April 2014

REPORT

FEASIBILITY STUDY

Manuherikia Catchment Ecology: Background Review and Technical Assessment

Submitted to:
The Manuherikia Catchment Water Strategy Group

Report Number. 1378110270_4000-400-R-Rev0

Golder Associates

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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 irrigation options for water users within the Manuherikia River catchment.

A staged assessment approach has been adopted in order to assess the viability of any future irrigation options. The first stage of assessment was a High Level Overview Study which assessed water availability and demand within the catchment (Aqualinc 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).

The irrigation development options identified in the Prefeasibility Study included three options for raising Falls Dam by 5 m, or 8 - 10 m or 27 m and developing a dam on the Ida Burn at Mt Ida.

MCWSG have now commissioned a Feasibility Study, which is due for completion in October 2014. 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)). Golder Associates (NZ) Limited (Golder) has been engaged by MCWSG to undertake the Feasibility Study.

1.2 Purpose of this Report

This report provides the results of a background data search for ecological and environmental information for the Manuherikia River catchment. It is one of a series of reports that assess the feasibility of dam construction, water supply for irrigation schemes in the Manuherikia River valley and the first report that assess the ecological information available. The report assembles the existing information available on the environments, terrestrial, aquatic and avian species and habitats that may be affected by the proposed irrigation developments in the Manuherikia River Catchment and use the available data to assess:

- The type and significance of environments, terrestrial and aquatic values supported in the Manuherikia Valley;
- The likely nature and magnitude of any effects on the environment and ecology of the Manuherikia Valley; and
- Whether there are any significant ecological issues that could inhibit or prevent the development of irrigation in the Manuherikia catchment.

A further assessment of the ecological and environmental issues and opportunities will be conducted once the feasibility study field studies are complete. In addition any recommendations for further work to support a consent application will be provided once the current feasibility studies are completed.

1.3 Report Limitations

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

2.0 MANUHERIKIA CATCHMENT IRRIGATION PROJECT

2.1 Environmental Setting

The Manuherikia River catchment, including both the Manuherikia and Ida Burn 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 2012a). This distinctive combination of climate, topography and geology has led to locally adapted ecosystems and species present in the Manuherikia Valley. The ecosystems present include:

- Dryland
- Tussock grasslands
- Grey shrublands
- Wetlands—both upland and lowland
- Saline ecosystems
- Riverine habitats

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

2.2 Current Irrigation Schemes

At present, six 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 the key water storage infrastructure for these irrigation companies (MCWSG 2013).

Falls Dam is also utilised for the generation of hydro-electricity and managed by Pioneer Generation Limited.

As a simplistic overview, in terms of water resource use, the existing irrigation schemes:

- Store water in dams.
- Divert, or take, water to supplement storage or irrigation activities (i.e., into water races or other distribution systems).

Use the water within the scheme by irrigating it onto land.

3.0 REVIEW OF EXISTING DATA

3.1 Background

The purpose of this section is to describe the existing environment of the Manuherikia catchment. This information is drawn from existing reports, papers and national databases and has been used to provide an initial assessment of the ecological values of the Manuherikia Valley and the possible effects of the proposed construction or increases in dam storage capacity and irrigation options. The review also highlights any data gaps in order to focus the field surveys on the collection of relevant data; and also identify potential risks associated with the lack of important information.

3.2 Data Sources

Two national databases, the New Zealand Freshwater Fish database (administered by NIWA, NZFFD) and the New Zealand Herpetofauna database (Department of Conservation (DOC) BioWeb Herpetofauna database, NZHD), have been interrogated to locate fish and reptile records for the Manuherikia region. In addition the Land Environments New Zealand (LENZ) terrestrial environments classification was used to assess the distribution and occurrence of terrestrial environments. The LENZ classification was coupled with the threatened environments classification (Walker et al. 2008) to provide an assessment of the level of protection of respective environments within the Manuherikia Valley and the threat status of each environment.

The Land Information New Zealand (LINZ) reports for pastoral lease tenures were searched to locate conservation resources reports for pastoral leases in the Manuherikia Valley, especially with reference to the Falls Dam and Ida Burn Dam sites. These reports provide information on the flora and fauna present on pastoral leases and the associated conservation value at the time of surveys and reporting. The Otago Regional Council (ORC) State of the Environment (SOE) and catchment management reports (ORC 2004, 20011, 2012a, b) were reviewed to assess the water quality and water quantity in the Manuherikia catchment. Raw data used in SOE and catchment reporting was also provided by the ORC for inclusion in the review. The ORC Water Plan was also reviewed to locate protected wetlands in the Manuherikia Valley. The DOC Otago Conservancy Management Strategy 2013-2023 (CMS) (DOC 2013) was reviewed to identify any key areas of conservation interest and general conservation objectives for the Manuherikia Valley.

Additional client reports for private companies were accessed when possible to abstract relevant ecological data. Published scientific papers were also reviewed for ecological and water quality data relevant to the project sites.

4.0 REVIEW RESULTS

4.1 Land Environment New Zealand Classification

4.1.1 Background

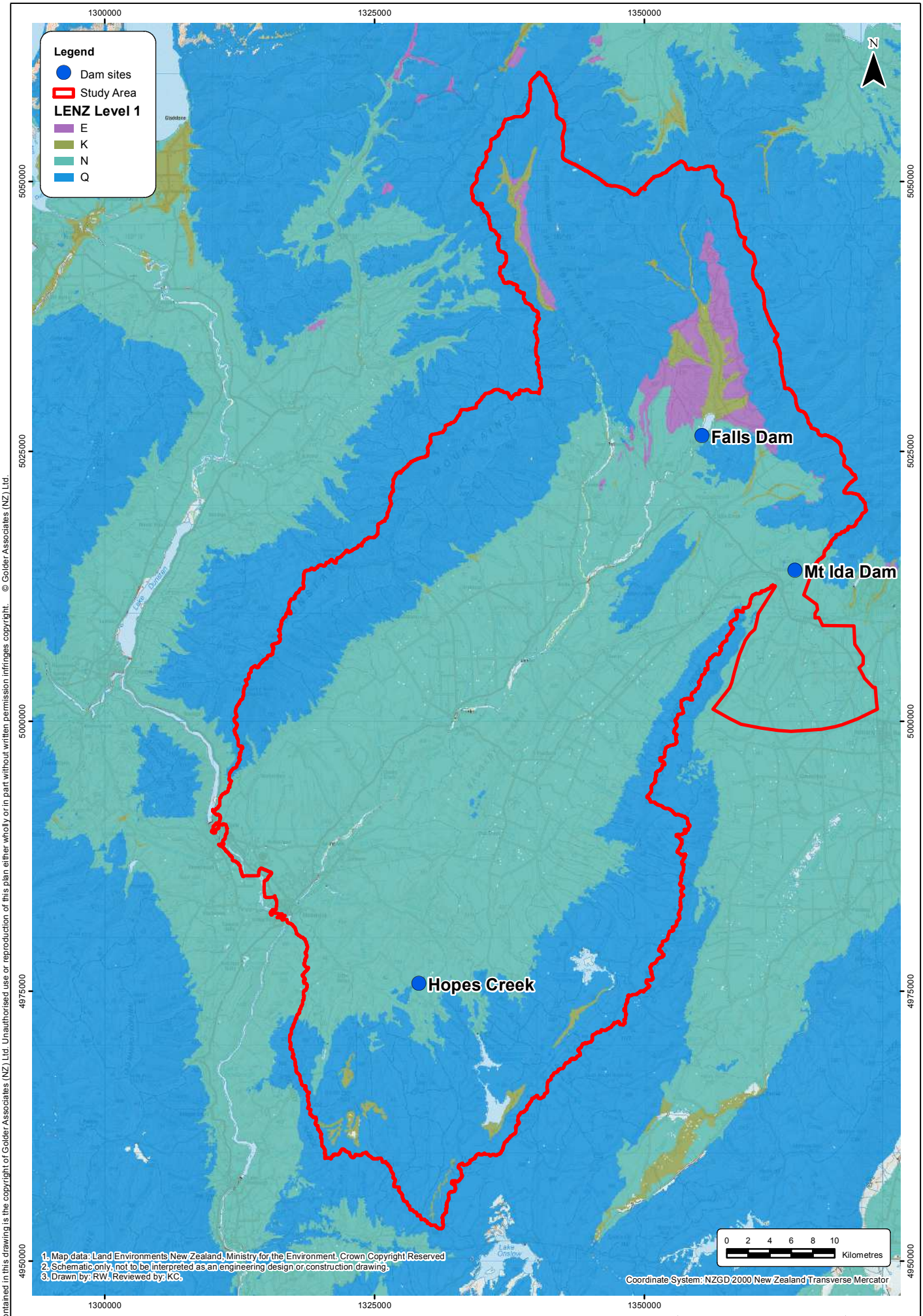
The Land Environment New Zealand (LENZ) environment classification system provides a basis for describing the environments present within the Manuherikia Valley. LENZ uses a range of geologic, climate, soil and geographic (e.g., aspect, elevation) data to cluster land areas with the same or similar attributes 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

4.2 Manuherikia LENZ Classification

4.2.1 LENZ classification

The majority of the Manuherikia Valley and surrounding mountain ranges fall into two Level 1 environments (Figure 1). The valley floors of the Manuherikia and Ida valleys are within Environment N – Eastern South Island Plains. This is an environment with a cool climate, moderate sunshine and moderate water and vapour deficits. The land is generally flat and soils are generally alluvial sands and gravels derived from greywacke and schist rocks and these are often overlain by loess. 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 Valley and the underlying geology is generally schist or greywacke.



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TITLE | LENZ LEVEL 1 ENVIRONMENTS FOR THE MANUHERIKIA VALLEY

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Two other Level 1 environments are recognised from the upper Manuherikia Valley above Falls Dam. The first is an area immediately beside the Manuherikia River and is classified as Environment K – Central Upland Recent Soils. This is a recent flood plain area with alluvial soils derived from greywacke rocks. The climate is cool, and water and vapour deficits are low. Rainfall varies from relative high close to the main divide to low in more eastern areas. The second environment recognised only in the upper Manuherikia River catchment is Environment E – Central Dry Foothills. The hill slopes at the foot of the Hawkdun and Saint Bathans ranges are grouped in this environment. These are areas of gentle hill country with underlying greywacke. 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. Environment K is scattered throughout the South Island on inland valley floors and the total extent of Environment K is limited to 163,426 ha and this is the fifth smallest Level 1 environment in LENZ level 1 (Figure 2).

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 (Figure 3). The distinctive upper Manuherikia River area is again evident at the level 4 classification level.

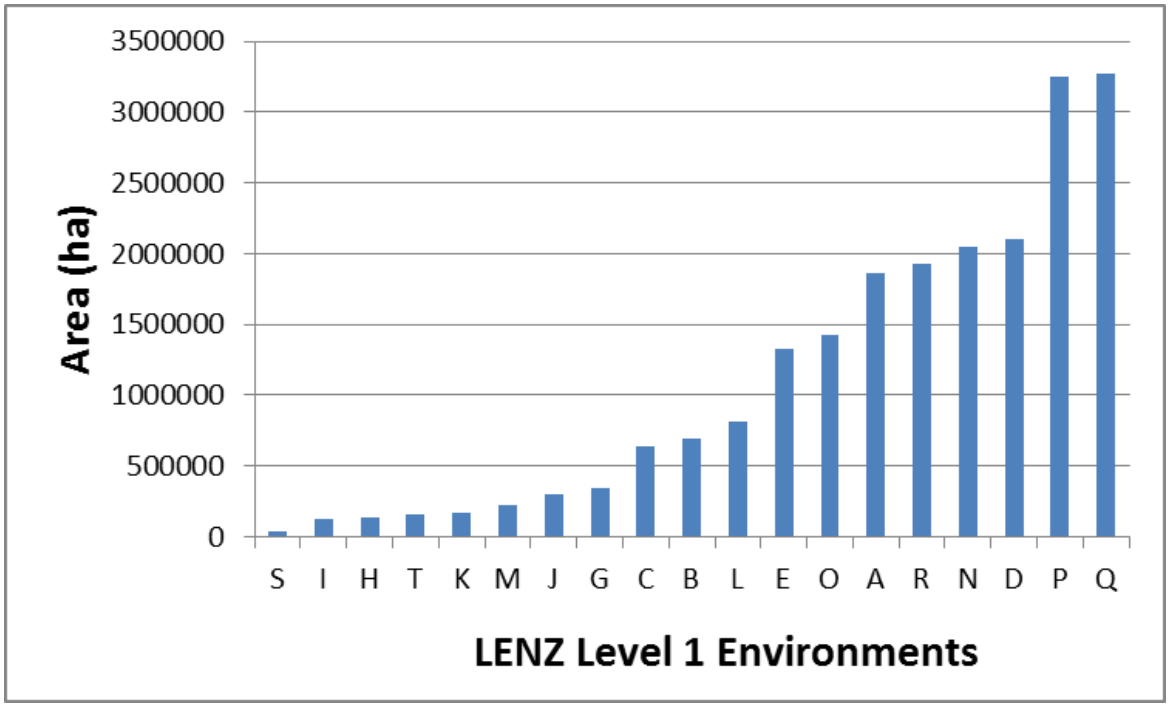
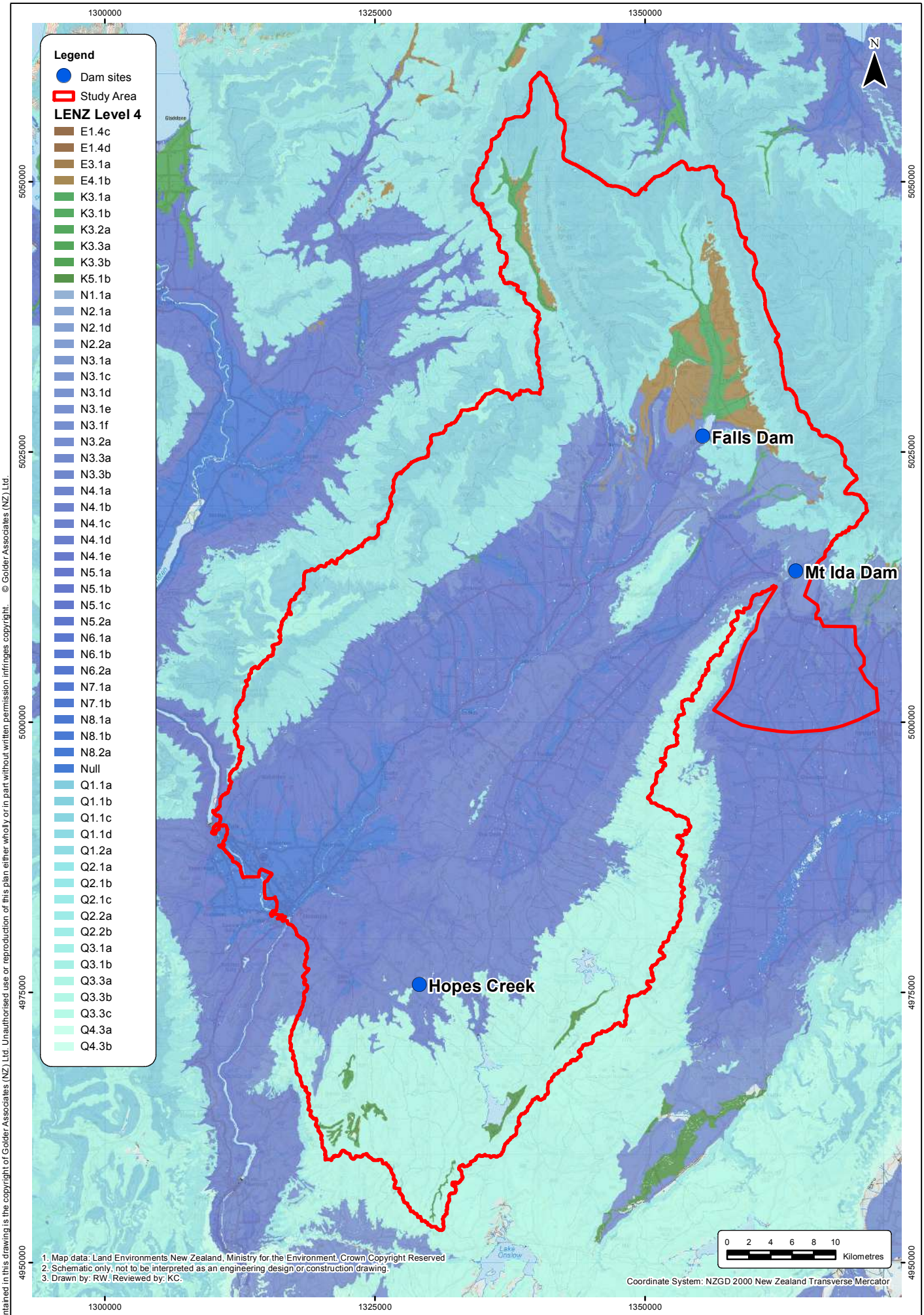


Figure 2: Total area (ha) for each of the 20 Level 1 LENZ environments in New Zealand.

4.2.2 Threatened Environments

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). Using a GIS analysis it is possible to provide an estimate of the area remaining in indigenous vegetation (from LCBD) and the proportion of each LENZ level 4 environment that is protected from modification (DOC estate and other legally protected land). This analysis is conducted by overlaying the LCDB vegetation maps and legally protected land over the LENZ level 4 layer. This overlap of indigenous vegetation with protected land indicates how much of intact indigenous vegetation is protected. As this information is overlain on the Level 4 environment areas the protected areas of indigenous vegetation in each environment can be determined from the overlap of all three GIS layers (Walker et al. 2008).



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Walker et al. (2008) provides a five-tier threat classification for the Level 4 environments (Table 1). However for long-term environmental protection it is not meant to imply the protecting 20 % of an environment will be sufficient to maintain indigenous biodiversity (Walker et al. (2008). Rather the environment threat ranking provides measures the environmental change occurring and any changes to environment protection being achieved.

Table 1: 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
Underprotected	>30 % left and <10 % protected
Critically 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 fall 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. 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 Walker et al. (2008).

4.3 Terrestrial Ecosystems in the Manuherikia Valley

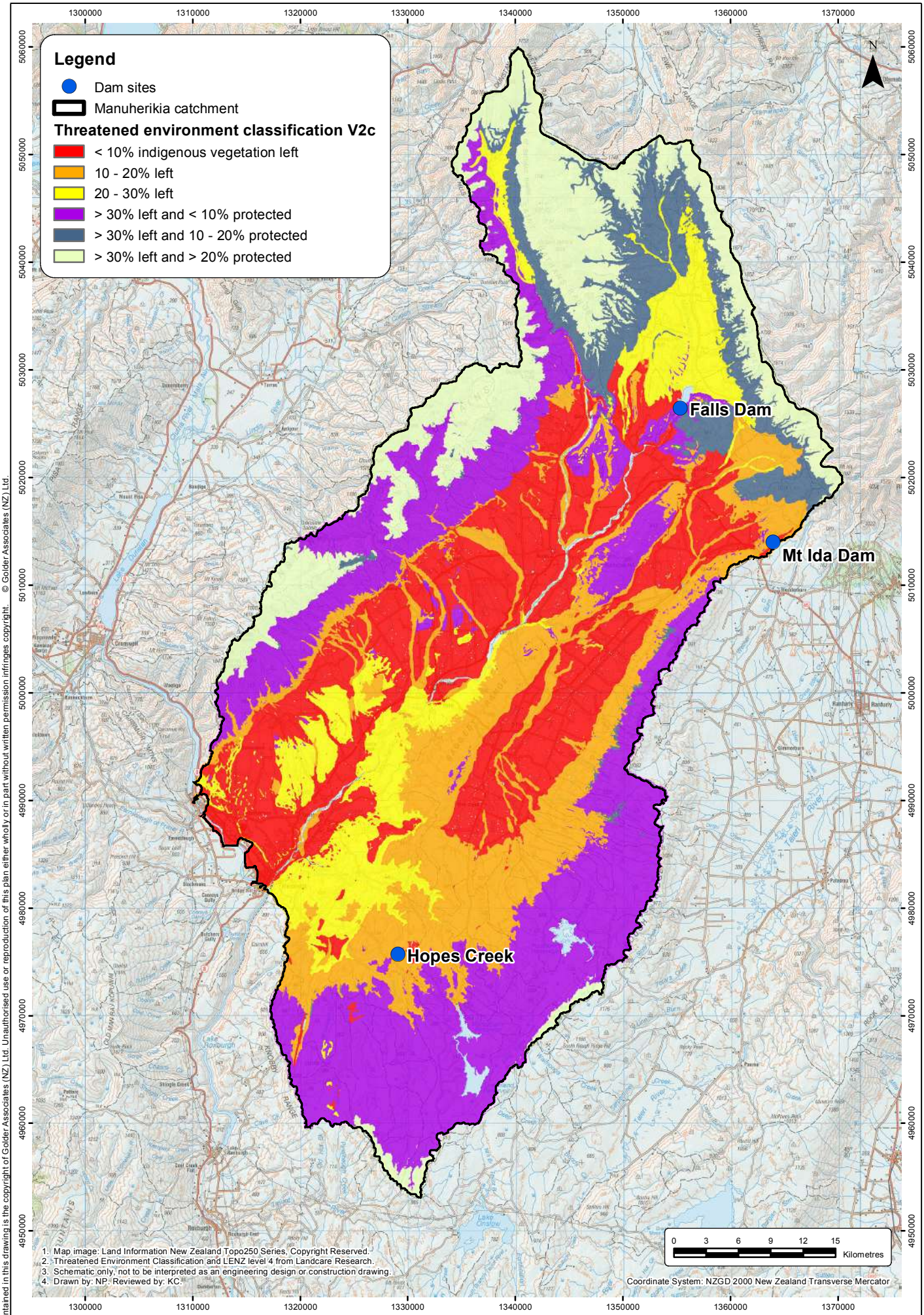
4.3.1 Upper catchment and surrounding ranges

The range crests surrounding the upper catchment are the remains of one of New Zealand's most ancient land surfaces and contain the transition zone between Otago's schist and Canterbury's greywacke (DOC 2013). The Oteake Conservation Park is the largest reserve in this area and centres on the St Bathans, Ewe, Hawkdun, Ida and St Marys Ranges and includes areas of the upper Manuherikia Basin. The draft Otago CMS (DOC 2013) has identified many of the extensive tussock grasslands, successional shrublands, subalpine grasslands, wetlands and scree slopes within this upper Manuherikia and surrounding ranges as priority ecosystem sites for protection (DOC 2013). The intact altitudinal vegetation present on both the St Bathans and Hawkdun Ranges provide significant biodiversity values and habitat for threatened species.

The dominant vegetation in Oteake Conservation Park is narrow-leaved tussock, which is found in a wide range of altitudes and situations. Oteake Conservation Park also provides protection environment for numerous threatened plant communities, including: cypress hebe, native broom (coral and dwarf), *Ranunculus acraeus* and scree pea.

4.3.2 Lower catchment drylands

The lowland catchment drylands which include the Manuherikia and Ida Burn 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 extreme dry conditions leading to highly adapted plant and animal communities. Schist rock formations (tors) often feature prominently in the landscape and can also be refuges for threatened plants and animals. The drylands areas contain some of the most threatened and least protected indigenous ecosystems and species in the country as is apparent with all LENZ level 4 environments on the Manuherikia and Ida Burn Valley floors classified as acutely threatened (Figure 4). Most (~ 90 %) of Otago's threatened plant species are also dependent on dryland habitat (DOC 2013)



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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. These wetlands at Rockdale, Dunnard, Moa Creek, and Galloway and these are included in the Otago Regional Plan as regionally significant wetlands. Tiny threatened plants such as *Lepidium kirkii* and the salt grass *Puccinellia raroflorens*, and a range of insects can be found at these sites. Inland saline ecosystems are threatened by weed invasion and land use change and are considered a highly threatened ecosystem (DOC 2013).

The indigenous ecosystems and landscapes of the drylands have been modified extensively during human settlement. Impacts from gold mining, pastoral farming, weed invasions, pest browsers and more recently cropping, viticulture, horticulture, dairying, forestry and lifestyle blocks have all lead to widespread loss of the indigenous vegetation. Additional threats to these species include predation, fire and plant and animal pests. The Manuherikia catchment contains remnant dryland habitats that provide some of the only remaining habitat for many nationally threatened species.

4.3.3 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.

4.3.4 Threatened plants of Central Otago

The following tables of threatened plants were identified as present or likely to be present in the Manuheirkia and Ida Valleys (ERA Environmental Solution Ltd. 2013). For the Nationally Critical plants fourteen species are listed of which two are only known from Central Otago (de Lange et al. 2013) (Table 2). *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).

Ten plant species are ranked as Nationally Endangered (de Lange et al. 2013), none of which are endemic to Central Otago (Table 3). However, some plant species such as the Alexandra cress are now known from fewer than 1,000 plants in the wild (NZPCN 2014b). Eighteen plant species are ranked as nationally vulnerable (de Lange et al. 2013); again none of which are restricted to Central Otago (Table 4).

Table 2: Nationally critical threatened plants present or possibly present within the Manuherikia Valley (Bold = plants endemic to Central Otago).

Scientific Name	Common Name	Distribution
Acaena* aff. *rorida		**Central Otago**
Cardamine (b)		Eastern South Island
Carmichaelia curta	*Waitaki broom, Whip broom*	Canterbury & Central Otago
Ceratocephala pungens		Canterbury & Central Otago
Chaerophyllum colensoi var. *delicatulum*	*Mountain myrrh*	Upland North & South Islands
Chenopodium detestans	*New Zealand fish-guts plant*	South Island & overseas
Crassula peduncularis		North, South & Stewart Islands & overseas
Epilobium pictum	*Grassland willow herb*	Upland North & South Islands
Lepidium kirkii	***Kirk's scurvy grass, salt pan cress***	**Central Otago**
Leptinella conjuncta	*Button daisy*	Canterbury & Central Otago
Pseudognaphalium ephemerum	*Kettlehole cudweed*	Eastern South Island
Puccinellia raroflorens	*Saltgrass*	South & Stewart Island
Simplicia laxa	*Simplicia*	North & South Islands
Triglochin palustris	*Marsh arrow grass*	Eastern South Island

Table 3: National endangered threatened plants present or possibly present within the Manuherikia Valley.

Scientific Name	Common Name	Distribution
Carex uncifolia	*Sedge*	Upland North & South Islands
Crassula multicaulis		South Island
Euchiton ensifer	*Creeping Cudweed*	North & South Islands
Iphigenia novae-zelandiae		South Island
Lagenophora montana.	*Papataniwha*	North & South Islands & overseas
Leonohebe cupressoides	*Cypress hebe*	Eastern South Island
Lepidium sisymbrioides	*Kawarau cress, Schist cress, Kawarau scurvy grass*	Canterbury & Central Otago
Lepidium solandri	*Alexandra cress, Matau cress, Inland cress*	Canterbury & Central Otago
Myosurus minimus subsp. novae-zelandiae	*New Zealand mousetail, bearded mousetail*	Eastern South Island
Ranunculus brevis		North & South Islands

Table 4: Nationally vulnerable threatened plants present or possibly present within the Manuherikia Valley.

Scientific Name	Common Name	Distribution
Amphibromus fluitans	*Water brome*	North & South Islands & overseas
Anemanthele lessoniana	*Gossamer grass*	North & South Islands
Anogramma leptophylla	*Jersey fern, Annual fern*	North & South Islands & overseas
Atriplex buchananii	*Buchanan's orache*	New Zealand
Carex inopinata	*Grassy mat sedge, Unexpected sedge*	Eastern South Island
Carmichaelia kirkii.	*Climbing broom, Kirk's broom*	Eastern South Island
Daucus glochidiatus	*Native carrot, New Zealand carrot*	North, South & Chatham Islands & overseas
Gratiola concinna		North & South Islands & overseas
Hypericum rubicundulum		North & South Islands
Isolepis basilaris	*pygmy clubrush*	Eastern North & South Islands
Kirkianella novae-zelandiae	*Kirkianella*	South Island
Myosotis brevis		North & South Islands
Myosotis glauca		Upland North & South Islands
Olearia fimbriata		South Island
Pachycladon cheesemanii		Eastern South Island
Ranunculus ternatifolius		North, South & Stewart Islands
Rytidosperma merum	*Slender bristle grass*	Upland North & South Islands
Senecio dunedinensis	*Fireweed*	South Island

An additional 33 Declining plants species, 47 naturally uncommon plants species and 15 data deficient plants species were identified as present or possibly present in the Manuherikia region (Appendix B).

4.3.5 Upper Manuherikia Valley flora

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.

The vegetation on Fiddlers Flat consists of areas of dryland shrubland and short tussock grassland on alluvial terraces and risers with areas of sedgeland (mainly *Carex coriacea*) in drainage channels that is an example of vegetation communities that are now rare nationally and is also home to several rare or threatened species.

The vegetation communities on the outwash gravels of the Manuherikia Flats above Falls Dam comprise montane matagouri shrublands, short tussock grassland, tall tussock dry grassland, tall tussock wetland, dryland herbfield, riverbed shingle communities and with limited-extent seepage cushion bog and flush wetlands. These communities improve in condition along a north-easterly gradient (i.e., up-valley) and are home to several rare or threatened species. Indigenous vegetation on Pleistocene outwash gravels, such as

the Manuherikia Flats is a Naturally Uncommon ecosystem (Landcare 2014) and the upper Manuherikia (together with Dunstan Creek) is a distinct rain-shadow environment with less than 20 % protected (Walker et al. 2003). Wildlands (2011) note that wetland areas above Falls Dam may be habitat for a number of rare spring annual herbs including *Myosurus minimus subsp. novaezelandiae* and stony sites and scabweed cushions could also provide habitat for *Myosotis brevis*. However, in the area of the upper Manuherikia survey neither plant was found by Wildlands (2011).

Within the Falls Dam gorge are cliff and steep-ground shrub and herb communities. Heenan (1995) and the Home Hills tenure review report (DOC 2006) note the presence of a population of the Nationally Critical broom *Carmichaelia curta* in the gorge at Falls Dam, noting that although a small area, it is one of two known locations where some recruitment of this species is occurring. This species is threatened by weeds, browsers and pasture plants.

Allen (1998a, b) and Heenan & Barkla (2007) also report on studies of Nationally Endangered cress *Lepidium sisymbrioides* which has a population at Falls Dam. They note that remaining populations of this species are now greatly reduced, and often only consist of small and fragmented populations in high-fertility sites threatened by degradation of habitat from invasion of weeds, browsing animals (though Allen 1998b provides evidence that browsing animals have little effect on this species) and environmental catastrophes. Plants in the Manuherikia are genetically and morphologically distinct from those in the Kawarau River and Waitaki Valley vicinities.

The Home Hills tenure review report (DOC 2006) and Grove (1994) (drawing on an unpublished 1985 report by Chapman) also note the presence of additional populations of species that are At Risk or Threatened:

- Nationally Critical button daisy *Leptinella conjuncta* on the Fiddlers Flat terrace riser.
- Declining leafless pohuehue vine *Muehlenbeckia ephedrioides* on the Fiddlers Flat terrace riser.
- Declining fan-leaved mat daisy *Raoulia monroi* on the Fiddlers Flat terrace riser.
- Declining dwarf brooms *Carmichaelia vexillata* and *Carmichaelia nana* on Fiddlers Flat.
- Declining *Pimelea sericeovillosa subsp. pulvinaris* on Fiddlers Flat.
- Declining orchid *Hymenochilus tanypodus* on Fiddlers Flat.
- Declining shrub *Coprosma intertexta* on upper Manuherikia Flats and within the gorge.
- Declining coral broom *Carmichaelia crassicaulis subsp. crassicualis* on the upper Manuherikia Flats.
- Declining bidibid *Acaena buchanani* in the gorge.
- Naturally Uncommon nettle *Urtica aspera* in the gorge.
- Data Deficient sprawling shrub *Coprosma brunnea* on the Fiddlers Flat terrace riser.
- DOC (2006) also noted populations of the rare *Carex muelleri* on Fiddlers Flat.

Falls Dam reservoir is noted as “holds an impressive aquatic flora which is revealed at low lake levels” but no further details are given (DOC 2006).

4.4 Reptiles

The lizard fauna of the Central Otago region is diverse, comprising 13 species recorded within 100 km of Alexandra (Table 5). The taxonomic identity and ecological requirements are unknown for several species, some of which are known from only a small number of individuals (Hitchmough et al. 2012, NZHD). Lizard species distribution reflects habitat availability (particularly the availability of refuges, and warm microhabitats) and predator abundance. Norbury et al. (2009) found that ground vegetation in pastoral properties in Otago provided habitat for skinks, but in highly modified grassland environments at least 50 % groundcover is needed to support skink populations. However, even in highly modified environments and grazed grasslands, lizards may persist in habitat fragments including small areas of scrub, forest and rocky outcrops.

Table 5: Lizard fauna recorded within 100 km of Alexandra, and species recorded in the vicinity of Manuherikia catchment are identified ([2]) (NZDB DOC, accessed December 2013).

Common name	Scientific name	DOC threat classification[1]	Preferred habitat
Common Skink[2]	*Oligosoma polychroma*	Not Threatened	Lowland - open habitats – grassland and shrubland
Cromwell Gecko[2]	*Woodworthia "Cromwell"*	Not Threatened	Montane - schist rock outcrops in grassland and shrubland environments
McCann's Skink[2]	*Oligosoma maccanni*	Not Threatened	Lowland - open, dry habitats including rocky habitats, grasslands and shrublands.
Grand Skink	*Oligosoma grande*	Nationally Critical	Montane – deeply creviced schist outcrops in grassland and shrublands
Otago Skink	*Oligosoma otagense*	Nationally Critical	Montane - deeply creviced schist outcrops in grassland and shrublands
Roys Peak Gecko	*Mokopirirakau* "Roys Peak"	Threatened – Nationally Vulnerable	Alpine – rock outcrops and boulder fields.
Takitimu Gecko	*Mokopirirakau cryptozoicus*	Threatened – Nationally Vulnerable	Montane - rocky habitats in alpine zone, beech forest and lowland forest.
Jewelled Gecko	*Naultinus gemmeus*	At Risk - Declining	Lowland - shrubland and forest
West Otago Green Skink (undetermined)	*Oligosoma* "West Otago"	Undetermined	Montane - tussock grasslands, scree, eroding river terraces and alpine ridges
Cryptic Skink	*Oligosoma inconspicuum*	At Risk – Declining	Lowland - open and rocky habitats, tussock grassland and scrubland.
Nevis Skink (undetermined)	*Oligosoma toka*	Threatened – Nationally Vulnerable	Unknown.
Large Otago Gecko	*Woodworthia* "Otago/Southland"	At Risk- Declining	Lowland - open and rocky habitats, shrubland and native forest.
Southern Alps Gecko	*Woodworthia "Southern Alps"*	Not Threatened	Montane - predominantly rocky habitats

Note: [1]Threat classification follows Hitchmough et al. 2012.
[2]Species recorded within 20 km of Manuherikia catchment boundary.

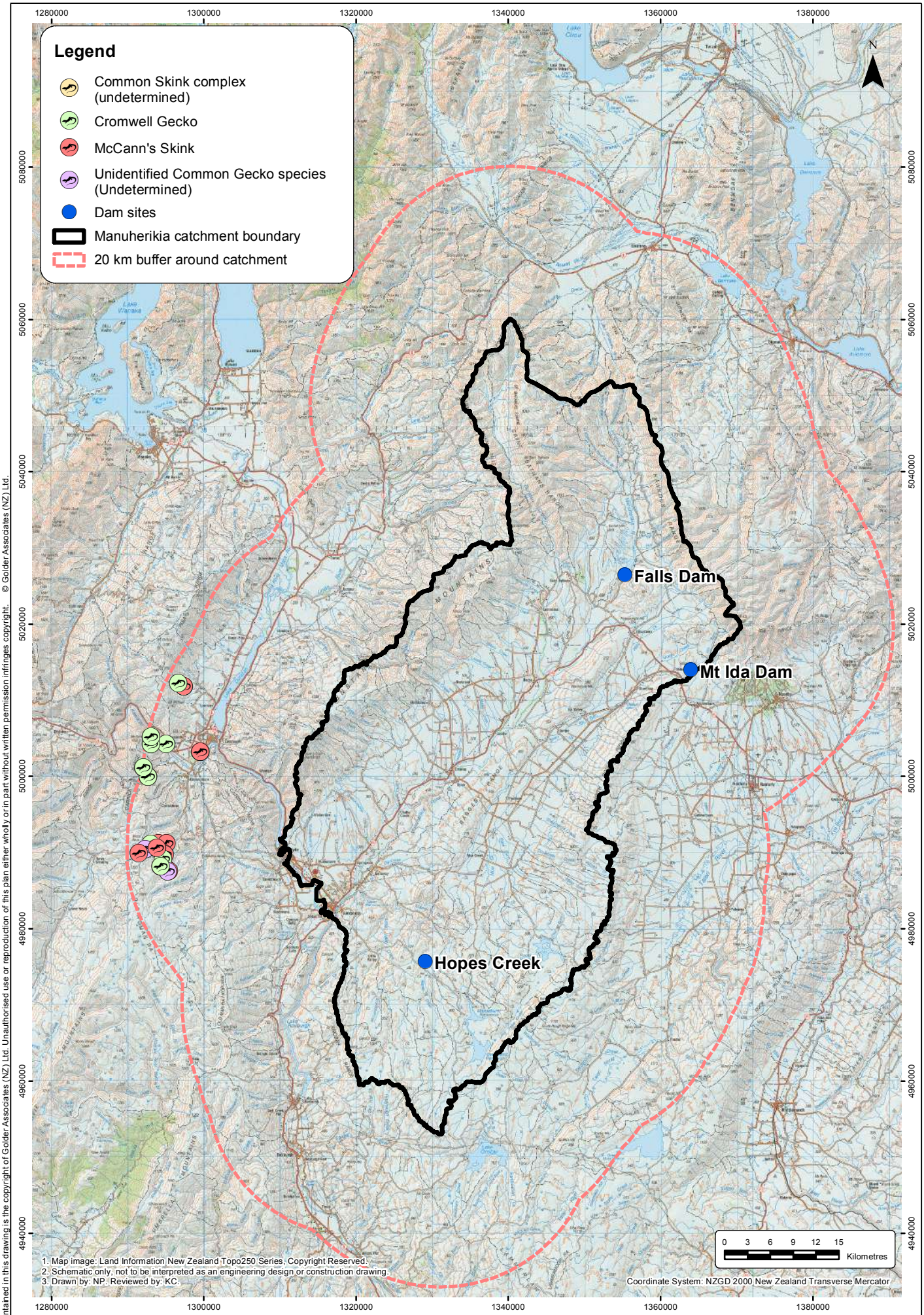
The NZHD holds 280 records for lizard species within 100 km of Alexandra, comprising seven gecko species (Figure 5) and eight skink species. Of these, four lizard species (common skink, Cromwell gecko, McCann's skink and common gecko) have been recorded within 20 km of the Manuherikia catchment boundary (Table 5, Figure 6). None of these species is identified as a threatened species (Hitchmough et al. 2012). The NZHD has no records for lizards within the catchment itself. However, essentially this reflects a lack of reporting to the NZHD rather than an absence of lizards.

The Home Hills pastoral lease tenure review conservation resources report (DOC 2006) does contain records of lizard observations in the Falls Dam area. Five lizard species where reported: green skink, McCann's skink, common skink, cryptic skink and Southern Alps gecko. DOC (2002) reported the results of a 1996 survey of the Little Mt Ida pastoral lease and also reported the five lizard species present; two species of common skink, green skink, scree skink and common gecko. Scree skink was considered the most significant find as this was the rarest species observed. This species is still considered threatened with a ranking of nationally vulnerable (Hitchmough et al. 2012). However, this species occupies steep unstable scree slopes and was 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 irrigation project.

Figure 5: Gecko collected from Johnstones Creek area, at Falls Dam.

Since the DOC (2002, 2006) tenure review reports were written the skink and gecko taxonomy has been reviewed and additional species described so the exact species recorded in this DOC surveys is uncertain. This is of particular concern with regard to the rare green skink that is now likely to fall with in the West Otago green skink range and for which so little information exists no threat ranking is even possible (Hitchmough et al. 2012, Table 5). DOC (2006) also noted that the habitat around Falls Dam and its immediate tributaries is 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.

Lettink (2011) conducted lizard surveys in the upper Manuherikia Valley upstream of Falls Dam. This survey located two skink species, common and McCanns' skinks. These species were common in the tussock grassland areas surveyed and were thought to be common in areas with good vegetation cover. It can be expected that these lizards are also present in the tussock areas around the proposed Ida Burn dam site.



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TITLE | LIZARD RECORDS WITHIN 20KM OF MANUHERIKIA CATCHMENT

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The lizards present in the Manuherikia and Ida Burn Valley area include species that are not threatened, and are in the At Risk declining threat category or have no threat status as they have not been assessed in the DOC ranking process. The undetermined species are the result of recent reviews of the lizard taxonomy and newly recognised species have not been ranked. However, regardless of the threat ranking 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.

4.5 Birds

The avifauna of the Upper Manuherikia valley has been reported in a number of publications and the area has been recognised as providing habitat for a number of threatened braided riverbed birds.

Douglas (2012) reports the nesting of black fronted terns along the upper Manuherikia River river bed and notes the presence of black billed gulls, banded dotterels and pied stilts.

Wildlands (2013) report the results of a three year of bird survey along the braided river zone above Falls Dam. This report identified a black billed gull nesting area immediately upstream of Falls Dam and notes that black fronted tern nesting is likely along the whole braided reach of the Manuherikia River. More historic reports note that black stilts and wrybills also utilise this braided river area (McEwen 1987). However, recent birds survey have failed to locate these two species (Wildlands 2013)

Additional birds species have been reported in the upper Manuherikia valley DOC (2006) recorded eleven bird species in the Home Hills tenure review report (Table 6). Of these six are introduced birds and five are native.

Additional native species expected to be present in the wider Manuherikia catchment including the New Zealand falcon (*Falco novaeseelandiae*), bellbird (*Anthornis melanura*), and silvereye (*Zosterops lateralis*). Of these only the falcon is considered threatened with a ranking of Nationally Vulnerable.

4.6 Aquatic Ecosystems

The largest river within the scheme area is the Manuherikia River. The mainstem of the Manuherikia River is approximately 85 km in length and the river flows south-west from the Hawkdun and St Bathans ranges to discharge into the Clutha River at Alexandra. The upper reaches above Falls Dam include a 10 km braided section that is unique to the Manuherikia River catchment and rare in the wider Clutha River catchment. Downstream of Falls Dam the river flows through gorge and open channel sections with three gorges – the upper gorge at Falls Dam, the Lauder Gorge and the gorge downstream of Ophir ; all three gorges together comprising approximately 19 km (c. 23 %) of the length of the main stem of the Manuherikia River.

The Manuherikia has three major tributaries all of which despite having large catchment areas contribute relatively small flows to the main stem (Table 7). The Ida Burn despite being the largest tributary catchment contributes less flow to the Manuherikia that either of the smaller Dunstan Creek or Manor Burn catchments.

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

Table 6: Bird species recorded in the Upper Manuherikia Valley above Falls Dam (sources Wildlands 2011, 2013, DOC 2006).

Common Name	*Scientific name*	DOC threat classification
Black-billed gull	*Larus bulleri*	Nationally Critical
Black stilt	*Himantopus novaezelandiae*	Nationally Critical*
Black-fronted tern	*Chlidonias albostriatus*	Nationally Endangered
Australasian bittern	*Botaurus poiciloptilus*	Nationally Endangered
Banded dotterel	*Charadrius bicinctus bicinctus*	Nationally Vulnerable
Wrybill	*Anarhynchus frontalis*	Nationally Vulnerable*
South Island Pied oystercatcher	*Haematopus finschi*	Declining
Pied stilt	*Himantopus himantopus leucocephalus*	Declining
Pipit	*Anthus novaeseelandiae*	Declining
Black shag	*Phalacrocorax carbo novaehollandiae*	Naturally Uncommon
Little shag	*Phalacrocorax melanoleucos brevirostris*	Not Threatened
Black-backed gull	*Larus dominicanus dominicanus*	Not Threatened
Grey teal	*Anas gracilis*	Not Threatened
Paradise shelduck	*Tadorna anadensi*	Not Threatened
White-faced heron	*Ardea novaehollandiae*	Not Threatened
Gray warbler	*Gerygone igata*	Not Threatened
Australian harrier hawk	*Circus approximans*	Not Threatened
Pukeko	*Porphyrio melanotus*	Not Threatened
South Island fantail	*Rhipidura fulignosa fuliginosa*	Not Threatened
Kingfisher	*Todiramphus sanctus vagans*	Not Threatened
Black fronted dotterel	*Charadrius melanops*	Native-coloniser
Starling	*Sturnus vulgaris*	Introduced and Naturalised
Chukur	*Alectoris chukar*	Introduced and Naturalised
California quail	*Callipepla californica*	Introduced and Naturalised
Goldfinch	*Carduelis carduelis*	Introduced and Naturalised
Dunnock	*Prunella modularis*	Introduced and Naturalised
Greenfinch	*Carduelis chloris*	Introduced and Naturalised
Redpoll	*Carduelis flammea*	Introduced and Naturalised
Australian magpie	*Gymnorhina tibicens*	Introduced and Naturalised
House sparrow	*Passer domesticus*	Introduced and Naturalised
Pigeon	*Columba livia*	Introduced and Naturalised
Canada goose	*Branta anadensis*	Introduced and Naturalised
Chaffinch	*Fringilla coelebs*	Introduced and Naturalised
Mallard	*Anas platyrhynchos*	Introduced and Naturalised
Spur-winged plover	*Vanellus miles novaehollandiae*	Introduced and Naturalised
Skylark	*Alauda arvensis*	Introduced and Naturalised
Yellowhammer	*Emberiza citronella*	Introduced and Naturalised

* Reported as present by McEwen (1987) but not observed more recently.

Table 7: Flow statistics for the Manuherikia River and its three major tributaries (source River Ecosystem Classification).

River	Catchment Area (km^2)	Mean flow (m^3/s)	Annual Low Flow (m^3/s)
Manuherikia River	3035	16.43	1.968
Ida Burn	821	2.76	0.222
Manor Burn	504	2.16	0.303
Dunstan Creek	298	2.81	0.358

4.7 Water Quality

Water quality sampling has been conducted by the ORC at long-term SOE monitoring sites and also less frequent as part of catchment management studies. Therefore, considerable data is available on water quality throughout the Manuherikia catchment rather than data being restricted to a few locations and occasions. This provides a relatively robust dataset to assess the current water quality status.

The ORC regularly collects samples for water quality analysis from seven sites within the Manuherikia catchment, all downstream of Falls Dam. The locations of these sites are marked on (Figure 7). Three sites are on the main stem of the Manuherikia, and four are on major tributaries into the main stem. A summary of the data measured is provided in Table 8, and compared, where available, to the “Good Quality Water” limits identified in the “Regional Plan: Water for Otago”.

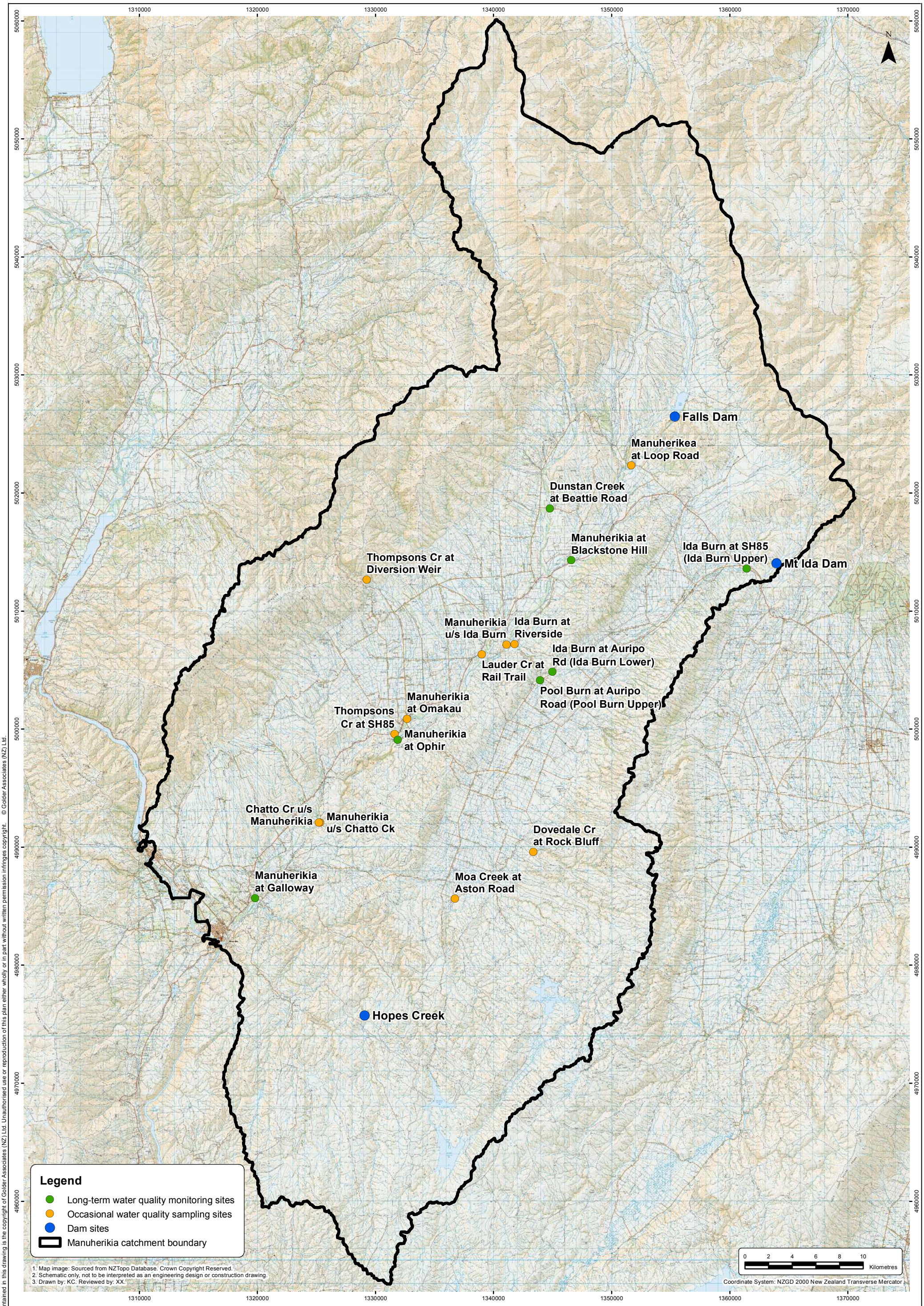
In general, the sampled waters are typical of inland streams in rural catchments and at altitude. Water temperatures reflect climate and thus range from near freezing in winter, to greater than 20 °C in summer. Suspended sediment concentrations and conductivity are generally low, but occasionally spike, most likely the product of large volumes of run-off entering the catchment’s waterways during rainfall events after prolonged dry periods.

Historical concentrations of nitrogen species (i.e., ammoniacal nitrogen, nitrite and nitrate) are relatively low throughout the catchment, although concentrations of nitrate and nitrite approach the “Good Quality Water” limit in the lower part of the Manuherikia. Similarly, for the other three key parameters, the water quality of the upper catchment is better than that of the lower catchment. In particular, sites in the lower catchment contain concentrations of dissolved reactive phosphorus typically elevated above the ORC “Good Quality Water” limit, and relatively high turbidity.

It should be noted the “Good Quality Water” limits identified in the “Regional Plan: Water for Otago” are intended to represent the upper 80th percentile value of data collected over five years, not averages, and only during periods of median or lower flows. Thus, comparison of these values with the historical data for the catchment is provided for context, rather than an assessment off compliance.

In the 2007 Otago Regional Councils State of the Environment (SOE) Report, ORC described the overall water quality in the Manuherikia catchment as “generally good” (ORC 2011). This is considered to be at least in part due to the existing low intensity farming practices in the catchment (ORC 2011).

More recently (2009 – 2010) and partially in response to the increasing likelihood for farming to intensify, the ORC initiated a sampling program specifically aimed at describing the current state of ecological health and water quality in the Manuherikia catchment. Thus, as part of this sampling program water was collected and analysed for a range of physical, chemical and microbial parameters, fortnightly from 17 stream sites throughout the catchment (Figure 7).



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TITLE | ORC WATER QUALITY MONITORING SITES

APRIL 2014

PROJECT | 1378110270

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Table 8: Summary of ORC monitoring data for key water quality parameters

Waterway	Site	Ammoniacal-N	DRP	*E. coli* (MPN)	Nitrate + nitrite[#]	Turbidity (NTU)
Manuherikia	Blackstone Hill	0.012 ± 0.0017	0.0065 ± 0.0019	63 ± 22	0.018 ± 0.0066	**3.2 ± 1.5**
	Ophir	0.012 ± 0.0011	**0.018 ± 0.0038**	**190 ± 82**	**0.078 ± 0.028**	**6.9 ± 2.8**
	Galloway	0.012 ± 0.0013	**0.014 ± 0.002**	**260 ± 140**	**0.058 ± 0.018**	**6.9 ± 3.0**
Dunstan Creek	Beattie Road	0.011 ± 0.00068	0.0043 ± 0.0014	51 ± 28	0.039 ± 0.012	1.1 ± 0.26
Ida Burn	SH85	0.01 ± 0	0.0068 ± 0.002	53 ± 35	0.012 ± 0.0059	1.1 ± 0.98
	Auripo Rd	0.013 ± 0.0018	**0.035 ± 0.012**	**570 ± 320**	0.048 ± 0.024	**3.8 ± 1.7**
Pool Burn	Auripo Road	0.022 ± 0.018	**0.054 ± 0.013**	**200 ± 180**	0.046 ± 0.026	2 ± 1
ORC Plan Change 6A "Good Quality Water" Limits		**0.10**	**0.01**	**260***	**0.075**	**5**

Notes: Except where indicated otherwise, all units g/m^3 . Data marked in red and bold indicate historical averages greater than ORC "Good Quality Water" Limit. Data marked in blue is marginal with respect to limits. *Limit as stated is for cfu (coliform forming units), not MPN (most probable number). [#]As nitrogen. DRP – dissolved reactive phosphorus.

The ORC findings and conclusions from their investigation (ORC 2011) were:

- Water quality results showed that overall the Manuherikia River main stem had 'good' water quality, with a change from 'excellent' water quality at the top of the catchment (at Loop Road), to 'good' at the bottom, (at Galloway).
- There were some tributaries of the main stem of the river that had degraded water quality during periods of low flow, and which was probably caused by run-off form irrigated pasture.
- Nitrogen was well below effects-based guideline values (Biggs 2000), especially during the high risk summer period when streams flows were low when algae can bloom to nuisance levels. Analysis suggests this catchment is nitrogen limited which is currently preventing algal proliferation.
- If nitrogen (nitrate, nitrite, and ammonia) concentrations increase, the lack of flushing flows during the summer could make the Manuherikia catchment high risk of an increase in potentially prolific algal growth.
- DRP concentrations were above the guideline value (particularly for low flows) in many of the tributaries of the Manuherikia River, which contributed to the increase in DRP in the lower part of the Manuherikia River.
- *E. coli* levels were low for the upper catchment sites (e.g., Loop Rd) and most of the Manuherikia main stem, with the exception of downstream of Ophir, which is influenced by high *E coli* levels from Thomsons Creek.
- Elevated *E. coli* levels in Dovedale Creek were probably the result of deer accessing the stream.
- Suspended solids concentrations were below the ORC plan change 6A limits.
- Elevated DRP, TP, TN and *E. coli* in the lower Thomsons Creek, Pool Burn and Lauder Creek sites are consistent with what is to be expected from runoff from flood irrigation systems. It is possible that DRP levels increase downstream because all the DRP cannot be fully utilised by plant growth, due to low NNN concentrations limiting algal growth.
- Elevated *E. coli*, TP and DRP in the Manuherikia at Ophir during low flows are possibly due to contributions from Thomson's Creek.

In the most recent ORC SOE report (ORC 2012b) it was noted that total nitrogen, *E. coli* and turbidity have all shown overall increasing trends in the Manuherikia River (at Ophir) since sampling begun in 2006 and may be related to the water quality of inflowing tributaries.

4.8 Periphyton Communities

There is one site in the Manuherikia catchment (Manuherikia River at Blackstone Hill) that is part of the SOE monitoring programme undertaken by the ORC. Periphyton communities were sampled on four occasions in the Manuherikia River at Blackstone Hill between 2009 and 2013. Periphyton communities have also been sampled once in 2010 at two other sites within the catchment, Dunstan Creek at Beattie Road and Ida Burn at SH85. Periphyton taxa and coded abundance results for sites sampled within the Manuherikia are provided in Appendix C.

During aquatic surveys undertaken in late 2010, the ORC found that the majority of sites sampled within the Manuherikia catchment only had a thin layer of algae present on the bed substrates.

Of note are the records of the invasive alga *Didymosphenia geminata* (Didymo) within the catchment (see Appendix C). Didymo has been observed upstream of Falls Dam (Golder unpublished data) and in tributaries of Falls Dam. Therefore, 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 and river conditions will control the extent to which didymo growths are apparent.

4.9 Aquatic Macroinvertebrates

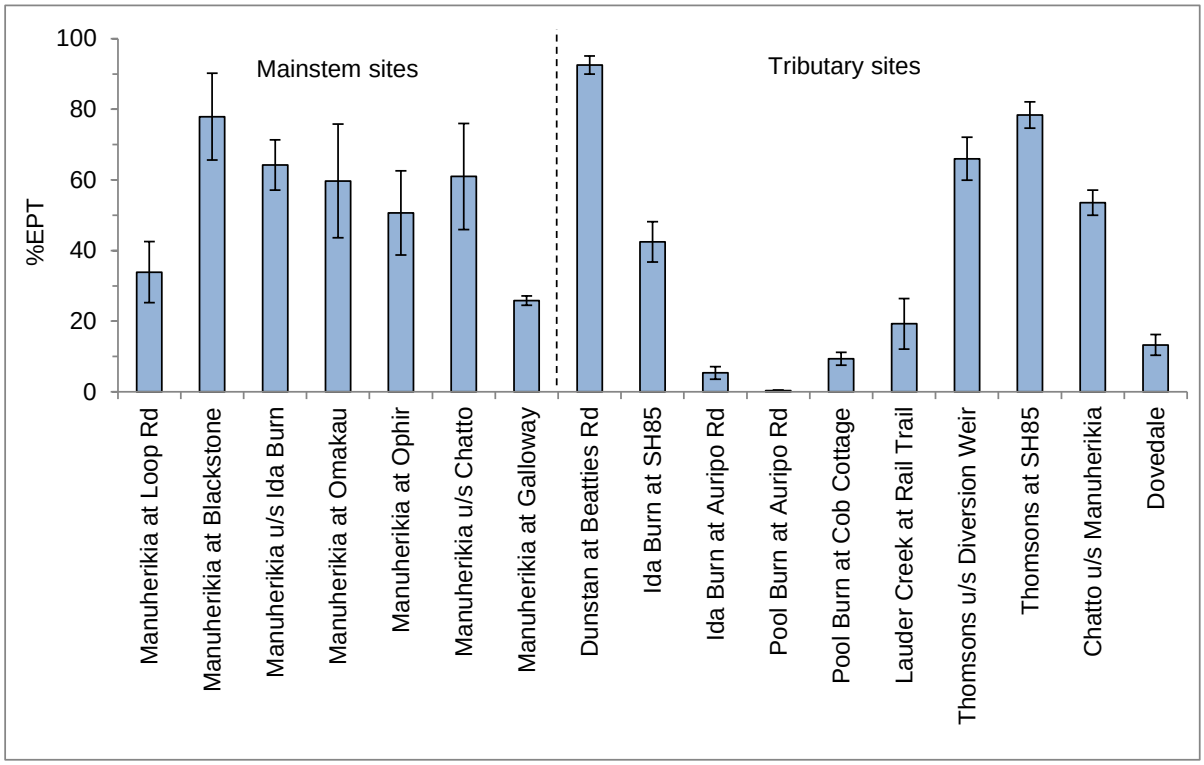
4.9.1 Summary of ORC Manuherikia Catchment Survey

As mentioned above, the ORC monitor one site in the Manuherikia Catchment (i.e., Manuherikia River at Blackstone Hill) annually since 2009 as part of the State of the Environment (SOE) monitoring programme. Additional sampling was conducted by the ORC in the Manuherikia catchment at 17 stream sites under baseflow conditions in December 2010. No invertebrate sampling appears to have been conducted in the upper Manuherikia River upstream of Falls Dam.

In 2010, the percentage of the macroinvertebrate community consisting of sensitive Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa was highly variable between sampling sites. Some of the more upstream sampling sites had the highest EPT percentages and include Dunstan Creek at Beatties Road (92 %EPT), followed by Thomsons Creek lower (78 %EPT) and Manuherikia River at Blackstone (78 %EPT) (Figure 8). The lowest EPT percentage (0.4 %) was recorded in the Pool Burn upper site. ORC control sites on Lower Ida Burn and Dovedale Creek had macroinvertebrate communities consisting of 42 % and 13 % EPT, respectively.

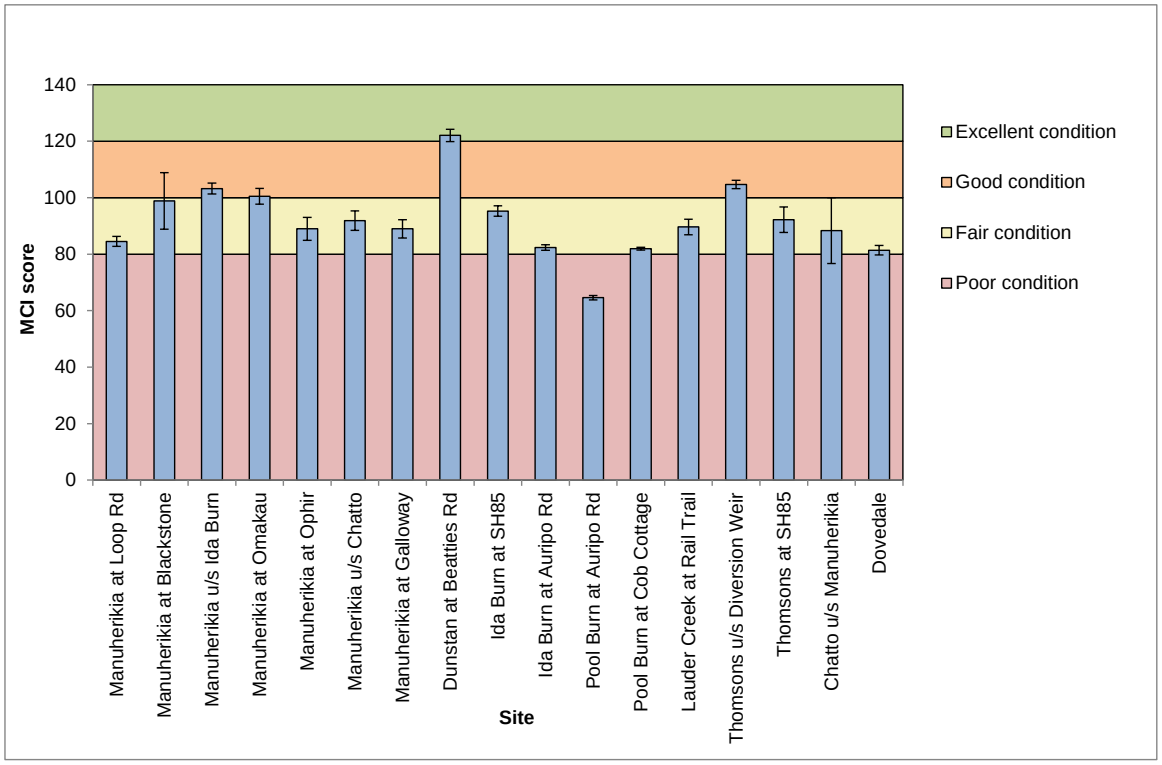
Mean macroinvertebrate Community Index (MCI) scores recorded in 2010 were highest in Dunstan Creek at Beatties Road, which was the only site to achieve a MCI score >120 and was indicative of “excellent” instream habitat or water quality conditions (Figure 9). The macroinvertebrate community in Dunstan Creek at Beattie Road was dominated by sensitive taxa primarily the mayfly *Deleatidium*, and cased caddisflies (especially *Pycnocentrodes* and *Olinga* species). The Pool Burn upper site (at Auripo Road) was the only site that had a mean MCI score that was indicative of ‘poor’ instream habitat or water quality conditions. Upper Pool Burn was dominated by tolerant taxa in particular worms and snails (*Potamopyrgus antipodarum*). Manuherikia upstream of the Ida Burn confluence and the upstream Thomsons Creek site (upstream of diversion weir) had MCI scores in the ‘good’ category, while the remaining sites fell into the ‘fair’ category. These latter sites were dominated by the cased caddisfly *Pycnocentrodes* and the mayfly *Deleatidium*.

Quantitative Macroinvertebrate Community Index (QMCI) scores recorded during the ORC survey in 2010 were highest in Dunstan Creek at Beatties Road, which was classified as being in ‘excellent’ condition and is not surprising given that this site had the highest percentage of sensitive EPT present (Figure 8; Figure 10). This was followed by Chatto Creek and the Manuherikia at Blackstone, which had QMCI scores categorising them as being in ‘good’ condition. The two sampling sites on Thomsons Creek were also classified as being indicative of ‘good’ habitat or water quality. The downstream Ida Burn site at Auripo Road achieved the lowest QMCI score, followed by the upstream Pool Burn site, also at Auripo Road. Overall, out of the 17 sites sampled in the Manhuherikia Catchment, a total of eight sites had mean QMCI scores <4 and were indicative of “poor” habitat and/or water quality (ORC 2011).



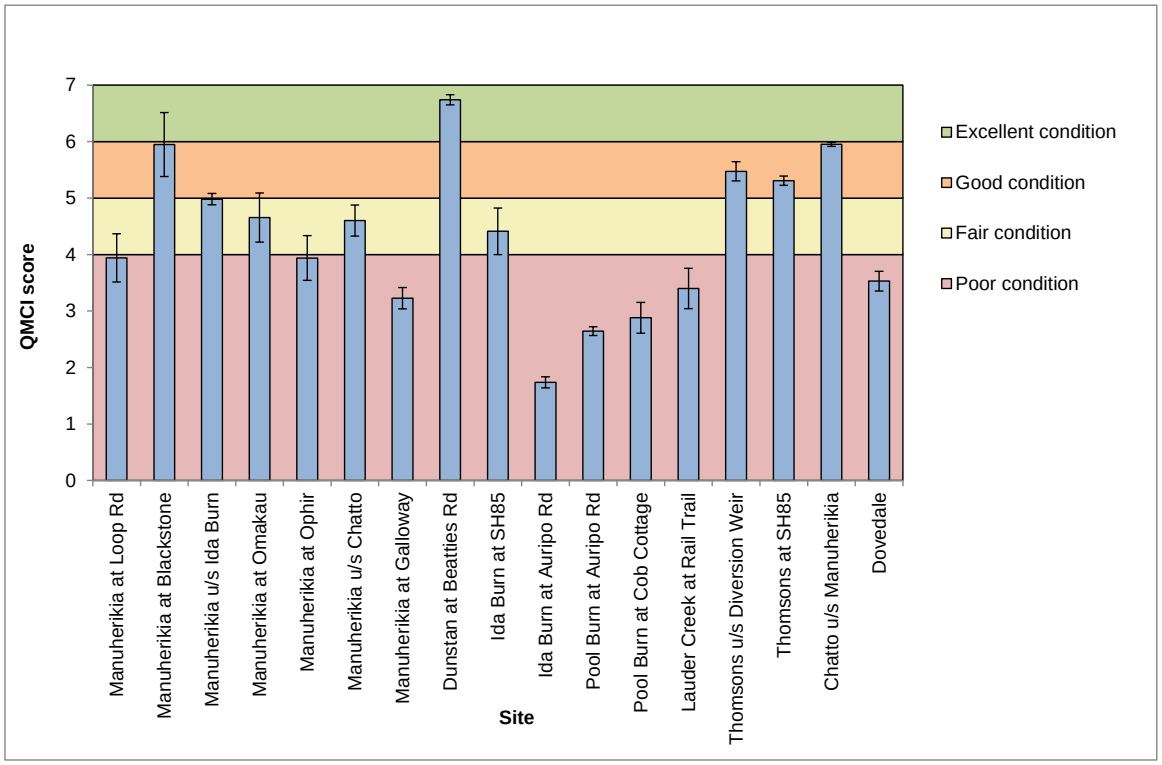
Note: Data provided by ORC.

Figure 8: Mean (±1SE) %EPT recorded in the Manuherikia River mainstem and tributaries.



Note: Data provided by ORC.

Figure 9: Mean MCI (±1SE) scores recorded in the Manuherikia River main stem and tributaries.



Note: Data provided by ORC.

Figure 10: Mean QMCI (±1SE) scores recorded in the Manuherikia River mainstem and tributaries.

Table 9 provides further interpretation of MCI and QMCI scores.

Table 9: Interpretation of MCI and QMCI values from hard-bottomed streams.

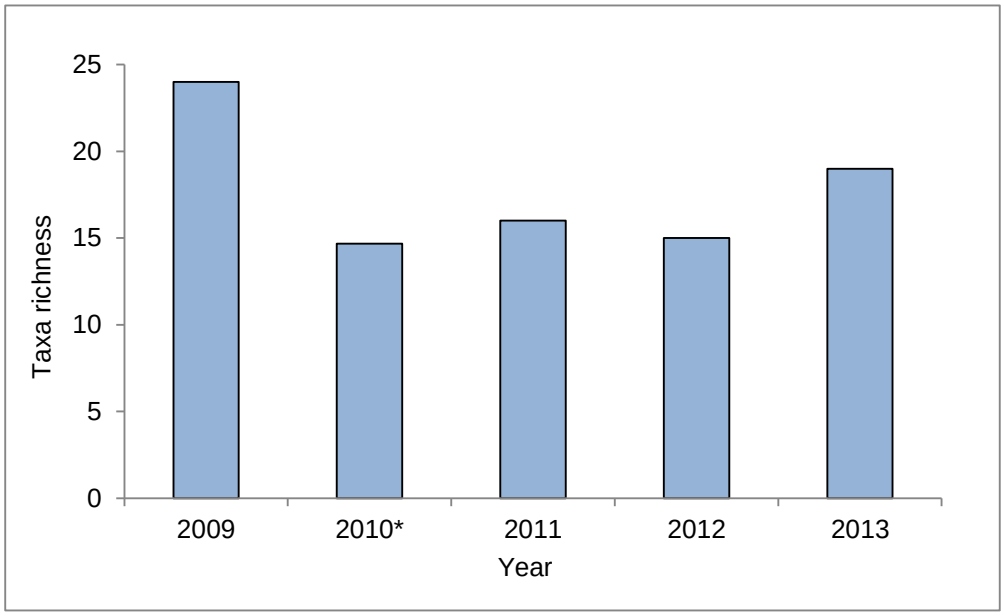
Water quality class	Description	MCI	QMCI
Excellent	Clean water	>120	>6
Good	Doubtful quality or possible mild degradation	100 - 120	5 – 6
Fair	Probable moderate degradation	80 – 100	4 – 5
Poor	Probable severe degradation	<80	<4

Note: Water quality classes after Stark & Maxted (2007) and descriptions after Stark (1998).

4.9.2 Summary of ORC SOE Monitoring in the Manuherikia River at Blackstone

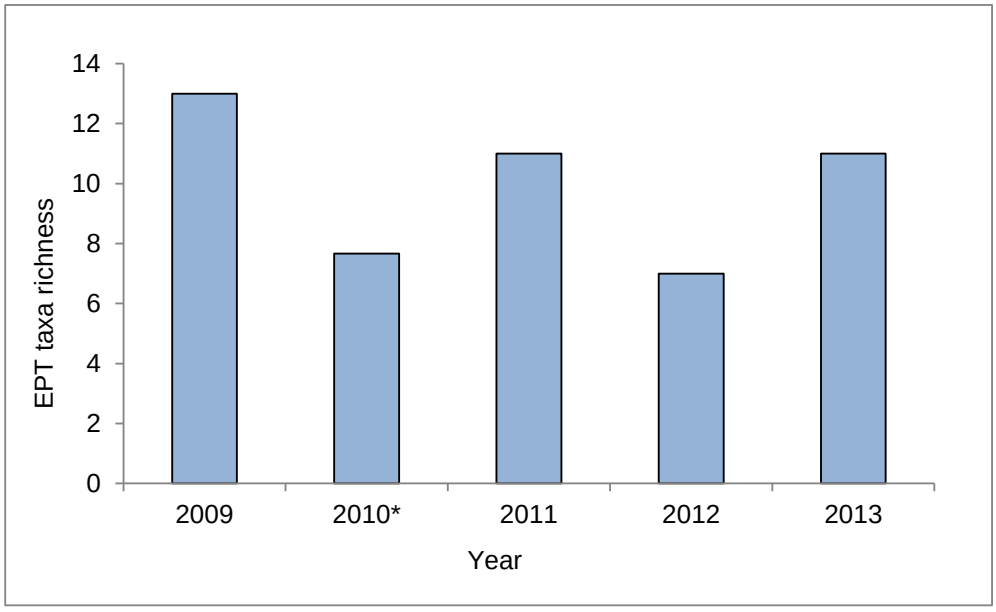
Macroinvertebrate taxa richness recorded in the Manuherikia River at Blackstone Hill between late 2009 and late 2013 has ranged from 15 taxa to 24 taxa (Figure 11). The number of "pollution-sensitive" Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa has varied between years, ranging from 7 EPT taxa to 13 EPT taxa, and consequently there has been no clear trend in either increasing or decreasing EPT taxa richness over time (Figure 12).

MCI scores recorded over time have ranged from 99 to 108 and have been indicative of "fair" to "good" water and / or habitat quality (Figure 13; Table 9).



Note: Data provided by ORC. *Data shown for 2010 is an average calculated from three Surbers, data shown for other years is based on one kick-net sample.

Figure 11: Taxa richness recorded in the Manuherikia River at Blackstone from 2009 - 2013.

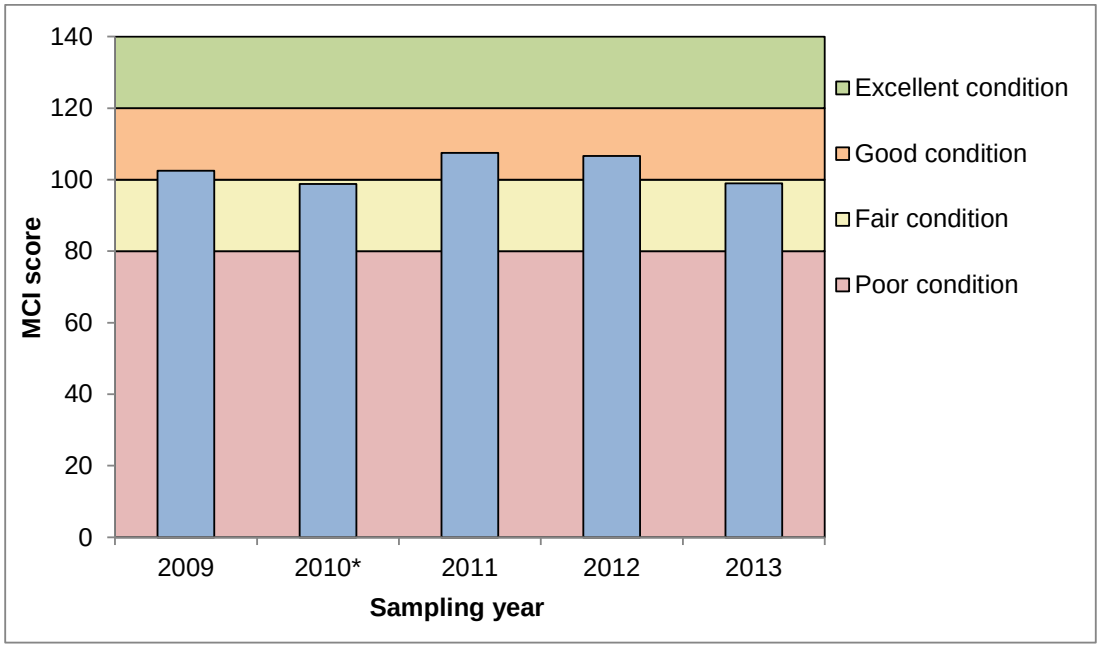


Note: Data provided by ORC. *Data shown for 2010 is an average calculated from three Surbers, data shown for other years is based on one kick-net sample. EPT richness excludes Hydroptilid caddisflies.

Figure 12: EPT taxa richness recorded in the Manuherikia River at Blackstone from 2009 - 2013.

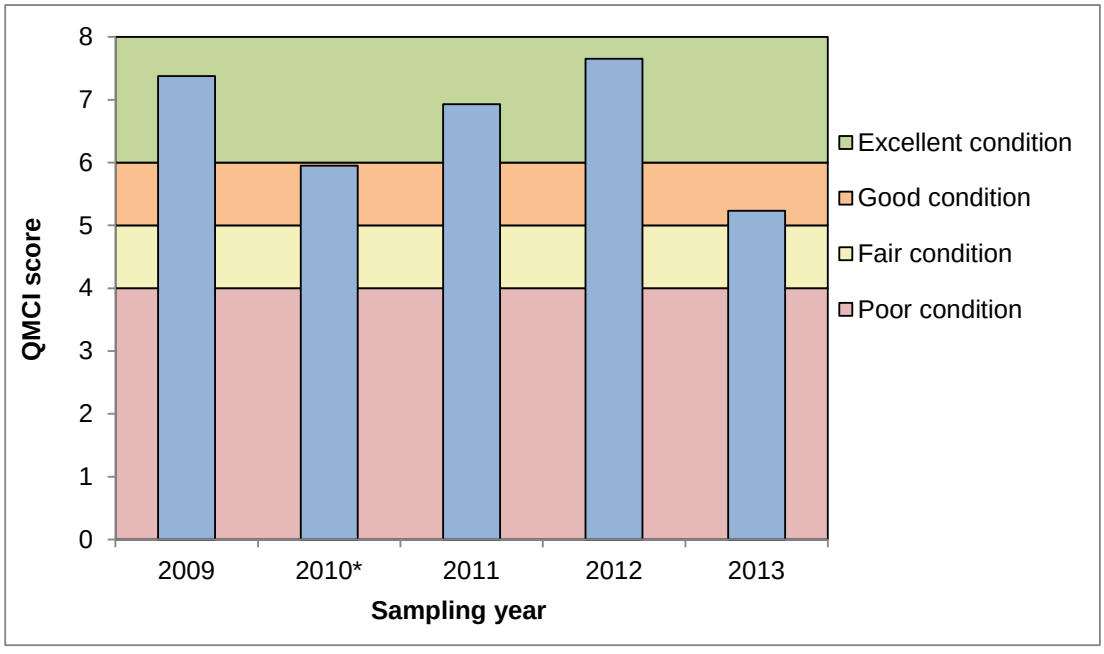
SQMCI scores recorded in the Manuherikia River at Blackstone Hill have ranged from 5.2 to 7.7, with scores being indicative of water and/or habitat quality in the “good” to “excellent” category (Figure 14; Table 9). SQMCI recorded in 2013 indicated a decline in “health” compared to previous years. However, this decline is likely to reflect the increased abundance of orthoclad midge larvae recorded in 2013. In previous years the mayfly *Deleatidium* was typically the most abundant and dominant species present. Notably, the presence of the invasive alga didymo was recorded in periphyton samples collected at this site in 2013, whilst didymo had not been recorded during surveys undertaken in the preceding two years.

Studies on the impact of didymo in waterways it invades have indicated that it can significantly alter the composition of benthic macroinvertebrate communities (Kilroy et al. 2009; Gillis & Chalifour 2010). For example, a recent New Zealand study found that the presence of didymo typically resulted in increases in algal biomass, increased macroinvertebrate abundances and shifted community composition from sensitive taxa to more tolerant taxa, such as oligochaetes and chironomid larvae (Kilroy et al. 2009).



Note: Data provided by ORC. *Data shown for 2010 is an average calculated from three Surbers, data shown for other years is based on one kick-net sample..

Figure 13: MCI scores recorded in the Manuherikia River at Blackstone from 2009 - 2013. Water quality categories "Excellent – Poor" are also shown with interpretation provided in Table 9.



Note: Data provided by ORC. *Data shown for 2010 is an average value calculated from three Surbers, data shown for other years is based on one kick-net sample.

SQMCI scores calculated using coded abundance have been provided for all years, except for 2010 where a QMCI score based on count data has been provided.

Figure 14: SQMCI scores recorded in the Manuherikia River at Blackstone from 2009 - 2013. Water quality categories "Excellent – Poor" are also shown with interpretation provided in Table 9.

4.9.3 Macroinvertebrate species of potential conservation interest

The largest macroinvertebrate that is known to be present in the Manuherikia catchment is the freshwater crayfish or koura (*Paranephrops zealandicus*). However, koura are restricted to a few sites in the Pool Burn sub-catchment and a short reach of the Ida Burn. No koura have been report from the streams in the Manuherikia Valley (Figure 15). At present no further threatened invertebrates have been noted in the data available or reports reviewed.

Koura populations have been determined as being in gradual decline nationally (Hitchmough et al 2007). However, it is noted that DOC have conducted a review of the freshwater invertebrate taxa rankings and the ranking for all species may differ once the new rankings are published.

4.10 Fish

4.10.1 Introduction

The Manuherikia River supports a total of 11 fish species (Table 10, Appendix D) (NZFFD; ORC records). Currently five of these species are classified as threatened (Allibone et al 2010) but no species recorded within the catchment are currently ranked in the highest threat 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 (see Appendix D for distribution maps).

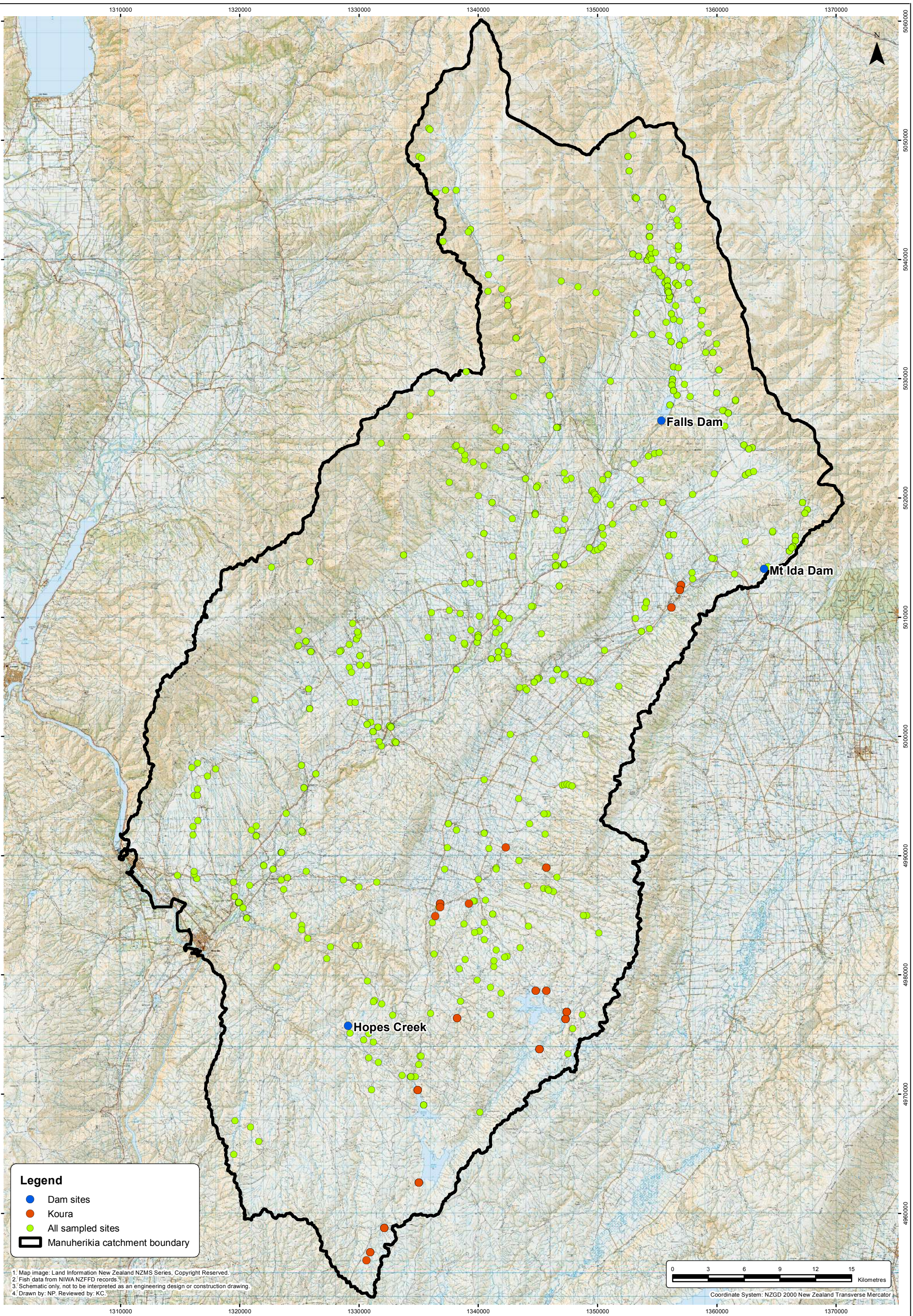
However, we note that the threat status for freshwater fish have been reviewed (conducted June 2013) and draft amended rankings have seen the threat status for the Central Otago roundhead galaxias and the yet to be named Clutha flathead (*Galaxias* spD.) move from both previously nationally vulnerable to nationally endangered and nationally critical, respectively.

Table 10: Fish species present within the Manuherikia catchment (Sources: New Zealand Freshwater Fish Database, ORC records and Fish & Game Otago records).

Common name	Species name	DOC threat classification*
Alpine galaxiid	*Galaxias paucispondylus aff manuherikia*	Nationally endangered
Central Otago roundhead galaxiids	*Galaxias anomalus*	Nationally vulnerable
Clutha flathead	*Galaxias* SpD	Nationally vulnerable
Longfin eel	*Angullia dieffenbachii*	Declining
Koaro	*Galaxias brevipinnis*	Declining
Common bully	*Gobiomorphus cotidianus*	Not threatened
Upland bully	*Gobiomorphus breviceps*	Not threatened
Rainbow trout	*Oncorhymchus mykiss*	Introduced and naturalised
Brown trout	*Salmo trutta*	Introduced and naturalised
Brook char	*Salvelinus fontialis*	Introduced and naturalised
Perch	*Perca fluvialtilis*	Introduced and naturalised

Note: *threat rankings from Allibone et al (2010) soon to be superseded by the June 2013 rankings.

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.



Golder Associates

TITLE | KOURA DISTRIBUTION IN THE MANUHERIKIA RIVER CATCHMENT (DATA SOURCED FROM THE NZFFD)

APRIL 2014

PROJECT | 1378110270

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Alpine galaxias (*Galaxias paucipondylus* aff Manuherikia) (Figure 16) is the only fish species restricted to just the Manuherikia 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) 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 lower 2 km is more sporadic.

Craw et al. (2012) provide the most recent taxonomic information for this taxon and indicate it was isolated from its closest relative in the Waitaki catchment approximately 800,000 years ago. The two populations (i.e. the Waitaki and Manuherikia populations) have subsequently undergone genetic drift accumulating to a genetic divergence of approximately 4 % (Craw et al. 2012). The Manuherikia population has not yet been described as a distinct species, but recent taxonomic work on galaxiids fishes has recognised fish populations as distinct species with shorter isolation times and lower genetic divergences than that evident for the Manuherikia alpine galaxiids. Therefore, this population should be treated as a distinct species. The distinctiveness of the Manuherikia alpine galaxiids has previously been recognised by Allibone et al. (2010) in the DOC 2009 freshwater fish threat rankings and in the more recent 2013 draft threat rankings.

Figure 16: The Manuherikia alpine galaxias.

Clutha flathead is a stream resident species that occupies small to moderate sized stream 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. Previous population decline for Clutha flatheads has been due to invasion and subsequent predation by introduced salmonids and loss of stream habitat due to water abstraction and reservoir creation (e.g., Pool Burn reservoir) that has inundated stream habitat. Currently, few if any populations have long-term security from these threats. Populations of the Clutha flathead previously thought to be secure and stable have declined and areas with habitat protection have also under gone population decline and loss due to salmonid invasions. The Clutha flathead has risen rapidly from the lowest threat classification to the highest threat ranking in the last ten years as a result of the observed populations losses (Hitchmough 2002, Hitchmough et al. 2007, Allibone et al. 2010).

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 Hope Creek. This population is known to occur from about the proposed dam site upstream (See Figure 3). The downstream population limit is unknown but is likely to be set at an upstream passage barrier (e.g., waterfall) that prevents brown trout penetrating further up Hope Creek.

Central Otago roundhead galaxias (Figure 17) has also declined due to the impacts of salmonids, reservoir construction, water abstraction and droughts. This species 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 trout predation, as Central Otago roundhead galaxias are generally only found reaches occupied by few if any trout and barries (e.g., waterfalls and perched culverts), thermal, and hydrological (dewatering) exclude trout. However, when trout breach these barrier or environmental conditions change trout invasions can occur. Additional declines are likely to be the result of 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.

Figure 17: The Central Otago roundhead galaxias.

Longfin eel has been reported from the Manuherikia River catchment. The lack of fish passage at Roxburgh Dam and small numbers of elvers transfer upstream of the dam means 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 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 for 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

Rainbow trout, (*Oncorhymchus mykiss*) perch (*Perca fluvialtilis*), and brook char (*Salvelinus fontialis*) are also present in the Manuherikia River catchment.

4.10.2 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 lake 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).

The national angler survey in 2007-2008 has shown that the Manuherikia River is the 40th most fished brown trout fishery of the 500 river fisheries surveyed. For Otago the river ranks as the fifth most used river for trout fishing. Angling activity generally peaks in the December January period of each year during the summer holiday period. Fishing effort on the major tributaries, Dunstan Creek, Ida Burn, Manor Burn and Pool Burn is variable both among the years surveyed and among the streams. The Ida Burn is the least frequently fished and the Manor Burn the most consistently fished tributary.

Angler assessments of the fishing experience on the Manuherikia River indicate that the river provides a number of valuable features. The fishing is enjoyable but not exceptional, access to the river and the river setting is good, catch rate is high and it's relative proximity to home or holiday accommodation is important. The river also provides good fishing for all methods – bait, spin and fly fishing allowing a range of anglers to utilise the river.

Fishing also occurs in the various water reservoirs in the Manuherikia River catchment. The two most popular fisheries are the Pool Burn and Upper Manor Burn Dams. The Pool Burn and Manor Burn dam fisheries are sustained by natural spawning and fry rearing in streams upstream of the two reservoirs. Pool Burn is considered to have limited spawning habitat and spawning activity of the rainbow trout present in the reservoir is monitored to ensure the small areas of spawning habitat are maintained. Fishing activity at Falls Dam is significantly lower that at the two other dams with about 200 angler days per year reported. Trout surveys during the 1979-1981 period found that upstream of Falls Dam large trout are not abundant but young of the year fish were abundant indicating the area upstream of the reservoir provides good juvenile trout rearing habitat. Trophy class trout are also reported from the East and West branches of the Manuherikia River although the density is low. Downstream of Falls Dam trout numbers are moderate to high and juvenile trout can be abundant.

Spawning surveys have been conducted in the Manuherikia catchment and the timing of the surveys is set to detect brown trout spawning in late autumn and winter rather than rainbow trout spawning that occurs in late winter and spring. Spawning surveys in the upper Manuherikia located trout spawning in the main stem and many of the tributaries. In the lower Manuherikia recent spawning surveys in 2009 and 2010 identified trout spawning in the Manor Burn, Chatto Creek, Lauder Creek and the lower Ida Burn. Electric fishing surveys of the lower Manuherikia River have identified brown and rainbow trout fry present in the river in November and December and spawning for both species is expected in the main stem.

4.11 Aquatic Habitat Modelling

Aquatic habitat models are used to assess the change in habitat available to fish, aquatic invertebrates and algal as flow changes in a reach river. Any habitat modelling process and flow setting decision requires information on the physical habitat in the river (e.g., water depth, water velocity, stream width, stream bed substrate) and how these parameters change with change in flow. Flow setting also requires information on river flow preferably over a period of years so that flow statistics such as mean flow and the 7day mean annual low flow (7dMALF) have been calculated from sufficient data to have robust estimates.

The most common habitat modelling process used in New Zealand is the River Hydraulics and Habitat Simulation program (RHYHABSIM) (Jowett 2010). This method creates habitat models for reaches of a river that have similar habitat characteristics. For instance a model can be developed for a gentle gradient reach with runs, riffles and pools but this cannot be used to model habitat in a higher gradient gorge with rapids and plunge pools. It should also be noted that while this model is commonly used in New Zealand, other flow setting process are available and there is considerable debate on the use of models and methods for flow setting (e.g., Hudson et al. 2003).

For the Manuherikia River two RHYHABSIM models are available to assess the changes in aquatic habitat with changes in flow. Jowett & Wilding (2003) developed a model for the lower Manuherikia River at Galloway and Golder (2008) developed a model for Dunstan Creek. Both models have been developed on gentle gradient reaches with riffle run pool habitat and stream bed substrates dominated by cobble and gravel. These models are appropriate for the majority of the Manuherikia River as this is predominately a cobble gravel bed river. These models cannot be used to assess habitat availability in the gorge sections of the Manuherikia River. The ORC has been collecting flow data for the main stem of the Manuherikia River and good estimates of mean flow and 7dMALF are available. This data does need to be correct to account for irrigation abstractions and additions to the Manuherikia River to change the measured flows to natural flows.

For the tributaries of the Manuherikia River (except Dunstan Creek) little if any flow data is available and no habitat models have been developed. For any tributary of interest new RHYHABSIM models (or other models) would have to be developed and modelled stream flows used to assess aquatic habitat changes with flow.

5.0 ISSUES AND RISKS

5.1 Water Quality

Water quality data is collected from seven sites in the Manuherikia River catchment on a monthly basis by the ORC. However, water quality data for many tributaries is limited to occasional samples or no samples. In addition flow data for tributaries is limited or absent. This means that calculating nutrient loads for individual streams can only be done from modelled flow data and estimates of nutrient loads in runoff.

The current water quality data indicates that at some sites: the Manuherikia River at Ophir and Galloway, and the Ida Bun and Pool Burn at the Auripo Road bridges, phosphorus is exceeding the ORC water plan change 6A requirements. Additional farm development and any increased use of fertilisers has the potential to increase the current levels.

The available water quality data indicates that algal and plant growth in the Manuherikia River and tributaries can be limited by the nitrogen available in the streams. This is unlike many New Zealand rivers and streams where phosphorus is the limiting nutrient for plant and algal growth. The key risk for the Manuherikia catchment is that if farming intensity increases and stock numbers increase then nitrogen levels will increase in the runoff. This has risk of generating algal blooms especially in the summer low flow periods. This will lead to declining water quality and impacts on instream fauna. Some mitigation is possible with appropriate farm management such as nutrient budgeting and riparian setbacks. Therefore, management of stock numbers and nutrients is of high importance if the current water quality and instream values and compliance with ORC water quality rules are to be maintained.

5.2 Falls Dam

5.2.1 General ecological values

Falls Dam and the area upstream in terms of its terrestrial environmental classification and the braided river habitat is a distinct and rare environment within the Otago region. 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 the only 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 the upper Manuherikia River. The terrestrial areas around Falls Dam also support abundant and specious lizard populations including at least one species of possible high conservation value – green skink (yet to have a formal threat ranking). The best lizard habitat does appear to be concentrated in the rocky gorges of tributaries to Falls Dam and downstream in the Manuherikia Gorge.

When considering the broad range of environmental and ecological values at Falls Dam and the local, regional and national significance of these values all of the proposed options for raising the height of Falls Dam faces significant environmental issues.

5.2.2 Potential ecological impacts of raising the height of Falls Dam

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 18

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 18). South of this point, the ground contours are demonstrably further apart representing a gentler slope where river braids form. Point A on Figure 18 is coincident with the LINZ 700m 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 Falls Dam with the existing dam (reservoir full) is 10.88km.

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 6 m raise (reservoir full): 10.63 km (2.3% loss, or 250 m)
- Total length of braided river for a 15 m raise (reservoir full): 10.16 km (6.6% loss, or 720 m)
- Total length of braided river for a 27 m raise (reservoir full): 8.24 km (24.3% loss, or 2,640 m)

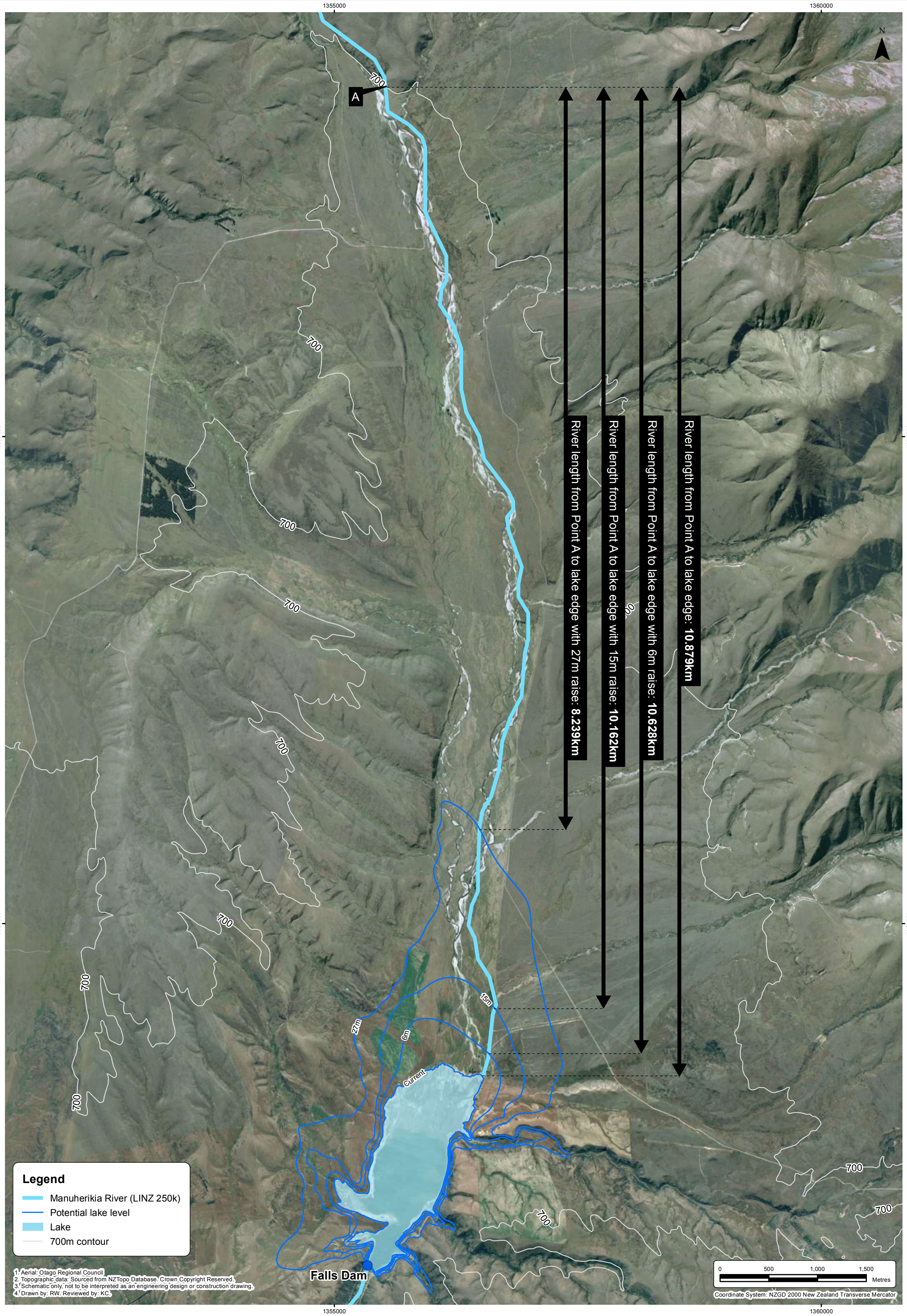
This habitat loss for all dam raise options will have an impact on known rare fish and the only known nesting area of the nationally critically threatened black-billed gull in the Manuherikia Valley. A proportion of the nesting habitat of the nationally endangered black fronted tern will also be lost as will some threatened plants and a portion of high value lizard habitat.

Initial field survey work (Golder unpublished data, 2014) indicates that the potential effect of raising Falls Dam is not restricted to inundation of river habitat and loss of habitat for the alpine galaxiid. The initial survey work indicates that the presence of abundant salmonids (mainly brown trout) may be excluding the alpine galaxiids from the Manuherikia River reach immediately upstream of the reservoir for some 500 m. Therefore, the potential threat to the alpine galaxias will be habitat loss (via inundation) and for an additional area upstream of the raised reservoir as trout displace the galaxiid from new 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 locating 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 and inundation will only affect a proportion of the nesting areas.

Additional effects on lizards and plants mean the high dam option has the likelihood of a highly significant impact on the indigenous flora and fauna of the upper Manuherikia River.



Golder Associates

TITLE | FALLS DAM: POTENTIAL INUNDATION OF RIVER BRAID

APRIL 2014

PROJECT | 1378110270

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5.2.3 Data Quality

Wildlands (2013) have 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. A better understanding of the bird populations of the river, their distribution, nesting areas and abundance could be achieved if access to the full length of river was available. 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 from an initial site visit by Golder staff indicates that the alpine galaxiid has a patchy distribution in the upper Manuherikia River.

Within the braided reaches of the Manuherikia River occupied by alpine galaxias there is an ongoing interaction between the salmonids and the alpine galaxiid. As noted above, salmonids appear to 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 absent 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. The lack of distribution and population data means that distribution and abundance of the alpine galaxias in the river is not well understood.

It is important to determine if the reaches potentially inundated by raising the dam height are areas with abundant alpine galaxiids or whether the areas are of with little value for the fish. Gaining information on the distribution of suitable habitat for the alpine galaxiid and how erosion and channel stability in the braided river control the distribution of the salmonids and alpine galaxias is important for understand the long-term population survival and to complete an assessment of effects of the potential options for dam raising and reservoir creation. Studies to assess the distribution of alpine galaxias should be undertaken over more than one year and need to include sufficient habitat assessment observations to determine the key habitats within the braided river that support alpine galaxias. The habitat assessment can then be used to assess habitat availability along the whole braided reach using aerial photographs. If historic aerial photography is available then the long-term change in occurrence of habitat types can be assessed. This will allow a robust assessment of alpine galaxias habitat and its occurrence along the reach, the importance of each habitat and how these habitats vary over time.

5.2.4 Possible Mitigation options

Lizards and plants

Mitigation options may be available to address the effects on lizards using predator control to increase lizard survival in the remaining habitat. However, the current habitat with abundant rock cover and thick vegetation does provide abundant refuge habitat from predators and predatory control operations may provide limited benefit to the lizards. Plant management may also be undertaken to protect the rare plants that are present outside the inundation zone.

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 programmes 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. These options would entail an ongoing commitment to providing funding for these offset operations.

Manuherikia alpine galaxias

Increasing the height of Falls Dam will result in the inundation of habitat 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 work would have to be applied to the alpine galaxias population in the upper Manuherikia River.

The viability of mitigating the loss of the habitat for the Manuherikia alpine galaxiid is unknown but can be fairly described as being very difficult with the likely effectiveness far from certain. Some overseas studies have used highly engineered river solutions as attempts at mitigating loss of habitat, but their long term success and applicability to New Zealand conditions are unknown.

Salmonids are currently recognised as a significant threat and removal of salmonids would benefit the alpine galaxias. However, the removal of salmonids that are impacting on the alpine galaxias is not possible on the scale of the upper Manuherikia Valley. Local scale habitat management or trout control is also likely to be costly and its effectiveness far from certain.

Translocation of the alpine galaxiid to a new river could be attempted to provide new habitat for the fish. 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 is provided to show the translocation would be successful, but not impact on other values at the translocation sites. Therefore, the translocation site needs habitat similar to the upper Manuherikia River; i.e. that the site is 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 and the likelihood of locating an appropriate site is considered highly unlikely.

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 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 didymo transfer would not occur in these 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.

6.0 SUMMARY

6.1 Environments

The Manuherikia and Ida valleys are well developed for pastoral activity and indigenous vegetation and intact indigenous ecosystems are essentially absent from the valley floors. The 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 progressive less developed and provide larger areas indigenous vegetation and the associated fauna. The upper Manuherikia valley above Falls Dam is a unique feature of the Manuherikia and wider Clutha River Catchment. The upper Manuherikia has environments that only found to the north in Canterbury or are uncommon throughout New Zealand.

6.2 Indigenous Flora and Fauna

The upper Manuherikia Valley supports a significant array of indigenous plants, birds, lizards and fish. The braided river habitat in the upper Manuherikia valley is also unique and provides the only habitat for the Manuherikia alpine galaxiid and habitat for a number of threatened braided river birds. Additional rocky gorge habitat in the vicinity of Falls Dam provides good habitat for threatened plants and a number of lizard species.

Saline wetlands scattered across the Manuherikia 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 ORC water plan as regional significant wetlands.

The highly modified valley floors downstream of the Loop Road bridge on the Manuherikia 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.

6.3 Water Quality

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). Tributaries have variable water quality with water quality again declining in a downstream direction as the streams flow across the Manuherikia and Ida valley floors. Current irrigation discharges from flood irrigation in summer is thought to be supplying phosphorus to the water courses and elevating the nutrient concentrations. There is potential for algal blooms although this is currently limited by low levels of nitrogen in the streams.

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APPENDIX A

Report Limitations

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APPENDIX B

Plants

APPENDIX B
Declining, natural uncommon and Data defiecient plants present in Central Otago

Table 1: Declining plant species present in Central Otago.

Scientific Name	Common Name	Distribution
Acaena buchananii Hook.f.	Bidibid, piripiri	Eastern South Island
Aciphylla subflabellata W.R.B.Oliv.	*Spaniard*	South & eastern South island
Brachyglottis sciadophila (Raoul) B.Nord.	*climbing groundsel*	North & South Islands
Carex albula Allan	*White Sedge*	Eastern South Island
Carex tenuiculmis (Petrie) Heenan et de Lange	*Slender Niggerhead*	South, Stewart & Chatham islands
Carmichaelia corrugata Colenso	*Common dwarf broom*	Eastern South Island
Carmichaelia crassicaulis Hook.f. subsp. *crassicaulis*	*coral broom*	Eastern South Island
Carmichaelia nana (Hook.f.) Hook.f.	*Dwarf Broom*	Upland North & South Islands
Carmichaelia vexillata Heenan	*dwarf broom*	Eastern South Island
Connorochloa tenuis (Buchanan) Barkworth, S.W.L.Jacobs et H.Q.Zhang	*prostrate bluegrass*	Upland North & South Islands
Convolvulus verecundus Allan	*Trailing bindweed, tussock bindweed*	Eastern South Island
Coprosma intertexta G.Simpson		Eastern South Island
Coprosma virescens Petrie		North & South Islands
Coprosma wallii Petrie		North, South & Stewart Islands
Deschampsia cespitosa (L.) P.Beauv.	*tufted hair-grass, wavy hair-grass*	New Zealand & Overseas
Geranium solanderi Carolin	*Turnip-rooted geranium*	North, South & Chatham Islands & Overseas
Hymenochilus tanypodus (D.L.Jones, Molloy et M.A. Clem.) D.L.Jones, M.A.Clem. et Molloy		South Island
Hymenochilus tristis (Colenso) D.L.Jones, M.A.Clem. et Molloy		North, South & Stewart Islands
Hypericum involutum (Labill.) Choisy	*grassland hypericum*	North & South Islands & Overseas
Lepidium tenuicaule Kirk	*Shore cress*	Southeastern South Island
Lobelia ionantha Heenan	*Hypsela*	South Island
Luzula celata Edgar	*dwarf woodrush*	South & Stewart Island
Melicytus flexuosus Molloy et A.P.Druce		North, South & Stewart Islands
Mentha cunninghamii Benth.	*New Zealand mint, Hihoi*	North, South, Stewart & Chatham islands

Scientific Name	Common Name	Distribution
Muehlenbeckia ephedroides Hook.f.	*Leafless pohuehue, leafless muehlenbeckia, Twigs*	North & South Islands
Myosotis pygmaea Colenso	*pygmy forget-me-not*	North, South & Stewart Islands
Olearia lineata (Kirk) Cockayne		South Island
Parahebe canescens (A.Wall) W.R.B.Oliv.	*Tarn Speedwell, Tarn Parahebe*	Eastern South Island
Pimelea aridula Cheeseman subsp. *aridula*	*Pimelea*	Canterbury & Central Otago
Pimelea sericeovillosa Hook.f. subsp. *sericeovillosa*	*Pimelea*	Eastern South Island
Raoulia monroi Hook.f	*fan-leaved mat daisy*	Eastern South Island
Rytidosperma telmaticum Connor et Molloy	*Tarn Bristle Grass*	Canterbury & Central Otago
Teucridium parvifolium Hook.f.	*Teucridium*	North & South Islands

Table 2: Naturally uncommon plants present in Central Otago.

Scientific Name	Common Name	Distribution
Acaena microphylla var. *pauciglochidiata* Bitter	*Bidibid, piripiri*	Otago to Stewart Island
Achnatherum petriei (Buchanan) S.W.L.Jacobs et J.Everett	*Petries needle grass*	Central Otago
Agrostis petriei Hack.		Canterbury & Central Otago
Anemone tenuicaulis (Cheeseman) Parkin et Sledge	*New Zealand anemone*	North & South Islands
Anisotome cauticola J.W.Dawson		Eastern Otago
Anthosachne aprica (Á.Löve et Connor) C.Yen et J.L.Yang	*Blue wheat grass*	Central Otago
Anthosachne falcis (Connor) Barkworth et S.W.L.Jacobs		Canterbury & Central Otago
Botrychium australe R.Br.	*parsley fern, patotara*	New Zealand & Overseas
Carex allanii Hamlin	*Allans Sedge*	Canterbury & Central Otago
Carex berggrenii Petrie	*Berggrens Sedge*	Upland North & South Islands
Carex capillacea Boott	*Sedge*	Upland North & South Islands & overseas
Carex carsei Petrie	*Carses sedge*	Upland North & South Islands
Carex enysii Petrie	*Enyss Sedge*	South Island
Carmichaelia compacta Petrie	*Cromwell broom*	Central Otago
Celmisia hookeri Cockayne	*Hooker's mountain daisy*	Otago & Southland
Centipeda aotearoana N.G.Walsh	*New Zealand sneezewort*	North & South Islands
Chenopodium allanii Aellen		North & South Islands
Colobanthus brevisepalus Kirk	*pin cushion*	Eastern South Island
Convolvulus fractosaxosa Petrie	*Shingle convolvulus*	Eastern South Island
Crassula mataikona A.P.Druce		North & South Islands
Deyeuxia youngii (Hook.f.) *Buchanan*		South Island
Dracophyllum uniflorum var. *frondosum* G.Simpson	*sprawling inaka, sprawling turpentine scrub*	South Island
Euchiton paludosus (Petrie) Holub		North, South & Stewart Islands
Euchiton polylepis (D.G.Drury) Breitw. et J.M.Ward		North & South Islands
Gingidia baxterae (J.W.Dawson) C.J.Webb	*Baxters Aniseed*	South Island

APPENDIX C

Periphyton

Figure 1: Periphyton Data

Periphyton taxa recorded at ORC sampling sites at Blackstone Hill (Table 1) and in Dunstan Creek and Ida Burn (Table 2).

Table 1: Periphyton taxa and coded abundance recorded in the Manuherikia River at Blackstone Hill on four occasions.

	Year sampled			
Taxa	**2009**	**2011**	**2012**	**2013**
Filamentous Green Algae				
Cladophora		1		
Rhizoclonium			1	
Filamentous Red Algae				
Audouinella		2	3	
Cyanobacteria				
Nostoc				2
Oscillatoria			1	
Rivularia			2	
Diatoms				
Cymbella				1
Didymosphenia germinata	2			3
Epithemia				2
Frustulia	3			1
Gomphoneis	4		2	
Gomphonema				4
Hantzschia		1		
Melosira		2	3	3
Naviculoid	4			
Rhopalodia				2
Stauroneis	3			
Synedra		1		
Tabellaria	5			
Phytoplankton				
Asterionella	5			
Cosmarium	1			
Scenedesmus	1			

Note: Data provided by ORC. No sampling was undertaken in 2010. Coded abundance where 1=rare, 2=rare-occasional, 3=occasional, 4=occasional-common, 5=common, 6=common-abundant, 7=abundant, 8=dominant, after Biggs and Kilroy (2000).

Table 2: Periphyton taxa and coded abundance recorded in Dunstan Creek and Ida Burn in 2010.

Taxa	Dunstan Ck at Beattie Rd	Ida Burn at SH85
GREEN FILAMENTS		
Bulbochaete spp.		3
Microspora spp.	8	7
Mougeotia spp.		3
Oedogonium sp.		3
Spirogyra spp.		3
GREEN (NON-FILAMENTOUS)		
Ankistrodesmus spp	2	2
Cosmarium spp.	2	2
Pediastrum spp.		2
Scenedesmus spp.	2	
DIATOMS		
Achnanthidium spp. (small)	3	4
Brachysira spp.	2	
Cocconeis placentula	5	1
Cymbella aspera	1	1
Cymbella kappii		6
Cymbella cf. *tumida*	1	
Diatoma hiemale	2	
Didymosphenia geminata	3	
Encyonema cf. *minutum*	5	4
Epithemia sorex		4
Fragilaria spp. (small. cf. *vaucheriae*)	5	4
Frustulia vulgaris		2
Gomphoneis minuta var. *cassieae*	3	4
Gomphonema cf. *minutum* (15 µm)	4	4
Gomphonema cf. *parvulum*	6	
Gomphonema cf. *berggrenii?*		4
Gomphonema spp. (small)	2	
Melosira varians	4	
Meridion circulare	1	
Navicula cf. *margilithi*	3	
Navicula cf. *gregaria*		3
Nitzschia acicularis	1	
Nitzschia spp.(small)	3	
Nitzschia (skinny) 20-30x5µm		4

Taxa	Dunstan Ck at Beattie Rd	Ida Burn at SH85
Nitzschia cf. *linearis*		1
Pinnularia cf. *viridis*		3
Pinnularia cf. *subcapitata*		1
Rhopalodia novae-zealandiae		2
Rossithidium linearis		3
Synedra ulna cf. *ramesi*	6	
Synedra spp. cf. *rumpens*		2
Tabellaria flocculosa	1	4
CYANOBACTERIA		
cf. *Phormidium* spp.	4	8

Note: Data provided by ORC. Coded abundance where 1=rare, 2=rare-occasional, 3=occasional, 4=occasional-common, 5=common, 6=common-abundant, 7=abundant, 8=dominant, after Biggs and Kilroy (2000).

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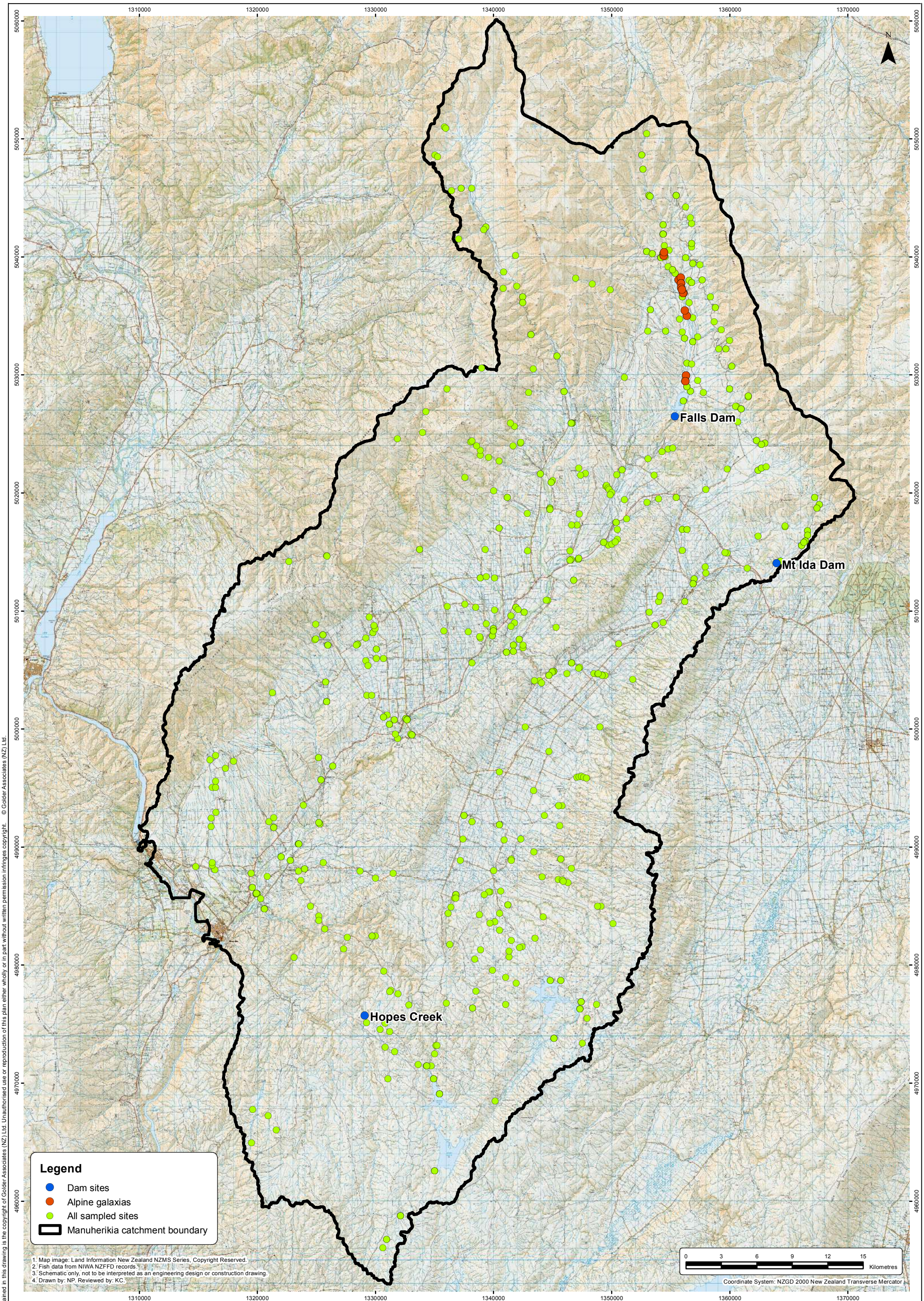
APPENDIX D

Fish



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TITLE | MANUHERIKIA ALPINE GALAXIAS SITES REPORTED IN THE NZFFD

APRIL 2014

PROJECT | 1378110270

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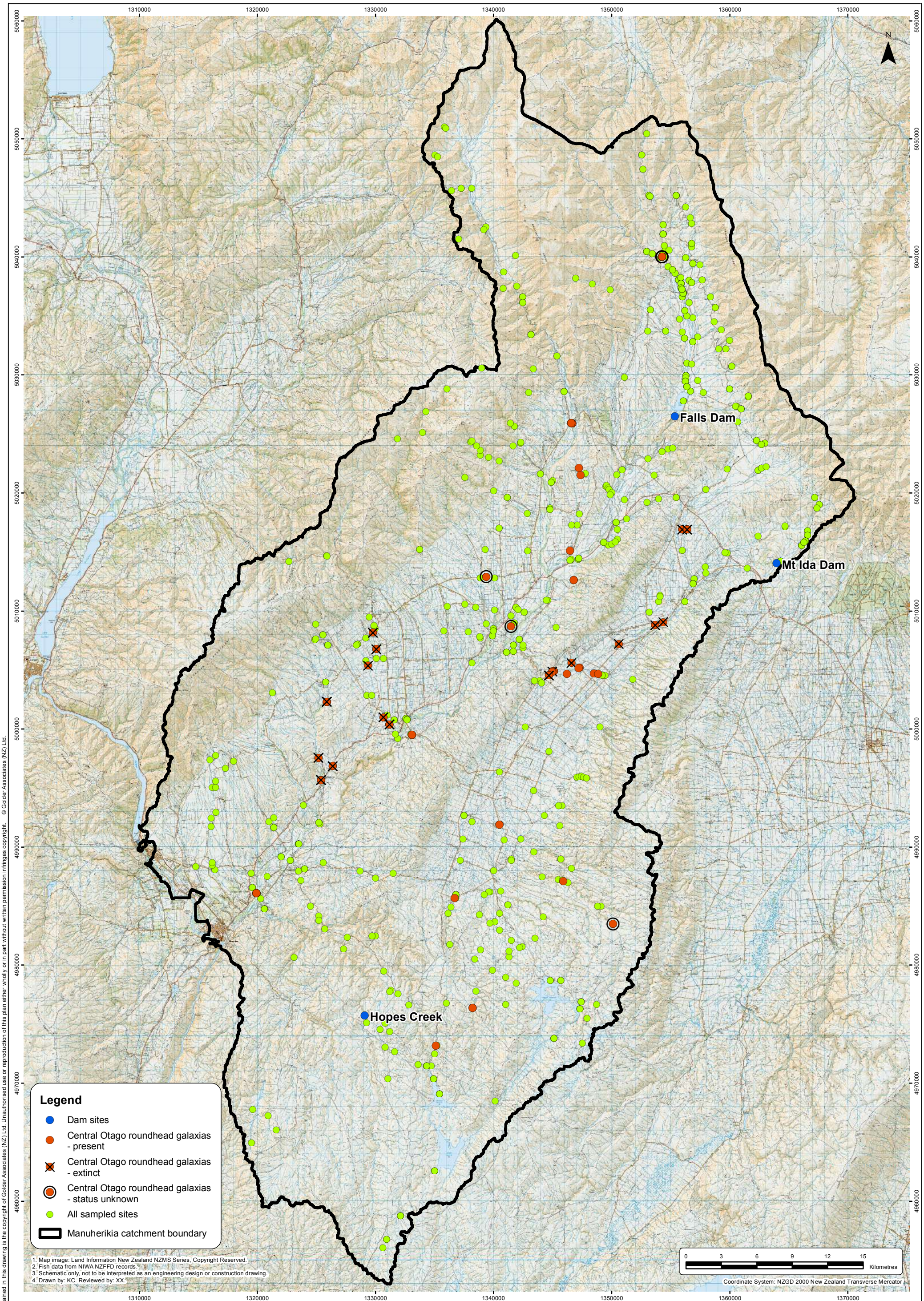

Golder Associates

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APRIL 2014

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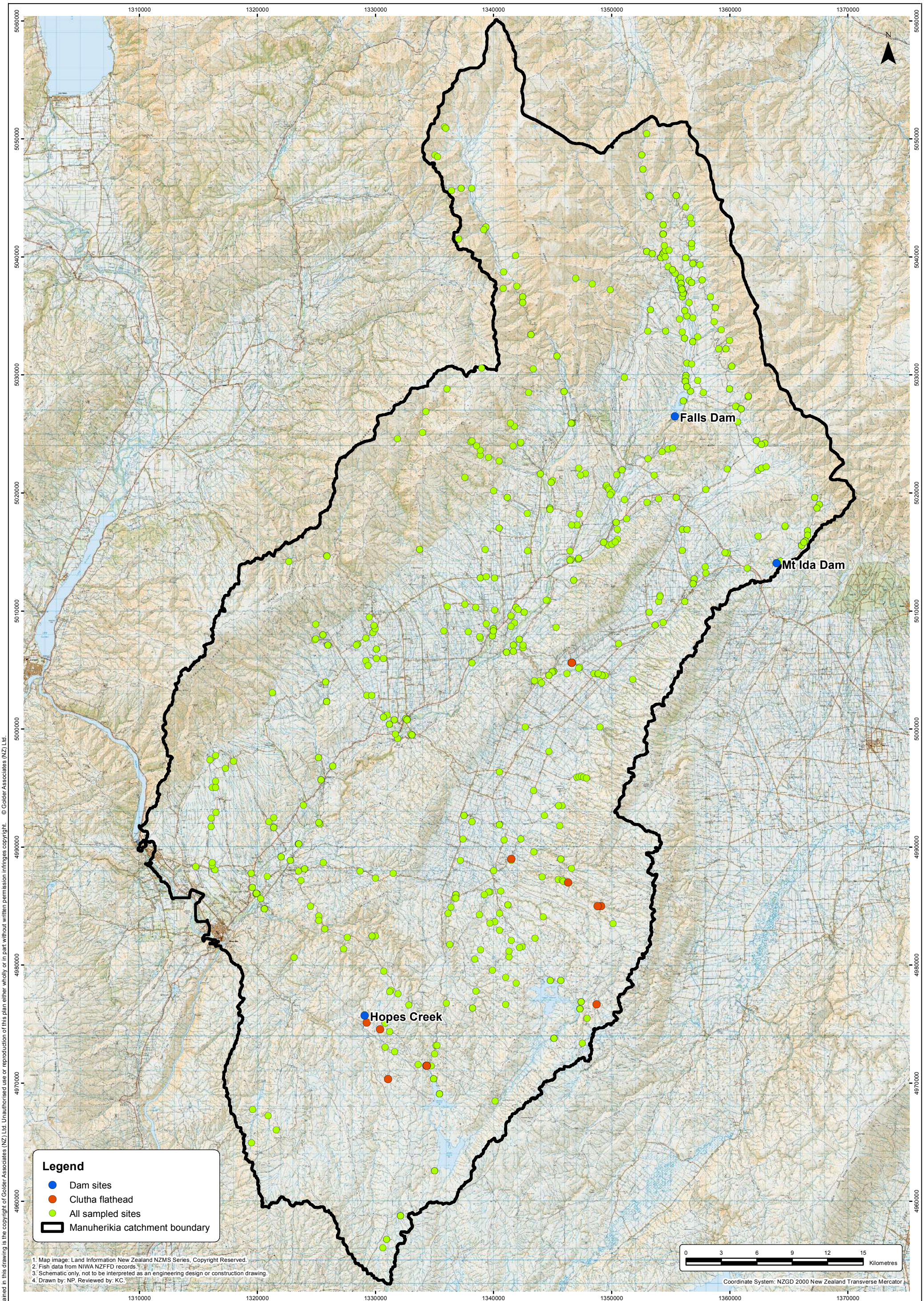

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APRIL 2014

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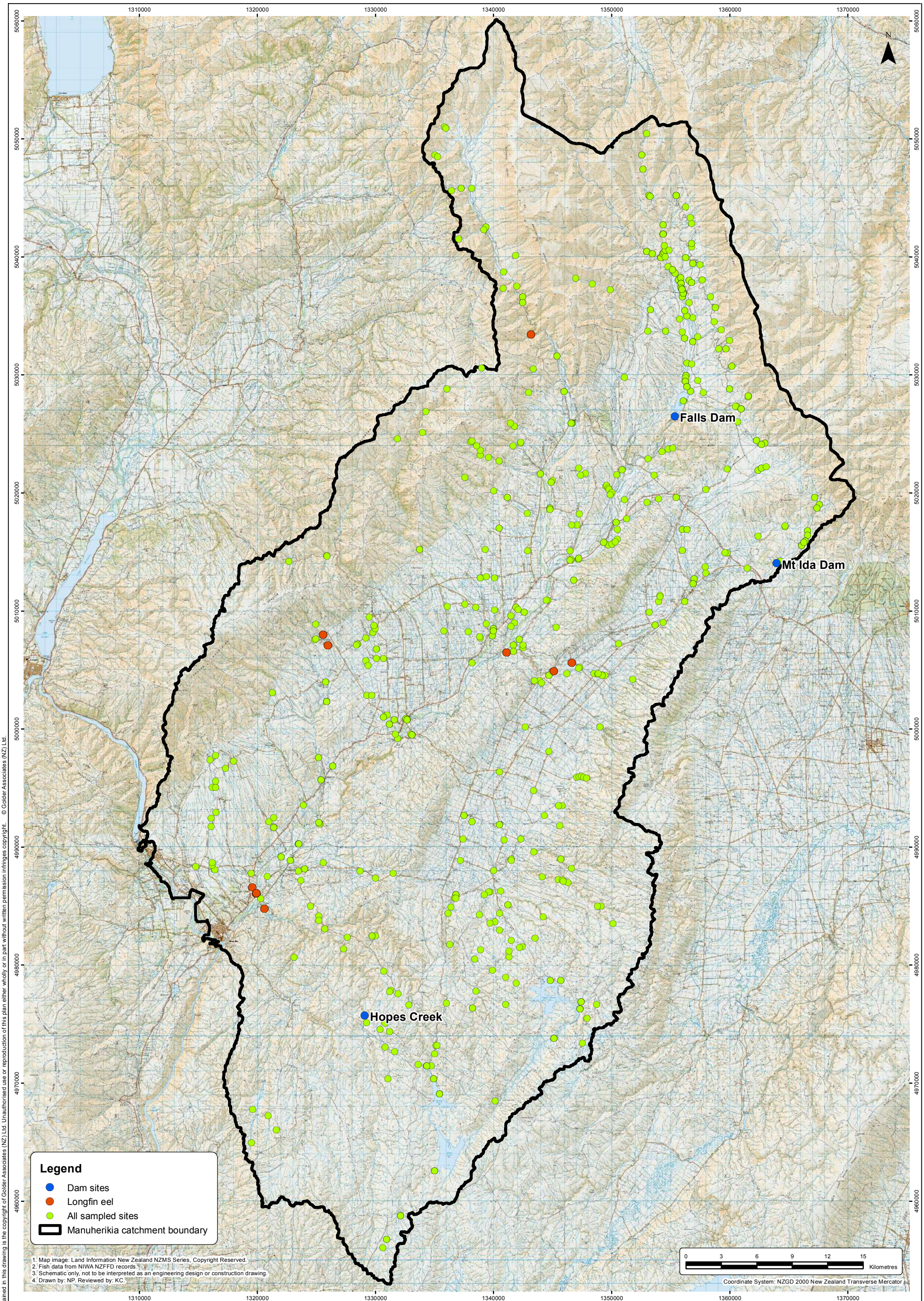

Golder Associates

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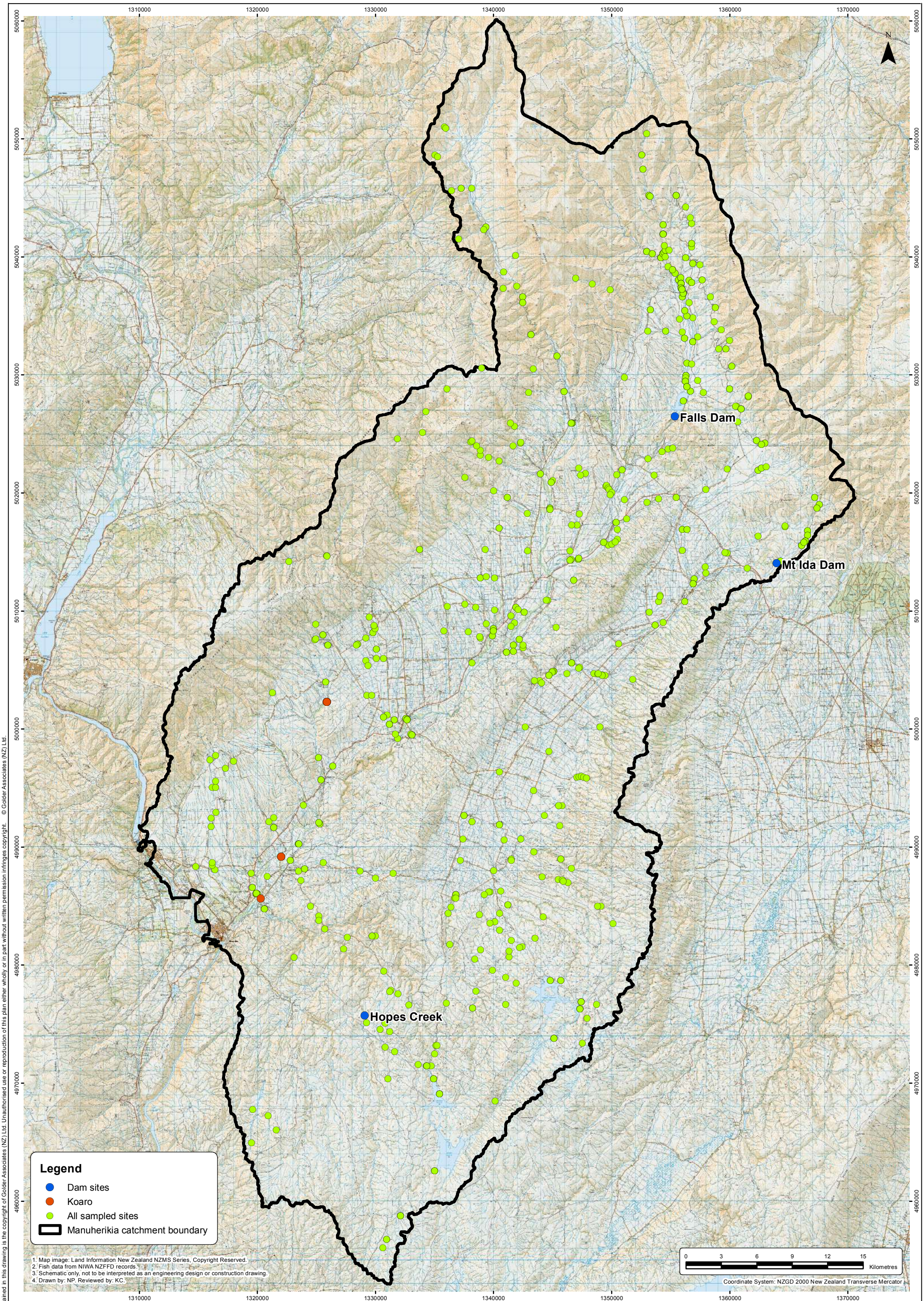

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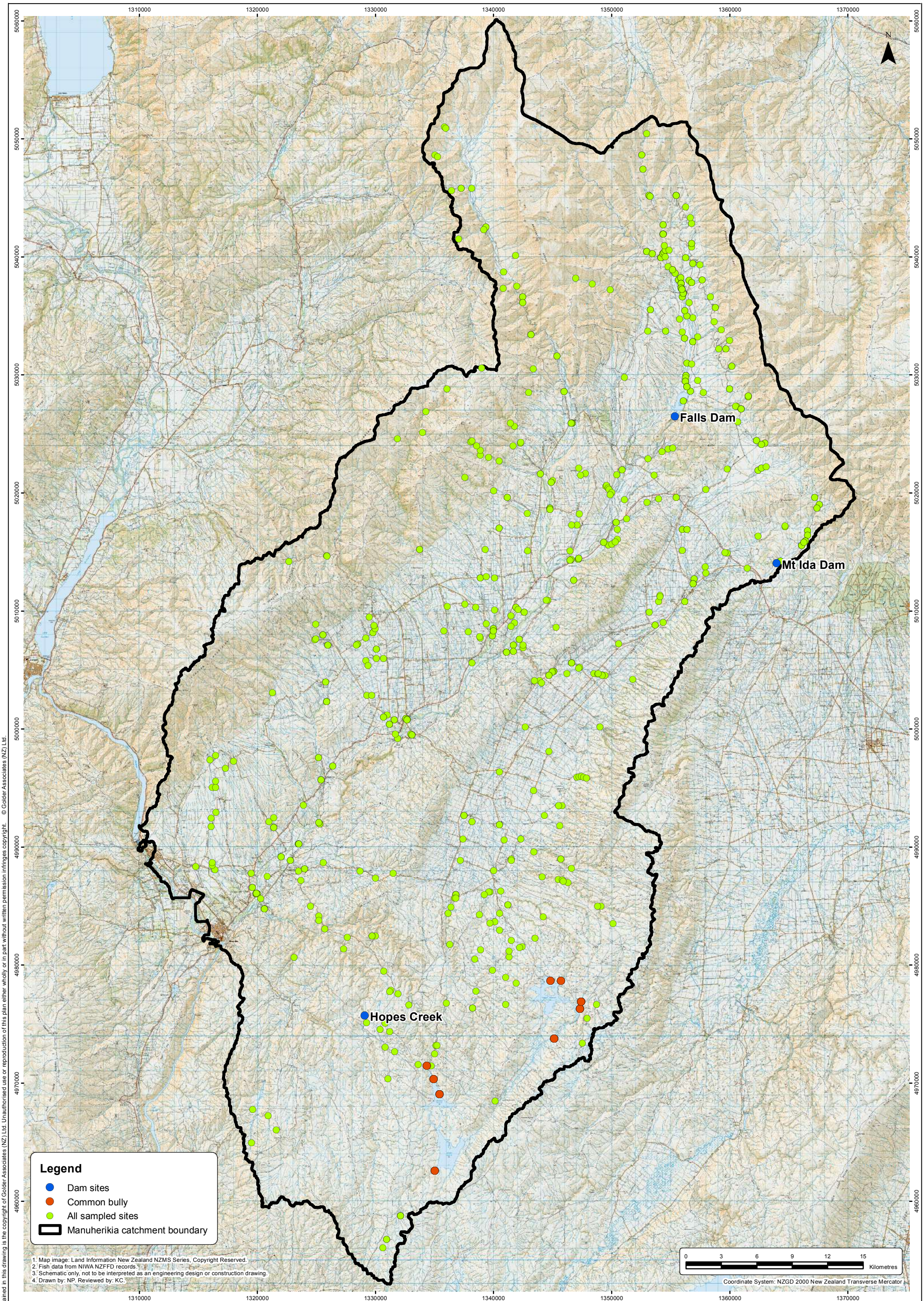

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Falls Dam

Mt Ida Dam

Hopes Creek

Legend

- Dam sites
- Upland bully
- All sampled sites
- Manuherikia catchment boundary

1. Map image: Land Information New Zealand NZMS Series, Copyright Reserved.
2. Fish data from NIWA NZFFD records.
3. Schematic only, not to be interpreted as an engineering design or construction drawing.
4. Drawn by: NP. Reviewed by: KC.

0 3 6 9 12 15 Kilometres

Coordinate System: NZGD 2000 New Zealand Transverse Mercator

TITLE | UPLAND BULLY SITES REPORTED IN THE NZFFD

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PROJECT | 1378110270

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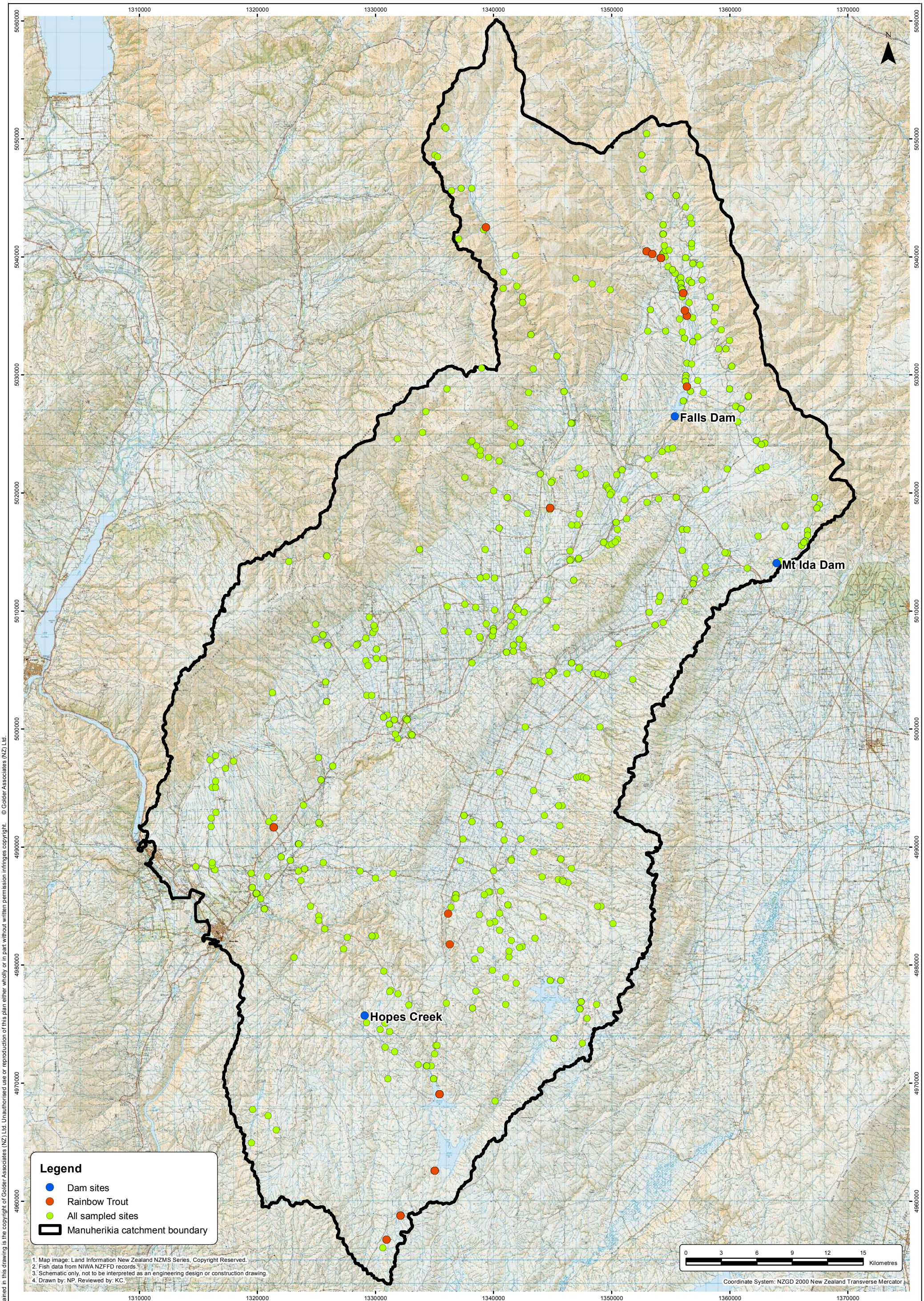

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Falls Dam

Mt Ida Dam

Hopes Creek

Legend

- Dam sites
- Brown trout
- All sampled sites
- Manuherikia catchment boundary

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0 3 6 9 12 15 Kilometres

Coordinate System: NZGD 2000 New Zealand Transverse Mercator

TITLE | BROWN TROUT SITES REPORTED IN THE NZFFD

APRIL 2014

PROJECT | 1378110270

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Falls Dam

Mt Ida Dam

Hopes Creek

Legend

- Dam sites
- Brook charr
- All sampled sites
- Manuherikia catchment boundary

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2. Fish data from NIWA NZFFD records.
3. Schematic only, not to be interpreted as an engineering design or construction drawing.
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0 3 6 9 12 15 Kilometres

Coordinate System: NZGD 2000 New Zealand Transverse Mercator

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TITLE | BROOK CHAR SITES REPORTED IN THE NZFFD

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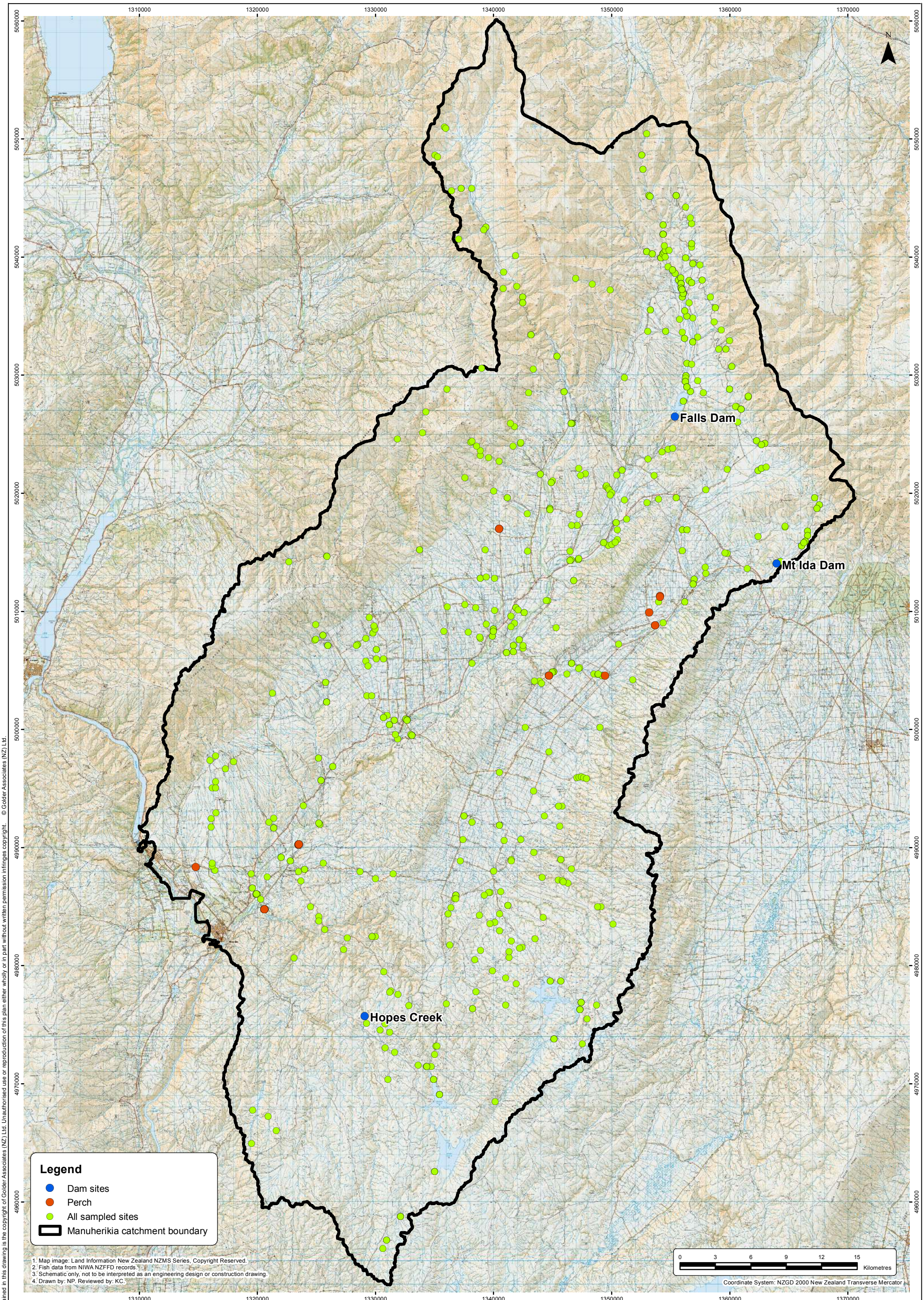

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TITLE | PERCH SITES REPORTED IN THE NZFFD

APRIL 2014

PROJECT | 1378110270

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