in the gorge below the dam. A particularly extensive bluff system is present midslope in Johnstones Creek (see photograph in Appendix B), where it extends upslope to approximately the 27 m raise impoundment level. The bluffs nestle into often dense grey shrublands. The rocklands vary from steep rock faces with vertical cracks that support a range of native plant species, to more fragmented areas with lots of soil-filled mini-platforms and cracks.

Native species diversity is reasonably high given the acidic nature of the rock. On a rocky spur on the true left of Johnstones Creek, *Hebe buchananii, Luzula ulophylla,* 'At Risk' mat broom *Carmichaelia vexillata, Carex breviculmis, Scleranthus uniflorus* grow in the vicinity of a population of Kawarau cress.

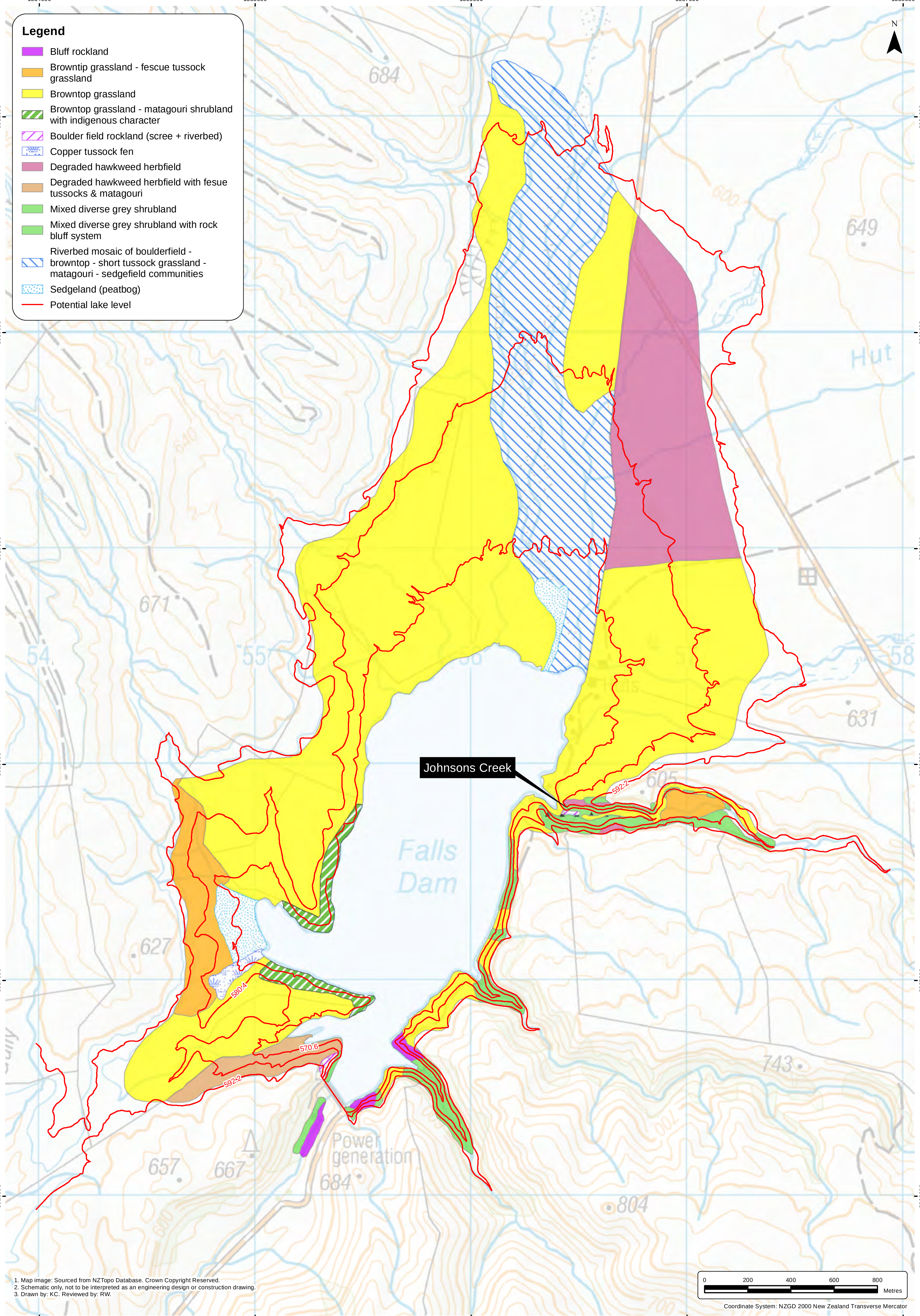
The rock bluffs immediately below Falls Dam support a small population of the threatened Waitaki broom (*Carmichaelia curta*), threatened Kawarau cress, blue-wheat grass (*Elymus falcis*) and *Rytidosperma buchananii*. Current options for increasing the storage of Falls Dam are related to the construction of a new RCC embankment immediately downstream of the current dam (Golder 2015a). Construction methodologies will be finalised during detailed designed however it is anticipated that the construction zone will stretch for approximately 200 - 300 m downstream of the current embankment. Considerable disturbance is expected within the construction zone which includes the small populations of the threatened Waitaki broom (*Carmichaelia curta*), threatened Kawarau cress, blue-wheat grass (*Elymus falcis*) and *Rytidosperma buchananii*. Downstream of the new embankment disturbance will focus around upgrading the assess road and the formation of an open race both of which will be located on the river terrace and are not expected to impact the rock bluffs.

On the western side of Falls Dam, there is one gently sloping basin where peat has accumulated in conjunction with a copper tussock fen. The threatened marsh arrow-grass (*Triglochin palustris*) was observed growing in a seep at this location.

The upper Manuherikia River that flows into Falls Dam has braided river characteristics and supports a mosaic of plant communities (boulderfield, fescue short tussock grassland, silver tussock grassland, brown top grassland, matagouri shrubland and wetland communities of *Carex* sedgeland and shallow water). The most consistent vegetation feature of the river bed ecosystem is the dominance of the browntop grass, which extends over most of the stable river bed, particularly on the western side of the river.

At Falls Dam three rare ecosystems were recognised by Williams et al 2007:

- A seep within the copper tussock fen area on the true right of Fall Dam reservoir.
- The Manuherikia braided river bed upstream of the reservoir.
- The acidic rock outcrop areas in Johnstones Creek and the other gullies on the Home Hills property and downstream of Falls Dam in the Manuherikia River gorge.



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Coordinate System: NZGD 2000 New Zealand Transverse Mercator

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TITLE SUMMARY MAP OF TERRESTRIAL ECOSYSTEMS AT FALLS DAM

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Three ‘Threatened’ plants and four ‘At Risk’ plant species where identified in the area that could be inundated by an enlarged Falls Dam impoundment or alongside the Manuherikia River immediately downstream of the dam (Table 4). The most abundant rare plant was the Kawarua cress which was relatively abundant on the bluffs in Johnstones Creek and is also present downstream of the dam around Fiddlers Flat (Figure 6). Two of the plants, marsh arrow-grass and willowherb are restricted to the fen on western side of the reservoir (Figure 6). A survey of spring annual plants (Wardle 2015 copy attached in Appendix E) did not find any within the area that could be inundated by an enlarged Falls Dam impoundment.

Table 4: Threatened plants recorded during 2013 – 2014 field surveys in the vicinity of Falls Dam.

Common Name	Species name	Location	Number of plants	Threat category*
Native broom	*Carmichaelia curta*	Downstream of dam	2	Nationally critical
Marsh arrow-grass	*Trigochin palustris*	Seepage western side of reservoir	5	Nationally critical
Kawarau cress	*Lepidium sisymbrioides*	Johnstones Creek SW side of reservoir Downstream of dam on bluff	62 4 4	Nationally endangered
Mat broom	*Carmichaelia vexillata*	Johnstones Creek SW side of reservoir	65 present	At risk declining
Coral broom	*Carmichaelia crassicaulis subsp crassicaulis*	Majority on SW side of reservoir, other scatter throughout survey area	c. 400	At risk declining
-	*Coprosma intertexta*	Johnstones Creek, un-named gullies, reservoir faces and downstream of dam	108	At risk declining
-	*Chenopodium allanii*[#]	Base of bluffs and under dense grey shrubland	Not counted	At risk, naturally uncommon
Willowherb	*Epilobium insulare*	In fen western side of reservoir	Not counted	Data deficient

* threat categories from de Lange et al 2012.
[#] listed as *Einadia allanii* in de Lange et al 2012.

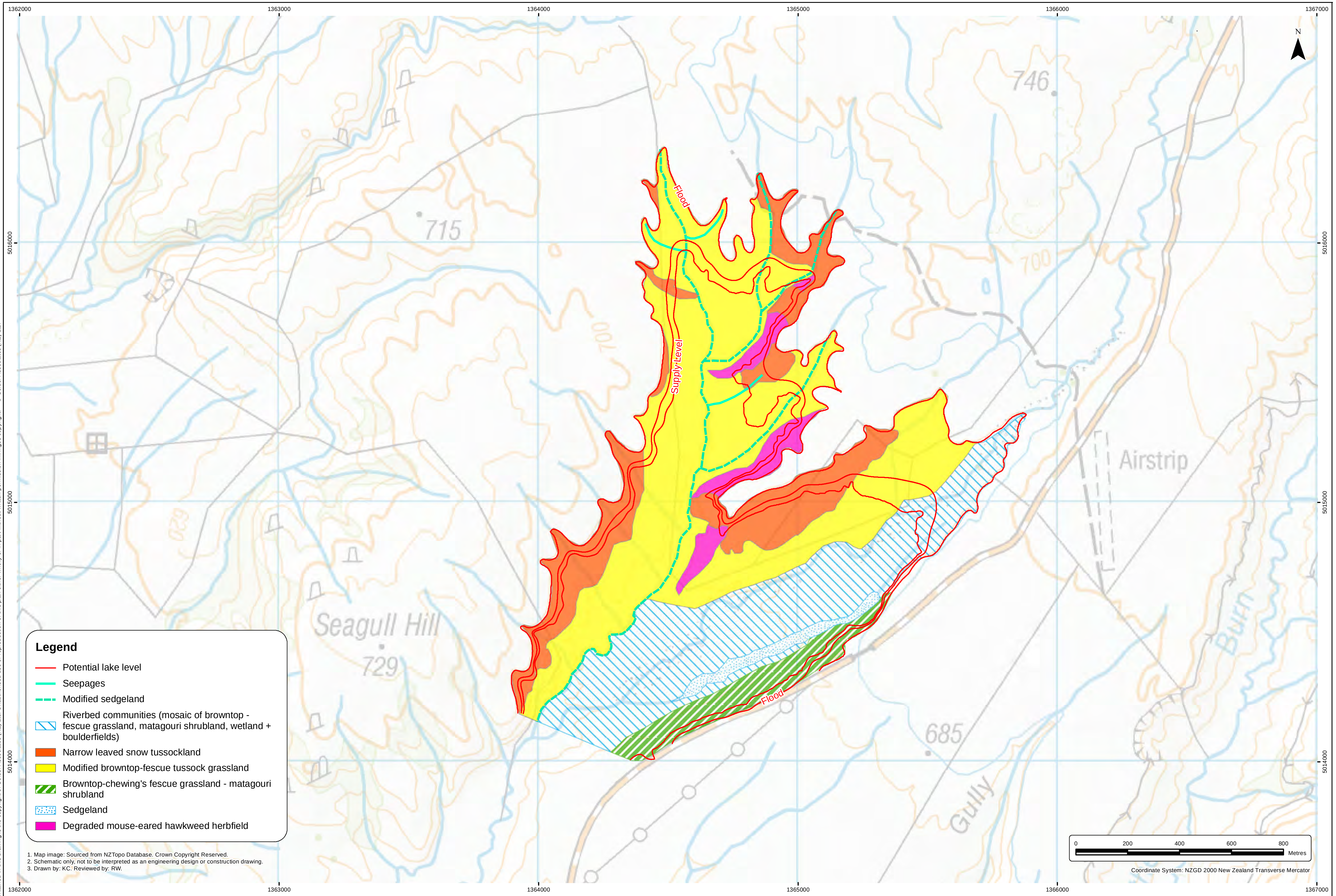
2.3.4 Mount Ida Dam area

Figure 7 summarises the ecosystems present in the vicinity of the proposed Mount Ida Dam impoundment relative to the potential area of inundation.

The Ida Burn braided river bed, which owes its origin to the greywacke rock and periodic flooding, has cut off meanders and levees that support a mosaic of modified hard and silver short tussock grasslands, occasional narrow-leaved snow tussock, and localised patches of matagouri – mingimingi shrubland. These communities are not presented separately on the vegetation map.

The Ida Burn riverbed was dry at time of survey. However, recently flooded channels have sparsely vegetated boulderfields, with scattered native willowherb, bidibid and creeping pohuehue. The vegetation cover elsewhere is a mosaic of grassland, shrubland and hawkweed herbfield.

Native species diversity declines with increasing time since flooding disturbance, and with increasing soil depth. Areas of old flood plain surfaces are dominated by an exotic brown top-Chewing’s fescue grassland that may have residual fescue tussocks and matagouri present - this community also occupies the high terrace surface and risers, and lower hillslopes. Snow tussock frequency and cover increase upstream.



Golder Associates

TITLE SUMMARY MAP OF TERRESTRIAL ECOSYSTEMS AT THE PROPOSED MT IDA DAM IMPOUNDMENT

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Silver tussock short tussock grassland is present on heavier soils on the flood plain. Matagouri shrubland is present on older terraces within the floodplain, and on the adjacent hillsides.

A linear bog extends approximately 800 m along the valley floor at toe slopes on the eastern side of the valley. This permanently wet bog is 5 - 15 m wide, and comprises patches of *Carex secta*, with *C. gaudichaudiana* and sharp spike-sedge (*Eleocharis acuta*), while much of the channel is dominated by *Carex diandra*, exotic oval sedge and soft rush. Patches of comb sedge, *Gonocarpus micranthus*, cudweed, daisy, *Juncus pusillus*, and *Ranunculus amphitrichus* are present at the drier margins of the sedgeland.

A number of seepages flow down the eastern terrace face to the main valley, feeding the linear bog. These appear to arise from a subsurface pan that is deflecting water from its normal downward movement through the gravels. The flushes have flowing water and are predominantly mossy, with *Sphagnum cristatum* present in places, together with native *Carex coriacea*, comb sedge, viola, spike sedge, and wind grass (*Lachnagrostis filiformis*) present with exotic pasture species, musk and selfheal.

The majority of waterways within the dam footprint are small and have limited flow during summer, and support a modified sedgeland community that has been grazed down to a turf. Species are difficult to identify due to their cropped nature. The most modified areas are dominated by exotic species: oval sedge, soft rush, browntop and Yorkshire fog. Native species persist in other areas and include localised sphagnum moss with *Gonocarpus micranthus*; or a matfield of *Leptinella squalida*, *Celmisia gracilenta*, *Ranunculus royi*, white clover, browntop and sweet vernal.

A small tributary channel in the centre of the footprint supports a *Carex gaudichaudiana* sedgeland, which additionally has gentian (*Gentianella grisebachii*), and comb sedge, cutty sedge and sedge tussock at its margins.

A reasonable sized mixed age population (192 plants recorded) of the 'At Risk' sedge *Carex tenuiculmis* is present in a grazed dryish *Carex ovata-C. diandra-C. gaudichaudiana-Eleochaeris gracilis* sedgeland that drains a south-eastern facing slope. A handful of copper tussocks and willowherb are also present.

A very small localised ephemeral wetland (dry at time of survey) occupies a narrow depression within a Chewing's fescue-browntop grassland, and is dominated by native wetland plants including *Crassula sinclairii*, with *Lobelia angulata*, plantain (*Plantago triandra*), *Gonocarpus micranthus*, moss and sedge *C. gaudichaudiana* also present. A larger ephemeral wetland supports a grass that was unable to be identified due to heavy browsing.

Localised ponds of shallow water are present within waterways some of which have red pondweed and floating sweet grass present.

The most widespread vegetation community within the proposed dam footprint is modified browntop-fescue short tussock grassland. On the lower slopes at the western side of the footprint, fescue tussock cover is about 15 %, and is present with exotic pasture grass and clover species. Mouse eared hawkweed is present with 1 – 40 % cover. With increasing altitude or on shady faces, scattered narrow-leaved snow tussocks (*Chionochloa rigida*) are present, grading into patches of narrow-leaved snow tussockland (described later).

Within this grassland, there are localised patches of matfield, dominated by mats of *Gaultheria macrostigma* and *Coprosma atropurpurea,* with grassland daisy (*Celmisia gracilenta*), the mauve flowered grass lily (*Herpolerion novae-zelandiae*) and pasture grasses and clover present.

The high terrace that occupies the eastern side of the footprint supports a browntop-Chewing's fescue exotic grassland, with mouse eared hawkweed common. Scattered native shrub species include matagouri, coral broom, desert broom sub-shrubs the mat-forming turfy coprosma (*Coprosma petriei*) and dwarf mingimingi; herbs, grassland daisy and turf mat daisy (*Raoulia subsericea*); and grasses occasional fescue tussock, blue tussock, plume grass.

This community extends down the terrace face, where increased soil moisture has resulted in taller shrubs and tussocks.

Localised patches of matagouri shrubland are present both on the river flats, and on the adjacent hillslopes. These are dominated by matagouri, with desert broom, coral broom and porcupine shrub occasionally present. Shrublands of the hillslopes have been oversown and top dressed, resulting in a groundcover dominated by pasture grasses, and narrow-leaved snow tussock in places.

Shrublands on the river flats have a ground tier that includes native species such as creeping pohuehue, bidibid, silver tussock, blue wheat grass and *Geranium aff. microphyllum*.

On sunny faces there are localised areas of herbfield with greater than 50 % cover of mouse-eared hawkweed, and an occasional emergent fescue tussock, desert broom or matagouri present. Browntop, Chewing's fescue, and clovers are also present.

The north-facing terrace edge in the centre of the footprint has 65 % bare ground, and supports a degraded herbfield of mouse-eared hawkweed, turfy coprosma, creeping pohuehue, *Scleranthus uniflorus*, and occasional pasture grasses and clovers, blue tussock, and porcupine shrub. About 10 'At Risk' mat broom were recorded.

Relatively dense tall tussock grassland extends down to approximately 750 m asl. (close to the maximum water level), and to lower altitudes on shady faces. Where oversowing and top dressing has taken place, pasture grasses and clovers dominate the intertussock spaces, though scattered matagouri, coral broom, desert broom, Maori onion and golden speargrass may be present.

However, where such development hasn't taken place, or not for some time, a range of native herbs, grasses, and shrubs (including coral broom) are present. Examples of these better tall tussocklands include the shady face in the centre of the dam footprint, and at the northern (higher) extent of the site where tussock cover exceed 50 %. Native intertussock species include blue tussock, *Pimelea oreophila*, comb sedge, *Gaultheria macrostigma*, *Coprosma atropurpurea*, viola, daisy, and the sprawling coprosma (*C. cheesemanii*). Tussock hawkweed is occasionally present.

In the Ida Burn footprint area, three rare ecosystems were identified, two of which are in the wetland category - seepages and flushes, ephemeral wetland, and one in the alpine and inland category – braided river beds.

At Ida Burn, seepages are present on the eastern high terrace riser, and these feed the linear bog feature in the valley floor. In addition, two very small ephemeral wetlands are present; neither support threatened or at risk plants.

The Ida Burn has characteristics of a braided riverbed, and support communities that include relict species of the postulated pre-human vegetation cover for Maniototo Ecological District (Grove 1994) fescue tussock and matagouri, while now dominated by exotic grasses, would have once dominated the very stony areas in the riverbed.

The spring annuals survey (Wardle 2015 (refer Appendix C)) at Mt Ida located the New Zealand mousetail (*Myosurus minimus* subsp *novae-zelandiae*) along a ridgeline within the inundation area. The plants were common at stock camp sites on the ridge immediately west of the Ida Burn. The plant was not found on any other ridgelines or stock camp areas. New Zealand mousetail tends to grow as clusters of plants and determination of the number of plant present is not possible. However, 153 clusters of plants were located and these are estimated to have on average 100 plants. These plants were spread along a 90 m section of the ridge and occurred in an altitudinal range between 675 and 690 m asl. The expected inundation height for the Mt Ida Dam is 680 m so not all the plants are at risk of inundation, although flooding and wave action driven erosion will impact on the population above the 680 m inundation level.

Threatened species at Mount Ida

Of the native vascular plant species present, three are listed as 'Threatened' or 'At Risk' and one as 'Data Deficient' in the most recent threat classification system listing (de Lange et al. 2013). A list of these species with their threat of extinction status and distribution within the dam footprint is provided below in Table 5.

Table 5: Threatened plant species found within the proposed Mount Ida dam footprint.

Super Category	Threat Category	Species	Location
Threatened	Nationally Endangered	New Zealand mouse-tail (*Myosurus minimus* subsp *novae-zelandiae*)	153 plant patches located along the ridgeline in the centre of the dam inundation area.
At Risk	Declining	Sedge (*Carex tenuiculmis*)	192 plants, both mature and young; in modified *Carex* sedgeland in side gully on western side of Ida Burn.
	Declining	Coral broom (*Carmichaelia crassicaulis subsp crassicaulis*)	73 plants recorded; scattered through snow tussock grassland, modified browntop-fescue grassland, and browntop-Chewings fescue-matagouri shrubland on the high terrace surface.
	Declining	Mat broom (*Carmichaelia vexillata*)	10 plants recorded in degraded herbfield on terrace edge at centre of footprint.
Data Deficient		Willowherb (*Epilobium insulare*)	Associated with the *Carex tenuiculmis* population in modified sedgeland.

2.4 Reptiles

The area around Falls Dam and its immediate tributaries has been recognised as good lizard habitat with dense shrubbery, rocky outcrops and scree slopes that provides good feeding, sun basking and predator refuge areas. This habitat extends downstream through the Manuherikia Gorge from immediately below Falls Dam for approximately 1 km and includes the terrace slopes at Fiddlers Flat.

Five lizard species have been reported within the Home Hills pastoral lease: green skink, McCann's skink, common skink, cryptic skink and Southern Alps gecko. Scree skink (a threatened skink), while not confirmed as present may also occupy the gullies in the Home Hills area. This species is known to occupy scree slopes and was found at altitudes greater than 700 m on the nearby southern flanks of the Hawkdun Range at sites above the altitudes potentially affected by the Manuherikia irrigation project. The presence of similar greywacke screes at Falls Dam does provide the appropriate habitat for scree skink and this is the furthest south such habitat exists.

Although not all these species are threatened, all indigenous lizards are protected under the New Zealand Wildlife Act. Any activity that will harm lizards will require permission from the Minister of Conservation and any approval can be expected to include efforts to mitigate effects and transfer lizards away from the area affected.

The area around the proposed Mount Ida Dam is not considered significant lizard habitat although species such as McCann's Skink and common skink are expected to be present. During a site inspection prior to test pitting of the embankment site no significant lizard habitat was identified.

2.5 Birds

The Manuherikia River above Falls Dam regularly supports substantial breeding populations of three threatened bird species, black-billed gull, black-fronted tern, and banded dotterel, and one At Risk species, South Island pied oystercatcher. It also supports a substantial population of southern black-backed gull, a species known to prey on the eggs and chicks of braided river birds. Populations of all species, particularly black-billed gulls, demonstrate natural fluctuations in numbers from year-to-year. Wrybill have been historically reported in the area but were not observed during surveys by Wildlands in 2010, 2011 and 2014 (Wildling, 2015). DOC reported[1] Wrybill in both spring and December 2014. Black stilts have also been historically reported in the area, but none have been reported for several decades.

[1] Email from Jacob Dexter of DOC to Kate Scott of the MCWSG dated 19 January 2015.

Wildlands (2015) (refer Appendix C) has undertaken a detailed assessment of effects on river birds of increasing the height of Falls Dam. Wildlands (2015) concluded that increasing the height of Falls Dam by 27 m would result in a loss of approximately 25 % of the breeding habitat for four key species: black-billed gull, black-fronted tern, banded dotterel and pied oystercatcher. Black-billed gulls and black-fronted terns would be less affected because they nest in colonies and tend to move colony sites from year to year. Banded dotterel and pied oystercatchers are solitary nesters and Wildlands note that a reduction in breeding habitat could result in a similar scale of population reduction. It is also noted that a pest control programme for black-backed gulls could successfully mitigate the potential population reduction of banded dotterel and pied oystercatchers and generally offset adverse effects on river birds.

The area around the proposed Mount Ida Dam is not considered significant bird habitat and no bird issues have been identified.

2.6 Aquatic Ecosystems

Within the Manuherikia River catchment there is a broad range of freshwater habitats including upland and lowland wetlands, braided rivers, reservoirs, large rivers flowing through dryland environments and numerous smaller streams.

Water Quality

Data collected as part of the current study indicate that the water quality of the Manuherikia River itself is relatively good, particularly in the upper reaches, but that the water quality of its tributaries is typically much poorer (Appendix B). Bacterial populations and nutrients in the tributaries were elevated, in particular the lower Ida Burn and Thomsons Creek. Overall, the results of the 2014 survey were consistent with historical ORC monitoring data for the catchment. The gradual degradation in water quality from the upper to lower Manuherikia River can be attributed to the nutrient loads from the tributaries.

Periphyton

The current study found algal abundance in the Manuherikia River was generally low (Appendix B). Thin and medium thickness algal mats were the most common algal communities found. The exception was the Manuherikia River at Loop Road site, where algae formed a thick mat with some additional filamentous algal and the algal community extended across all wadeable areas of the river. Upstream of Falls Dam didymo was present in some areas and in Johnstones Creek formed large continuous thick mats. The presence of didymo upstream of Falls Dam means all reaches of the Manuherikia River downstream of Falls Dam and any tributaries that receive water from Falls Dam will be exposed to didymo. Local stream conditions will then control the extent to which didymo growths are apparent.

The Manuherikia River downstream of the Dunstan Creek confluence had patchy algal communities. The most notable observation was the occurrence of medium to thick black mats at the Omakau - Ophir bridge site. These mats covered less than 10 % of the river bed, but were noteworthy because these are potentially the blue-green algae *Phormidium,* that can at times release toxins to the water.

Macroinvertebrates

Macroinvertebrate taxa richness recorded in the Manuherikia River at Blackstone Hill between late 2009 and late 2013 has ranged from 15 taxa to 24 taxa. The number of “pollution-sensitive” Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa has varied between years, ranging from 7 EPT taxa to 13 EPT taxa, and consequently there has been no clear trend in either increasing or decreasing EPT taxa richness over time. MCI scores recorded over time have ranged from 99 to 108 and have been indicative of “fair” to “good” water and / or habitat quality. The macroinvertebrate indices determined from samples collected in 2014 indicate that tributary sites have poorer water and/or habitat quality.

Details of the available macroinvertebrate data are provided in Appendix B.

Mount Ida Dam

At the proposed Mount Ida Dam site the Ida Burn is a typical small creek which over summer has very limited flow. Downstream of State Highway 85 (approximately 1.5 km downstream of the proposed Mount Ida Dam) the Ida Burn regularly goes dry. Upstream of the proposed dam site the Hawkdun IdaBurn Irrigation Company has approval to divert most of the Ida Burn's summer flow (up to 227 L/s) into the Mount Ida Race to be used predominantly for irrigation. Given the very low summer flows and almost ephemeral nature of the Ida Burn at the proposed Mount Ida Dam site it is not considered to have significant aquatic ecosystem value.

2.7 Fish

The Manuherikia River supports a total of 11 fish species (NZFFD; ORC records, a list of species is provided in Appendix B). Currently three of these species are classified as threatened and two as at risk (Goodman et al 2014) including the Clutha flathead (*Galaxias* spD) that is ranked in the highest category, Nationally Critical. The distribution of the individual fish species is varied with some species present throughout the Manuherikia catchment and others restricted to small areas of the catchment. Figure 8 provides a summary of the distribution of fish species throughout the Manuherikia Catchment relative to the potential inundation and irrigation command area. Individual distribution maps for each fish species are provided in Appendix D.

The most widespread fish in the Manuherikia catchment is the introduced species, brown trout (*Salmo trutta*) and the most widespread native fish is the upland bully (*Gobiomorphus breviceps*). It is also understood that the common bully (*Gobiomorphus cotidianus*), while a native species, has been introduced to many Central Otago reservoirs generally as forage food and bait fish for the trout fisheries.

Alpine galaxias (*Galaxias paucipondylus* aff Manuherikia) is the only fish species restricted to just the Manuherikia River catchment (Appendix D, Figure 1) and only occurs upstream of Falls Dam. It has been recorded sporadically in the braided river reach and possibly once upstream in Johnsons Creek, a tributary of the East Branch of the Manuherikia River. DOC (2009 and 2014) and Golder (this study) provide the most recent survey data indicating that the fish is essentially restricted to the braided section of the upper Manuherikia River and that its occurrence in the first 1 km upstream of the Falls Dam reservoir is more sporadic. In December 2014 DOC surveyed 30 sites on the upper Manuherikia River between Falls Dam (site 1) and the Hawkdun Runs Road Bridge (site 30). Sites 1 to 14 were located below the 592.2 m contour and are within the area that would be inundated by a 27 m raise of Falls Dam. The other 16 sites were located at fairly regular spacing up to the Hawkdun Runs Road Bridge. Large numbers of brown trout were regularly identified up to site 16 after which very low number of brown trout were identified. An essentially opposite trend was found in the numbers of Alpine galaxias. Very low numbers of Alpine galaxias were identified in sites 1-8 after which numbers started to increase with sites from 19 onwards having high numbers of Alpine galaxias particularly sites 23, 25 and 29. These findings mirrored the surveys conducted by Golder in February 2014 the data for which is shown in Appendix B.

Clutha flathead is a stream resident species that occupies small to moderate sized streams from valley floor areas (e.g., Cardrona River) to steep mountain streams (e.g., Cluden Creek). This species is considered limited to the Clutha River Catchment with populations known from the Cardrona River downstream to tributaries of the Tuapeka River. The Clutha flathead has risen rapidly from the lowest to the highest threat ranking in the last ten years as a result of the observed population losses (Hitchmough 2002, Hitchmough et al. 2007, Allibone et al. 2010, Goodman et al 2014). Currently Clutha flathead is present in the Pool Burn and Manor Burn sub-catchments of the Manuherikia catchment. One population of Clutha flathead is present in the upper reaches of Hopes Creek.

Central Otago roundhead galaxias resides in valley floor streams in the Manuherikia and Maniototo (Taieri River catchment) regions. Desktop analysis of populations in the Manuherikia and Ida Burn Valley concluded that stable co-existence occurred between salmonids and Central Otago roundhead galaxias (Leprieur et al. 2006). However, within the Manuherikia Valley the majority of populations discovered in the period 1996 - 2006 have now disappeared (DOC unpublished data). The local extinctions are believed to be due to predominantly trout predation, as Central Otago roundhead galaxias are generally only found in reaches occupied by few if any trout but will also be influenced by drought and low flow effects. A population of Central Otago roundhead galaxias still exists in the Ida Valley in Spain Creek and scattered remnant populations occur in tributaries of the Manuherikia River. No known populations will be affected by the proposed construction of the Mt Ida Dam or the raising of Falls Dam and the inundation of areas upstream of the dams. However, irrigation activity and other farming practices, together with salmonids and climate effects, have the potential to continue to impact on the remaining populations.

Longfin eel has been reported from the Manuherikia River catchment. The lack of fish passage at Roxburgh Dam and the small numbers of elvers transferred upstream of the dam means that eels are now very rarely encountered in the Manuherikia River catchment. Until elver numbers at the Roxburgh Dam increase and a successful trap and transfer operation is underway, eel numbers will remain low in the upper Clutha River catchment.

The final threatened fish in the Manuherikia River is koaro. This is a whitebait species that also forms landlocked populations in some lakes, including lakes Wanaka, Hawea, Wakatipu and Dunstan. It is rare in the Manuherikia River catchment due to a lack of juvenile fish migrating into the Manuherikia River from the rearing habitat in lakes or at sea. Koaro have been noted to pose a threat to the smaller non-migratory galaxiids (e.g., Clutha flathead) and the creation of new reservoirs or enlarging of existing reservoirs may provide koaro juveniles with rearing habitat and is a possible threat to the established non-migratory galaxiids.

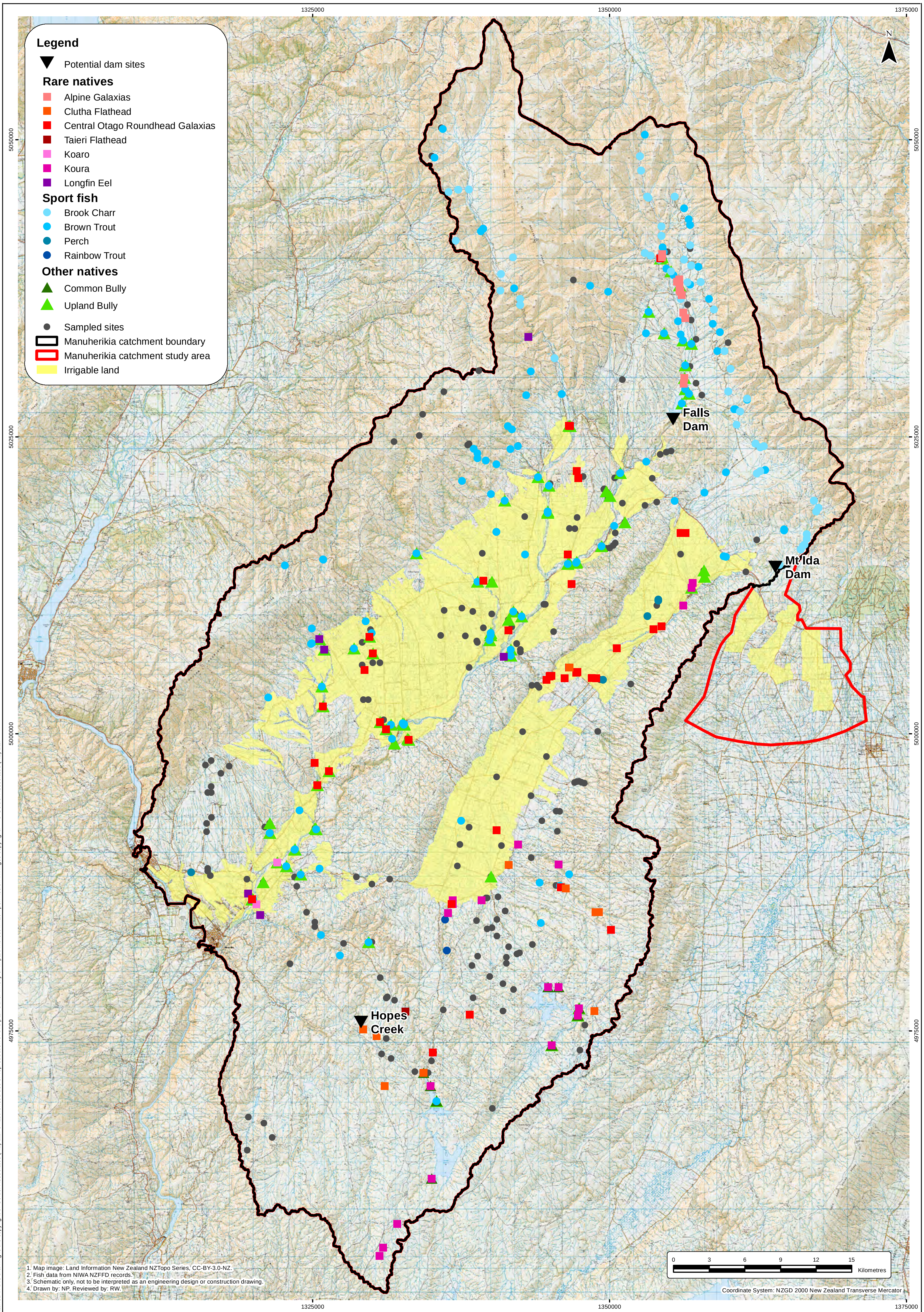
2.7.1 Sport fisheries

The section below has been summarised from data and a draft report provided by Fish & Game Otago (Fish & Game Otago 2013). Brown trout and rainbow trout are the most significant sports fishery values in the Manuherikia Valley with reservoir and riverine fisheries present. Brook char and perch form smaller incidental sports fisheries. Fish survey records show brown trout are widespread whereas the other three species are more restricted in distribution (See Appendix D for distribution maps). Key sports fisheries areas are the main stem of the Manuherikia River and Dunstan Creek and the overall rivers trout fishery is considered regionally significant. The upper Manuherikia River (above Falls Dam) and Dunstan Creek above Loop Road have a remote “backcountry” feel which adds to the overall fishing experience. Falls Dam and the Poolburn, Manorburn and Greenland reservoirs are also popular fishing locations.

In addition to the main water bodies the Manuherikia Catchment has a large number of ponds and wet areas many of which are associated with irrigation. These ponds and wetland provide habitat to waterfowl particularly paradise ducks and Mallards and hunting of wildfowl is a popular local activity.

2.7.2 Mount Ida Dam

The lack of summer flow and almost ephemeral nature of the upper Ida Burn at the proposed Mount Ida Dam site results in it having very limited fishery values.



TITLE DISTRIBUTION OF FISH SPECIES THROUGHOUT THE MANUHERIKIA CATCHMENT

JUNE 2015

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3.0 POTENTIAL ECOLOGICAL EFFECTS OF INCREASING IRRIGATION WITHIN THE MANUHERIKIA RIVER CATCHMENT

3.1 Enlarging Falls Dam Impoundment

3.1.1 General ecological values

Falls Dam and the area upstream is a distinct and rare environment within the Otago region for its terrestrial environmental classification and the braided river habitat. This area represents the furthest southern extension of the Central Dry Foothills environment (LENZ environment E) and also part of the relatively small Central Upland Recent Soils environment (LENZ environment K). The upper Manuherikia River above Falls Dam also provides important braided river habitat in the Manuherikia River catchment. This area supports a number of threatened braided river bird populations and a fish species restricted to just the braided reach of the main stem of the upper Manuherikia River. The terrestrial areas around Falls Dam also support abundant and specious lizard populations including at least one taxa of high conservation value – green skink (west Otago) and possibly scree skink. The best lizard habitat appears to be concentrated in the rocky gorges of tributaries to Falls Dam and downstream in the Manuherikia Gorge. The terrestrial vegetation around the dam also includes a number of threatened and at risk plant species much of which is contained within the Home Hills covenant area.

3.1.2 Potential ecological impacts of enlarging Falls Dam Impoundment

All options to raise Falls Dam will create a larger reservoir thereby inundating some of the braided river system that enters the reservoir. The extent of inundation of the braided river system upstream of the reservoir, for all three dam raise options, are shown on Figure 9.

The upstream extent of the braided river system is evident on aerial photographs where the main stem of the Manuherikia River exits an incised gorge (marked as Point A on Figure 9). South of this point, the ground contours are demonstrably further apart representing a gentler slope where a braided river morphology has formed. Point A on Figure 9 is coincident with the LINZ 700 m contour line and this has been used as the basis for estimating the length of the braided river system. From this, it has been determined that the total length of braided river upstream of the existing Falls Dam reservoir (when full) is 12.8 km.

The consequent loss of braided river habitat for each of the three dam raise options are as follows:

- Total length of braided river for a 570.6 m full storage level: 12.2 km (4.7 % loss, or 0.6 km)
- Total length of braided river for a 580.4 m full storage level: 11.1 km (13.3 % loss, or 1.7 km)
- Total length of braided river for a 592.2 m full storage level: 9.9 km (22.7 % loss, or 2.9 km)

Prior to construction of Falls Dam the braided section of the river is expected to have extended downstream to approximately the site of the current dam i.e. an additional approximately 2.3 km.

For all dam raise options this habitat loss will have impacts on the Manuherikia alpine galaxiid and the nesting area of the nationally critically threatened black-billed gull in the Manuherikia River valley. A proportion of the nesting habitat of the nationally endangered black fronted tern will also be lost as will some threatened plants and a portion of high value lizard habitat around the reservoir edge. The three dam raises will also reduce the area of the Home Hills Covenant, which has a total area of about 102 ha. The extent of inundation is presented on Figure 9.

- Total area of the Home Hills covenant inundated for a 570.6 m full storage level: 1.9 ha (2 % loss)
- Total area of the Home Hills covenant inundated for a 580.4 m full storage level: 4.3 ha (4 % loss)
- Total area of the Home Hills covenant inundated for a 592.2 m full storage level: 12.8 ha (13 % loss)

Field survey work (Golder unpublished data, 2014 and DOC unpublished data, 2014) indicates that the potential effect on the alpine galaxiid of raising Falls Dam is not restricted to inundation of river habitat and loss of habitat. Alpine galaxiids are very rare in the reach immediately upstream of the reservoir for at least some 500 m. The reason for this very low density is at present not understood and at least three options are possibly the cause:

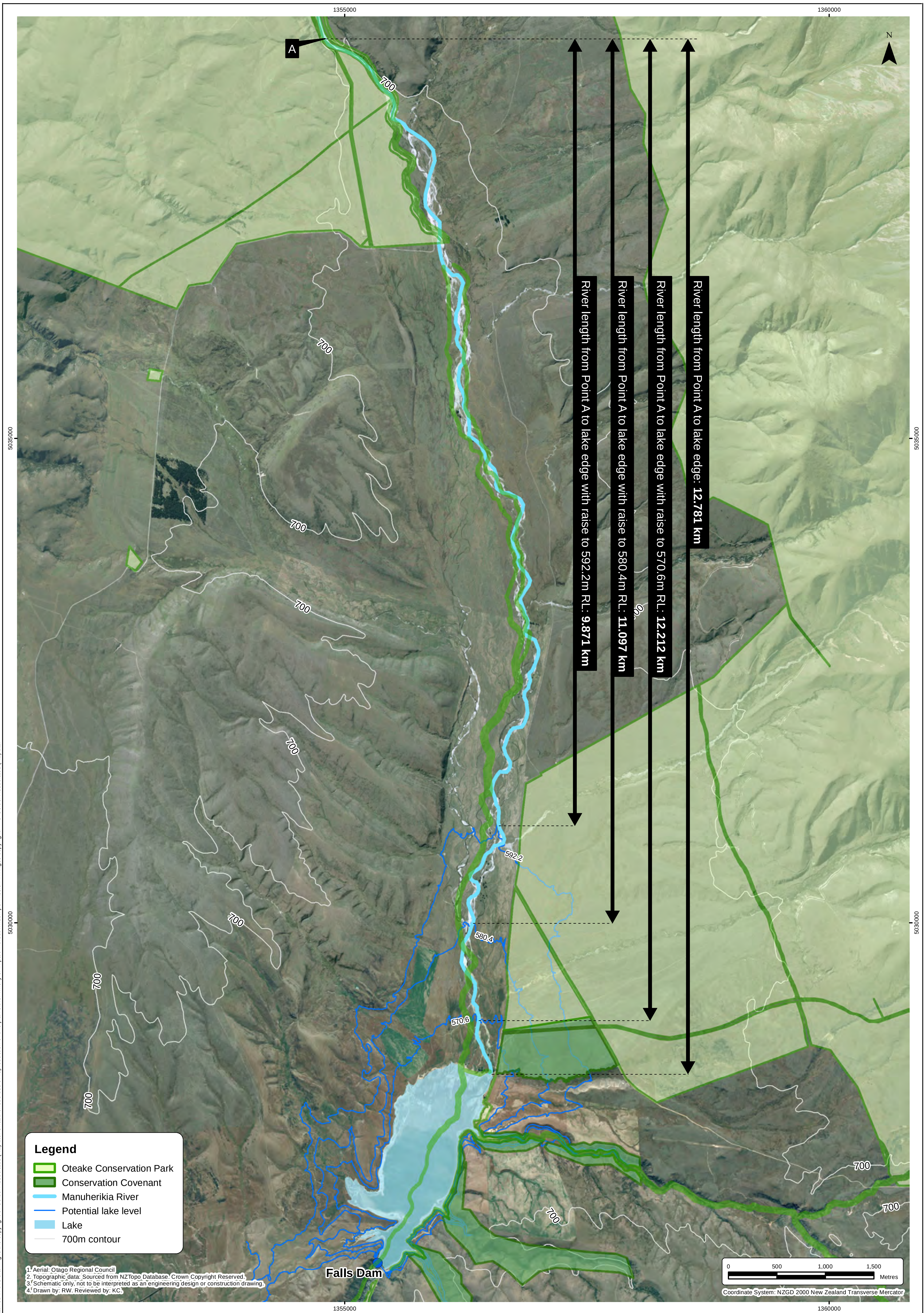
- Salmonids that are resident in the Falls Dam reservoir during winter and spring move upstream in the braided river habitat as the reservoir is drawn down over summer and autumn. These salmonids then prey upon and/or compete with alpine galaxiids, reducing their abundance in the upstream reach; or
- The formation of a delta at the head of the reservoir has created habitat that is too unstable during flood periods to support abundant fish populations and alpine galaxiids are reduced to very low densities due to the flood disturbance of the braids in the delta; or
- Habitat conditions are unsuitable for spawning in the lower section of the river and few larval alpine galaxiids drift downstream to occupy this reach; or
- A combination of these three factors is leading to very low alpine galaxiid density immediately upstream of the reservoir.

Therefore, the potential decline in range for the alpine galaxias is likely to be due to two factors, habitat loss (via inundation) and for an additional area upstream of the raised reservoir as trout displaces, or unsuitable delta habitat restricts the galaxiid from areas upstream from the reservoir.

For the black-billed gull, larger nesting sites are known from other braided rivers in the country, but the loss of nesting habitat above Falls Dam may lead to two possible outcomes: the black-billed gulls locate new breeding sites along the other sections of the upper braided reach of Manuherikia River; or alternatively, the birds abandon the Manuherikia River catchment as they seek other braided river habitat for breeding. The effect on black fronted terns is also significant as a greater proportion of the national breeding population nests on the Manuherikia River than do the black-billed gulls (Wildlands 2013). However, the effect on the black fronted terns is unclear as nesting sites are more dispersed along the river. Inundation will only affect a proportion of the nesting areas and availability of breeding habitat is unlikely to be a limiting factor.

Enlarging the impoundment will also have an impact on the indigenous flora and fauna of the upper Manuherikia River. The 570.6 m full storage level option will cause a small reduction in the area occupied by lizards around the reservoir as some inundation occurs in the eastern gullies on Home Hills and of the lizard habitat along the rock and bluff systems of the current shoreline. For threatened plants the coral broom plants on the western shoreline will be lost to inundation.

The 580.4 m full storage level option will increase the loss of lizard and plant habitat and extend the range of threatened plants subject to loss to include the marsh arrow grass and some of the threatened plants including a small number of the Kawarau cress, mat broom, coral broom, *Coprosma intertexta* and *Chenopodium allanii.* The majority of these threatened plants are present within the Home Hills covenant and on the steep faces on the eastern shoreline of the reservoir. The fen on the western side of the reservoir with the marsh arrow grass and willowherb will also be partially submerged.



Golder Associates

TITLE FALLS DAM: POTENTIAL INUNDATION OF RIVER BRAID

JUNE 2015

PROJECT 1378110270

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The 592.2 m full storage level option will flood the largest area of threatened plant and lizard habitat and will include a high proportion of the known Kawarau cress plants in Johnstones Creek and the 2 ha fen on the western side of the reservoir. The impact on individual species will be varied as they are not evenly distributed in the gullies and species that occupy areas on the gully floors and lower hill slopes will be disproportionally affected. This is likely to include species that specialise in scree slope habitats that only occur on the lower slopes of the gullies.

3.1.3 Data quality

It is important to note that the current data available for all threatened species and ecosystems of the upper Manuherikia River is fairly limited. However, the data that is available identifies the threatened species and ecosystems that are likely to be present, allows generic assessment of potential effects, and potential mitigation options to be developed. It should be noted that further assessment will be required during the detailed design phase of the preferred irrigation development option to confirm the effects and design appropriate mitigation if required. It is anticipated that assessments of this nature would be a requirement of consent conditions.

Wildlands (2013) has reported the results of a three year bird survey on the upper Manuherikia River. Much of this survey was conducted by observing the birds from public roads in the valley as access to private property was not available. Wildlands (2015) has addressed some of the issues associated with limited observations along the river bed but further information on species such as wrybills and nesting along the full length of braided upper river would still be beneficial. Wildlands (2010) also note that to conduct robust bird surveys the work should be conducted over a period of years so that variation in habitat use and population size can be assessed.

The available fisheries data from the NZFFD, DOC (2009 and 2014) and from the site visits by Golder staff indicates that the alpine galaxiid has a patchy distribution in the upper Manuherikia River. The December 2014 DOC survey assessed 30 sites between Falls Dam and the Hawkdun Runs Road Bridge a distance of approximately 9 km. The intensity of that survey coupled with the fact that it findings mirror those from the Golder survey in February 2014 provide a good understanding of the distribution of alpine galaxiid in the upper Manuherikia River although the underlining reasons for the distribution and the detailed habitat requirement of alpine galaxiid are not well understood.

Within the braided reaches of the Manuherikia River occupied by alpine galaxias there is expected to be an ongoing interaction between the salmonids and the alpine galaxiid. As noted above, salmonids may be excluding the galaxiid from some areas of the braided river, whereas in other areas trout are rare or absent and the alpine galaxias is abundant. This is further complicated by the complete absence of alpine galaxias from some areas where few, if any, salmonids are present. Based on our current knowledge and understanding it appears that the upper Manuherikia River provides a mosaic of habitats that support different fish populations. It is therefore likely that the abundance of alpine galaxias is controlled by a number of factors including the abundance of salmonids, the occurrence of different habitats such as stable braids, unstable eroding braids and the proximity to Falls Dam and to salmonid spawning areas in the main channel or tributaries. Given this intricate interplay it is difficult to fully estimate the likely decline in alpine galaxiid with the various dam raise scenarios aside from indicating the area of riverine habitat that is lost.

Gaining information on the detailed habitat preferences of alpine galaxiid, the distribution of such habitat and how erosion and channel stability in the braided river control the distribution of the salmonids and alpine galaxias is important for understanding the long-term population survival and to fully assess the potential effects of the three Falls Dam storage enlargement options.

3.2 Potential Ecological Effects on the Manuherikia River downstream of Falls Dam

Schedule 2 of the Regional Plan: Water for Otago sets a minimum flow for the Manuherikia River of 0.82 m^3/s at Ophir. Currently there are no other minimum flow requirements in the catchment other than those stipulated on a number of individual abstraction consents, the most significant of which relates to operation of Falls Dam and requires a residual flow of 0.5 m^3/s below Falls Dam.

Flow information provided by Aqualinc (2014) indicates that during the 40 year period from 1 June 1973 to 31 May 2013, average daily flow in the Manuherikia River at Ophir fell below 0.82 m^3/s on 53 occasions which were split between 4 years (February 1974, March 1976, February / March 1982, and February / March 1999). Flows during the irrigation season tend to be elevated at Ophir due to irrigation releases from Falls Dam. Flow in the Manuherikia River at Campground which is below all the irrigation takes is a better representation of residual flows in the river. Flow information provided by Aqualinc (2014) indicates that during the period 23 October 2008 to 31 May 2013, average daily flow in the Manuherikia River at Campground fell below 0.82 m^3/s on 66 occasions with flows below 0.82 m^3/s occurring each year. Similarly during the period 4 February 1999 to 18 April 2013, average daily flow in the Manuherikia River below Falls Dam fell slightly below 0.5 m^3/s for 11 days from 28 June to 8 July 2001.

The hydrological regime proposed by the MCSWG and used in the hydrological modelling undertaken by Aqualinc is aimed at providing the following:

- A residual flow of 0.5 m^3/s in the Manuherikia River below Falls Dam.
- Flushing flows immediately below Falls Dam of three times median reservoir inflow (i.e., 3 x 3.88 m^3/s = 11.64 m^3/s). The flushing would occur as required over the irrigation season (mid September to mid April) with flushing flows triggered whenever flow below Falls Dam is less than three times median inflow for 30 consecutive days and the periphyton build-up has been assessed as excessive.
- A minimum flow of 0.82 m^3/s in the Manuherikia River at Ophir in line with Regional Plan: Water for Otago.
- To increase low flows, where possible, in the Lower Manuherikia River (i.e., at Campground) up to approximately 1.5 m^3/s, as well as ensuring flow variability in the range 1.5 - 2.5 m^3/s.
- In addition it is proposed to hold some water in the reservoir to allow for additional flushing and other environmental releases.

The above regime was developed by the MCWSG during a consultation process which considered irrigation reliability and environmental requirements. It was based on a large irrigation development option (i.e., 27 m raise of Falls Dam) but did not consider in any detail the cost implications of increasing the storage. It was recognised that the larger the storage at Falls Dam the greater the potential for increased environmental releases (i.e., flushing flows). Golder understands that if a smaller development option is favoured then the above regime would need to be revisited particularly when the cost implications of the development options are better understood.

The increase in the minimum flow in the Manuherikia River at Campground and the proposed flushing is expected to improve the water quality and ecological health of the main stem of the Manuherikia River.

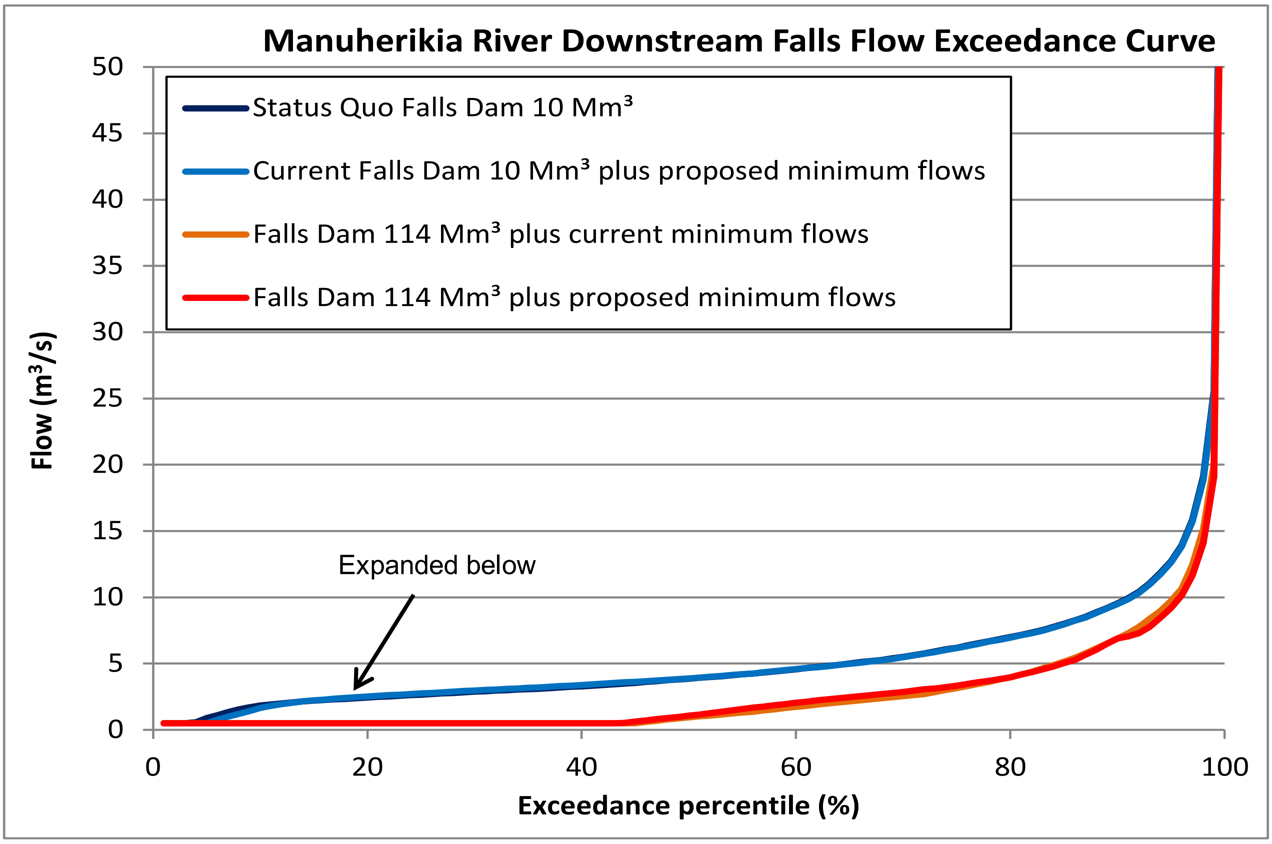
Aqualinc (2014) have assessed the following four scenarios using the Manuherikia Valley hydrological model (Aqualinc 2013).

1. The current situation with 10 Mm^3 of usable storage in Falls Dam, 7,500 ha irrigated above Ophir (excluding the Ida Valley) and 4,500 ha irrigated below Ophir with a minimum flow at Ophir of 820 L/s.
2. The current situation with minimum flow on the tributaries and at Campground (2 m^3/s).

3. Large scale development (27 m raise) and no change to minimum flows i.e., 114 Mm^3 of usable storage in Falls Dam, 20,500 ha irrigated above Ophir (excluding the Ida Valley) and 4,500 ha irrigated below Ophir with a minimum flow at Ophir of 820 L/s.
4. Large scale development (27 m raise) minimum flow on the tributaries and at Campground (2 m^3/s).

Flow exceedance curves, for flow in the Manuhuerikia River; immediately below Falls Dam, at Ophir and at Campground, under the four scenarios are shown in Figure 7, Figure 8 and Figure 9 respectively.

The proposed large scale development (27m raise of Falls Dam) significantly increases storage which potentially allows higher minimum flows to be maintained compared to current. Under scenario 4 Flow in the Manuhuerikia River at Ophir is projected to exceed 3 m^3/s 98% of the time. Flow in the Manuhuerikia River at Campground is projected to always exceed 2 m^3/s and exceed 3 m^3/s 79 % of the time. This will reduce low flow stress on the aquatic ecosystem throughout the lower sections of the river. However, due to the increased water harvesting (i.e,. the larger storage takes significantly longer to fill) flow in the Manuhuerikia River immediately below Falls Dam will be held at its minimum low flow level of 0.5 m^3/s for significantly longer periods of time, particularly during autumn and winter when the reservoir is refilling. Currently flow in the Manuhuerikia River immediately below Falls Dam exceeds 0.5 m^3/s 94% of the time. Under the large scale development option (27 m raise) flow in the Manuhuerikia River immediately below Falls Dam is projected to exceed 0.5 m^3/s 56% of the time. This would result in long periods of very stable flow which would provide stable habitat for aquatic ecosystems but would encourage the growth of periphyton. Regular flushing would be required in the reach from Falls Dam to the Dunstan Creek confluence to prevent excessive periphyton build-up. Provided the release of flushing flows is appropriately managed the proposed large scale development option (27 m raise) is expected to have an overall positive impact on the aquatic ecology of the main stem of the Manuherikia River below Falls Dam.



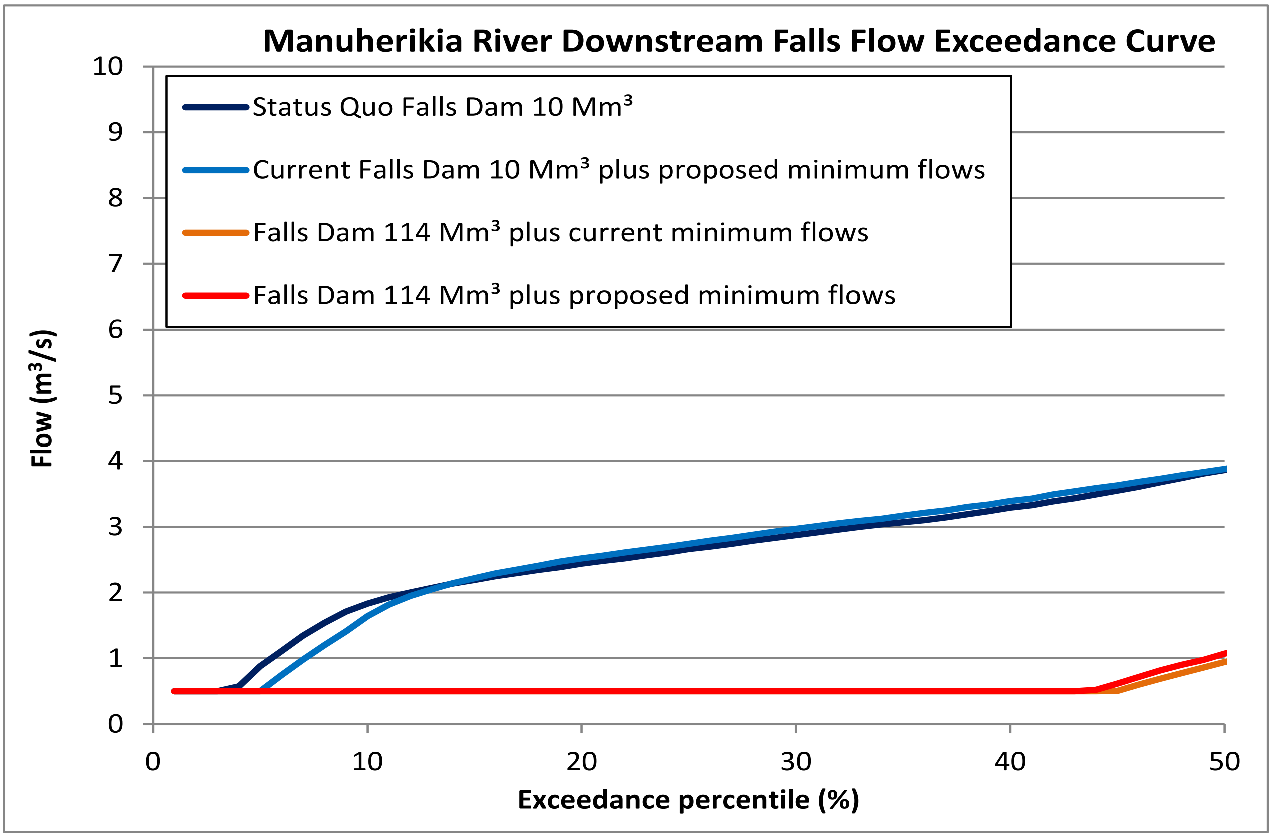
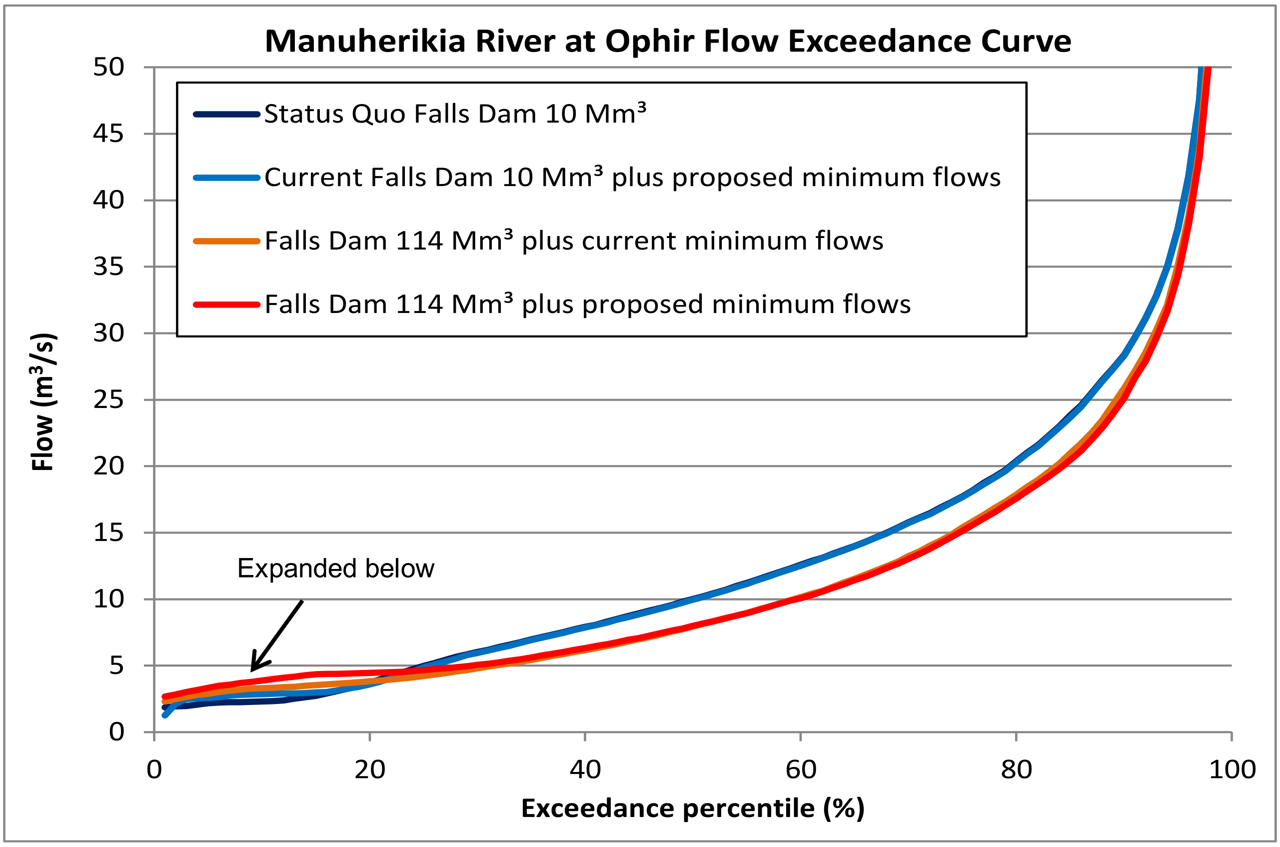


Figure 10: Predicted Flow Exceedance Curves for the Manuherikia River downstream of Falls Dam for the current dam and the proposed high (27 m) raise under the current and increased minimum flow regimes.



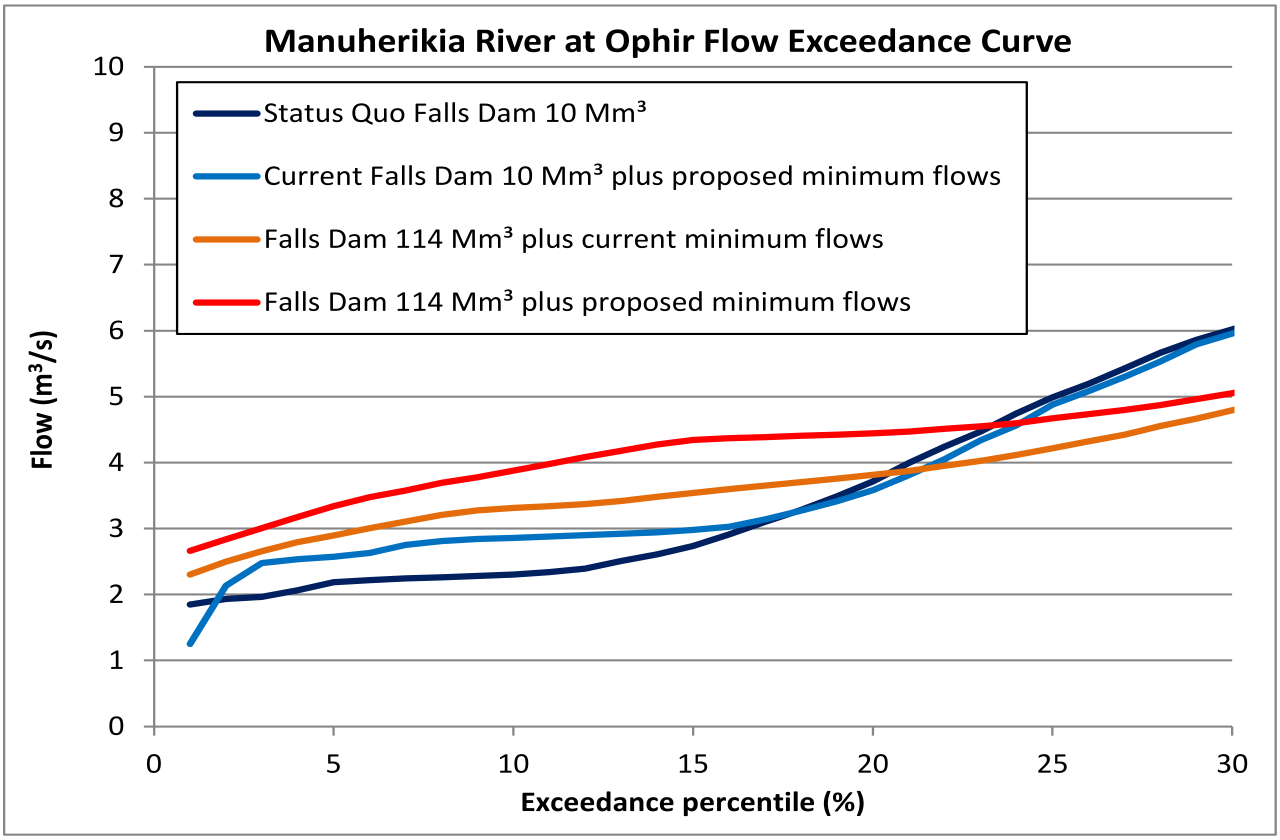
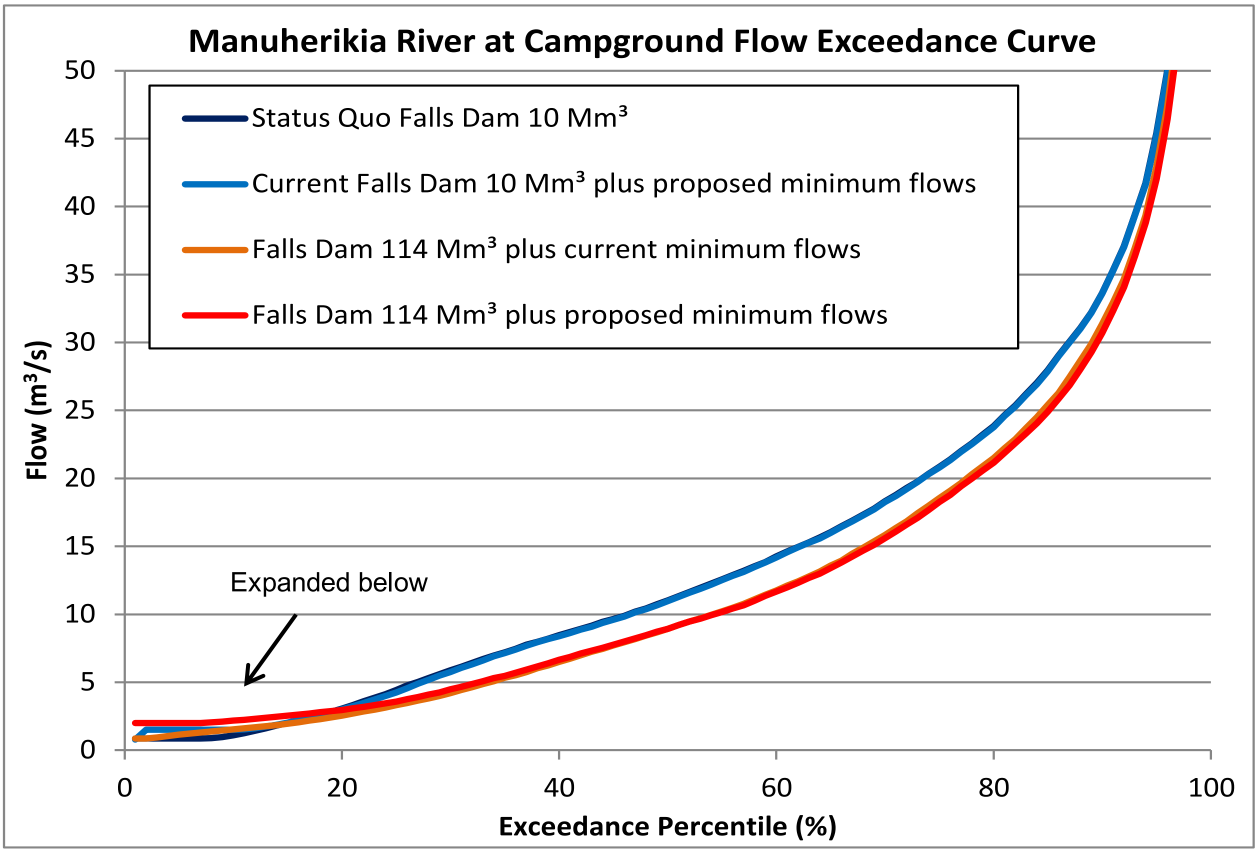


Figure 11: Predicted Flow Exceedance Curves for the Manuherikia River at Ophir for the current dam and the proposed high (27 m) raise under the current and increased minimum flow regimes.



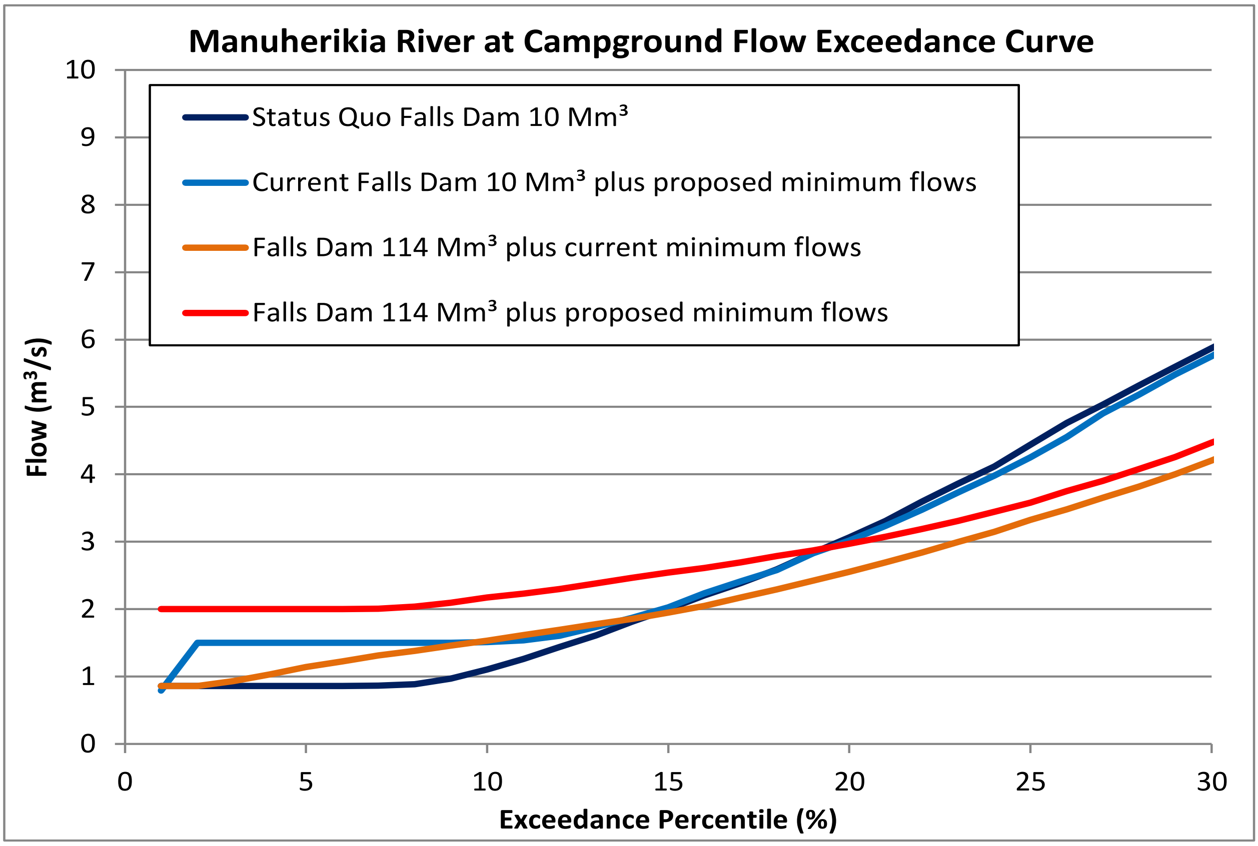


Figure 12: Predicted Flow Exceedance Curves for the Manuherikia River at Campground for the current dam and the proposed high (27 m) raise under the current and increased minimum flow regimes.

3.3 Fiddlers Flat

The construction works associated with raising Falls Dam or building a new dam will likely entail the loss of some of the downstream vegetation along the side of the Manuherikia River. This grey shrub community includes some rare native broom plants that may be present in the dam construction footprint. It is expected that the overall reduction in high value vegetation will be limited as the objective is to place any new dam as close as possible to the existing dam and this will restrict vegetation loss. This grey shrub community is also an area where green skinks have been reported and geckos are also present. A small loss of habitat for these lizards can also be expected due to the dam construction.

Fiddlers Flat will also be affected by the upgrade to the access road and also by the construction of a proposed High Race that will convey water from Falls Dam. As noted above Fiddlers Flat has been recognised as an area with a number of threatened plant species. The full effects of the road and race construction have not been determined as this will depend on the desired alignments, which would be determined during detailed design. There is likely to be some flexibility in the alignment of both the road and proposed High Race and it is recommended that ecological expertise is included in the detailed design of the road and High Race to ensure, where possible, the threatened plants communities and areas of significant lizard habitat in the Fiddlers Flat area are avoided.

3.4 Manuherikia River Tributaries

The effects of the irrigation scheme on the tributaries, their flows and habitat provided are less certain, due to a lack of hydrological data. Currently there are no minimum or residual flow requirements for the tributaries other than those stipulated on a very small number of individual abstraction consents. In future it is expected that most water takes will be subject to residual flow requirements that are expected to provide more water immediately downstream of any take points, when compared with the current deemed permit takes. However, more efficient irrigation practices such as spray irrigation, as opposed to flood irrigation, is expected to mean that recharge of stream flows via shallow groundwater inflow and irrigation runoff will be reduced and a reduction in flow in the lower reaches of some tributaries is possible. Compounding this, the assessment of effects on fish will depend on the habitat preference of the fish and those preferring low velocity flows, such as the Central Otago roundhead galaxiid and Clutha flathead, may benefit from low residual flows whereas salmonids may gain little benefit unless large instream flows are provided. An adaptive case by case approach to setting minimum flows is recommended, which allows site specific issues and values to be considered within a whole catchment minimum flow objective.

The Central Otago roundhead galaxiid is present in a number of streams within the catchment (see distribution map in Appendix D). While most of these streams are outside of the irrigation command area some small remnant populations are likely to remain within the command area which potentially could be influenced by the proposed irrigation developments. The Clutha flathead is only known to be present in the Pool Burn and Manor Burn sub-catchments of the Manuherikia catchment with no other confirmed sightings in the catchment. Neither the Pool Burn nor the Manor Burn catchments are affected by the five irrigation development options currently being considered.

The hydrological regime proposed by the MCSWG for large irrigation development option (i.e., 27 m raise of Falls Dam) is aimed at providing the following residual flows in the tributaries of the Manuherikia River:

- A residual flow of 80 % of natural 7 day mean annual low flow (7 Day MALF) in both Dunstan Creek and Lauder Creek below the proposed High Race. The objective of this residual flow was to provide benefit to salmonids.
- A residual flow of 0.05 m^3/s (50 L/s) in Thomsons Creek below the proposed High Race. The objective of this residual flow was to provide benefit to native fish species while avoiding such flow that would encourage increased use of the watercourse by salmonids.

Due to a lack of hydrological data the hydrological model (Aqualinc 2013) does not differentiate the other tributaries of the Manuherikia River and hence residual flows have not been proposed. Based on current information it is proposed that the main stem of the Manuherikia River up to Falls Dam, the catchment's large reservoirs (i.e., Falls, Manorburn, Greenland, Poolburn and Lower Manorburn reservoirs), Dunstan Creek and to a lesser extent Lauder Creek and Chatto Creek be managed mainly for salmonids. The tributaries above Falls Dam, Thompsons Creek, Pool Burn, Ida Burn and other smaller tributaries should be managed for native fish species where they are present. It is expected that further aquatic ecological assessment will be required during detailed design of the preferred irrigation development option to confirm any residual flow requirements. It is anticipated that assessments of this nature would be a requirement of consent conditions.

The imposition of residual flows on the tributaries is expected to improve the water quality and ecological health of those water courses and is considered to be an improvement on the current situation of no tributary minimum flows.

3.5 Potential Ecological Effects of Proposed Mount Ida Dam

The Mt Ida Dam and reservoir site is predominantly highly modified dryland pasture with few remaining natural values. The area has been assessed as having relatively low values and no significant ecological effects are anticipated. A small number of threatened plant species have been identified in the area which would be inundated. These plants could potentially be transplanted although their loss in the wider context of the surrounding landscape is not considered significant.

3.6 On Farm Impacts

On farm impacts due to any changes in farm management have not been assessed as this will be determined by individual farm management at the time changes are implemented. It is expected that Farm Management Plans would be a requirement of any future irrigation development. Such plans should include environmental and biodiversity protection goals to ensure potential impacts are avoided or mitigated. Given the rarity of indigenous vegetation in the valley floors of both the Manuherikia and Ida valleys, it is important that the farm plans identify the remaining areas.

4.0 MITIGATION OPTIONS

4.1 Water Quality Improvement

Sampling conducted for this study indicates that under current conditions and irrigation usage the water quality in tributaries of the Manuherikia River has the potential to breach the ORC Plan Change 6A water quality rules. Nutrient modelling undertaken (AgResearch 2015) indicates that nutrient loss is very dependent on irrigation efficiency and moving from the current predominantly flood based irrigation system to spray irrigation is expected to significantly reduce nutrient loss. This is predominantly due to the catchment's dry climate and deep soils, which, under efficient spray irrigation, results very limited drainage. Areas of shallow bony soils, which are generally located on river terraces adjacent to the Manuherikia River, remain susceptible to increased nutrient loss, as will sub-catchments where there are significant areas of new irrigation. For the maximum potential development scenario (i.e., a large increase in storage at Falls Dam and the Mount Ida Dam) overall catchment nutrient loss from the root zone is expected to increase by approximately 10 %. Given this, the following management actions are likely to be required:

- A reduction in runoff when irrigating to reduce the risk of overland flow carrying nutrients and contaminants to water courses. Runoff is reduced by ensuring irrigation does not saturate the soil and that application rates do not exceed the soils infiltration rate.
- A reduction in drainage when irrigating to reduce the risk of leaching of nutrients through the soil profile and potential contamination of shallow groundwater and spring fed watercourses. Drainage is reduced by improved irrigation management, applying smaller application depths and deficit irrigating.

- Fencing of riparian zones along streams to prevent stock access. This reduced the potential for both direct faecal contamination and stream bank erosion.
- Planting of riparian zones to reduce overland flow and to encourage nutrient uptake and to provide shading to the watercourses.
- Farm management plans that include nutrient management objectives.
- The creation of treatment wetland areas to strip nutrients and to capture contaminants from spring discharges and runoff. Treatment wetlands are often difficult to develop and manage and are usually only considered an option in areas of very elevated nutrient levels. The creation of wetlands does provide additional biodiversity and habitat values.

The balance of management actions on any individual property or stream catchment will depend on the on-farm activities, ability to construct wetlands and stream flow regimes.

In addition to the on farm activities to reduce runoff effects, flushing flows for the Manuherikia River can be provided. Flushing flows will scour the river bed and remove the majority of algae and flush fine sediment from the bed of the river. Both these actions improve the habitat for aquatic species and the flushing removes nuisance algal build up and will remove the potentially toxic *Phormidium* algae. The current recommended flushing regime for a river is to provide a flow three times the median flow for between 24 and 48 hours. Depending on the rate of algal growth the flushing flow may be provided at intervals of 30 days or more. The flushing flows can also be combined with natural high flow events to maximise or enhance the natural flushing effect.

The Manuherikia River from Falls Dam to the confluence with Dunstan Creek is the reach most in need of flushing, particularly during periods of stable flow associated with either dam filling or relatively constant irrigation releases. Periphyton monitoring and observations during Golder's site visits indicate that freshes and floods in Dunstan Creek provide flushing downstream of the confluence. Periyphon growth may also require management in the lower reaches of the Manuherikia River below the irrigation intakes (i.e., near Campground) due to public use of that area and the lower residual flow that remains following the upstream irrigation abstractions. The hydrological regime proposed by the MCSWG for the 27 m raise and used in the hydrological modelling undertaken by Aqualinc is aimed at providing flushing flows immediately below Falls Dam of three times median reservoir inflow (i.e., 3 x 3.88 m^3/s = 11.64 m^3/s). The flushing would occur as required over the irrigation season (mid-September to mid-April) with flushing flows triggered whenever flow below Falls Dam is less than three times median inflow for 30 consecutive days and the periphyton and/or macrophyte build-up has been assessed as excessive. In addition, it is proposed to hold some water in the reservoir to allow for additional flushing and other environmental releases.

These flushing flows will provide a significant improvement to the Manuherikia River immediately downstream of Falls Dam, where currently algal communities exceed national periphyton guidelines through the late summer and autumn, as little or no natural flushing occurs during the irrigation season. Flushing flows will only occur in the Manuherikia River and flushing cannot be used to reduce algal growth or to provide fine sediment removal in the tributaries. For the tributaries, riparian management can reduce fine sediment inputs. If shade trees are planted the shading can reduce algal growth and will also beneficially reduce water temperatures.

4.2 Mitigation of Potential Adverse Effects of Enlarging Falls Dam Impoundment

4.2.1 Lizard and plant mitigation options

Mitigation options are available to address the effects of habitat loss due to construction works around Falls Dam or inundation due to an enlarged impoundment. Standard practice management activities such as predator control and reduction in browsing pressure are often applied as mitigation. The scale of such operations will need to be determined but mitigation management areas are usually considerably larger than the areas to be submerged. More recently mitigation for impacts on lizard populations has include the creation of new habitat for lizards and translocation of lizard from the impact areas to the new habitats.

Potential management sites for plants and lizards in the vicinity of Falls Dam include:

- Areas of the Home Hills covenant not submerged by raising larger impoundment.
- The Fiddlers Flat Conservation area.
- The true right bank of the Manuherikia River in the gorge section downstream of the Falls Dam site.

All these sites are recognised as retaining native plant and lizard species. Potential mitigation activities include fencing areas to exclude stock, weed removal and enhancement planting with native plants and conducting pest animal controls to reduce browsing and predation pressure. Some of these mitigation activities, such as fencing and planting, would require a significant initial effort but would then reduce to low maintenance level activities. Other mitigation such as pest control would require an ongoing commitment.

For long-term protection of the mitigation activities and the gains made, DOC or Queen Elizabeth II National Trust covenants could be created, subject to approval of private landowners. Currently there are six registered National Trust covenants in the Manuherikia Catchment[2].

4.2.2 Manuherikia alpine galaxias

Enlarging the Falls Dam impoundment will result in the inundation of habitat of the alpine galaxiid that cannot be readily replaced. As no populations of the Manuherikia alpine galaxias occur elsewhere there are no other sites at which the offset works can occur. Therefore, any mitigation efforts would likely have to be applied to the alpine galaxias population in the upper Manuherikia River. Salmonids are currently recognised as a significant threat and removal of salmonids is expected to benefit the alpine galaxias. However, the removal of salmonids is not feasible on the scale of the whole of the upper Manuherikia River valley, an area with approximately 450 km of watercourse, the majority of which are likely to be inhabited by salmonids. Small scale trout removal in one or more tributaries of the upper Manuherikia River may be possible, though a feasibility study would be required. It is likely that this would require the installation of a permanent fish passage barrier at the lower end of any salmonid removal area. Local scale habitat management could be attempted that seeks to influence the instream habitat of the upper Manuherikia River to provide habitat features that benefit alpine galaxiids rather than salmonids. This mitigation would require some investigation of the habitat preferences of alpine galaxias and the likely completion of a demonstration site showing the benefits to alpine galaxiid before it is likely to be accepted. Finally, local scale trout control could be undertaken to reduce the density and size range of salmonids present to reduce the predation and competition impacts of salmonids.

The three possible mitigation activities above would all require ongoing commitments to maintain effectiveness.

Translocation of the alpine galaxiid to a new river could be attempted to provide new habitat. This would require the permission of the Minister of Conservation under Section 26zm of the Conservation Act and may also need the approval of Ngai Tahu. To gain permission it can be expected that sufficient information would need to be provided to show the translocation would be successful, but not impact on other values at the translocation sites. The translocation site would need similar habitat to the upper Manuherikia River, i.e., a high altitude, low gradient (possibly braided) river system. To improve the likelihood of success the translocation site should be free of predatory fish, such as salmonids. However, salmonid free areas are not common.

Finally, any potential translocation should not endanger the existing values of the translocation sites. The presence of didymo in the Manuherikia River does mean that there is a potential to transfer didymo to a new river system. A translocation to another waterway with didymo would pose no issue. However, if a suitable

[2] Based on information shown on the following website http://www.openspace.org.nz/Site/Publications_resources/Annual_statistics_maps_and_graphs.aspx accessed on 3 June 2015.

translocation site is identified that is didymo free then any translocation process would require decontamination of the fish, the water they are transported in and any other equipment used. This will increase the operational difficulties for a translocation and most likely increase fish mortality. Salmonid free habitats are also more likely to be didymo free as angling, a common method of transfer would not occur in those waters and didymo invasion is less likely to have occurred.

No translocation of this species or the closely related alpine galaxias of Canterbury and Southland has ever been conducted and there is no proven method for a translocation. Fish transfers are routinely conducted for some species (e.g., brown trout) and are successful. However, for other species, success is more limited and establishment of large healthy populations has not occurred. For instance, a recent translocation of the lowland longjaw galaxias to the Waianakarua River as part of the conservation management programme has failed to establish a large healthy population and the long term success of the translocation is uncertain (DOC unpublished data). In the event that a translocation of the alpine galaxias is undertaken, it should be expected that monitoring of the translocated population will be undertaken for some years to prove the fish has established. This proof of establishment maybe required prior to the any inundation of the existing habitat in the Manuherikia River.

4.2.3 Upper Manuherikia bird populations

The extent of effects on the threatened bird breeding populations is currently unknown as the response of black billed gulls to the impoundment enlargement and associated habitat reduction is not known. However, if the birds retain a presence in the upper Manuherikia River valley then a predator control programme in the vicinity of the nesting colony would provide some mitigation and aim to reduce chick and adult bird mortality during the breeding season. The area over which predator control is undertaken could also be designed to incorporate at least some of the black-fronted tern breeding area, extending some protection to these threatened birds too. However, prior to determining the size of such an operation it would be beneficial to understand the current predation impacts in the upper Manuherikia River so that control operations target the appropriate species be they black-backed gulls, mustelids, hedgehogs, feral cats or other predators.

Offset compensation may also be possible for the braided river birds with conservation management activities being undertaken to assist in the protection of populations or enhance breeding of threatened braided river birds elsewhere in the South Island. The exact nature of this offset would have to be determined via consultation with other parties. However, it is likely that predator and/or weed control at other braided river bird breeding sites would be the most feasible options.

4.3 Mt Ida Dam Impoundment

The Mt Ida dam and reservoir site has been assessed as having relatively low values and mitigation is considered limited or not necessary. If required it could be in the form of retirement of grazing of an area with good indigenous vegetation in the vicinity of the Ida Burn.

4.4 Command Area Mitigation and Environmental Management Options

4.4.1 On farm options

Biodiversity values on individual farm properties have not been identified. While the general extent of irrigation schemes is known, the future individual farm uptake of water and areas on individual properties that may be developed for irrigation are unknown. The LENZ analysis indicates that the Manuherikia Valley and Ida Valley are well developed for pastoral farming, and indigenous vegetation and ecosystems are rare. Therefore, it is expected that ecosystems with significant biodiversity values, which would benefit from protection will be rare on the farm properties. However, for each farm that becomes part of an irrigation scheme it is recommended that the Farm Management Plans (FMP) include a biodiversity assessment, especially for any areas where new irrigation development is occurring. The results of the assessment are then used in the FMP, with areas of high biodiversity value excluded from development, and consideration being given to protection and enhancement of areas of low to moderate biodiversity value.

A larger, scheme-wide objective could also be restoration of a proportion of the indigenous vegetation cover and promoting the establishment of indigenous fauna in areas across the Manuherikia and Ida Valleys. This restoration work could be coupled with riparian management, with fenced off areas being planted with indigenous vegetation and the riparian management zones used to link any larger restoration areas.

A scheme or catchment based approach which co-ordinates individual on-farm activities should be encouraged and it will enhance overall environmental management and maximise the benefit from any mitigation activities.

4.4.2 Central Otago roundhead galaxiid

The Central Otago roundhead galaxiid is present in a number of streams within the command area. While some of these streams may not be subject to water abstraction, flows may currently be influenced by irrigation runoff. However, the Central Otago roundhead galaxiid may still exist, as small remnant populations, in abstracted streams such as Thomsons Creek and Lauder Creek. Changes to stream flow as a result of reduction in irrigation runoff, or a halt to water abstraction, will alter the instream habitat and may also alter the use of the stream by predatory fish such as salmonids. Riparian management to reduce nutrient and contaminant runoff also has the potential to alter instream habitat and species coexistence, as riparian management will stabilise stream banks and potentially narrow water courses over the long term. Therefore, it is recommended that streams with Central Otago roundhead galaxiid populations are managed to maintain the native fish populations. The management of these streams will require an adaptive process because habitat and flow management to protect small galaxiid fishes has not been undertaken before. Possible management actions include:

- Riparian management with a goal to maintain a willow and woody weed free stream channel.
- Salmonid management to reduce the density of large predatory salmonids.
- Instream habitat management to ensure areas of shallow water (5 - 15 cm deep) are common during the low flow summer period.
- Reintroductions of Central Otago roundhead galaxiids to areas they have been lost from.

4.4.3 Saline wetlands

The saline wetlands of the Manuherikia River valley are a rare ecosystem type that harbours a range of saline tolerant plants. Five saline sites are recognised in the Manuherikia catchment and these are included in the Otago Regional Plan as regionally significant wetlands (Figure 5). Four of the five saline wetlands are outside or adjacent to the irrigation command area and therefore unaffected by the changes to irrigation and water abstraction. The Rockdale saline wetland is located near Chatto Creek near the boundary between the Tiger Hills part of the Omakau Irrigation Scheme and the Manuherikia Irrigation Scheme. Changes to the irrigation regimes on properties surrounding this wetland, have the potential to affect water level and salinity within the wetland. Local irrigation details are yet to be determined but care will be required when considering irrigation changes in this area. Monitoring of water and salinity levels in the wetland, to ensure the saline nature of the wetland is retained, is important and this will ensure the plants dependent on these saline soils continue to be present. Given the location (near the edge of the irrigated area) and the relatively small size of the Rockdale saline wetland, it is expected that simple local measures, including buffer zones, will ensure the wetland is suitably protected.

5.0 CONCLUSIONS

The lowland areas of the catchment have been highly modified which has significantly reduced the ecological values that are present. Indigenous vegetation and intact indigenous ecosystems are essentially absent from the valley floors of both the Manuherikia and Ida valleys. Any remaining areas of indigenous vegetation in the valley floor are of high value due to their rarity and five regionally significant saline wetlands have been identified in the lower Manuherikia River catchment.

The upper parts of the catchment are substantially less modified and contain significant ecological values. The upper Manuherikia River valley supports a significant array of indigenous plants, birds, lizards and fish. The braided river habitat in the upper Manuherikia River valley provides the only habitat for the Manuherikia alpine galaxiid and habitat for a number of threatened braided river birds. Additionally, the Manuherikia River gorge immediately downstream of Falls Dam and gullies to the east of Falls Dam provide good habitat for threatened plants and lizard species.

The upper parts of the Manuherikia River catchment have in general excellent water quality and aquatic habitat value. However, in the lower reaches of the Manuherikia River at Galloway, the water quality has declined to 'good' and the habitat values are reduced. In the tributaries, water quality and habit values declines downstream as each stream flows across the Manuherikia or Ida valley floors.

Raising Falls Dam will create a larger reservoir thereby inundating some of the braided river system that enters the reservoir and some of the terrestrial vegetation around the dam the most notable of which is within the Home Hills covenant area. All three options for raising Falls Dam will cause varying degrees of inundation of the braided river system upstream of the reservoir and the Home Hills covenant. This habitat loss will have impacts on the Manuherikia alpine galaxiid and the nesting area of the nationally critically threatened black-billed gull in the Manuherikia River valley. A proportion of the nesting habitat of the nationally endangered black fronted tern will also be lost as will some threatened plants and a portion of high value lizard habitat around the reservoir edge.

The current data available for all threatened species and ecosystems of the upper Manuherikia River is fairly limited. However, the data that is available identifies the threatened species and ecosystems that are likely to be present, allows generic assessment of potential effects, and potential mitigation options to be developed. It should be noted that further assessment will be required during the detailed design phase of the preferred irrigation development option to confirm the effects and design appropriate mitigation if required. It is anticipated that assessments of this nature would be a requirement of consent conditions.

The Mt Ida dam and reservoir site has been assessed as having relatively low values and mitigation is considered limited or not necessary.

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APPENDIX A

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