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Environmental Consultants





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Tekapo Power Scheme Reconsenting Assessment of Effects – Vegetation

Submitted to:
Genesis Energy Limited

water fauna flora land

Quality Assurance

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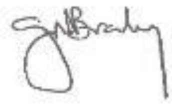

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1.0 Executive Summary

The Tekapo Power Scheme ('TekPS') forms part of the Combined Waitaki Power Scheme which is the largest hydroelectric scheme in New Zealand using water stored in Lakes Tekapo, Pūkaki and Ōhau through eight power stations located between Lake Tekapo and Lake Waitaki. Two of these power stations (Tekapo A and Tekapo B) receive water directly from Lake Tekapo and make up the TekPS owned by Genesis Energy Limited. The resource consents to operate the TekPS expire on 30 April 2025 and as such Genesis Energy Limited must apply for new resource consents in order to continue operating beyond that date.

The Ecology Company (now Ecological Solutions Limited) was retained in 2019 to describe the ecological context of the TekPS and the vegetation present in the braided rivers, wetlands and lake edge, identify and assess the current ecological quality of wetlands which might be affected by the scheme, identify the ecological values of vegetation surrounding the TekPS, consider the benefits of Project River Recovery for indigenous vegetation surrounding the TekPS, identify future potential management options which would benefit indigenous vegetation and present an overall conclusion with respect to the magnitude of any effects on indigenous vegetation associated with the continued operation of the scheme.

The indigenous vegetation of the Mackenzie Ecological Region has been dramatically altered by historic burning, development for farming and invasion of weeds and pests. The remaining indigenous vegetation is fragmented and contains a high proportion of exotic species. The effects of the construction of the TekPS have been more localised and restricted to the lake edge, the area surrounding the canal, the Tekapo River (particularly the upper part) and hydrologically connected wetlands.

In order to describe the vegetation surrounding the TekPS a total of 70 plots were completed including 58 around Lake Tekapo, two near Lake Pūkaki and 10 along the Tekapo River between Lake George Scott and Grays River. Twenty-eight of the plots were located within wetlands. Vegetation near the Tekapo Canal was described from walk through surveys.

Currently indigenous vegetation and habitats are sparse and widely spread around the existing TekPS. The areas of indigenous vegetation vary in ecological value when assessed using the EcIA framework from 'low' to 'very high' and there are a number of species of conservation concern which occur sporadically throughout. These species are mostly considered to be "at risk" although "threatened" species may also occur in suitable habitats. Only one "threatened" species (dwarf common broom, *Carmichaelia corrugata*) was detected in our surveys. In general, the highest value habitats were wetlands, but there were some (usually small and discontinuous) areas of lake edge vegetation, vegetation growing on the terraces of the Tekapo River and vegetation near the Tekapo Canal which included native species and are considered ecologically valuable because of their rarity and distinctiveness. Significant vegetation in terms of the Canterbury Regional Policy Statement (RPS) is patchily distributed throughout.

The lake edge vegetation was typically dominated by rocky substrate and exotic plant species. The vegetation varied in quality from low (sparse, predominantly exotic e.g., exotic herbs growing between cobble and boulders) to moderate (included more native species, representative and demonstrated ecological gradients e.g., matagouri shrubland or some turf vegetation). Some areas of lake edge vegetation were considered to be significant in terms of the RPS, including six locations on the eastern side of the lake and four on the western side. Ecological value assessed using the EcIA framework ranged from "low" to "high".

Wetland vegetation included a higher proportion of native species and all wetland areas were considered significant with respect to the RPS. Wetland condition scores were indicative of comparatively good quality wetlands with a low degree of modification and low – medium external modification pressures. Some of the wetlands near the Tekapo River were considered man-made whilst others appeared to be natural. It appears that the lake-edge wetlands assessed as part of this study pre-date the TekPS, although they may have been affected by it. The wetlands were typically of “high” – “very high” ecological value according to the EcIA framework.

Riverine vegetation was typically sparse and predominantly exotic and therefore of low to moderate ecological quality. This riverine vegetation was also typically of low ecological value except where native species predominated or wetlands occured. Wetlands and predominantly native riverine vegetation was of “moderate” or better value according to the EcIA framework. Significant vegetation in terms of the RPS was present at some locations along the Tekapo River (e.g., near plots 3–5).

More than seventy “threatened” or “at-risk” plant species have been recorded from the Upper Waitaki catchment. One species (dwarf common broom) which is regarded as “threatened (nationally vulnerable)” and nine species which are regarded as “at risk (declining)” were detected near the TekPS during the surveys. The majority of these species were seen in short tussock grassland habitat near the Tekapo Canal or in other habitats which would not be affected by the continued operation of the scheme, including cobble above the lake, roadsides near the lake edge and on terraces above the Tekapo River. Additional “threatened” or “at risk” species may be present, including *Chenopodium detestans* (New Zealand fish guts plant) which is known from other locations nearby. There are no public records of fish guts plant from the edge of Lake Tekapo.

Since the Tekapo A Power Station was commissioned in 1951 and Tekapo B in 1977, the vegetation communities around the TekPS have developed under a regime of managed water levels in Lake Tekapo and managed flows in the Tekapo River. In combination with other external pressures (e.g., farming, flood protection works, planting by the former Catchment Board and more recently the regional council, pest browsing pressure and colonisation by invasive species), this has resulted in generally low-quality lake edge vegetation, low-quality braided river vegetation and typically moderate or better quality wetland vegetation. The ecological value of this vegetation varies. Near the TekPS significant vegetation is generally limited to disconnected remnants of varying size. The vegetation recorded reflects the overall level of ecological change in the wider area as well as the management regime and is not expected to be affected to any more than a very low level by continued operation under the same control levels. The overall level of unmitigated local (ecological district) effects due to continued operation of the TekPS on wetlands, braided river vegetation and lake edge vegetation is considered to be ‘low’ (for wetlands) or ‘very low’ (based on ecological values ranging from ‘low’ to ‘very high’ and a ‘negligible’ magnitude of effects).

Hydrological investigations undertaken by PDP (2021) indicate that hydraulic connection between the lake and wetlands nearby is generally low and rainfall is more important in determining wetland levels, except when lake levels are high. Given the proposal to continue to operate within the existing management parameters, adverse effects on wetland and lake edge vegetation, and therefore effects on ecological significance, due to the continued operation of the TekPS are considered to be “low” or “very low”. Riverine vegetation within the Tekapo River is already substantially altered from the pre-scheme situation because of reduced flows in the river affecting natural geomorphological processes and therefore plant succession. These effects are not expected to worsen as a result of the continued operation of the scheme.

With respect to addressing adverse effects of the scheme on vegetation, Project River Recovery has focussed on removal of weeds from headwater catchments, surveillance of weeds and creation or enhancement of wetland habitats. Project River Recovery has made a substantial contribution to maintaining indigenous vegetation in the Waitaki catchment, particularly with respect to weed control.

One approach that would assist in documenting ecological outcomes would be to monitor wetland condition to develop a long-term data set of vegetation changes in wetlands near the TekPS. With respect to frequency, wetland condition monitoring is recommended every five years.

In addition, expansion of native species in the area surrounding the TekPS is limited in part by a lack of suitable native seed sources. Undertaking an area of planting using existing remnants as a starting point and guided by local knowledge (including mana whenua) would assist in establishing native vegetation which could then act as a source of seeds and other propagules for the wider area, including areas downstream, and could assist in reducing the current exotic species dominance in the area surrounding the scheme and improving ecological resilience to future changes. Given the difficult nature of the climate and soils in the region, the scale and extent of any planting should be modest to begin with and take an adaptive approach in order to capitalise on methods which have been proven effective as the works proceed.

2.0 Introduction

2.1 Background

2.1.1 Tekapo Power Scheme

The Tekapo Power Scheme (**'TekPS'**) forms part of the Combined Waitaki Power Scheme, (**'CWPS'**) which is a large-scale (1763MW) hydro-generation scheme in the Waitaki Catchment of the Mackenzie District of the South Island. The CWPS is the largest hydroelectric scheme in New Zealand and stores and uses water derived from the alpine headwaters feeding Lakes Tekapo, Pūkaki and Ōhau to generate electricity by directing stored water from Lake Tekapo through eight power stations located between Lake Tekapo (at Lake Tekapo township) and Lake Waitaki (near Kurow township). Two of these power stations (Tekapo A and Tekapo B) receive water directly from Lake Tekapo via a lake intake or the Tekapo Canal. Construction of Tekapo A began in 1938 and the power station was commissioned in 1951. Tekapo B was commissioned in 1977. Together these two power stations make up the TekPS and have been owned by Genesis Energy Limited (**'Genesis'**) since 2011. The remaining six power stations in the CWPS are owned by Meridian Energy Limited (**'Meridian'**) and known collectively as the Waitaki Power Scheme (**'WPS'**).

The TekPS controls water levels in Lake Tekapo and diverts water from there to Lake Pūkaki via the 26km Tekapo Canal. Electricity is generated at the two hydroelectric power stations en route – Tekapo A situated at the start of Tekapo Canal and Tekapo B situated at the downstream end of the Tekapo Canal, upslope of Lake Pūkaki. The generation capacity of both stations is 190MW. The canal was constructed as part of the larger Combined Waitaki Power Scheme in the 1970s.

Water enters the TekPS from Lake Tekapo, either via an intake structure in the bed of the lake and subsequently a tunnel under the outskirts of the Tekapo township, or through the Lake Tekapo Control Structure (**'Gate 16'**) at the natural outlet of Lake Tekapo into the Tekapo River. Gate 16 also forms the bridge over the Tekapo River at the entry to Lake Tekapo township. The Tekapo River is dammed further downstream by a concrete weir, creating Lake George Scott. Water spilled from Lake Tekapo and impounded in Lake

George Scott can be discharged into the Tekapo Canal via Gate 17 or flow over the Lake George Scott Weir and continue down the Tekapo River to Lake Benmore.

2.1.2 Lake Tekapo

Lake Tekapo covers approximately 87 km^2 and is approximately 25 km long and 120 m deep. Lake Tekapo is fed at its northern end by the Godley River and throughout its length by various streams and creeks, the largest of which is the Cass River which enters the western side of the lake approximately half way along its length. Most of the Lake Tekapo shoreline is steep and bouldery, but at the Cass River and Godley River deltas it is gently sloping with deposits of shingle, sand and silt (Pierce 1983). Flat, silty substrates also occur near Lake McGregor and closer to Lake Tekapo township including east of the Church of the Good Shepherd and near the lower slopes of Mt St John.

Lake Tekapo is the sole source of water for the TekPS and is controlled by Gate 16. Water from the lake can be discharged directly to the upper Tekapo River from Gate 16, but such discharges occur infrequently and are discussed in more detail in Section 2.1.3 below. As described above, most water enters the TekPS via an intake structure in the bed of the lake.

Lake Tekapo has a normal operating range from 702.1 metres above sea level (**'m asl'**) to 710.9 m asl; however, the minimum and maximum operating levels vary throughout the year. The current minimum operating level of Lake Tekapo is as follows:

- 1 April and 30 September – Minimum Level of 702.1 m asl; and
- 1 October and 31 March – Minimum Level of 704.1 m asl.

However, the level of Lake Tekapo may be further reduced to 701.8 m asl between 1 October and 31 March if the Electricity Commission determines that reserve generation capacity is required, or the National or South Island Minzones[1] have been breached.

The current maximum operating levels for Lake Tekapo are as follows:

- September to February – Maximum Level of 709.7 m asl;
- March – Maximum Level of 710.0 m asl;
- April and August – Maximum Level of 710.3 m asl;
- May - Maximum Level of 710.3 m asl; and
- June and July – Maximum Level of 710.9 m asl.

Since 1952, when Gate 16 was commissioned, the lake level range has extended between 701.7 m and 712.6 m. However, since 1991, the lower part of the range has been entered less often, with the range being between 702.9 m and 712 m. The maximum recorded level was 712.55 m asl in December 1984, while the lowest recorded level was 701.75 m in August 1976. A graph of the Tekapo Lake levels since 2000 is provided as Appendix A.

2.1.3 Tekapo River

The Tekapo River is approximately 55 km long and flows from Lake Tekapo to Lake Benmore. Approximately 2 km downstream of Gate 16, the Tekapo River is dammed by a

[1] The Minzone is an analytical tool that helps electricity system planners understand the data about hydro storage levels. It is based on the record of 74 years of hydro inflows into the storage lakes and is intended to provide a 1 in 74 security of supply standard (more conservative than the government's 1 in 60-year target). That is, in only one year out of 74 would there be shortage that would require further action.

concrete weir, creating Lake George Scott. The stretch of river between Gate 16 and Lake George Scott is often referred to as the '**upper Tekapo River**'.

Water spilled from Lake Tekapo and impounded in Lake George Scott can be discharged into the Tekapo Canal via Gate 17 or, less commonly, flow over the Lake George Scott Weir and continue down the Tekapo River to Lake Benmore. Flow through Gate 16 from Lake Tekapo to Lake George Scott occurs regularly in order to maintain the water level of Lake George Scott. Flows from Lake George Scott to the Tekapo River below the lake are less frequent, and only occur as part of managing the upper level of Lake Tekapo. Thus, there is normally little to no flow in the Tekapo River upstream of its confluence with Fork Stream as a result of lake management.

Downstream, flows in the Tekapo River are augmented by spring fed flows and tributaries including Fork Stream and the Grays and Maryburn rivers. The Tekapo River converges with the Pūkaki River (arising from Lake Pūkaki) before discharging into the Haldon Arm of Lake Benmore.

2.1.4 Tekapo Canal

Outflows from Tekapo A Power Station enter the 26 km long Tekapo Canal. The canal enables water from Lake Tekapo to be used by four other power stations – Tekapo B, Ohau A, Ohau B, and Ohau C (the latter three being owned by Meridian), before entering Lake Benmore.

Construction of the Tekapo Canal in the 1970s involved a combination of cut and fill excavation and included the crossing of a number of streams and rivers. The passage of these streams and rivers is facilitated by varying types and sizes of culverts, depending on the scale and nature of the watercourse, which pass underneath the canal itself. The canal has a maximum capacity of 130 m^3/s and is a homogenous trapezoid shape. The canal bed is composed of gravels and cobbles.

2.2 Scope and Objectives

Genesis' existing resource consents to operate the TekPS were granted under the Water and Soil Conservation Act 1967 and are therefore "deemed resources consent" under the Resource Management Act 1991. These consents expire on 30 April 2025 and as such Genesis must apply for new resource consents in order to continue operating beyond that date.

In September 2019 Genesis retained The Ecology Company Limited (now Ecological Solutions Limited) to:

1) Describe the ecological context of the TekPS and the vegetation present in the braided Tekapo River, wetlands and lake edge;
2) Identify and assess the current ecological quality of wetlands which might be affected by the scheme;
3) Identify the ecological values of vegetation surrounding the TekPS and define the nature and magnitude of any effects of the continued operation of the scheme;
4) Consider the benefits of Project River Recovery for indigenous vegetation surrounding the TekPS;
5) Identify future potential management options which would benefit indigenous vegetation; and
6) Present an overall conclusion of overall magnitude of any effects of the continued operation of the scheme.

The information in this report is directed at understanding the existing ecological context within which the TekPS occurs and how the continued operation of the scheme might affect the quality and persistence of any ecological values currently present.

This information is required to inform an assessment of environmental effects to accompany the applications for resource consent.

3.0 Methodology

3.1 Field Survey

In order to describe the vegetation surrounding the elements of the TekPS, plots were undertaken around the lake edge, along the Tekapo River, within the wetlands identified as monitoring locations by PDP (described in Section 3.2) and within some other wetlands identified during the field visits. Plots were not randomly located, rather they were limited to sites which could be easily accessed from the road or adjoining farmland. Lake edge and river edge plots were chosen so as to be representative of the vegetation nearest the high-water mark and wetland plots were chosen to be representative of the most common vegetation type(s) within that particular wetland. Field surveys were undertaken 25 and 26 September 2019, 25 – 29 November 2019 and 3 – 6 November 2020.

Plots were 2 x 2 m in wetlands and 5 x 5 m elsewhere. For each plot the percentage cover of each species in each of two tiers (0-30 cm, >30 cm) was estimated by eye, a maximum canopy height was recorded and a list of all species present within the plot was compiled. Species encountered whilst walking through the area were also recorded and photographs were taken of the vegetation to assist in describing it. Near the Tekapo canal, walk through surveys of the vegetation only were conducted.

As well as undertaking vegetation plots in wetlands, the condition of each wetland was assessed using the condition assessment methods of Clarkson et al. (2003) to provide a summary of the condition, components and pressures at each wetland. This method provides an average score out of five for hydrological integrity (three indicators), physico-chemical parameters (four indicators), change in ecosystem intactness (two indicators), change in browsing, predation and harvesting regimes (three indicators) and change in dominance of native plant cover (two indicators). These average scores are summed to give a wetland condition index score out of 25. In addition, each of six pressures[2] is given a score out of five and summed to give a wetland pressure index score out of 30. At least one record plot sheet and one wetland record sheet (see Clarkson et al. 2003) was completed for each wetland. The wetland condition data was intended to provide a basis against which effects can be predicted and each wetland can be compared in future to track changes in condition.

3.2 Wetland Identification

Historic aerial photographs, the Canterbury wetlands GIS layer (now removed from the Canterbury Regional Council website), wetland points provided by the Department of Conservation and field survey were all used to identify potential wetlands in the vicinity of the TekPS. Initial desktop analysis by Pattle Delamore Partners Limited (**'PDP'**) (2021) indicated that wetlands above around 720 m asl were considered unlikely to be affected by lake levels, except perhaps during infrequent events when lake levels exceed the maximum operating levels. Modelling later reduced this to wetlands above approximately 711 m asl. Wetlands

[2] Modifications to catchment hydrology, water quality within the catchment, animal access, key undesirable species, percentage of the catchment in introduced vegetation and other pressures.

below 720 m asl, and particularly the seven monitoring wetlands identified by PDP, were prioritised for field survey.

Identification of wetlands is required to determine the presence of natural inland wetlands as defined by the National Policy Statement for Freshwater Management (2020, amended February 2023) (**'NPS-FM'**).

Clause 3.21 of the NPS-FM defines 'natural inland wetland to mean:

"*a wetland (as defined in the Act*[3]*) that is not:*

- *(a) in the coastal marine area; or*
- *(b) a deliberately constructed wetland, other than a wetland constructed to offset impacts on, or to restore, an existing or former natural inland wetland; or*
- *(c) a wetland that has developed in or around a deliberately constructed water body, since the construction of the water body; or*
- *(d) a geothermal wetland; or*
- *(e) a wetland that:*
  - *(i) is within an area of pasture used for grazing; and*
  - *(ii) has vegetation cover comprising more than 50% exotic pasture species (as identified in the National List of Exotic Pasture Species using the Pasture Exclusion Assessment Methodology (see clause 1.8)); unless*
  - *(iii) the wetland is a location of a habitat of a threatened species identified under clause 3.8 of this National Policy Statement, in which case the exclusion in (e) does not apply*".

Pasture species are those identified within Cosgrove et al. (2022). The pasture exclusion test is the percentage of pasture species present in the plot, which is assessed as the total pasture species cover (P) divided by the total (all strata) vegetation cover (TVC), multiplied by 100, i.e., P/TVC x 100 = X%. The pasture exclusion test is passed if this value (X) exceeds 50%, and thus the sampled area is considered to be pasture and excluded from being a natural inland wetland.

Habitats at the site were assessed in accordance with the Vegetation Tool (Clarkson 2014), by undertaking the 2m x 2m vegetation plots within representative vegetation at potential wetlands across the site. This data was then used to apply the rapid, dominance and prevalence tests and the pasture exclusion test to confirm wetland status.

As described above, based on the maximum and minimum consented operating levels for Lake Tekapo, PDP compiled an initial list of all wetlands near the lake that were less than 720 m asl. Wetlands above this level would not be expected to be influenced by variation in the lake levels. PDP identified 49 wetlands or waterbodies that were less than 720 m asl, and installed monitoring devices in seven of them to monitor water levels to estimate the degree of hydrological connection (and hence influence) with Lake Tekapo. Monitoring devices were installed in October 2019 and January 2020. The seven wetlands monitored by PDP included Lake Alexandrina, Lake McGregor, Wetland 16135, Rapuwai Lagoon, Lake Tekapo West 3, Lake Tekapo East 2 and Godley River Wetland 23. The location of the wetlands identified by PDP, including the monitoring locations is shown in Figure 1.

[3] Resource Management Act 1991. *Wetland includes permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions*.

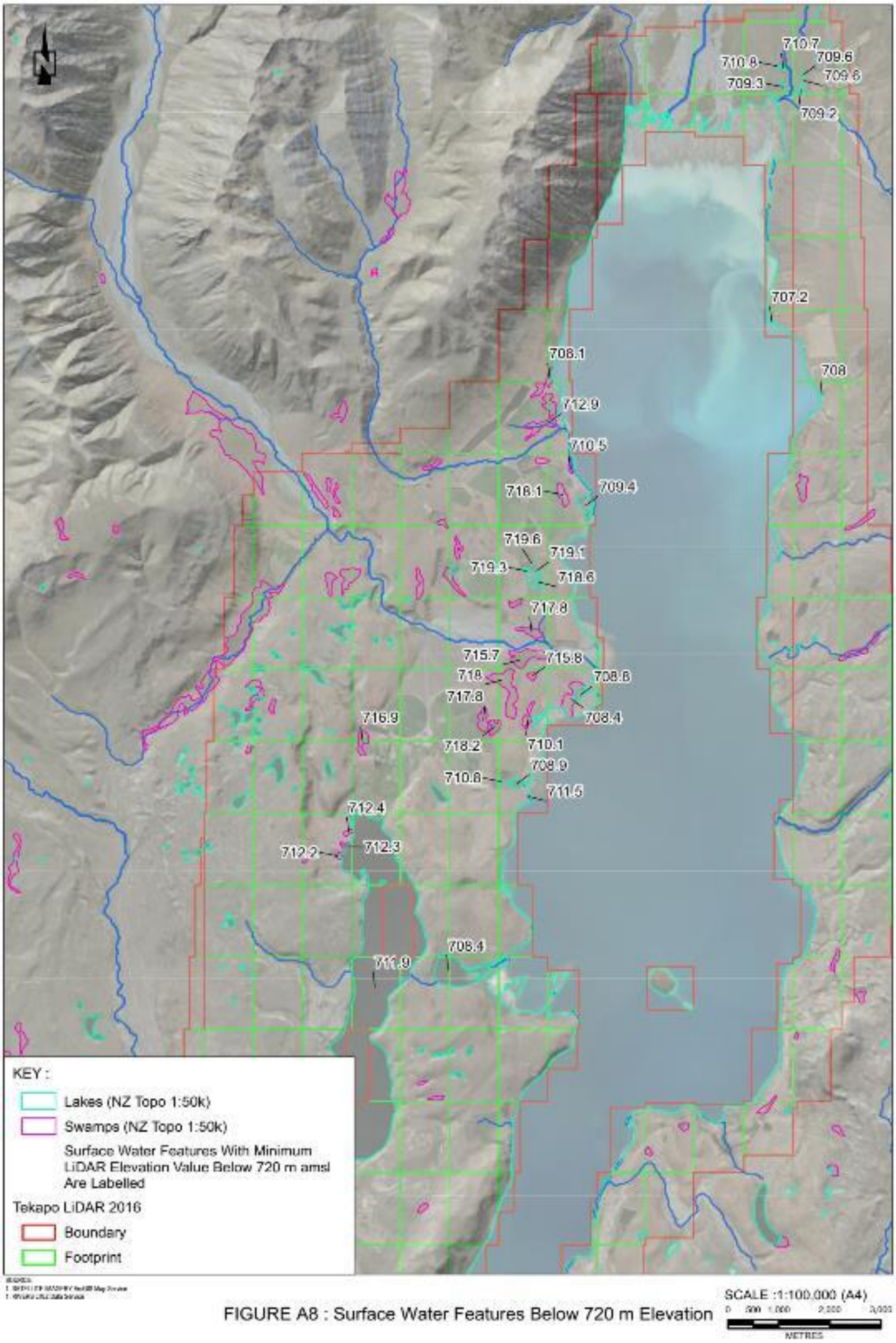

Figure 1: Location of surface water features below 720m asl (from PDP).

3.3 Assessment of Ecological Values

Terrestrial ecological (vegetation) values were assigned following the approach outlined in the Ecological Impact Assessments (EcIA) guidelines (Roper-Lindsay et al. 2018) published by the Environment Institute of Australia and New Zealand (EIANZ). The EcIA guidelines outline a standardised approach for assessing ecological values. The approach involves assessing four matters, including representativeness, rarity/ distinctiveness, diversity and pattern and ecological context with consideration of the attributes outlined in Table 4 (for terrestrial habitats) of the EcIA guidelines.

Note that these four matters are broadly the same as those identified in the Canterbury Regional Policy Statement (2013) (**'the RPS'**) as set out below. The difference is that when assigning significance, the area or habitat is considered to be significant if it meets one or more of the criteria, i.e., significance in terms of the RPS is a binary condition ('significant' or 'not significant'). The ecological value is a continuum from 'none' to 'very high' and is a ranking of relative importance which is arguably more helpful when assessing effects. Both ecological value and ecological significance have aspects of quantity (rarity or extent) and quality (integrity, functionality or condition). When using the EcIA guidelines, once each ecological feature (species, vegetation type, habitat and/or ecosystem) has been identified for assessment, a value is assigned for each of the four matters through considering the relevant attributes (in Table 4 of the EcIA guidelines). Overall value is assigned to a feature using the scoring system provided in Table 6 of the EcIA guidelines. By way of example, if a particular habitat scores 'high' for three or four of the assessment matters it is given a "very high" overall ecological value. Such habitats are likely to be nationally important and recognised as such (Roper Lindsay et al. 2018).

Note that both the terms 'ecological value' and 'ecological quality' are used in this report but they are not interchangeable. Ecological quality refers to the intactness, native dominance, distinctiveness and overall 'standard' of the habitat being discussed. Ecological value refers to the importance or relative worth of that vegetation or habitat. By way of illustration, a low-quality habitat can have high ecological value, if for example it is a very rare (although degraded) example or it includes individuals which are highly threatened. The converse is also true, for example a high-quality habitat which is widespread and abundant and comprises only common species could be low value, although such examples are rare because of the widespread influence of weeds, pests and human disturbance in most native ecosystems.

3.4 Assessment of Ecological Significance

Objective 9.2.3 of the RPS states: Areas of significant indigenous vegetation and significant habitats of indigenous fauna are identified and their values and ecosystem functions protected. An assessment is required to assign 'significance' or not to a particular area of vegetation. To support the objective, Policy 9.3.1 of the RPS requires protection of areas within the region identified as significant (i.e., significant natural areas) so as to ensure no net loss of biodiversity. Significance, with respect to ecosystems and indigenous biodiversity, is to be determined by assessing areas and habitats in relation to their representativeness, rarity or distinctive features, diversity and pattern and ecological context. The assessment of each matter is to be made using the criteria listed in Appendix 3 of the RPS and areas or habitats are considered to be significant if they meet one or more of the criteria. Specifically, these criteria are:

Representativeness

1. Indigenous vegetation or habitat of indigenous fauna that is representative, typical or characteristic of the natural diversity of the relevant ecological district. This can

include degraded examples where they are some of the best remaining examples of their type, or represent all that remains of indigenous biodiversity in some areas.

2. Indigenous vegetation or habitat of indigenous fauna that is a relatively large example of its type within the relevant ecological district.

Rarity/Distinctiveness

3. Indigenous vegetation or habitat of indigenous fauna that has been reduced to less than 20% of its former extent in the region, or relevant land environment, ecological district, or freshwater environment.
4. Indigenous vegetation or habitat of indigenous fauna that supports an indigenous species that is threatened, at risk, or uncommon, nationally or within the relevant ecological district.
5. The site contains indigenous vegetation or an indigenous species at its distribution limit within Canterbury Region or nationally.
6. Indigenous vegetation or an association of indigenous species that is distinctive, of restricted occurrence, occurs within an originally rare ecosystem, or has developed as a result of an unusual environmental factor or combinations of factors.

Diversity and Pattern

7. Indigenous vegetation or habitat of indigenous fauna that contains a high diversity of indigenous ecosystem or habitat types, indigenous taxa, or has changes in species composition reflecting the existence of diverse natural features or ecological gradients.

Ecological Context

8. Vegetation or habitat of indigenous fauna that provides or contributes to an important ecological linkage or network, or provides an important buffering function.
9. A wetland which plays an important hydrological, biological or ecological role in the natural functioning of a river or coastal system.
10. Indigenous vegetation or habitat of indigenous fauna that provides important habitat (including refuges from predation, or key habitat for feeding, breeding, or resting) for indigenous species, either seasonally or permanently.

The vegetation and habitats surveyed were assessed using these criteria and the results are set out in Section 5.7.

3.5 Assessment of Effects Methodology

The effects assessment method in this report followed the approach outlined in the EcIA guidelines (Roper-Lindsay et al. 2018). The EcIA guidelines assist with assessing values and effects in a consistent and transparent way and requires application of professional judgement when applying the framework and matrix approach. The method involves assigning ecological values (refer to Section 3.3) and assessing the ‘magnitude of effect’ using the criteria in Table 1 to determine an ‘overall level of effect’ using the matrix in Table 2 below.

Magnitude of Effect

The magnitude of effect on each ecological value was considered in relation to the scale of the effect, extent of habitat loss or modification in relation to remaining habitat, duration of effect, extent of effect on species at the population level and impact on the sustainability of the ecosystem and intensity of the unmitigated effect. The magnitude of effect on associated with each activity was evaluated based on the criteria outlined in Table 1 and range between 'negligible' and 'very high'.

Table 1: Criteria for describing magnitude of effect from EcIA guidelines.

Magnitude	Description
Very high	Total loss or very major alteration to key elements/ features of the baseline conditions such that the post development character/ composition/ attributes will be fundamentally changed and may be lost from the site altogether; AND/OR Loss of a very high proportion of the known population or range of the element/feature.
High	Major loss or major alteration to key elements/ features of the baseline (pre-development) conditions such that post development character/ composition/ attributes will be fundamentally changed; AND/OR Loss of a high proportion of the known population or range of the element/feature.
Moderate	Loss or alteration to one or more key elements/features of the baseline conditions such that post development character/composition/attributes of baseline will be partially changed; AND/OR Loss of a moderate proportion of the known population or range of the element/feature.
Low	Minor shift away from baseline conditions. Change arising from the loss/alteration will be discernible but underlying character/composition/attributes of baseline condition will be similar to pre-development circumstances/patterns; AND/OR Having a minor effect on the known population or range of the element/feature.
Negligible	Very slight change from baseline condition. Change barely distinguishable, approximating to the "no change" situation; AND/OR Having negligible effect on the known population or range of the element/feature.

Overall Level of Effect

The overall 'level of effect' for each activity on ecological features was determined using the matrix approach outlined in the EcIA guidelines. The matrix approach matches 'ecological values' with the 'magnitude of effect' associated with each proposed activity to derive an overall 'level of effect'. An overall 'level of effect' for each proposed activity was determined with mitigation and without mitigation. This assessment framework allows for effects to be ranked on a gradient from 'very high' to 'positive' (see Table 2) and the EcIA guidelines also provides justification for avoidance, mitigation and offsetting requirements based on the overall level of effects.

Table 2: Criteria for describing level of effects from EcIA guidelines.

Magnitude ▼	**Ecological value ►**				
	Very high	***High***	***Moderate***	***Low***	***Negligible***
Very high	Very high	Very high	High	Moderate	Low
High	Very high	Very high	Moderate	Low	Very low
Moderate	High	High	Moderate	Low	Very low
Low	Moderate	Low	Low	Very low	Very low
Negligible	Low	Very low	Very low	Very low	Very low
Positive	Net gain	Net gain	Net gain	Net gain	Net gain

Adverse residual effects (i.e., after mitigation is taken into account) in the 'Very High' category are unlikely to be acceptable on ecological grounds and should be avoided. Adverse residual effects in the 'High' and 'Moderate' categories represent a level of effect that requires careful assessment and analysis. Such effects may be able to be managed through avoidance, design, or extensive offset or compensation actions. Adverse residual effects in the 'Low' and 'Very Low' categories would not normally be of concern, although normal design, construction and operational care should be exercised to minimise adverse effects (Roper Lindsay et al. 2018). 'Very low' level of effects are considered to be 'not more than minor' effects in the context of the Resource Management Act (1991) (Roper-Lindsay et al. 2018).

4.0 Ecological Setting

4.1 Ecological Districts

4.1.1 Introduction

In an attempt to ensure a representative system of reserves as required by the Reserves Act (1977), the Biological Resources Centre (a division of New Zealand's Department of Scientific and Industrial Research prior to 1987 and incorporated into the Department of Conservation after that date) developed the ecological districts framework in 1982 (McEwen 1987).

This framework divided New Zealand into a series of Ecological Regions, each of which was further divided into smaller parts known as Ecological Districts. The basis for the framework was 260 ecological districts spread throughout the country, each with its own distinctive pattern of ecosystems and special features. Definition of an ecological district depends on a consideration of topography, geology, climate, soils, vegetation and human induced modification. A particular ecological district is therefore a local part of New Zealand where the topographical, geological, climatic, soil, biological features and cultural use produce a recognisable landscape and range of biological communities.

Adjacent ecological districts with closely related characteristics together form an ecological region. The number of districts in any particular region varies – for very distinctive ecological districts they may form their own ecological region.

4.1.2 Location

Lake Tekapo and surrounds, along with most of the Tekapo Canal, are located within the Tekapo Ecological District. The north-western edge of the lake and the Godley River immediately upstream of the lake are within the Godley Ecological District, while the area south of the outlet of Lake Tekapo, including a short section of the canal and the Tekapo River and surrounds, are located in the Pūkaki Ecological District as shown in Figure 2. The Godley Ecological District, located in the eastern foothills of the Southern Alps adjoins the Tekapo Ecological District to the south-east, which in turn adjoins the Pūkaki Ecological District further south and east as shown in Figure 2. Both the Tekapo and Pūkaki ecological districts are within the Mackenzie Ecological Region, whilst the Godley Ecological District is within the Tasman Ecological Region (McEwen 1987).

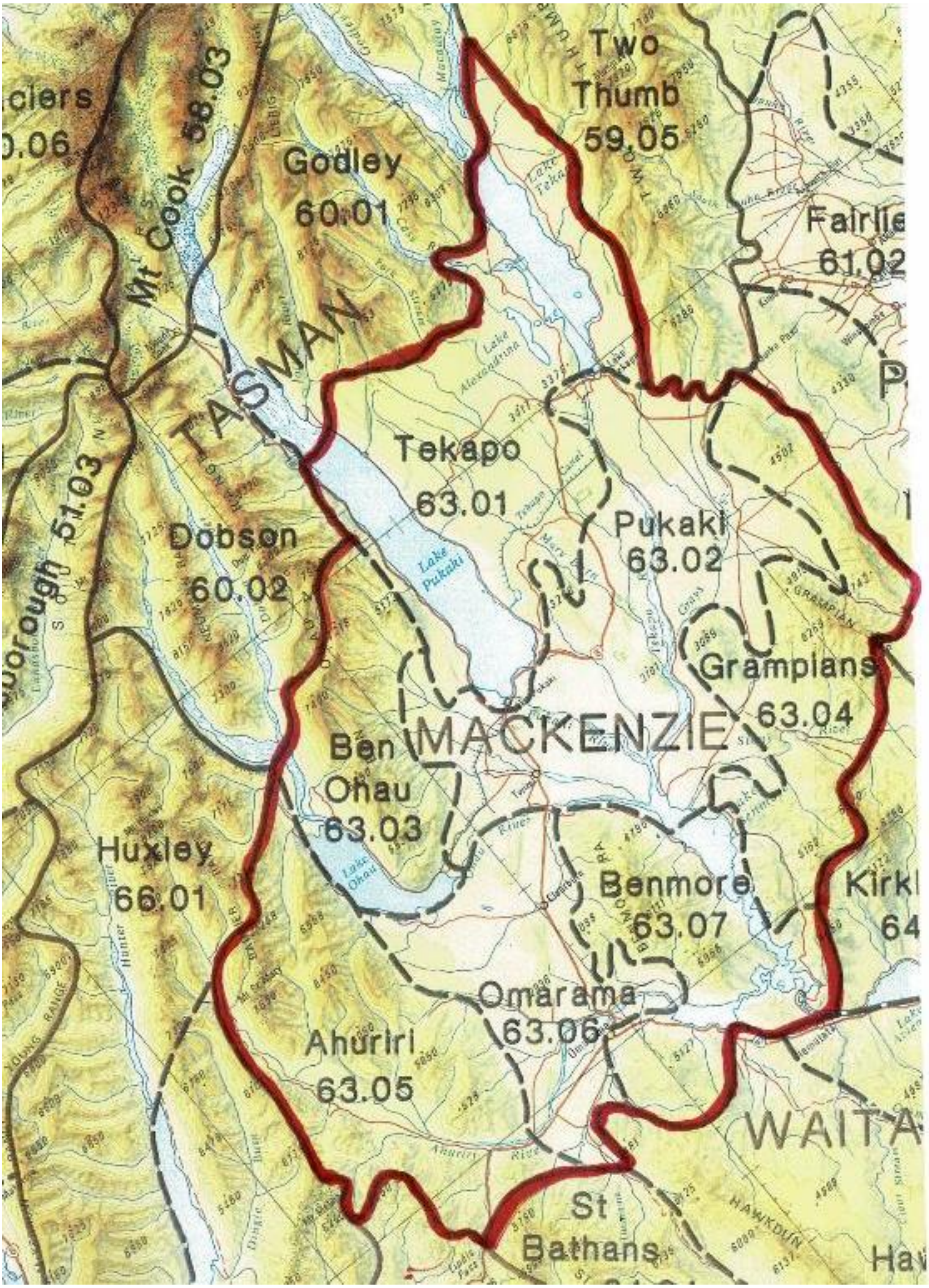

Figure 2: Location of the Godley, Tekapo and Pūkaki Ecological Districts (from McEwen 1987).

The Mackenzie Ecological Region comprises seven ecological districts (Tekapo, Pūkaki, Grampians, Benmore, Omarama, Ahuriri and Ben Ohau) and extends from the northern side of Lake Tekapo, south to the ranges on the southern side of the Ahuriri River (McEwen 1987). The region consists of a large intermontane basin bounded by dissected block mountains and glaciated alpine areas (Espie et al. 1984). The region experiences cold winters and warm summers and has a sub-continental climate with prevailing warm north – westerly winds bringing rainfall to the western and northern mountains with the major influence on precipitation being the distance from the main divide (Espie et al. 1984). The Tekapo Ecological District includes semi-arid areas with 600 – 1,600 mm of annual rainfall (McEwen 1987). The topography of the district varies from fan, moraine and outwash terraces at approximately 500 m above sea level to lower slopes of the glaciated mountains at around 1,200 m above sea level in the north and west and block mountains of similar altitude in the south and east (Espie et al. 1984). Lakes Tekapo, Ōhau and Pūkaki occupy glacial trenches and the rivers above and below the lakes have braided gravel beds.

Espie et al. (1984) mapped and briefly described most of the areas of indigenous natural vegetation within the Mackenzie Ecological Region as part of the Protected Natural Areas Programme (**'PNAP'**) with the purpose of proposing representative examples of the main vegetation communities and faunal habitats suitable for conservation. Espie et al. (1984) also provided an analysis of the main vegetation types as well as information on threatened species and other taxa of scientific interest present. Within the Tekapo Ecological District, Lake Tekapo (Site 26) and Lake Pūkaki (Site 3), as well as several areas around the lakes, were identified by Espie et al. (1984) as Priority Natural Areas for protection. These included:

- The small island adjacent to Motuariki Island (within Lake Tekapo) (Site 27).
- Raupo Lagoon (also known as Rapuwai Lagoon, west of Lake Tekapo, Site 25).
- Lower Cass River (west of Lake Tekapo, Site 23)
- Micks Lagoon (west of Lake Tekapo, Site 24).
- Mailbox Exclosure (west of Lake Tekapo, Site 20).
- Lakes Alexandrina and McGregor (Site 18).
- Western Lake Pūkaki Scrub (west of Lake Pūkaki, Site 5).
- Southern Lake Pūkaki Scrub (south of Lake Pūkaki, Site 6).

Within the Pūkaki Ecological District, the Tekapo River bed (Site 15), Tekapo River Terrace (Sawdon Station, Site 16) and the Maryburn Flats (Site 14) were the Priority Natural Areas for protection in the vicinity of the TekPS. Many of these areas had wildlife values (particularly waterfowl or terrestrial insects) with a smaller number having particular vegetation values (Sites 5, 6, 23, 24, 25 in the Tekapo Ecological District and Sites 14 and 16 in the Pūkaki Ecological District) (Espie et al. 1984).

4.1.3 Historical Changes

The Mackenzie Ecological Region includes some of the driest, most drought-prone and seasonal climates in New Zealand. The near-continental climate in an otherwise oceanic, moist archipelago has resulted in speciation of unusual plants and animals (particularly invertebrates) and distinctive communities adapted to its extremes and found nowhere else. One consequence of the dry climate has been an elevated susceptibility to fire and, as a result, less unmodified vegetation exists in this region than anywhere else in New Zealand (McGlone 2004).

Rapid tectonic uplift between 5 and 2 million years ago created the axial mountain chains of southern New Zealand and global cooling approximately 2.5 million years ago led to the expansion of grassland and shrublands and the retreat of the previously widespread moist temperate forests. The processes of geological uplift, erosion and alluvial transport continue to maintain the braided rivers and associated wetlands which are typical of the area.

Most of the last 2.5 million years has been relatively dry and cold and the increased land area created by tectonic uplift increased the seasonal variation in temperature in the hinterland with winters becoming colder and summers warmer than previously. Pollen records from the eastern South Island suggest an open grass and herb dominated landscape with some scattered patches of low-growing shrubs, perhaps similar to a dry, cold tundra occurred in that area (McGlone 2004).

A rapid warming between 12,000 and 10,500 years ago began our current interglacial period. Mountain glaciers retreated rapidly and forests expanded to cover the lowland plains and fertile valley bottoms into the montane regions. In the very driest areas of the central south-eastern South Island small-leaved shrubs and grassland continued to dominate until 8,000 years ago (McGlone 2004). After that time podocarps spread into all but the very driest regions. From about 7,000 years ago the climate began to cool again and silver beech (*Lophozonia menziesii*) began to increase throughout the southern South Island and about 1,500 years ago other beech species also began to spread.

The plains of the Mackenzie Basin were formed some ten thousand years ago, following the end of the last glaciation. As glaciers retreated, they left behind beds of gravels and boulders. The Tekapo, Pūkaki, Ōhau and Ahuriri Rivers collected more gravels and silts from their upstream catchments and deposited them downstream. Together, these combined to form the flat inter-montane basin traversed by meandering river channels known as the Mackenzie Basin.

The pre-human vegetation of the dry central and south-eastern districts of the Mackenzie Basin and Central Otago is difficult to reconstruct because these areas have “been more thoroughly transformed by subsequent events” than other districts (McGlone 2004). The major vegetation changes between 1840 and 1984 can be summarised as a change from tall tussock grassland to short tussock grassland more suitable for grazing, the loss of around 90% of red tussock vegetation and a similar proportion of wetlands, the loss of 75% of riverbed habitats and 70% of forest habitats and a reduction in scrub and alpine vegetation combined with an increase in pasture, waterbodies and weeds (Espie et al. 1984).

At the time of Māori settlement most of New Zealand was forested. These dry inland valleys are at the climatic limit for continuous forest because the areas further east are too dry to support it. Scanty fossil evidence suggests that small-leaved shrublands of *Muehlenbeckia*, matagouri (*Discaria toumatou*), *Coprosma* species and *Olearia* species were the main vegetation cover, with kōwhai (*Sophora* sp.) and kānuka (*Kunzea* sp.) along the river courses and on deeper soils, and grassland or mat herbs and shrubs on the driest soils (McGlone 2004). This vegetation type was prone to occasional outbreaks of fire, and charcoal deposits suggest that fire return times were measured in the hundreds to thousands of years.

The arrival of Māori increased the frequency of fire and the repeated, deliberate burning cleared approximately 75% of the forest and tall scrub cover of the eastern South Island. Grasses and some shrubby species such as matagouri, kānuka, mānuka (*Leptospermum scoparium* agg.) and kōwhai had life history traits or morphology that enabled them to increase in abundance and range as a result of this increased fire pressure.

From the 1850s sheep numbers in the lowland plains and downlands of the South Island rose rapidly as farms were run under a model of “exploitative pastoralism” (O’Connor 1982) which relied on exploiting the biotic and physical capital of the natural vegetation and soils by grazing unimproved grasslands. Initially, this did not significantly alter the broad pattern of forest and grassland established by earlier Māori colonists (McGlone 2004). Over decades the collective impact of grazing, burning, weeds and pests transformed the nature of high-country grasslands. Palatable shrubs, herbs and grasses rapidly declined under the browsing impact of millions of sheep, rabbits, goats, hares and pigs. Increased burning used to remove woody species and stimulate fresh palatable foliage from the poor-quality tussock and native grass fodder resulted in a decline in the stature, vigour and cover of matagouri and taramea (speargrass, *Aciphylla* spp.) as well as the main tussock species. Burning of shrublands adjoining rivers may have reduced the stability of braided rivers and led to an increase in riverbed size. Enlarged scree slopes, possibly brought about by overgrazing and burning, would have contributed to increased runoff and flooding which in turn would also have contributed to downstream changes in braided river dynamics.

The accidental or intentional release of aggressive weeds such as gorse (*Ulex europaeus*), broom (*Cytisus scoparius*), brier (*Rosa rubiginosa*), willows (*Salix* spp.), pines (*Pinus* spp.) and hawkweeds (*Pilosella* spp.) resulted in the exclusion of indigenous species and the formation of new scrub and grassland communities which included a substantial proportion of exotic species throughout the high country (McGlone 2004).

Soil erosion, particularly due to wind, was historically recognised as an important high-country issue (Martin et al. 1994, Cuff 1994). Basher (1996) found widespread evidence of erosion in the Mackenzie Basin with bare sites losing 13-35 mm (mean 25 mm) of soil over a 40-year period. From fully vegetated sites there was no loss. The sparse vegetation on large areas of shallow, friable soil in the Mackenzie Basin gives little protection from frost heave and westerly winds.

Towards the end of the 20th century pressure for the protection and conservation of non-forested lands grew. There is now abundant evidence that native species richness is declining across non-forest vegetation and that exotic weeds continue to increase. Cessation of fire and grazing regimes has had variable consequences for the indigenous elements because of the interaction of exotic weeds and fertility levels. More recently irrigation and conversion to dairy farming has transformed the appearance and ecological values of the Mackenzie Ecological Region with very little natural vegetation remaining, particularly on flat or gently contoured land amenable to irrigation and development with machinery.

The effects of construction of the TekPS included effects on the downstream sections and deltas of the Godley River and the Cass River, Lake Tekapo itself, Lake Pūkaki, the Tekapo River and effects on the habitats through which the Tekapo Canal passes. Wilson (2000) used GIS based maps and databases, aerial photographs, cadastral information, hydrological information, soils information and maps of early pastoral runs to estimate the historical extent of wetlands and physical and biological features in the Upper Waitaki Basin and map areas that were inundated or altered by lake formation and/or modification. Wilson’s conclusions with respect to the effects of the TekPS can be summarised as follows:

- Inundation of approximately 824 ha of lake edge habitats including:
    - 230 ha of braided river in the Godley River;
    - 64 ha of habitats in the Cass River;
    - 220 ha of vegetated riverine islands;
    - 230 ha of river terraces;
    - 65 ha of wetlands.
- Modification (including reduced flows) of braided river habitat in the Tekapo River with

48 ha currently having baseflow only, 1,404 ha having very low flow and 1,726 ha having reduced flow. Lake Tekapo output to the Tekapo River was previously around 79 m^3/s, but is now limited to intentional releases.

- Raising of the mean lake level from approximately 705.1m asl to approximately 707.9 m asl.
- Increased variability in lake levels throughout the year;
- Altered seasonality of lake levels with highest levels now in autumn and early winter rather than spring and early summer as previously. Lowest levels were previously in winter, but are now typically in late winter and spring (following the peak electricity demand);
- Removal of terrestrial habitats for construction of the canal;
- Creation of new lake edge habitat around Lake Tekapo;
- Creation of new wetland areas around Lake Tekapo, the Tekapo River and the Tekapo Canal. This included deliberate construction (e.g., Patersons Ponds) and unintentional construction (e.g., some wetland areas near the Canal brought about by local changes in hydrology or drainage as a result of canal construction);
- Increase in abundance of species tolerant of disturbance (including grazing) and exotic species.

Raising Lake Tekapo submerged the deltas of the Godley and Cass Rivers. The Cass River had a broad swampy delta, with large, stable, vegetated islands. The Godley River delta was gently sloping with several large, stable, vegetated islands and swamps, including the red tussock swamp known locally as “Bottom End Swamp” (Wilson 2000). These vegetated islands and swamps have disappeared from the Godley River delta and the area may still be reaching ecological equilibrium, however vegetation within the new deltas is probably similar to the previous vegetation although with a higher proportion of naturalised species and species which are tolerant of the lake operating regime and surrounding land use effects.

Woolmore (2011) considered that human influence on braided rivers (through road and track development, frequency of use and level of disturbance as well as flow regulation for human uses) and the large size and close proximity of exotic propagule sources were having the greatest influence on plant community composition in the upper Waitaki River catchment communities he described. The most natural riverbed communities adjoined lands with very little human activity or infrastructure development, and occupied sites at higher elevations where surrounding communities were also predominantly native.

4.1.4 Tekapo Ecological District

The Tekapo Ecological District contains soils composed of tills of the Otira glaciations derived from the greywacke and argillite mountain ranges to the north. The stony soils are mainly shallow to moderately deep and in lower rainfall areas are moderately leached, with more pronounced leaching in higher rainfall areas (McEwen 1987).

Prior to human occupation the dominant vegetation was probably beech – podocarp forest with scrub and tussock grassland only at the driest sites (Espie et al. 1984). Burning by early Māori modified the vegetation to extensive red tussock (*Chionochloa rubra*) grassland. More than a century of farming activity, including burning, grazing, ploughing, oversowing with pasture species and more recently irrigation, initially created highly modified fescue tussock (*Festuca novae-zelandiae*) – red tussock grasslands with snow tussock (*Chionochloa rigida*) at higher altitudes, but more recently irrigation has replaced indigenous vegetation with exclusively exotic pasture species at many locations.

Red tussock now only persists in damp areas and along watercourses (Espie et al. 1984). Fescue tussock grassland is typically only common where the topography or other factors have precluded irrigation and more intensive land use. As a result of these activities, areas of natural vegetation are scarce with most areas being modified to varying degrees. Intact areas of fescue tussock with scattered blue tussock (*Poa colensoi*), prostrate mat plants such as *Coprosma petriei* and *Raoulia subsericea* as well as small native herbs and taller shrubs including taramea (*Aciphylla* spp.), native brooms (*Carmichaelia* spp.), matagouri and *Coprosma propinqua* are rare in the Tekapo Ecological District.

4.1.5 Godley Ecological District

The Tasman Ecological Region includes the Godley and Dobson Ecological Districts and comprises high mountains and broad valleys formed by glaciers, as well as present glaciers. The Godley Ecological District was defined on the basis of landforms, climate, vegetation, glaciation and geology (McEwen 1987). The climate is semi-continental and dominated by the rain shadow effect of the main divide with rainfall ranging from approximately 5000 mm in the west to less than 1000 mm in the east (McEwen 1987). Vegetation comprises chiefly tall tussock grassland with short tussockland and matagouri on river flats. Bare rock and scree are common, especially at higher altitudes, with scattered specialised plants. Forest and shrubland are very limited in extent (McEwen 1987).

A significant proportion of the Godley Ecological District lies above the natural timberline, and originally supported (and still supports) extensive areas of rockland, boulderfield (talus), stonefield/gravelfield (scree), tall tussockland and cushionfield. In the montane zone, scattered low-stature forest dominated by mountain toatoa (*Phyllocladus alpinus*) and mountain tōtara (*Podocarpus laetus*) is likely to have been present at stable sites. Small areas of silver beech (*Lophozonia menziesii*) forest may have been present in the southeast of the ecological district (McEwen, 1987). Elsewhere, dense mountain toatoa-inaka (*Dracophyllum longifolium*) scrub, tall tussockland, herbfield and stonefield (scree and rock pavement) are likely to have been dominant. At lower-altitudes, on the beds of the Cass River and Fork Stream, stonefield mossfield, cushionfield and areas of short tussockland were probably present (Department of Conservation 2006a, Woolmore 2011).

4.1.6 Pūkaki Ecological District

The Pūkaki Ecological District is located in the centre of the Upper Waitaki Basin and was defined on the basis of climate, topography and geology (McEwen 1987). The district comprises dry outwash plains between Lakes Tekapo and Benmore, mostly below 600 m asl, but including isolated hills up to 1000 m, Mary Range and Simons Hill (McEwen 1987, Espie et al. 1984). The soils of the district are comprised of shallow fluvioglacial outwash deposits which are stony and have low fertility (Espie et al. 1984). The climate is semi-arid with cold winters and annual rainfall of 600-1600 mm (McEwen et al. 1987). This district contains the greatest extent of fescue tussock (*Festuca novae-zelandiae*) grassland in the Mackenzie Ecological Region, but is typically more affected by weeds (Espie et al. 1984). Matagouri is the main shrub species. Most of the deeper soils have been transformed to pasture, but the district still provides important habitats for birds of braided rivers (Espie et al. 1984).

4.2 Terrestrial Vegetation

4.2.1 Land Environments

The Land Environments of New Zealand (**'LENZ'**) database is an attempt to objectively define ecological units at multiple spatial scales (Leathwick et al. 2003). The database uses 15 environmental variables (such as climate and soil type) that correlate strongly with species distribution to classify New Zealand into discrete environment types. LENZ can be used to identify the type of land environment and thus the vegetation expected at a particular site. The advantage of LENZ is that it provides an objective measure of the extent and significance of environments in a regional, national and, at least potentially, global context.

Lake Tekapo and the TekPS is surrounded by, or comes in contact with, twelve different land environments including B8.1a, E4.1a, E4.1b, E4.1b, E1.4c, E4.1d, E4.2b, K2.1a, K2.1b, K4.1c, N6.1b and J2.2a. The location of these land environments is shown in Appendix B. The majority of the area immediately surrounding Lake Tekapo, the Tekapo Canal and the eastern side of Lake Pūkaki is land environment E which comprises dry foothills and basin floors at mid-elevations. Environment 4.1 has a mean elevation of 700 m and has well drained, high fertility soils from greywacke alluvium with some loess, colluvium and till. The climate experiences moderate to high annual water deficits and high solar radiation. There are smaller areas of land environments B8.1, J2.2, K2, K4 and N6. Environment J has recent soils and a mild dry climate. Environment K2 comprises areas of recent soils with moderate water deficits and alluvial soils which are well drained and of high fertility. Environment K4 has poorly drained soils and much higher annual water deficits.

LENZ mapping does have limitations due to accuracy and resolution of the data from which it is derived. In particular the resolution is seldom sufficiently fine scale to detect naturally uncommon ecosystems (Williams et al. 2007). Naturally uncommon ecosystems can be defined as those having a total extent less than 0.5% (i.e., < 134,000 ha) of New Zealand's total area (268,680 km^2) prior to human colonisation and includes ecosystems that are small in size and geographically widespread as well as those that are larger but geographically restricted in distribution (Williams et al. 2007). In the Mackenzie Ecological Region this includes ephemeral wetlands (kettleholes), tarns, inland alluvial surfaces, moraines, inland dunes, braided rivers, flushes and seeps and lake margins.

4.2.2 Land Cover

The New Zealand Land Cover Database (**'LCDB'**) is a spatial dataset which maps vegetation types across the country based on satellite imagery, aerial photography and other sources undertaken approximately each five years since summer 1996/97. Version 5.0 of LCDB was released in January 2020 and includes attributes designed to readily identify and monitor wetlands for the first time. The Land Cover Database information is useful for understanding how land cover has changed since 1996, and particularly for determining which land cover is now found (rather than that predicted by LENZ). This can then be verified by field survey. The database is also useful for determining which types of land cover (or habitat) are becoming rare and should therefore be considered threatened (Walker et al., 2015). LCDB version 5 of identifies 14 land cover types around Lake Tekapo and the TekPS, including four grassland types (high producing exotic grassland, low producing grassland, tall tussock grassland, depleted grassland), three forest types (deciduous hardwoods, exotic forest and harvested forest), three shrubland types (mānuka and/or kānuka, mixed exotic shrubland and matagouri or grey scrub), one wetland vegetation type (herbaceous freshwater vegetation), one bare or lightly vegetated type (gravel or rock) and two artificial surfaces (the built up area of Tekapo settlement and the infrastructure of Tekapo B power station). The location of these vegetation classes is shown in Appendix B.

For the reasons described in Section 4.1.3, only very small areas of native vegetation remain in the vicinity of the TekPS and within the Waitaki River catchment generally. Burrell and Ferguson (2004) identified 714 records of 78 threatened plant species within the Waitaki River catchment using the Bioweb database administered by the Department of Conservation this list of plants is provided in Appendix C.

4.2.3 Threatened Environments

Once ecological units have been identified using LENZ, the current level of protection for those units can be defined using the Threatened Environment Classification (**'TEC'**) (Walker et al. 2015). The TEC is a combination of three national databases: LENZ, LCDB and the protected areas network (which shows areas legally protected for the purpose of natural heritage protection). The classification includes six categories reflecting how much indigenous vegetation has been cleared and how much is legally protected. When selecting areas for protection, reference to the TEC can inform which types of environments should be prioritised. Indigenous vegetation associated with land environments within categories 1 and 2 (less than 20% remaining) on private land has been identified as a national priority for protection (Department of Conservation and Ministry of the Environment 2007).

As shown in Appendix B, the majority of the land environments immediately surrounding Lake Tekapo are either category 2 (10 – 20% remaining in indigenous vegetation) or 3 (20 – 30% remaining in indigenous vegetation, shaded orange and yellow respectively in the figure provided in Appendix B). These environments are regarded as 'threatened' (Walker et al. 2015), and indicates that any areas of predominantly natural vegetation in the vicinity of the TekPS might be ecologically important because of their relative rarity at a national level.

4.3 Other Vegetation

4.3.1 Lake Edges

At unmodified lakes, fluctuations in lake water levels, which occur naturally both seasonally and annually to varying degrees, typically lead to marked zonation of shore vegetation, with the most aquatic vegetation at the base (usually fully submerged) and an upslope sequence of turf zones having decreasing flood-tolerance merging to forest or tussock grassland up slope. Turf is typically rich in species including native genera such as *Myriophyllum*, *Crassula*, *Lobelia*, *Eleocharis*, *Carex*, *Sellieria*, *Epilobium*, *Isolepis*, *Viola*, *Hydrocotyle*, *Leptinella*, *Gonocarpus*, *Lilaeopsis*, *Gnaphalium*, *Galium*, *Gunnera*, *Limosella*, *Myriophyllum* and *Centella* as well as naturalised species present to varying degrees (Johnson and Brooke 1989, Wilson 2000). One indicator species of the uppermost water level around lakes in inland Canterbury is the lowermost elevation limits of hard/fescue tussock (*Festuca novae-zelandiae*). Burnett (1927) wrote that Lake Tekapo had a belt of matagouri on its shores, but no forest or shrubland on surrounding land at that time.

Eastern Lake Tekapo Edge

Department of Conservation (2006b) concluded that the lower altitude parts of Mt Hay (nearest the eastern shoreline of Lake Tekapo) probably originally supported short tussock grassland dominated by *Festuca* and *Poa* species and scrub, with areas of red tussock in damper hollows and perhaps mountain tōtara – hardwood forest along incised streams. At Mt Hay one of the common vegetation types present along the lake shore and lower colluvial slopes when the Conservation Resources Reports for the tenure review process were prepared (i.e., early 2000s) was mikimiki (*Coprosma propinqua*) – matagouri scrub and Department of Conservation (2006b) concluded that this vegetation was formerly more widespread across the lower altitude parts of the property.

Department of Conservation (2006b) considered that the “best and only” substantial example of a lake margin plant community at Mt Hay (on the eastern side of Lake Tekapo) was at Roy’s Lagoon (a lagoon inland from, and upstream of, Lake Tekapo), but that turf communities were also present and relatively intact, at many of the larger kettlehole tarns on that property.

Department of Conservation (2006c) described the vegetation recorded in the early 2000s at an area known as “the Island” which comprises the extensive valley-floor flats northwest of the Mt Gerald homestead on the true left of the Godley River where it enters Lake Tekapo (between Lilybank Road and the Godley and Macaulay rivers). At that time the vegetation included wetland habitats, dry grassy ridges, matagouri dominated shrubland and areas of recently-deposited river gravel. Within the wetland zones there were extensive bog rush-dominated rushlands, marshy areas of red tussockland, deep spring-fed streams and tarns. These flood prone flats comprised alluvial gravels with varying amounts of soil and degrees of drainage. The Island was crossed by a network of water channels and had a series of ponds.

The vegetation at the Island varied considerably in response to the substrate and degree of drainage. At the northern end and extending about halfway southwards, were stonefields of river-deposited stones and gravel. Where the stonefield regularly flooded were scattered grasses (sweet vernal (*Anthoxanthum odoratum*), browntop (*Agrostis capillaris*), fescue tussock and silver tussock, willow herb (*Epilobium melanocaulon*), creeping pohuehue (*Muehlenbeckia axillaris*) and mat daisies (also known as scabweeds, mainly *Raoulia australis* and *R. tenuicaulis*). On the older more stable stonefields were complex carpets of indigenous plants specialised for that habitat, including mat daisies (at least three species), creeping pohuehue, *Coprosma petriei*, pātōtara (*Styphelia nesophila*), *Colobanthus brevisepalus*, *Scleranthus uniflorus*, *Acaena inermis*, *Pimelea oreophila* and common lichens and mosses. Low bushes of matagouri, scattered fescue tussock, sparse exotic pasture plants and mouse-ear hawkweed (*Cerastium fontanum* subsp. *fontanum*) were also present. Indigenous specialist stonefield plants were present throughout this vegetation.

Ponds and channels carrying water were flanked by communities dominated by bog rush, with various other sedges, rushes and grasses. In flowing and standing water were macrophytes including red pondweed (*Myriophyllum triphyllum*), water forget-me-not (*Myosotis laxa*) and water buttercup (*Ranunculus trichophyllus*). Ponds prone to drying up had ephemeral turfs of very small sedges and tiny prostrate plants such as *Galium perpusillum*. There were extensive damp areas dominated by red tussock accompanied by sedges (bog rush, rautahi (*Carex geminata*) and several fine-leaved *Carex* species), various rushes and exotic grasses (especially sweet vernal). There were scattered shrubs of *Olearia bullata* in places, areas in which *Hebe odora* was common and pockets of sphagnum moss.

On the moraine on the eastern side of the Island was a combination of pasture (mainly browntop, sweet vernal and fescue tussock) and matagouri shrubland (including some *Coprosma intertexta* and *Olearia odorata*), with small pockets of red tussock in damp hollows. The ponds there had fringes of bog rush, other sedges, rushes and a scattering of *Olearia bullata*. The southern ponds were quite heavily used by livestock and had been modified in places by machine excavation. There were trees of crack willow (*Salix fragilis*) and Lombardy poplar (*Populus nigra*) planted in places. The willows were considered to be spreading along water channels but being kept largely in check by livestock browsing (Department of Conservation 2006c).

Western Lake Tekapo Edge

At Godley Peaks Station in the late 1990s, the northeast-facing lake terraces just east of Micks Lagoon supported matagouri and native broom with a ground-cover of fescue tussock, mat daisies (*Raoulia* spp.), sand and stones (Department of Conservation 2003). Department of Conservation (2003) considered that the lower-altitude portions of that property were likely to have supported red tussockland, short tussockland, wetland vegetation, or stonefield communities originally, depending on substrate and drainage, but noted that vegetation had been substantially altered for grazing.

Department of Conservation (2006a) noted that in the early 2000s small areas of remnant shrubland occurred on the terraces immediately beside Lake Tekapo south of Pierces Pond. These shrublands occurred as strips of relatively large matagouri (up to 2.5 m tall), and included *Olearia odorata*, *Clematis marata*, scrub pohuehue (*Muehlenbeckia complexa*) and porcupine shrub (*Melicytus alpinus*). On top of the lower terrace at the northern end on an exposed deflated (wind-scoured) surface of unconsolidated sandy soils, similar to a dune field, a similar shrubland included stunted matagouri in combination with fescue tussock, blue tussock, large *Carmichaelia vexillata*, *Convolvulus verecundus*, *Coprosma petriei*, *Raoulia monroi*, *R. australis*, *Scleranthus uniflorus*, *Pimelea pulvinaris* and pātōtara. Department of Conservation (2006a) noted that historically the lower country adjoining Lake Tekapo at Glenmore Station would have supported wetlands but most of this area had already been drained and cultivated.

4.3.2 Wetland Vegetation

At higher altitudes flush wetlands[4] would most likely have been dominated by red tussock with a range of smaller plants such as wire rush (*Empodisma minus*), *Carpha alpina* and *Oreobolus pectinatus* growing under the canopy (Johnson and Brook 1989). As altitude increased the taller growing species would have declined in abundance and been replaced by cushion plants and mosses (Johnson and Brook 1989).

The majority of wetlands in the Upper Waitaki area (85%) have been subjected to significant modification (Wilson 2000). Depending on their location and position in the landscape, wetlands receive varying proportions of their water supply from precipitation, groundwater and/or surface water. Low lying areas next to braided rivers or lakes could be inundated by floodwaters, but in arid regions, the main contribution is often groundwater. In wetlands that receive continuous groundwater discharge, groundwater can buffer episodic events such as flooding. For wetlands which are dependent on groundwater, alteration of the water table will disrupt the wetland's function. The botanical values of a wetland are often related to hydrological factors, particularly groundwater seepage.

Wilson (2000) identified five types of landforms which were associated with wetlands in the Upper Waitaki Valley:

i) Moraines – river and stream systems dammed by glacial moraine forming lakes and lake edge swamps. Also, depressional wetlands (such as kettleholes, tarns and some swamps).

ii) Alluvial fans – wetlands have formed where fan material has blocked the watercourse resulting in swamps. Also associated with groundwater discharge where a change in slope occurs.

iii) Braided rivers – riverine swamps, oxbow ponds, back swamps and the like.

iv) Lowland areas and coalescing fans – where outwash terraces or fans have

[4] Flushes form where groundwater emerges on hillsides to form soils that are mostly permanently saturated with relatively nutrient and oxygen rich water. Flushes are often due a periodic pulse of water following rain (c.f seepages, where water is more constant, Johnson & Gerbeaux 2004). The high water table excludes most woody plants from these habitats and herbaceous species dominate. Flushes may be extensive in some circumstances, but they are often relatively small, covering no more than a few tens of square metres. Flushes were identified as naturally uncommon ecosystems by Williams et al. (2007) and are regarded as 'Threatened' (Holdaway et al. 2012).

coalesced and the combined surface and groundwater inputs are enough to form a wetland.

v) Slope areas – hill slope flushes where the water table intersects the land surface and groundwater discharge occurs.

Wetlands in the Upper Waitaki are typically associated with poorly drained soils, although some occur on free draining soils with suitable hydrological conditions (such as continuous groundwater input).

The most saturated poor to imperfectly drained soils in the Upper Waitaki Basin are typically dominated by *Carex* spp., *Juncus* spp. and bog rush (Wilson, 2000). Wardle (1991) and Wilson (2000) identified eight dominant vegetation types in the Upper Waitaki Valley as follows:

i) Raupō rushlands occurring in slowly moving water up to 2 m deep.

ii) Flax (*Phormium tenax*) is confined to very wet, less acidic areas in association with purei (*Carex secta*), *C. diandra*, *C. sinclairii*, *Eleocharis acuta*, *Juncus articulatus* and *J. edgariae*.

iii) Where water levels fluctuate, pure stands of purei can develop. In open water the pedestalled sedges dominate, but in drier areas are colonised by mikimiki, ferns and grasses.

iv) *Carex coriacea* dominates on wet flood-deposited gravel and silt. *C. coriacea* is indicative of cultivated wetland soils and disturbance. *Juncus articulatus* is also often associated with disturbance.

v) *Carex diandra* dominates on fertile wetter sites, whereas *C. sinclairii* and *Sphagnum* spp. are more prevalent at low fertility sites.

vi) Bog rush dominates in shallow valley-floor swamps and flushes on the slopes. The moss *Breutelia pendula* often forms a mat underneath.

vii) In higher rainfall areas red tussock (*Chionochloa rubra*) dominates in medium to low fertility swamps, often with bog rush.

viii) Shallow infertile swamps are invaded by *Sphagnum cristatum* and *S. falcatulum* which raise the acidity and come to dominate.

Department of Conservation (2003) described two wetlands at Godley Peaks Station based on site visits in the late 1990s, Rapuwai Lagoon (also known as Raupō Lagoon) and an unnamed pond immediately behind the homestead. Micks Lagoon is also located at Godley Peaks Station, and both Micks Lagoon and Rapuwai Lagoon were listed as Sites of Special Wildlife Interest (**'SSWIs'**) of "outstanding" value to wildlife (Espie et al. 1984, Jarman, 1987). Rapuwai lagoon was described as the best raupō habitat in the Mackenzie Ecological Region (Jarman, 1987).

Department of Conservation (2006b) considered that the most extensive wetland plant community at Mt Hay comprised herbfield growing around kettleholes in the southern part of the property which are located at some distance from the eastern edge of Lake Tekapo at altitudes between 760 m asl and 820 m asl.

4.3.3 Braided River Vegetation

Because of the dynamic environment in which they occur, braided riverbed plants are typically pioneers capable of colonising extreme or unstable environments. Many species naturalised to New Zealand are also adapted to these types of habitats. The type and mechanical stability of substrate (sand, gravel, cobble and the like), regional rainfall and/or water table level, flooding energy, timing and return period, local effects of islands or barriers (including vegetation), the age of the vegetation, the density of the vegetation and the soil system, availability of propagules and the impacts of biological (e.g., grazing), chemical or mechanical control agents will all influence the extent and quality of plant cover on riverbeds (Meurk and Williams 1989).

Braided rivers are recognised as ecosystems in their own right[5] and are characteristic of recently formed, rapidly eroding landscapes like the Southern Alps. Braided rivers with longitudinal gravel bars of the type occurring in New Zealand occur only here and in parts of North America and the Himalayas. The physical diversity of braided rivers makes them important for biodiversity. Unmodified braided rivers were considered "endangered" by Holdaway et al. (2012). Braided river habitats are common in the upper Waitaki Basin and Canterbury generally, and are characterised by their wide gravel beds, numerous channels which change and move over time, highly variable flow and a high base sediment load. The frequent channel adjustment which occurs in braided rivers results in a mosaic of ephemeral and more permanent habitats including bare gravel islands which support high biodiversity and unique plant and animal communities including a number of endemic bird species, some of which are of conservation concern. Habitat availability within braided rivers depends on the balance between flood events and vegetation growth. The more strongly rooted the vegetation is, the harder it is for floods to remove it and relocate channels through vegetated areas. River bed vegetation binds river bed sediments, hindering erosion and reducing the supply of bed sediments. This vegetation encourages island growth and stability, changes the local topography and directs flows, which hinders braiding. Bank to bank floods are expected approximately every decade[2]. Water abstraction (e.g., for irrigation) or damming/diversion (e.g., for hydroelectricity generation) typically reduces the average flood frequency in a river. This reduction in flows, along with the arrival and spread of fast growing invasive woody weeds (e.g., willows (often used for river management), gorse, broom, lupin (*Lupinus* spp.) and false tamarisk (*Myricaria germanica*)), means that in many braided rivers woody vegetation now dominates and the affected rivers are gradually becoming less braided.

The Manaaki Whenua – Landcare Research originally rare ecosystem website[2] list the notable flora of braided rivers as "threatened" species including climbing everlasting daisy (*Helichrysum dimorphum,* nationally endangered), *Crassula multicaulis*, braided riverbed broom (*Carmichaelia juncea*) and Lady's tresses orchid (*Spiranthes novae-zelandiae*, all "nationally vulnerable"), and "at risk" species including dwarf broom (*Carmichaelia vexillata*), Kirk's broom (*Carmichaelia kirkii*), dwarf woodrush (*Luzula celata*), leafless pohuehue (*Muehlenbeckia ephedroides*), *Coprosma pedicellata*, *Coprosma intertexta* (all "declining") and *Myosotis uniflora* and fierce lancewood (*Pseudopanax ferox*, both "naturally uncommon"). Of these species only *H. dimorphum*, and *C. juncea* have distributions which exclude the Waitaki Catchment. It is noted that some of these species are not limited to braided rivers and occur elsewhere as well.

The environmental stresses for plants occupying braided river habitats include the availability of moisture, the reflected and conducted heat from stones, the free draining, unconsolidated sediments that are very poor in organic colloids and nitrogen, the scouring and redeposition of the substrate and the channelled winds and the dust storms that ensue (Meurk and Williams 1989). These stresses favour plants with a low growth form (such as rosette herbs, prostrate or creeping vines and mat or cushion plants) or ones that will not impede wind or

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5 https://www.landcareresearch.co.nz/publications/naturally-uncommon-ecosystems/inland-and-alpine/braided-riverbeds/. Accessed 10 May 2021.

water flow (e.g., fastigiate[6] shrubs or grasses) and plants that can trap water (such as mosses) or fix nitrogen (i.e., native legumes such as *Coriaria* spp., *Sophora* spp. and exotic species such as lupins, gorse and broom).

Meurk and Williams identified 300 species of vascular plant occupying braided rivers in Canterbury, 55% (165) were indigenous. 132 (44%) were restricted to stabilised terraces or to swamps and lagoons associated with river margins rather than islands within the river. Meurk and Williams (1989) considered that periodicity of flooding and successional age were major determinants of plant species distribution in braided rivers and that native plant associations typical of braided rivers had largely disappeared from lowland environments and could be threatened in the high country unless weed control is initiated. They considered that the main threats to native species were weed encroachment, river engineering and grazing.

4.4 Project River Recovery

Project River Recovery ('**PRR**') is a restoration programme led by the Department of Conservation and funded by Meridian and Genesis. PRR aims to maintain and enhance river and wetland habitat, ecological communities and populations of indigenous animals and plants that use these habitats in the upper Waitaki Basin and was established in recognition of the adverse effects of hydroelectric power development on the braided river and wetland ecosystems there. The funding for PRR is tied to the term of the electricity generator's consents to take and use water (Rebergen and Woolmore 2015).

PRR began operations late in 1991 with the aim of carrying out jointly agreed programs of wetland habitat restoration and enhancement with the goal of providing habitat and conditions equivalent to or greater than the net loss of habitat and conditions attributable to the combined Waitaki hydro-electric power development.

PRR has been guided by a series of strategic plans, each covering seven years, the latest of which (the fourth) applies to the period 2012 – 2019. This plan takes a 'whole river, whole ecosystem approach' including the riverbanks, lower terraces and all associated wetlands (Rebergen and Woolmore 2015). One of the key objectives of this plan is to "maintain indigenous biodiversity and protect and restore terrestrial and aquatic river and wetland habitat and the ecological communities within it by controlling, and where possible, eradicating invasive weeds". The programme also undertakes research, monitoring, large scale pest control and advocacy about the values of the habitats they manage. An annual plan is prepared each year, along with an annual report which evaluates progress toward achieving the objectives of the strategic plan and includes financial information and information about the production of internal reports.

The upper Waitaki Basin includes approximately 32,000 ha of braided river habitat and PRR's weed control efforts are prioritised in accordance with a weed control plan. The highest priority is given to removing existing pockets of weeds, preventing new incursions and removing new infestations at priority locations (Gale et al. 2020). The focus has been on maintaining the values of the rivers above the lakes, because the rivers below the lakes contain larger infestations and more weed species.

[6] Fastigiate species have branches more or less parallel to the main stem.

5.0 Terrestrial Vegetation

5.1 Plot Locations and Types

A total of 70 plots were completed as part of the vegetation study. Fifty-eight plots were completed around Lake Tekapo, 30 on the western side of the lake and 28 on the eastern side, as well as two plots on the edge of Lake Pūkaki. The Lake Tekapo plots included 14 lake edge plots and 16 wetland plots on the western side of Lake Tekapo and 18 lake edge plots and 10 wetland plots on the eastern side of the lake. A further ten plots were completed along the Tekapo River between Lake George Scott and Grays River.

Of the 16 wetland plots completed on the western edge of Lake Tekapo, three were on the edge of Lake Alexandrina, three on the edge of Lake McGregor, two plots at Wetland 16135, one at TWP3, one at TWP7, four at Rapuwai Lagoon and two near the outlet of Mailbox Exclosure. Ten wetland plots were completed on the eastern edge of Lake Tekapo (one at each of 10 separate locations), along with one wetland plot near Lake Pūkaki. The location of the plots around Lake Tekapo is shown in Figure 3 and the plots are characterised in Table 3. A list of all the plants recorded is provided in Appendix D.

5.2 Lake Edge Vegetation

Lake edge vegetation varied around the lake, but at most locations, particularly on the eastern side, a steeply sloping strip of boulder or cobble was present above the water, which transitioned to more gently sloping smaller rocks, sands and gravels upslope which was vegetated with small herbs and grasses and then further upslope there were more consolidated sands/soils with denser vegetation comprising grasses, herbs and some shrubs and perhaps trees. Turf vegetation was limited to flat areas which were regularly inundated to shallow depths, but also regularly exposed. This included the large area where Lake McGregor connects to Lake Tekapo at higher lake levels and on the shores east of the Church of the Good Shepherd. Russell lupins were most common closest to Tekapo township, where they dominated the lake edge vegetation, but were occasionally encountered elsewhere, including at Washdyke Stream on the eastern side of the lake. Matagouri and short tussock grassland was most common on the eastern side of the lake (particularly nearest Mount Hay Station), although there were also small areas of this vegetation on the western side of the lake both north and south of the Cass River outlet and immediately surrounding Lake Alexandrina.

Taken together, the average cover of the 32 lake edge plots comprised approximately 65% rock and/or gravel, 4.5% silt and/or sand, 1.6% moss, 0.9% algae and 2.2% litter. Of the remaining 26%, approximately 6% comprised indigenous vegetation and 20% comprised exotic vegetation. The average maximum height of the vegetation within the plots was 0.54m. A total of 103 plant species were recorded, 33 (32%) of which were native.

Within the 14 plots on the western side of the lake, 67 species were recorded, 19 (28.4%) of which were native species. On average, the plots comprised approximately 60% rock and/or gravel, 3.5% silt and/or sand, 2.7% litter, 0.3% moss, 5.5% indigenous plants and the remainder (approximately 28%) exotic vascular plants. The most common plants recorded in terms of average percentage cover were all exotic and included *Lotus pedunculatus* with an average cover of 3.3%, followed by the herb spring speedwell (*Veronica verna*), 3.1%, Californian stinkweed (*Navarretia squarrosa*) 2.1%, sweet vernal (*Anthoxanthum odoratum*), 2%, sheep's sorrel (*Rumex acetosella*) 1.9% and suckling clover (*Trifolium dubium*), 1.2%. The most common native species recorded in terms of average percentage cover were the shrubs mikimiki and matagouri with 1% cover, followed by, large-leaved pohuehue (*Muehlenbeckia complexa*), 0.4% and bidibid (*Acaena anserinifolia*) 0.3%.

Table 3: Vegetation Plot Location and Type

Plot Number	Plot Features				
	Location	**Size**	**Vegetation Type**	**Hydrosystem***	**Wetland Type**
1 TEP01	E1399180 N5125736	5x5	Lake edge		
2 TEP02	E1399197 N5125733	5x5	Lake edge		
3 TEP03	E1399752 N5126857	5x5	Lake edge		
4 TEP04	E1403832 N5149701	2x2	Wetland	Palustrine	Swamp
5 TEP05	E1403192 N5149159	2x2	Wetland	Palustrine	Marsh
6 TEP06	E1403298 N5149205	2x2	Wetland	Lacustrine?	Seepage
7 TEP07	E1403751 N5149976	2x2	Wetland	Lacustrine	Swamp
8 TEP08	E1404334 N5153559	2x2	Wetland	Palustrine	Swamp
9 TEP09	E1403203 N5147509	5x5	Lake edge		
10 TEP10	E1403231 N5146482	2x2	Wetland	Lacustrine	Ephemeral
11 TEP11	E1403179 N5146484	5x5	Lake edge		
12 TEP12	E1403242 N5145135	2x2	Wetland	Lacustrine	Ephemeral
13 TEP13	E1403228 N5145095	5x5	Lake edge		
14 TEP14	E1403503 N5141999	5x5	Lake edge		
15 TEP15	E1403520 N5141979	5x5	Lake edge		
16 TEP16	E1403778 N5141819	2x2	Wetland	Palustrine	Swamp
17 TEP17	E1404263 N5143696	2x2	Wetland	Palustrine	Swamp
18 TEP18	E1404230 N5143543	5x5	Lake edge		
19 TEP19	E1404248 N5143364	5x5	Lake edge		
20 TEP20	E1403360 N5137369	5x5	Lake edge		
21 TEP21	E1403412 N5137373	2x2	Wetland	Lacustrine	Shallow water
22 TEP22	E1403434 N5135251	5x5	Lake edge		
23 TEP23	E1403456	5x5	Lake edge		

	N5135239				
24 TEP24	E1404025 N5133650	5x5	Lake edge		
25 TEP25	E1404035 N5133662	5x5	Lake edge		
26 TEP26	E1403506 N5131973	5x5	Lake edge		
27 TEP27	E1403514 N5131956	5x5	Lake edge		
28 TEP30	E1399191 N5124510	5x5	Lake edge		
29 TWP01	E1396055 N5131946	2x2	Wetland	Lacustrine	Shallow water
30 TWP02	E1396023 N5131899	5x5	Lake edge		
31 TWP03	E1395974 N5131836	2x2	Wetland	Lacustrine	Shallow water
32 TWP04	E1395934 N5131773	5x5	Lake edge		
33 TWP05	E1397748 N5132270	2x2	Wetland	Lacustrine	Ephemeral
34 TWP06	E1397663 N5132271	2x2	Wetland	Lacustrine	Ephemeral
35 TWP07	E1397574 N5131999	2x2	Wetland	Lacustrine	Swamp
36 TWP08	E1398724 N5137233	2x2	Wetland	Lacustrine	Marsh
37 TWP09	E1398642 N5137213	2x2	Wetland	Lacustrine	Marsh
38 TWP10	E1398645 N5138062	2x2	Wetland	Palustrine	Marsh
39 TWP11	E1398994 N5143395	2x2	Wetland	Palustrine	Swamp
40 TWP12	E1399773 N5141427	5x5	Lake edge		
41 TWP13	E1399745 N5141429	2x2	Wetland	Lacustrine	Swamp
42 TWP14	E1399683 N5141586	2x2	Wetland	Lacustrine	Swamp
43 TWP15	E1399636 N5141210	2x2	Wetland	Lacustrine	Swamp
44 TWP16	E1399629 N5138987	5x5	Lake edge		
45 TWP17	E1399684 N5138900	5x5	Lake edge		
46 TWP18	E1399507 N5138988	5x5	Lake edge		
47 TWP19	E1399104 N5137212	5x5	Lake edge		
48 TWP20	E1399180	5x5	Lake edge		

	N5137354				
49 TWP21	E1398442 N5135828	2x2	Wetland	Lacustrine	Ephemeral
50 TWP22	E1398492 N5135890	2x2	Wetland	Lacustrine	Ephemeral
51 TWP23	E1398613 N5135900	5x5	Lake edge		
52 TWP24	E1398244 N5131632	2x2	Wetland	Lacustrine	Ephemeral
53 TWP25	E1398319 N5131616	5x5	Lake edge		
54 TWP26	E1398311 N5131296	5x5	Lake edge		
55 TWP27	E1396575 N5125297	2x2	Wetland	Lacustrine	Seepage
56 TWP28	E1396596 N5125407	5x5	Lake edge		
57 TWP29	E1396573 N5125468	5x5	Lake edge		
58 TWP31	E1399063 N5124394	2x2	Wetland	Lacustrine	Ephemeral
59 PUK1	E1368981 N5147803	5x5	Lake Edge		
60 PUK2	E1376822 N5109956	2x2	Wetland	Lacustrine	Ephemeral
61 TR1	E1396335 N5122590	5x5	River edge		
62 TR2	E1395983 N5122028	5x5	River edge		
63 TR3	E1395391 N5120772	5x5	River edge		
64 TR4	E1395123 N5119870	5x5	River edge		
65 TR5	E1394719 N5115187	5x5	River edge		
66 TR6	E1394998 N5110993	5x5	River edge		
67 TR7	E1393382 N5106822	5x5	River edge		
68 TR8	E1394536 N5119278	5x5	River edge		
69 TR9	E1394469 N5117238	5x5	River edge		
70 TR10	E1390393 N5104409	5x5	River edge		

* The hydrosystem has been inferred from observation and requires confirmation via hydrological study.

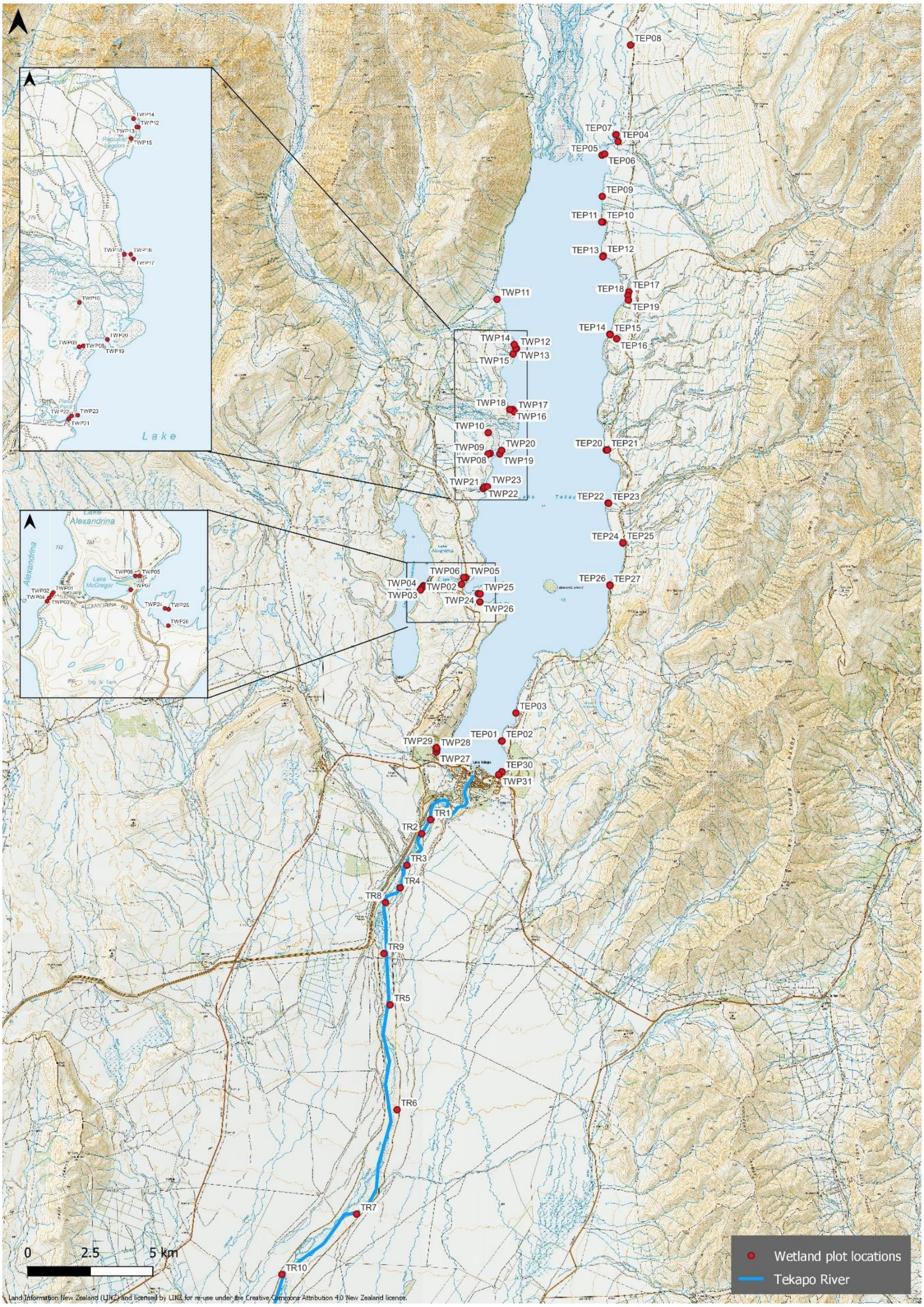

Figure 3: Location of vegetation plots at Lake Tekapo.

Exotic species were also recorded in more plots than native species, with sheep's sorrel and woolly mullein (*Verbascum thapsus*) both recorded in eight plots (57%) and Californian stinkweed, white clover (*Trifolium repens*) and borage (*Borago officinalis*) recorded in six plots each (43%). The most common native species in terms of the number of plots where it occurred were large-leaved pōhuehue and matagouri, which both occurred in three plots (21%), followed by small-leaved pōhuehue (*Muehlenbeckia axillaris*) and porcupine shrub (*Melicytus alpinus*) which occurred in two plots (14%).

On the eastern side of Lake Tekapo, the 18 plots contained 67 species, 21 (31.3%) of which were native species. On average, the plots comprised approximately 69% rock and/or gravel, 5.3% silt and/or sand, 2.5% moss, 6.1% indigenous plants and the remainder (17.1%) naturalised vascular plants. The most common plant recorded in terms of average percentage cover was matagouri (3.8%) followed by brier rose (3.5%), sweet vernal (1.6%), *Veronica verna* (1.5%), borage (1.3%) and mouse-eared hawkweed (*Pilosella officinarum*). Apart from matagouri, mountain oat grass (*Pentapogon avenoides*) was the only other native species with an average cover of 1% or more.

Exotic species were again recorded in more plots than native species, with St John's wort (*Hypericum perforatum*) recorded in 12 plots (67%), borage and woolly mullein both recorded in 11 plots (61%) and browntop and sheep's sorrel both recorded in six plots (43%). The most common native species in terms of the number of plots where it occurred was small leaved pōhuehue, which occurred in five plots (28%). Grassland sedge (*Carex breviculmis*) was recorded in three plots (17%).

5.2.1 Ecological Value

The lake edge vegetation varied in quality from low (sparse, predominantly exotic e.g., exotic herbs growing between cobble and boulders) to moderate (included more native species, representative and demonstrated ecological gradients e.g., matagouri shrubland or some turf vegetation). The majority of the lake edge comprised vegetation of low ecological quality and low to moderate ecological value.

Examples of the lakeside vegetation are shown in Figures 4 - 14. A commentary for each of the photographs follows.

Figure 4: Figure 4 shows a typical upper lake edge habitat dominated by small pebble merging to more silts and sands upslope. Species present within the plot were predominantly exotic grasses and dicot herbs, but matagouri, porcupine shrub and the exotic briar rose were occasionally present upslope of the plot. This vegetation is of low ecological quality and would not be considered significant.

Figure 4: Lake edge vegetation plot near Rapuwai Lagoon.

Figure 5: Figure 5 shows an area of gently sloping pebble which would be covered by water at high lake levels. The vegetation is predominantly opportunistic exotic species such as woolly mullein (in the left foreground of the photograph nearest the tape measure), selfheal, pimpernel, Californian stinkweed, and other species adapted to ephemeral habitats. Matagouri and porcupine shrub were present on the steeper banks (in the background of the photograph) above the highest lake level, along with occasional hard tussock and mikimiki and frequent exotic pasture grasses (mostly browntop) and herbs. This vegetation was of low ecological quality and would not be considered significant.

Figure 5: Lake edge vegetation north of Cass River.

Figure 6: Figure 6 shows an area similar to Figure 5, but with a higher proportion of fine sediment/silt. This is an area where turf species could be expected to develop (depending on the periodicity of exposure, which at this location has been apparently so infrequent that turf development is precluded). Vegetation is similar to that shown in Figure 5 and of similar low ecological quality and would not be significant.

Figure 6: Lake bed showing vegetation growing on the substrate exposed by low lake levels.

Figure 7: Figure 7 shows an area where there is sufficient aerial exposure that turf vegetation has developed. Species present included selfheal (the reddish tinge in the photograph), hawkweed and other common exotic species such as pimpernel along with occasional native species such as *Lobelia anceps* and native grasses such as *Pentapogon avenoides*. This vegetation is of moderate ecological quality. This vegetation was considered significant.

Figure 7: Lake edge turf near Mailbox Exclosure.

Figure 8: Figure 8 shows an area which is intermediate in exposure to Figure 5 and Figure 7, turf species are present, but are sparse compared to Figure 7 and there is a higher proportion of bare ground. This vegetation is of low ecological quality and was not considered significant.

Figure 9: Figure 9 shows the variation in substrate from large rocks to smaller pebbles and increasing sand/silt/sediment upslope. The increasing presence of sand as a growth substrate has allowed the colonisation of exotic species such as Russell lupin (the flowering plant) and willows (trees in the background). Native species are absent or very sparse, but included the native willowherb *Epilobium melanocaulon* and *Acaena* spp. This vegetation is of low ecological quality and was not considered significant.

Figure 8: Lake edge vegetation south of Cass River.

Figure 9: Lake edge vegetation at the southern end of Lake Tekapo.

Figure 10: Figure 10 shows an example of high-quality turf vegetation east of the Church of the Good Shepherd. Native species dominated, with species present including *Euphrasia zelandica*, *Linum catharticum*, *Hydrocotyle novae-zelandiae, Myriophyllum propinquum* and *Lilaeopsis novae-zelandiae*. This vegetation is of high ecological value and was considered significant.

Figure 10: Lake Edge turf vegetation near State Highway 8, Tekapo.

Figure 11: Figure 11 shows vegetation similar to Figure 9 in the background of the photograph and sparse turf vegetation dominated by exotic species in the foreground. Species present included *Sedum acre*, selfheal, pimpernel and *Viola arvensis*. This vegetation is of low ecological quality and was not considered significant.

Figure 11: Vegetation on the eastern lake edge, near Washdyke Stream.

Figure 12: Figure 12 shows vegetation similar to Figure 6 and Figure 8 – common woolly mullein, borage and other exotic herbs and grasses with only sparse/uncommon native species present. Native species such as *Acaena* spp. and rarely *Raoulia* spp. occurred in this type of habitat. This vegetation is of low ecological quality and was not considered significant.

Figure 12: Vegetation on the eastern lake edge, Lake Tekapo.

Figure 13: Figure 13 shows zonation of the substrate from boulders to sediment. Vegetation included almost continuous matagouri and porcupine shrub with common brier rose, mikimiki, pōhuehue and small native herbs such as *Lobelia angulata* and centella. This vegetation is of high ecological quality and was considered significant.

Figure 13: Lake edge vegetation near Mt Hay.

Figure 14: Figure 14 shows turf vegetation near Lake McGregor. Species present included *Carex* spp. *Juncus* spp. and occasional exotic grasses. This vegetation is of moderate ecological quality and was considered significant.

Figure 14: Lake edge vegetation at Lake McGregor.

5.2.2 Ecological Significance

Significant vegetation was scattered around the edge of Lake Tekapo and included turf vegetation, grey shrubland and rushland. Between areas of significant vegetation were areas dominated by exotic species or with sparse vegetation.

5.2.3 Assessment of Effects

At present the lake level variations are such that the extent of cobble and gravels is maintained and areas suitable for the development of turf vegetation are limited. Where turf vegetation does occur, there is limited opportunity for natural zonation to woodier indigenous vegetation typical of natural lake edges to occur because of other adjoining land uses. Development of matagouri shrubland is limited to the upper margins (above the boulder and cobble zones and above the highest water level. When Lake Tekapo is at a low level, the river flats at the head of the lake and various areas around the shoreline such as at Lake McGregor and near Tekapo township also become exposed. Some of these areas have developed turf vegetation of moderate or better ecological quality since commissioning of the TekPS, but their ecological value is generally limited by the high proportion of exotic species. Nonetheless, some of these areas include vegetation which meets the criteria for significance articulated in the RPS and some are high value.

Given the same operating parameters the low to high value habitats described above are expected to persist in much the same proportions and at the same locations where they currently occur. The ecological significance of the lake edge vegetation where it occurs is also expected to be maintained under status quo management of the lake.

5.3 Wetland Vegetation

A total of 83 species were recorded in the 28 wetland plots. Generally, the wetland plots included a higher proportion of native species cover (36%) than either the lake edge or river edge plots. The average percentage cover of native species per plot was approximately 22%, with rock occupying 4%, bare soil 7.4%, moss 8.6%, water 1.9%, litter 10.2% and the remainder comprising exotic vegetation. The average height of wetland plots was also taller than either lake edge or river edge plots at 1.01 m. This was due to the more widespread presence of shrub species such as crack willow (*Salix fragilis*) and taller wetland species such as raupō (*Typha orientalis*) and *Carex secta*.

The wetland plots located on the western lake shore comprised 69 species, with 29 (42%) of those being native. The species present included 25 exotic dicot herbs, 16 native dicot herbs, six exotic grasses, two native grasses, one exotic sedge, six native sedges, four exotic rushes, one native rush, four exotic composite herbs, two native composite herbs and two native monocot herbs.

The wetland plots located on the eastern lake shore comprised 42 species, 14 (33%) of which were native. The species present included 21 exotic dicot herbs, seven native dicot herbs, four naturalised grasses, two native grasses, three native sedges, one exotic sedge, three exotic rushes, no composite herbs and one native monocot herb.

5.3.1 Ecological Value

The average wetland condition index was 19.3 out of a possible 25, with the average pressure score of 16.1 out of a possible 30. This is indicative of comparatively good quality wetlands with a low degree of modification and low – medium external modification pressures. On that basis the wetlands are typically of high – very high ecological value. All of the wetlands were considered to comprise significant vegetation. Examples of wetland vegetation are shown in Figures 15 – 17. A commentary for each of the plates follow.

Figure 15: Figure 15 shows raupō (seasonally dead, brown leaves) and *Carex* spp. surrounded by a fringe of crack willow with occasional crack willow invading into the wetland itself. This vegetation is moderate – high ecological quality and was considered significant vegetation.

Figure 15: Wetland vegetation at Rapuwai Lagoon.

Figure 16: Figure 16 shows one of PDP's monitoring wetlands with low growing turf vegetation merging to hard tussock grassland and pasture. This vegetation is of high ecological quality and was also considered to be significant.

Figure 16: Wetland vegetation west of Lake Tekapo.

Figure 17: Figure 17 shows wetland vegetation near the Tekapo River with an area of open water, *Carex* sedgeland merging to grey shrubland dominated by matagouri and mikimiki. This vegetation is high quality and was also considered to be significant.

Figure 17: Wetland vegetation, Tekapo River.

5.3.2 Ecological Significance

All of the wetland areas were considered significant with respect to the criteria articulated in the RPS.

5.3.3 Assessment of Effects

Amongst other ecological drivers, the distribution and occurrence of wetlands in the landscape varies with the size, depth and connectivity of the wetland(s) to other hydrological systems. Modifications to the water table and the particular hydroperiod (i.e., timing, duration, frequency and periodicity of flooding) can potentially affect wetland vegetation. Such effects will often be subtle as the wetland adjusts over time. Overall, a reduction in water input usually results in a decrease in floristic diversity and an increase in exotic dryland vegetation, whereas an increase in water input can increase the size of the wetted area, increase the extent and depth of open water and bring about an increase in the abundance and diversity of aquatic vegetation, perhaps at the expense of species adapted to periodic exposure. Changes to the dominant plant species within a wetland (e.g., from rushes to trees) can also result in modification of the natural hydroperiod and cause drying out. There is no historic vegetation data for any of the wetlands in the vicinity of the TekPS against which current vegetation can be compared, however any wetlands which are hydraulically connected to Lake Tekapo or other parts of the TekPS (such as the canal) have developed or persisted over time under the hydrological regime imposed by the scheme and could be expected to continue to experience similar hydrological conditions under the similar management proposed.

PDP (2021) have confirmed that five of the seven representative wetlands that they monitored are hydraulically connected to Lake Tekapo for up to 50% of the time. The five wetlands are Rapuwai Lagoon, Godley Wetland 23, Wetland 16135, Tekapo East 2 and Lake McGregor. PDP (2021) concluded that wetlands above approximately 711 m asl did not appear to be connected to or affected by lake levels, but there are likely to be other wetlands located around the lake and below 711 m asl that are similarly connected to the lake and affected in similar ways to the five wetlands identified. Even for the wetlands which are hydrologically connected, rainfall appeared to be more important in determining water levels in the wetland than lake levels (PDP 2021), suggesting that changes to the wetland conditions due to status quo management are unlikely.

PDP (2021) have also undertaken water level monitoring in seven wetlands located near the reach of the Tekapo River immediately upstream of Grays Hills on both sides of the river. Only one of these wetlands (Irishman Creek Wetland) displayed an obvious correlation between flow changes in the Tekapo River and water levels in the wetlands, rather rainfall events were more closely linked to changes in wetland water level. Although the Irishman Creek Wetland was affected by changes in flow in the Tekapo River, the predominant effect on water levels in this wetland also appeared to be rainfall (PDP 2021). Patersons Ponds were not monitored by PDP, but are considered to be well connected to the Tekapo River and the flows therein (PDP 2021).

Beca (2008) defined the potential risk of ecological change associated with changes in water levels in wetlands as follows:

- Low – <0.2 m change in median water level and patterns of water level seasonality (summer vs. winter levels) remain unchanged from the natural state.
- Medium – > 0.2 m and < 0.3 m change to median water level and patterns of water level seasonality show a reverse from the natural state (summer relative to winter).

- High – >0.3 m change to median water level; and, patterns of water level seasonality show a reverse from the natural state (summer relative to winter).

The factors contributing to ecological significance are not expected to be affected by infrequent events of short duration. On the basis that Genesis propose no change to the current operating regime, the risk of ecological change in these wetlands would be low except perhaps in infrequent events when the lake levels either exceed the maximum operating levels (due to natural rainfall or snow melt) or fall below the minimum operating levels for a substantial amount of time (due to drought). These changes in lake level may occur as a result of climate change and are considered in more detail in Section 5.5. Effects due to climate change would be mitigated to some degree by the existing operating constraints of the scheme which would assist in maintaining ecological values. Groundwater movements are not expected to alter and no effects are expected from that source.

5.4 Tekapo River Vegetation

Thirty-three species were recorded from the ten plots along the Tekapo River which averaged 59% rock and/or gravel, 9.5% silt and/or sand, 1.5% moss, 1.4% litter and 28.6% vegetation. Six of the species recorded (18%) were native. The vegetation averaged 9.1% native vegetation (mostly comprising small-leaved pōhuehue, 8.5%) with a variety of native grasses or sedges (*Austroderia richardii*, *Rytidosperma* sp., *Poa* sp., *Carex* sp.) present as a minor component. The only native herb present was *Raoulia* sp., possibly *R. parkii*, which was present in one plot.

5.4.1 Ecological Value

Riverine vegetation was typically sparse and predominantly (c. 70%) exotic. On that basis the vegetation within the immediate surrounds of Tekapo River is generally of low to moderate ecological quality. Areas of wetlands near the river are of higher ecological quality as summarised above. Moderate value vegetation included small areas of matagouri and small leaved pōhuehue which occurred infrequently and were widely spaced throughout the river terraces.

Typical riverine vegetation is shown in Figures 18 – 23. A commentary for each of the figures follows.

Figure 18: Figure 18 shows the Tekapo River in the background and Patersons Ponds (constructed wetlands) in the middle of the photograph. The sparse vegetation on the terrace riser in the foreground comprised mostly exotic species including browntop and brier rose with common woolly mullein and other exotic herbs. Occasional examples of *Raoulia* spp. or other native species were encountered. This vegetation was typically of low ecological quality and low ecological value.

Figure 18: Tekapo River with Patersons Ponds in the foreground.

Figure 19: Figure 19 shows the sparsely vegetated first terrace/floodplain above the Tekapo River. Exotic willow trees are visible in the back right of the photograph. Species present were exotic or common natives. This vegetation was of low ecological quality and low ecological value.

Figure 19: Tekapo River vegetation.

Figure 20: Figure 20 also shows the first terrace/floodplain above the Tekapo River. Vegetation was dominated by browntop. This vegetation was of low ecological quality and low ecological value.

Figure 20: Vegetation on the true right of the Tekapo River.

Figure 21: Figure 21 shows vegetation within what appears to have been an historic braid of the Tekapo River. This vegetation was dominated by exotic species including sweet vernal, browntop and Yorkshire fog along with hawkweeds and other exotic herbs. This vegetation was of low ecological value.

Figure 21: Riverine vegetation, Lake Tekapo.

Figure 22: Figure 22 shows sparse native vegetation including matagouri and porcupine shrub interspersed with areas of bare ground and areas of exotic grasses. This vegetation was of low – moderate ecological quality and whilst degraded, was still considered to be of moderate – high ecological value.

Figure 22: Tekapo River edge vegetation.

Figure 23: Figure 23 shows more intact matagouri shrubland vegetation adjoining the Tekapo River. Brier rose was an occasional component of the shrubland, and the ground layer was dominated by exotic grasses and hawkweeds with occasional native species. This vegetation is of moderate ecological quality and was considered to be of high ecological value.

Figure 23: Matagouri and brier rose near the Tekapo River.

5.4.2 Ecological Significance

Ecologically significant (in terms of the RPS) vegetation is scattered along the Tekapo River in patches of varying size and integrity. The significant vegetation comprised grey shrubland dominated by matagouri with porcupine scrub, pōhuehue and occasional tussock and herb species. Examples of this significant vegetation are shown in Figures 22 and 23.

5.4.3 Assessment of Effects

Lake Tekapo outflows to the Tekapo River have been controlled since 1951 for electricity generation. The residual flow from Lake Tekapo into the upper Tekapo River is controlled by Gate 16 and comprises some groundwater inputs, but the upper Tekapo River is predominantly dry, except when water is released. The residual flow in the Tekapo River downstream of Fork Stream is augmented by tributaries including Fork Stream, Irishman Creek, Maryburn Stream and Grays River as well as groundwater. Above Fork Stream the residual flow comprises groundwater inputs for most of the time and the normal state is predominantly dry, except when water is released from Lake George Scott. Downstream the residual flow is higher than upstream, but still lower when compared to the pre-generation flow rate. Floods in the Tekapo River are now rare and usually of reduced magnitude (although the duration may be longer due to ramping up and ramping down requirements) when compared to pre-generation.

The modified flow regime in the Tekapo River appears to have favoured the spread of exotic species and vegetation of the Tekapo River now comprises mostly exotic species. The [Brier rose] / (*Muehlenbeckia axillaris*) herb – stonefield community (Community 5) described by Woolmore (1991) still comprises the majority of the vegetation in the Tekapo River today, where reduced flows will have created smaller, less isolated shingle bars and islands, with larger areas of the riverbed now stabilised by vegetation, particularly weed species (Meurk and Williams 1989). This has been exacerbated by historic planting of species such as crack willow (*Salix fragilis*) by the former Catchment Board and the Canterbury Regional Council. More recently willow clearance has been undertaken by the Canterbury Regional Council in an effort to restore natural patterns.

Plant species adapted to the unstable braided river environment have been adversely affected by the reduction in suitable habitat in particularly the upper Tekapo River, but the lack of seed sources in the upper river has also likely adversely affected the presence of indigenous vegetation in the lower river as well.

Dewatering the upper Tekapo River has affected the adjacent river flats and wetlands within the floodplains by reducing (or removing) water supply. The reduction in flood events will have reduced the natural process of erosion – deposition – aggradation within those sections of the braided river, which will in turn have created a more stable environment for vegetation, altering the frequency of disturbance and allowing species composition to change. This has resulted in a more stable river bed with reduced reconfiguring and therefore reduced creation of newly disturbed gravel habitats for early colonising species relative to the pre-existing state. River training and other activities undertaken by the Regional Council intended to prevent flooding, erosion and the natural meander of watercourses have also affected the natural character and dynamics of the Tekapo River. Maintaining the low flows in the Tekapo River will maintain the current vegetation which over time has developed vegetation typical of stable river edges (i.e., a higher proportion of long-lived woody species adapted to stable environments). Since there is a dearth of natural vegetation to act as a source of colonists for this vegetation, it is most likely to comprise exotic species. If exotic species are controlled, the present vegetation would likely be maintained.

5.5 Effects due to Climate Change

5.5.1 Climate Change impacts on the TekPS

PDP (2023) have summarised several recent (between 2017 and 2022) studies which have looked specifically at the likely effects of climate change on the CWPS and the TekPS, noting that the overall predicted changes for New Zealand draw heavily on climate model simulations from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (Ministry for the Environment 2018) which are similar to those from the previous assessment (the IPCC Fourth Assessment, Ministry for the Environment, 2008).

When considering the mid-range climate change scenarios for the Lake Tekapo catchment modelling indicates that between 1995 and 2055 annual temperatures will increase by approximately 1 – 1.5º C[7]. This is generally consistent across seasons although spring temperatures are predicted to experience the greatest increase in temperature and winter the least. Annual rainfall in the headwaters (close to the divide) is expected to increase by 5-10%. The main increase in rainfall in the headwaters is expected in winter (10-15%) with more moderate increases in summer, autumn and spring (0-5%).

Specifically in relation to Lake Tekapo, the studies reviewed by PDP were broadly similar in their predictions, including:

- An increase in average annual inflow to Lake Tekapo in the order of 5% and 8%.
- An increase in inflow to the lake in winter and spring. This is due to an increase in precipitation in winter (falling as rain rather than snow due to the higher temperatures) The increase in spring is thought to be associated with intensification of large rainfall events.
- Summer and autumn inflows to the lake are expected to remain approximately stable.
- An increase in both small and large floods.
- Low flows are expected to increase (due to more rain in winter (when flows are typically low) and increased snow melt.
- The total number of extreme low flow events is expected to decrease.

These seasonal changes could make it more difficult to manage water volumes and operations of the lake and there could be increasing risk of flooding (predominantly in winter and spring). Analysis of historical spill flow events indicates that spill events predominantly occur in spring/summer with no or very limited spills in winter (PDP, 2023). Lake levels are typically low in winter and spring and therefore any potential increase in flood flows during those seasons is likely to be mitigated by the lake storage ability to capture these flood flows and therefore spill flows during winter and spring may not increase.

We note that there is significant uncertainty in predicting the effects of climate change, the magnitude of effect also varies according to the emission scenario adopted and it remains unknown what actual emission scenario will be achieved.

Effects on vegetationMcGlone and Walker (2011) summarised the most common predictions for vegetation change as a response to climate change to include:

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[7] With regard to the projected temperature increases, NIWA (2010) suggest that New Zealand has experienced an increase of approximately 1º C in the past century. The projected increase in temperatures is in addition to that increase.

- Change in range and altitudinal distribution. Many species will experience suitable habitats becoming available further south or at higher altitudes than their current range. Some species will find their current range increasingly unsuitable.
- Phenological changes. The timing of seasonal activities such as flowering, breeding, seed production (including masting), growth and seed dispersal may alter.
- Species interactions. Phenological changes could disrupt pollination, seed dispersal or other relationships between species. Fluctuations in abundance and altered range limits will bring new combinations of organisms and new species interactions at a range of levels. This would have implications for both species and ecosystems.
- Trophic interactions. Plant productivity, below-ground processes (decomposers and mycorhyzial associations), and predator-prey interactions will be affected by climatic changes and increasing carbon dioxide concentrations
- As climate changes, existing indigenous species may be disadvantaged relative to exotic organisms better suited to the new prevailing climate. The expansion of existing weed species range and the successful invasion by new weed species is likely.
- Introduction or establishment of new plant diseases and pathogens.

Long lived plant species and those with poor dispersal power would be affected differently from short lived, highly dispersive species which could be expected to expand their range, or move to newly suitable habitat, more easily.

Warmer mean annual temperatures, higher minimum night temperatures, more hot days (>25ºC), fewer frost days, a slightly higher annual rainfall, including more seasonal variation and more droughts could all affect the vegetation surrounding the TekPS.

These effects would beparticularly noticeable in wetlands which are substantially influenced by rainfall and with only limited inputs from other sources. Wetlands fed by groundwater would likely be more resilient, because of their more reliable water source, as would wetlands fed by the lake or Tekapo River. The magnitude of effects would vary with particular species and at particular locations. In general terms, such changes in temperature and rainfall would probably be tolerated by robust native species (such as raupō or rautahi), and those native species adapted to hotter, drier conditions (mat daisies and the like), but they may put more sensitive species, such as small wetland herbs such as *Euphrasia zelandica* or other turf species which are adapted to occasional inundation and alternating exposure, at risk of being outcompeted by exotic plants if the higher rainfall results in more prolonged inundation. Species which are already of conservation concern would likely be at more risk than more common species, in part because they are rarer and more susceptible to stochastic events, often have a restricted or localised distribution and because their environmental tolerances are likely to be naturally more restricted than common species.

Cold adapted species (including alpine species) would also be more at risk due to warmer overall temperatures and smaller seasonal temperature variations.

Climate change will also likely increase the variety and range of plant diseases and increase the range of weed species and opportunities for weed invasion. Warmer temperatures would likely also increase the risk and decrease the return time of fires, which would also adversely affect vegetation.

Increased atmospheric carbon dioxide will also likely affect plants since all New Zealand indigenous plants use a C3 photosynthetic pathway which is favoured under temperate conditions. The C4 pathway gives C4 plants (mostly tropical grasses) a competitive advantage over C3 plants under warm, dry conditions with low carbon dioxide. C3 plants are likely to be more competitive with increased carbon dioxide, but may be limited by warmer, drier conditions. Plant responses to increased carbon dioxide are non-linear and depend on soil type, nutrition, light, water and plant age. Increasing carbon dioxide affects the growth of plants and therefore the quality of plant tissue which in turn affects herbivorous species (insects and other plant consumers) (McGlone and Walker 2011).

Whether these vegetation changes due to climate change would be slow/incremental or rapid (for example once a particular threshold is reached) remains unknown. These effects are not due to the operation of the TekPS and would not be exacerbated by continued operation under the same parameters.

McGlone and Walker (2011) concluded that the best defences against biodiversity loss as a consequence of climate change are the same actions necessary to prevent biodiversity loss due to ongoing pressures of pests, weeds, and land use change. Thus a focus on maintaining representativeness, ecological intactness, resilience, community resistance and indigenous dominance is likely the best approach to reducing effects due to climate change on vegetation adjoining the TekPS.

5.6 Plant species of Conservation Interest

The New Zealand Threat Classification System is set out in Appendix E. The latest threat ranking for indigenous plants is de Lange et al. (2018). Only one species which is regarded as "threatened (nationally vulnerable)" by de Lange et al. (2018) (*Carmichaelia corrugata*, dwarf common broom) was detected during the surveys, in sparse short tussock grassland near the Tekapo Canal. Dwarf common broom is most commonly found in sparsely vegetated gravels and sands, stone and gravel ridges, river terraces, river beds, and disturbed sites. The main threat to dwarf common broom is browsing by mammals.

In addition, nine species which are regarded as "at risk (declining)" were detected including coral broom (*Carmichaelia crassicaulis*), *Carmichaelia petriei*, *Coprosma brunnea*, *Coprosma intertexta*, matagouri, *Colobanthus brevisepalus*, *Raoulia parkii*, *Raoulia australis* and Buchanan's sedge (*Carex buchananii*). The majority of these species were seen in short tussock grassland or other habitats near the Tekapo Canal. One specimen of *R. parkii* was detected on the roadside and a second in cobble habitat near the Tekapo River. Matagouri was more widespread and was detected in habitats around Lake Tekapo and Lake Pūkaki as well as along the Tekapo River. Matagouri commonly co-occurred with brier rose and mikimiki and with depleted hard tussock grassland at some locations. The ongoing operation of the TekPS would not affect these lake edge communities because they are located above the high-water mark.

iNaturalist[8] includes four records of New Zealand fish guts plant (*Chenopodium detestans*) near Tekapo, but none are in close proximity to the TekPS infrastructure. Fish guts plant has been recorded near Tekapo township, where the current operating regime did not appear to limit its establishment. Fish guts plant grows in open, sparsely vegetated habitats, which do occur around Lake Tekapo as described above. These habitats would be maintained by the continued status quo operation of the scheme. The decline of fish guts plant seems to have been associated with competition from introduced pasture grasses and weeds, which crowd it out.

Burrell and Ferguson (2004) identified 31 species which are currently regarded as "threatened" from the Waitaki Catchment including 10 "nationally critical" species, eight "nationally endangered" and 13 nationally vulnerable" species (see Appendix C), although it should be noted that most of these species are not associated with the types of modified

[8] Accessed 29 August 2021

habitats present around the hydroelectricity lakes, within or around the Tekapo River or near the Tekapo Canal. Approximately 15 of the 31 threatened species identified by Burrell and Ferguson (2004) occur in wetlands, river terraces, wet margins or open water habitats and may occur in the area occupied by the TekPS, despite not being detected there. If they do occur there, their ongoing presence is unlikely to be affected by a continuation of management using the same operational limits.

Given their ongoing persistence under the current operating regime, for any species which are most at threat due to habitat removal or mammals, adverse effects on the species of conservation concern due to continued operation of the TekPS is not expected. For species of disturbed sites, the continued operation is not expected to allow the type of infrequent disturbance events (particularly floods) which would lead to new habitats becoming available, particularly within the Tekapo River. The majority of such species have already gone from the vicinity of the TekPS because of the management over the past 70 years, and those which remain are the species which can tolerate the operating regime. None of the threatened or at-risk species detected near the scheme were located in such close proximity to the infrastructure of the scheme that they would be affected by changing lake levels.

5.7 Assessment of Ecological Significance

The ecological significance of the vegetation and habitats surrounding the TekPS are assessed against the criteria for ecological significance set out in Appendix 3 of the RPS in Table 4.

Table 4: Assessment of Ecological Significance against the criteria in Appendix 3 of the Canterbury Regional Policy Statement.

Plot Number	Ecological Criterion				
	Representativeness	Rarity/Distinctiveness	Diversity and Pattern	Ecological Context	Ecological Significance
1 TEP01	No	No	No	No	No
2 TEP02	Yes	Yes	No	No	Yes
3 TEP03	Yes	Yes	No	No	Yes
4 TEP04	No	Yes	No	No	Yes
5 TEP05	Yes	Yes	No	Yes	Yes
6 TEP06	No	Yes	No	No	Yes
7 TEP07	No	Yes	No	No	Yes
8 TEP08	Yes	Yes	No	No	Yes
9 TEP09	No	No	No	No	No
10 TEP10	No	Yes	No	Yes	Yes
11 TEP11	No	No	No	No	No
12 TEP12	No	Yes	No	No	Yes
13 TEP13	No	No	No	No	No
14 TEP14	No	No	No	No	No
15 TEP15	Yes	No	Yes	No	Yes
16 TEP16	No	Yes	No	No	Yes
17 TEP17	No	Yes	No	No	Yes
18 TEP18	No	No	No	No	No

19 TEP19	No	No	No	No	No
20 TEP20	No	No	No	No	No
21 TEP21	No	Yes	No	No	Yes
22 TEP22	No	No	No	No	No
23 TEP23	No	No	No	No	No
24 TEP24	No	No	No	No	No
25 TEP25	Yes	Yes	Yes	No	Yes
26 TEP26	No	No	No	No	No
27 TEP27	Yes	Yes	No	Yes	Yes
28 TEP30	No	No	No	No	No
29 TWP01	No	Yes	No	Yes	Yes
30 TWP02	Yes	Yes	No	Yes	Yes
31 TWP03	No	Yes	No	Yes	Yes
32 TWP04	Yes	Yes	No	Yes	Yes
33 TWP05	No	Yes	No	Yes	Yes
34 TWP06	No	Yes	No	Yes	Yes
35 TWP07	No	Yes	No	Yes	Yes
36 TWP08	No	Yes	No	Yes	Yes
37 TWP09	Yes	Yes	No	Yes	Yes
38 TWP10	No	Yes	No	No	Yes
39 TWP11	Yes	Yes	No	No	Yes
40 TWP12	No	No	No	No	No
41 TWP13	Yes	Yes	Yes	Yes	Yes
42 TWP14	Yes	Yes	Yes	Yes	Yes
43 TWP15	No	Yes	No	Yes	Yes
44 TWP16	No	No	No	No	No
45 TWP17	No	No	No	No	No
46 TWP18	Yes	No	No	No	Yes
47 TWP19	No	No	No	No	No
48 TWP20	No	No	No	No	No
49 TWP21	No	Yes	No	Yes	Yes
50 TWP22	No	Yes	No	Yes	Yes
51 TWP23	No	No	No	No	No
52 TWP24	No	Yes	No	Yes	Yes
53 TWP25	No	No	No	No	No
54 TWP26	No	No	No	No	No
55 TWP27	No	Yes	No	No	Yes
56 TWP28	No	No	No	No	No
57 TWP29	No	No	No	No	No
58 TWP31	Yes	No	No	Yes	Yes
59 PUK1	Yes	Yes	No	No	Yes

60 PUK2	Yes	Yes	No	No	Yes
61 TR1	No	No	No	No	No
62 TR2	No	No	No	No	No
63 TR3	Yes	No	No	No	Yes
64 TR4	Yes	No	No	No	Yes
65 TR5	Yes	No	No	No	Yes
66 TR6	No	No	No	No	No
67 TR7	No	No	No	No	No
68 TR8	No	No	No	No	No
69 TR9	No	No	No	No	No
70 TR10	No	No	No	No	No

The significant areas of vegetation associated with the TekPS includes all of the wetlands surveyed, some of the lake edge vegetation distributed patchily around the lake, including lake edge turf, tussock and rushland and matagouri – mikimiki shrubland and similarly patchily distributed areas of grey shrubland dominated by matagouri, mikimiki and pōhuehue along the Tekapo River. This vegetation includes representative types and degraded areas which meet one of the other criteria for ecological significance articulated in the RPS (rarity/distinctiveness, diversity and pattern or ecological context). Generally speaking these significant areas are small, fragmented and dispersed with larger areas of predominantly exotic,not significant vegetation between them, although a small number do meet the ecological context criterion because they are part of an ecological linkage or buffer or provide important habitat.

Given the longstanding operation of the TekPS, the vegetation in areas affected by water levels in either the lake or the Tekapo River and which have been identified here (in Sections 5.2.2, 5.3.2 and 5.4.2) as being significant in terms of the RPS, can be expected be adapted to the existing operating regime. Given the status quo management proposed, the level of effect on these significant areas identified using the RPS criteria will be "barely distinguishable akin to a 'no change' situation". In other words, although there are areas of significant vegetation in the vicinity of the TekPS and these will not be affected by the continued operation of the TekPS under the present operating regime. In some cases, status quo management is expected to mitigate some of the effects of climate change (for example by reducing flooding impacts in the Upper Tekapo River).

5.8 Summary

The vegetation and habitats surrounding the TekPS have been substantially modified over the past 200 years, including for the construction of the hydroelectricity generation scheme approximately 70 years ago. Because of the substantial changes in the vegetation which date to before and after European settlement, native species are comparatively rare and exist in a matrix of predominantly exotic species. Few native vegetation communities exist which are substantially intact (i.e., dominated by native species and ecological processes). Nonetheless, remnants of indigenous vegetation survive and individual native plants persist where the conditions are suitable or where disturbance has been less. Elements of significant (in terms of the RPS) vegetation are scattered around the lake, canal and river and are of varying size and ecological value when assessed using the EcIA framework.

Since the Tekapo A Power Station was commissioned in 1951 and Tekapo B in 1977, the vegetation communities around the TekPS have developed under a regime of managed water levels in the lake and managed flows in the Tekapo River. The vegetation reflects that management and is not expected to be affected to any more than a low level by continued operation under the same control levels. The overall magnitude of unmitigated local (ecological district) effects on the three specific vegetation types identified is set out in accordance with EIANZ guidelines in Table 5.

Table 5: Unmitigated effects on vegetation and wetlands of continued operation of the Tekapo Power Scheme.

Habitat	Ecological Value	Magnitude of effect	Overall Level of effect
Wetlands	High – Very high	Negligible	Low – Very low
Braided River vegetation in the Tekapo River	Low – Moderate	Negligible	Very low
Lake edge vegetation	Low – High	Negligible	Very low

With regard to effects on significant vegetation identified using the criteria in the RPS, this includes lake edge vegetation (turf, grey shrubland, rushland), a variety of wetland types and vegetations and riparian vegetation (mostly grey shrubland). These vegetation types have persisted in remnants around the TekPS and are similarly adapted to the existing operating regime (where applicable). The overall level of effect of the ongoing operation of the TekPS on the ecological features which confer significance is expected to be barely distinguishable akin to a 'no change' situation.

6.0 Mitigation

6.1 Existing Mitigation/Offset – Project River Recovery

PRR provides the primary mitigation/offset/compensation for the effects of the TekPS on indigenous vegetation. The approach in relation to vegetation has been as follows:

- With respect to wetlands, to develop new habitat, or to enhance degraded habitat, in an attempt to increase the amount of good quality wetland habitat in the vicinity of the WPS; and
- With respect to braided rivers, to control and remove weeds, particularly within the more pristine upper catchments (above the hydroelectricity lakes).
- With respect to lake edge vegetation, no specific management has been undertaken to date.

Achievements of PRR in relation to vegetation prior to 1999 included:

- Removal of 160 ha of *Salix fragilis* from the Tekapo River delta area;
- Control of (an unspecified area of) wilding pines above the river delta;
- Creation of 98 ha of new wetlands at seven sites;
- Weed clearance from over 11,000 ha of riverbed; and
- Enlarged and fenced Mailbox Inlet and Mick's Lagoon.

Since 1999, the first PRR strategic plan (1998-2005; Brown & Sanders (1999)) was developed along with a 5-year weed control plan for the upper Waitaki basin (Brown 1999) that aimed to control pest plants to very low levels in the more natural braided riverbeds above the main lakes. In riverbeds below the lakes, the plan was to keep control of the pest plants in already treated areas, and extend weed-free areas where practicable.

Between 1999 and 2005 achievements included:

- Maintaining targeted removal of problem weeds over 35,000 ha of upper catchment braided river habitat before they become widespread (Woolmore & Sanders, 2005).

The intention was that by concentrating on protecting high quality habitats above the lakes, PRR could achieve greater conservation benefits than using the same resources to restore small sections of heavily modified or degraded riverbed (Woolmore & Sanders, 2005).

Between 2006 and 2012 (the life of the second seven-year strategic plan, Woolmore & Sanders 2005) the achievements in relation to vegetation according to Rebergen & Woolmore (2015) included:

- Maintaining more than 23,000 ha of high quality natural braided river habitat by continuing the strategy of targeted removal of problem weeds in the upper catchments before they become widespread.
- Undertaking weed management of selected sections of modified habitat to restore habitat quality over a further 7,000 ha of braided riverbed.
- Achieving a steady decrease in the coverage and size of lupins on the Tasman River each year.
- Mapping sites with yellow tree lupin and buddleia and continuing annual control. This work has resulted in a reduction in the presence of both species with a decline in the number and size of plants.
- Investigating some aspects of the efficacy of Russell lupin control methods, and publishing these. Studies have assessed the ability of lupin seedlings to germinate, mature and produce seed after control operations; development and viability of lupin seed following application of herbicide to mature plants at different stages of seed development; and the efficacy of a new herbicide (triclopyr amine) suitable for use around waterways.
- Establishing a comprehensive weed surveillance system to detect and deal with new incursions of weeds.
- Raising awareness about invasive weeds by running weed identification workshops and producing and distributing pocket-sized weed identification booklets to staff and contractors and raising the profile with the general public.
- Contributing to the understanding of braided river and wetland ecosystem composition, structure and functioning via PRR research publications.
- Ongoing management of over 80 hectares of constructed wetlands.
- Supporting PhD research to investigate how flood-induced processes affect lupin mortality and determine the correlating flood events that drive these processes. This research was intended to inform control of weeds in braided rivers.

The third strategic plan (2012-2019; Rebergen & Woolmore (2015)) looked to widen the project's scope to a 'whole ecosystem' approach to include riverbanks and low terraces. In terms of weed management, PRR's vision as expressed in the current strategic plan includes:

- Rivers above the glacial lakes will remain in 'essentially pristine condition' through weed control that keeps lupins, willows, gorse, broom and wilding trees at near-zero densities.
- River systems below the lakes will have their burden of weed species managed in an economically and ecologically-sustainable manner.
- Caruso (2006a, b) reviewed and summarised PRR after more than 10 years of operation and concluded PRR was "an excellent example of an ecological restoration program focusing on conserving and restoring unique habitat for threatened native bird species, but that also includes several secondary objectives". Caruso (2006b) went on to state that "PRR could achieve even greater success with expanded goals, additional resources, and increased integration of science with management, especially broader consideration of hydrologic and geomorphologic effects and restoration opportunities".
- An independent review of PRR was completed in 2012, which concluded that Project River Recovery had been highly effective at braided river restoration since its inception, was sustainably maintaining low weed density in 63% of the upper Waitaki Basin and had been very resource-efficient at achieving its outcomes (Innes and Saunders 2012). The review also endorsed the project's strategic direction as outlined in its 2005–2012 Strategic Plan.

Neither of the reviews of PRR considered the project outcomes in terms of offsetting the effects of the TekPS, probably because reliably determining the effects has been hindered by a lack of pre-scheme ecological data (Wilson 2000).

The 2020 PRR annual report (Gale et al. 2020) summarises that PRR continues to accord high priority to preventing weed invasions of the catchments above the hydro lakes and in 2020 spent considerable time and resources on targeted weed control in eight riverbeds (Godley, Macauley, Cass, Tasman, Ōhau, Ahuriri, Twizel and Pūkaki) four streams (Coal, Mistake, Fraser and Fork) and three wetlands (Ruataniwha, Fraser Stream and Waterwheel) as well as three lake shore sites (Ōhau, Poaka and Ruataniwha) and also contributed to landowner weed control in the upper Tekapo River, the Dobson River and upper Ahuriri River. PRR also undertook substantial pest control efforts as well as species monitoring and wetland management.

PRR has made a substantial contribution to maintaining indigenous vegetation in the upper Waitaki catchment, particularly with respect to weed control. In the absence of PRR the likely budget for weed control would be substantially less and the ecological values of the currently managed areas would slowly degrade over time as exotic species came to dominate as they do in the lower catchment.

6.2 Recommended Mitigation Actions

Native species were sparse throughout the area surrounding the TekPS. Nonetheless there were examples of high-quality vegetation, and areas of significant vegetation identified using the criteria set out in the RPS, particularly wetland areas. The reasons for the scarcity of native species are historical as set out in Section 2.1.3, but one current reason why native species are not expanding at some locations, even in the presence of effective weed and mammal pest control, is a lack of seed sources in the vicinity. On that basis one of the things that could be done to improve the extent and quality of native vegetation is to undertake an area(s) of planting in order to establish native vegetation which could link currently disconnected areas and then act as a source of seeds and other propagules for the wider area, including areas downstream. There are remnants of indigenous vegetation both along the Tekapo Canal (tussock grassland) and along the Tekapo River (grey scrub) that could from a nucleus around which any planting efforts could be based.

Wetlands near the TekPS typically have a higher proportion of native species than other areas and they could also serve as a starting point around which revegetation efforts could be based. Given the difficult nature of the climate and soils in the region, the scale and extent of any planting should make use of local knowledge, including that of mana whenua, and should initially be modest in extent and type and take an adaptive approach in order to capitalise on methods which have been proven effective as the works proceed.

We also recommend that monitoring of wetland condition at the seven locations monitored by PDP be continued in order to develop a long-term data set of vegetation changes at those sites. Vegetation data from other wetlands would also be helpful in describing vegetation change over time near the TekPS. With respect to frequency, wetland condition monitoring is recommended every five years.

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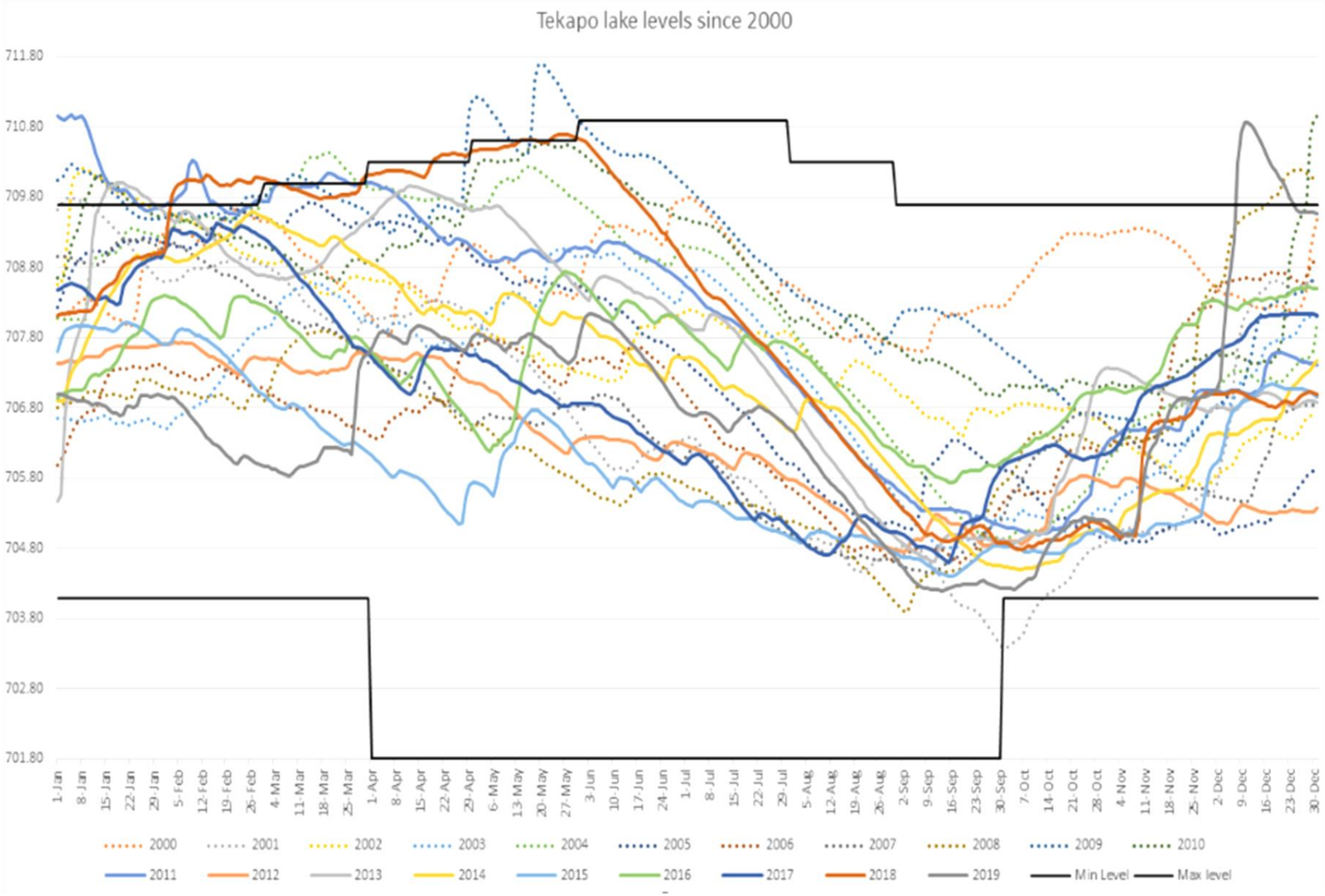
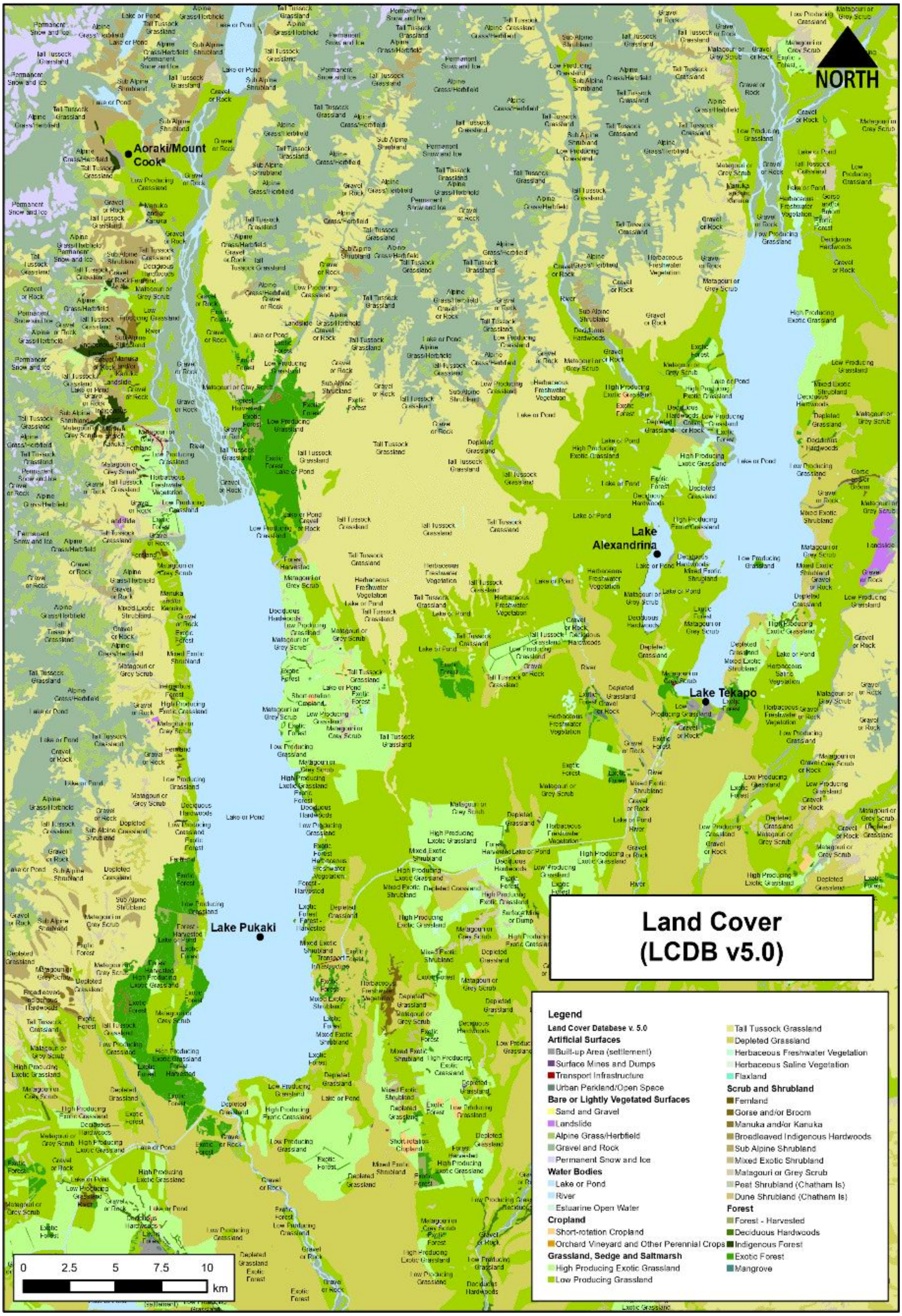
APPENDIX A
Lake Tekapo water levels since 2000

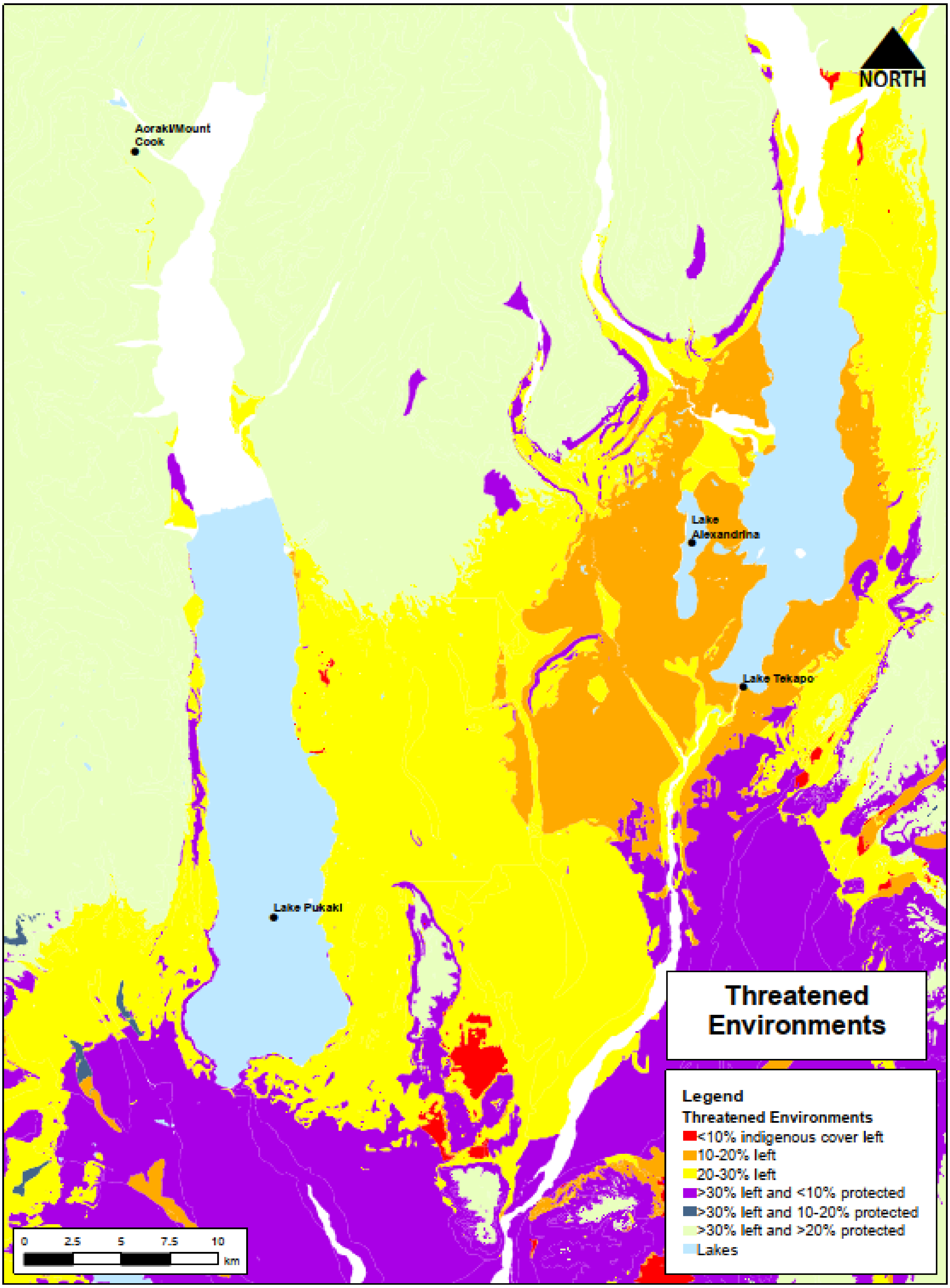

Tekapo lake levels since 2000
711.80
710.80
709.80
708.80
707.80
706.80
705.80
704.80
703.80
702.80
701.80
1-Jan
8-Jan
15-Jan
22-Jan
29-Jan
5-Feb
12-Feb
19-Feb
26-Feb
4-Mar
11-Mar
18-Mar
25-Mar
1-Apr
8-Apr
15-Apr
22-Apr
29-Apr
6-May
13-May
20-May
27-May
3-Jun
10-Jun
17-Jun
24-Jun
1-Jul
8-Jul
15-Jul
22-Jul
29-Jul
5-Aug
12-Aug
19-Aug
26-Aug
2-Sep
9-Sep
16-Sep
23-Sep
30-Sep
7-Oct
14-Oct
21-Oct
28-Oct
4-Nov
11-Nov
18-Nov
25-Nov
2-Dec
9-Dec
16-Dec
23-Dec
30-Dec
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
Min Level
Max level

APPENDIX B

Level 4 Land Environments, Land Cover Database and Threatened Environments Classification in the vicinity of the TekPS


NORTH
Aoraki/Mount Cook
Lake Alexandrina
Lake Tekapo
Lake Pukaki
Land Cover
(LCDB v5.0)
Legend
Land Cover Database v. 5.0
Artificial Surfaces
Built-up Area (settlement)
Surface Mines and Dumps
Transport Infrastructure
Urban Parkland/Open Space
Bare or Lightly Vegetated Surfaces
Sand and Gravel
Landslide
Alpine Grass/Herbfield
Gravel and Rock
Permanent Snow and Ice
Water Bodies
Lake or Pond
River
Estuarine Open Water
Cropland
Short-rotation Cropland
Orchard Vineyard and Other Perennial Crops
Grassland, Sedge and Saltmarsh
High Producing Exotic Grassland
Low Producing Grassland
Tall Tussock Grassland
Depleted Grassland
Herbaceous Freshwater Vegetation
Herbaceous Saline Vegetation
Flaxland
Scrub and Shrubland
Fernland
Gorse and/or Broom
Manuka and/or Kanuka
Broadleaved Indigenous Hardwoods
Sub Alpine Shrubland
Mixed Exotic Shrubland
Matagouri or Grey Scrub
Peat Shrubland (Chatham Is)
Dune Shrubland (Chatham Is)
Forest
Forest - Harvested
Deciduous Hardwoods
Indigenous Forest
Exotic Forest
Mangrove
0 2.5 5 7.5 10
km


NORTH
Aoraki/Mount Cook
Lake Alexandrina
Lake Tekapo
Lake Pukaki
0 2.5 5 7.5 10
km
LENZ
Level 4


NORTH
Aoraki/Mount Cook
Lake Alexandrina
Lake Tekapo
Lake Pukaki
Threatened Environments
Legend
Threatened Environments
<10% indigenous cover left
10-20% left
20-30% left
>30% left and <10% protected
>30% left and 10-20% protected
>30% left and >20% protected
Lakes
0 2.5 5 7.5 10 km

APPENDIX C

Threatened Plant Species recorded in the Waitaki Catchment by Burrell and Ferguson (2004)

Species[9]	Threat Status (de Lange et al. 2017)	Habitat	Number of records
Acaena buchananii	At risk (Declining)	Riverbeds and short tussock grassland	2
Acnatherum petriei	At risk (Declining)	Rock outcrops (limestone and schist)	8
Aciphylla montana var. *gracilis*	At Risk (Naturally uncommon)	Alpine, tall tussock grassland	2
Alepis flavida	At risk (Declining)	Semi-parasitic mistletoe	10
Amphibromus fluitans	Threatened (Nationally vulnerable)	Seasonally dry wetlands, lake edges	4
Anemanthele lessoniana	At risk (Relict)	Forest margins, scrub, cliff faces	2
Cardamine (a) (CHR 312947; tarn)	Threatened (Nationally critical)		2
Carex tenuiculmis	At risk (Declining)	Stream sides, lake margins and wetlands	2
Carmichaelia crassicaule	At risk (Declining)	Short tussock grassland	42
Carmichaelia curta	Threatened (Nationally critical)	Grey scrub on river terraces and alluvium	44
Carmichaelia hollowayi	Threatened (Nationally critical)	Limestone outcrops	17
Carmichaelia juncea	Threatened (Nationally vulnerable)	Stable but unconsolidated river and lake edges	1
Carmichaelia kirkii	Threatened (Nationally vulnerable)	High fertility sites. Grey scrub, wetlands.	106
Carmichaelia vexillata	At risk (Declining)	River terraces and risers, disturbed soils	56
Centipeda minima	Threatened (Nationally endangered)	Open lake, pond and stream margins	3
Ceratocephala pungens	Threatened (Nationally critical)	Dry open ground	5
Chenopodium detestans	Threatened (Nationally critical)	Open ground, dried river beds, salt pans	8
Convolvulus fract]o-saxosa	At risk (Naturally uncommon)	Scree, short tussock grassland	1
Convolvulus verecundus subsp. *verecundus*	Threatened (Nationally vulnerable)	Short tussock grassland	18
Coprosma intertexta	At risk (Declining)	Grey scrub	17
Corallospartium crassicaule	At risk (Declining)	Tussock grassland and scrub	4
Crassula multicaulis	Threatened (Nationally endangered)	Tarn margins and braided river beds	11
Crassula peduncularis	Threatened (Nationally critical)	Wetlands and lake margins	5
Crassula ruamahanga	At risk (Naturally uncommon)	Damp open habitats	1
Deschampsia cespitosa	At risk (Declining)	Wetlands and lake margins	11
Elymus falcis	At risk (Declining)	Dry open ground, riverbeds	1
Epilobium chionanthum	Not threatened	Wetland, lake and river	1

9 Note that the name used here is that used in the original publication (i.e., it has not been updated where required).

		margins	
Epilobium hirtigerum	At risk (Recovering)	Wetland margins, braided rivers, lake edges	4
Epilobium purpuratum	At risk (Naturally uncommon)	High altitude scree and gravel	4
Gentiana liliputiana	At risk (Naturally uncommon)	Alpine bogs and flushes	1
Gratiola nana	Threatened (Nationally endangered)	Muddy hollows, lake and river edges	1
Hebe cupressoides	Threatened (Nationally endangered)	Grey scrub and disturbed sites	16
Hebe matthewsii			1
Hebe sp.			7
Helichrysum plumeum	At risk (Declining)	Open areas in the south Canterbury mountains	15
Iphigenia novae-zelandiae	Threatened (Nationally endangered)	Wetlands and seepages within tussock grassland	19
Ischnocarpus exilis	Threatened (Nationally critical)	Dry, exposed limestone rock	15
Ischnocarpus novae-zelandiae	Threatened (Nationally endangered)	Tussock grassland, grey scrub, rock faces	11
Isolepis basilaris	At risk (Declining)	Wetland and river margins	2
Isolepis fluitans	Threatened (Nationally vulnerable)	Aquatic, streams, ponds, tarns, lakes	1
Kirkianella novae-zelandiae	Threatened (Nationally vulnerable)	Tussock grassland, open stony ground	1
Lepidium sisymbrioides			1
Lepidium sisymbrioides subsp. *Kawarau*	Threatened (Nationally critical)	Limestone outcrops and semi-saline soils	7
Lepidium sisymbrioides subsp. *sisymbrioides*			28
Leptinella intermedia	Data deficient	Flushes and herbfields	2
Luzula celata	At risk (Declining)	Shingly ground, river terraces, tarn margins	6
Melicytus flexuosus	Threatened (Nationally vulnerable)	Alluvial terraces and floodplains	4
Montigena novae-zelandiae	At risk (Declining)	Scree and occasionally depleted grasslands	1
Muehlenbeckia ephedroides	Threatened (Nationally vulnerable)	River flats, terraces and outwash gravels	5
Myosotis pygmaea var. *glauca*	Threatened (Nationally vulnerable)	Dry sandy or gravelly ground	2
Myosotis pygmaea var. *pygmaea*	At risk (Declining)	Herbfield and streamsides	3
Myosurus minimus subsp. *novae-zelandiae*	Threatened (Nationally vulnerable)	Damp hollows and tarn/kettlehole margins	4
Olearia fimbriata	Threatened (Nationally vulnerable)	Shrubland growing on alluvial and rocky substrates	5
Peraxilla tetrapetala	At risk (Declining)	Semi-parasitic mistletoe	52
Pittosporum patulum	Threatened (Nationally vulnerable)	Subalpine scrub and	16

		disturbed mountain beech forest	
Plantago obconica	At risk (Naturally uncommon)	Acidic bogs	1
Pleurosorus rutifolius	At risk (Naturally uncommon)	Dry, exposed rocky faces	3
Poa spania	Threatened (Nationally critical)	Limestone outcrops	4
Pseudopanax ferox	At risk (Naturally uncommon)	Alluvial and rocky places, grey scrub	1
Ranunculus brevis	Threatened (Nationally endangered)	Lake and pond margins	2
Ranunculus godleyanus	At risk (Recovering)	High alpine rocky places	6
Ranunculus grahamii	At risk (Naturally uncommon)	High alpine rock crevices	9
Ranunculus haastii subsp. *piliferus*	At risk (Declining)	Alpine rocky sites	13
Ranunculus macropus	Data deficient	Raupo dominated wetlands, semi aquatic	1
Ranunculus maculatus	At risk (Naturally uncommon)	Lake edges and wetlands	4
Raoulia monroi	Threatened (Nationally vulnerable)	Lowland to upland rocky ground	2
Raoulia parkii	At risk (Declining)	Upland to subalpine rocky places	1
Raoulia petriensis	At risk (naturally uncommon)	Subalpine rocky places and fellfield	3
Rytidosperma tenue	Not threatened	Grassland	1
Senecio dunedinensis	Threatened (nationally endangered)	Grey scrub	16
Simplicia laxa	Threatened (nationally critical)	Base rich rock overhangs and cave entrances	4
Teucridium parvifolium	At risk (Declining)	Streamsides and scrub	2
Triglochin palustris	Threatened (Nationally critical)	Wetlands, stream and lake margins	6
Tupeia antarctica	At risk (Declining)	Semi-parasitic mistletoe	7
Uncinia purpurata	At risk (Naturally uncommon)	Damp ground, seepages	7
Urtica aspera	At risk (Naturally uncommon)	Grey scrub	8
Utricularia protrusa	Threatened (Nationally critical)	Aquatic	1
Vittadinia australis	Not threatened	Stony places including dry riverbeds	1

APPENDIX D
Plant Species Recorded

Scientific Name	Common Name	Status
Trees, Shrubs and sub-shrubs		
*Abies nordmanniana**	Caucasian Fir	Naturalised exotic
*Alnus glutinosa**	alder	Naturalised exotic
Aristotelia serrata	makomako, wineberry	Not threatened
*Betula pendula**	silver birch	Naturalised exotic
Carmichaelia corrugata	common dwarf broom	Threatened (Nationally vulnerable)
Carmichaelia crassicaulis subsp. *crassicaulis*	coral broom	At risk (Declining)
Carmichaelia petriei	desert broom	At risk (Declining)
Coprosma brunnea		At risk (Declining)
Coprosma intertexta		At risk (Declining)
Coprosma petriei	turfy coprosma	Not threatened
Coprosma propinqua	mikimiki	Not threatened
Cytisus scoparius	Scotch broom	Naturalised exotic
Discaria toumatou	matagouri	At risk (Declining)
Gaultheria macrostigma	prostrate snowberry	Not threatened
*Larix decidua**	European larch	Naturalised exotic
*Lupinus arboreus**	tree lupin	Naturalised exotic
Melicytus alpinus	porcupine shrub	Not threatened
Muehlenbeckia axillaris	small leaved pōhuehue	Not threatened
Muehlenbeckia complexa	large leaved pōhuehue	Not threatened
Olearia bullata		Not threatened
Olearia virgata agg.	Twiggy tree daisy	Not threatened
Ozothamnus vauvilliersii	Mountain tauhinu	Not threatened
Pimelea oreophila agg.	Pimelea	Not threatened
Pimelea prostrata agg.		Not threatened
Pimelea sp.		
*Pinus nigra**	Black pine	Naturalised exotic
*Pinus ponderosa**	Ponderosa pine	Naturalised exotic
*Pinus sylvestris**		Naturalised exotic
Pinus sp.		Naturalised exotic
*Polygonum aviculare**	Wire weed	Naturalised exotic
*Populus deltoides**	Necklace poplar	Naturalised exotic
*Populus nigra**	Lombardy poplar	Naturalised exotic
Pseudotsuga menziesii	Douglas fir	Naturalised exotic
*Quercus robur**	Oak	Naturalised exotic

Rosa rubiginosa *	brier rose	Naturalised exotic
Salix x *chrysocoma**	weeping golden willow	Naturalised exotic
*Salix fragilis**	crack willow	Naturalised exotic
Sophora microphylla	kōwhai	Not threatened
Styphelia nesophila	pātotara	Not threatened
Veronica odora	hebe	Not threatened

Herbaceous dicots

Acaena agnipila var. *tenuispica*		Naturalised exotic
Acaena anserinifolia	bidibid	Not threatened
Acaena caesiiglauca	glaucus bidibid	Not threatened
Acaena ovina		
Acaena sp.		
*Achillea millifolium**	yarrow	Naturalised exotic
Aciphylla aurea	taramea, golden spaniard	Not threatened
Anagallis arvensis subsp. *arvensis* var *arvensis**	pimpernel	Naturalised exotic
*Angelica pachycarpa**	angelica	Naturalised exotic
Azorella haastii		Not threatened
Barbarea sp.	cress	
*Borago officinalis**	borage	Naturalised exotic
Brachyglottis haastii		Not threatened
*Callitriche stagnalis**	water starwort	Naturalised exotic
Celmisia gracilenta agg.		Not threatened
Centaurium erythraea	European centaury	Naturalised exotic
Centella uniflora	centella	Not threatened
Chaerophyllum novae-zelandiae		Not threatened
Cirsium arvense	Californian thistle	Naturalised exotic
Cirsium vulgare	Scotch thistle	Naturalised exotic
Colobanthus brevisepalus	Pin cushion	At risk (Declining)
*Crepis capillaris**	hawkbit	Naturalised exotic
*Capsella bursa-pastoris**	Shepherd's purse	Naturalised exotic
*Centaurium erythraea**	centaury	Naturalised exotic
*Cerastium fontanum**	mouse ear chickweed	Naturalised exotic
*Cerastium semidecandrum**	little mouse ear chickweed	Naturalised exotic
*Chenopodium album**	fathen	Naturalised exotic
*Cirsium arvense**	Californian thistle	Naturalised exotic
*Cirsium vulgare**	Scotch thistle	Naturalised exotic

Craspedia sp.		
*Dianthus armeria**	Deptford pink	Naturalised exotic
*Echium vulgare**	Viper's bugloss	Naturalised exotic
*Epilobium ciliatum**	willowherb	Naturalised exotic
Epilobium cinereum	willowherb	Not threatened
Epilobium komarovianum	creeping willowherb	Not threatened
Epilobium melanocaulon	willowherb	Not threatened
Epilobium pallidiflorum	tarawera, swamp willowherb	Not threatened
Epilobium sp.		
*Erodium cicutarium**	storksbill	Naturalised exotic
*Erythranthe guttata**	monkey musk	Naturalised exotic
*Eschscholzia californica**	Californian poppy	Naturalised exotic
*Euphorbia peplus**	milkweed	Naturalised exotic
Euphrasia zelandica	eyebright	Not threatened
Fumaria muralis subsp. *muralis**	scrambling fumitory	Naturalised exotic
*Galega officinalis**	goat's rue	Naturalised exotic
*Galium aparine**	cleavers	Naturalised exotic
Galium palustre subsp. *palustre**	marsh bedstraw	Naturalised exotic
Galium perpusillum	dwarf bedstraw	Not threatened
Gentianella corymbifera	Grassland gentian	Not threatened
Gentianella sp.		
Geranium brevicaule	shortflowered cranesbill	Not threatened
*Geranium molle**	doves foot cranesbill	Naturalised exotic
Glossostigma elatinoides		Not threatened
Gunnera dentata		Not threatened
*Helminthotheca echioides**	ox tongue	Naturalised exotic
*Hieracium lepidulum**	Tussock hawkweed	Naturalised exotic
Hydrocotyle novae-zelandiae		Not threatened
Hydrocotyle sulcata		Not threatened
*Hypericum perforatum**	St John's wort	Naturalised exotic
Hypericum pusillum	swamp hypericum	Not threatened
*Hypochaeris radicata**	catsear	Naturalised exotic
Leptinella pectinata subsp. *pectinata*		Not threatened
Leptinella sp.		
*Leucanthemum vulgare**	oxeye daisy	Naturalised exotic
Lilaeopsis novae-zelandiae		Not threatened
*Linum catharticum**	purging flax	Naturalised exotic

Lobelia sp.		
*Lotus pedunculatus**	lotus	Naturalised exotic
*Lotus suaveolens**	hairy birdsfoot trefoil	Naturalised exotic
*Lupinus polyphyllus**	Russell lupin	Naturalised exotic
*Malva neglecta**	dwarf mallow	Naturalised exotic
*Marrubium vulgare**	horehound	Naturalised exotic
*Medicago ?lupulina**	black medic	Naturalised exotic
Montia sp.		
*Myosotis discolor**	grassland forget-me-not	Naturalised exotic
*Myosotis laxa**	Water forget-me-not	Naturalised exotic
Myosotis sp.		
Myriophyllum propinquum	common water milfoil	Not threatened
Myriophyllum votschii		Not threatened
*Nasturtium officinale**	watercress	Naturalised exotic
*Navarretia squarrosa**	Californian stinkweed	Naturalised exotic
Oxalis corniculata subsp. *corniculata**	horned oxalis	Naturalised exotic
Oxalis rubens		Not threatened
*Parentucellia viscosa**	tarweed	Naturalised exotic
*Persicaria hydropiper**	water pepper	Naturalised exotic
*Persicaria maculosa**	willow weed	Naturalised exotic
*Pilosella officinarum**	mouse – ear hawkweed	Naturalised exotic
Pilosella x *stolonifera*	hawkweed	Naturalised exotic
*Plantago lanceolata**	narrow leaved plantain	Naturalised exotic
Plantago triandra	glossy plantain	Not threatened
*Polycarpon tetraphyllum**	allseed	Naturalised exotic
*Polygonum aviculare**	wireweed	Naturalised exotic
*Prunella vulgaris**	selfheal	Naturalised exotic
Pseudognaphalium luteoalbum		Not threatened
Raoulia australis	common mat daisy	At risk (Declining)
Raoulia glabra	mat daisy	Not threatened
Raoulia hookeri agg.	scabweed	Not threatened
Raoulia parkii	Celadon mat daisy	At risk (Declining)
Raoulia subulata	scabweed	Not threatened
*Ranunculus repens**	creeping buttercup	Naturalised exotic
*Reseda luteola**	wild mignonette	Naturalised exotic
*Rumex acetosella**	sheep's sorrel	Naturalised exotic
*Rumex crispus**	curly-leaved dock	Naturalised exotic

*Rumex obtusifolius**	broad-leaved dock	Naturalised exotic
*Sagina procumbens**	procumbent pearl wort	Naturalised exotic
Sceleranthus biflorus	Canberra grass	Not threatened
Scleranthus sp.		
*Sedum acre**	stone crop	Naturalised exotic
*Senecio bipinnattisectus**	Australian fireweed	Naturalised exotic
*Senecio vulgaris**	groundsel	Naturalised exotic
Senecio quadridentatus	cotton fireweed	Not threatened
Stackhousia minima		Not threatened
*Stellaria alsine**	bog stichwort	Naturalised exotic
*Stellaria graminea**	stitchwort	Naturalised exotic
*Solanum nigrum**	black nightshade	Naturalised exotic
*Sonchus oleraceus**	sow thistle	Naturalised exotic
*Spergula arvensis**	spurrey	Naturalised exotic
*Spergularia rubra**	sand spurrey	Naturalised exotic
Stylidium subulatum		Not threatened
*Taraxacum officinale**	dandelion	Naturalised exotic
*Trifolium arvense**	haresfoot trefoil	Naturalised exotic
*Trifolium dubium**	suckling clover	Naturalised exotic
*Trifolium repens**	white clover	Naturalised exotic
*Trifolium pratense**	Red clover	Naturalised exotic
*Tripleurospermum inodorum**	scentless mayweed	Naturalised exotic
*Verbascum thapsus**	woolly mullein	Naturalised exotic
*Veronica arvensis**	field speedwell	Naturalised exotic
*Veronica verna**	spring speedwell	Naturalised exotic
*Vicia sativa**	common vetch	Naturalised exotic
*Viola arvensis**	field pansy	Naturalised exotic
Wahlenbergia albomarginata	New Zealand harebell	Not threatened

Monocotyledons (Grasses, sedges etc.)

*Agrostis capillaris**	browntop	Naturalised exotic
*Agrostis stolonifera**	creeping bent	Naturalised exotic
*Aira caryophyllaea**	silvery hair grass	Naturalised exotic
*Alopecurus aequalis**	Orange foxtail	Naturalised exotic
*Anthosachne scabra**	Blue wheat grass	Naturalised exotic
*Anthoxanthum odoratum**	Sweet vernal	Naturalised exotic
*Arrhenatherum elatius elatius**	Tall oat grass	Naturalised exotic

Austroderia richardii	toetoe	Not threatened
*Bromus hordeaceus**	soft brome	Naturalised exotic
*Bromus tectorum**	cheatgrass	Naturalised exotic
*Briza maxima**	large quaking grass	Naturalised exotic
Carex breviculmis	grassland sedge	Not threatened
Carex buchananii	Buchanan's sedge	At Risk (Declining)
Carex coriacea	rautahi	Not threatened
Carex diandra		Not threatened
Carex geminata	rautahi	Not threatened
*Carex leporina**	oval sedge	Naturalised exotic
C ?resectans	desert sedge	Not threatened
Carex secta	purei	Not threatened
Carex sinclairii	Sinclair's sedge	Not threatened
Chionochloa macra	slim snow tussock	Not threatened
Chionochloa rubra	red tussock	Not threatened
Critesion murinum ssp. *murinum**	Barley grass	Naturalised exotic
*Dactylis glomeratus**	cocksfoot	Naturalised exotic
Festuca matthewsii	Matthew's fescue	Not threatened
Festuca novae-zelandiae	hard tussock	Not threatened
Festuca rubra subsp. *rubra**	red fescue	Naturalised exotic
*Glyceria fluitans**	floating sweetgrass	Naturalised exotic
*Holcus lanatus**	Yorkshire fog	Naturalised exotic
Isolepis aucklandica		Not threatened
Isolepis prolifera		Not threatened
Isolepis sp.		
Juncus acuminatus *	Sharp fruited rush	Naturalised exotic
*Juncus articulatus**	jointed rush	Naturalised exotic
Juncus australis	Leafless rush / wiwi	Not threatened
*Juncus bufonius**	toad rush	Naturalised exotic
Juncus effusus var. *compactus**	soft rush	Naturalised exotic
*Juncus tenuis**	track rush	Naturalised exotic
Juncus sp.		
Lachnagrostis filiformis	New Zealand wind grass	Not threatened
Lolium arundinaceum subsp. *arundinaceum**	tall fescue	Naturalised exotic
Luzula rufa var *rufa*	red woodrush	Not Threatened
Pentapogon avenoides	mountain oat grass	Not threatened
*Poa annua**	annual poa	Naturalised exotic

Poa cita	silver tussock	Not threatened
Poa colensoi	blue tussock	Not threatened
Poa maniototo	Desert poa	Not threatened
Poa sp.		
*Phleum pratense**	Timothy	Naturalised exotic
Rytidosperma sp.		
Schoenus pauciflorus	Bog rush	Not threatened
*Vulpia myuros**	rat's tail fescue	Naturalised exotic
Orchids		
Prasophyllum sp.		
Monocot herbs		
Lemna disperma	common duckweed	Not threatened
Typha orientalis	raupō, bullrush	Not threatened

***denotes introduced and naturalised species**

APPENDIX E

New Zealand Threat Classification System

The process of categorising the risk of extinction for New Zealand species has undergone significant revision since it was first proposed in 2002 (Molloy *et al*. 2002, Townsend *et al*. 2008).

The four main parameters used to assign threat ranking are total population size, population trend, geographical range and whether the taxon has directly or indirectly been affected by humans. By identifying threatened or potentially threatened species it is possible to compile lists of threatened taxa according to the New Zealand Threat Classification System proposed by Molloy *et al*. (2002). The categories have been revised and the lists are regularly updated (approximately every 3 – 5 years) to reflect improved knowledge or changes in status. Figure 1 illustrates the New Zealand threat classification system.

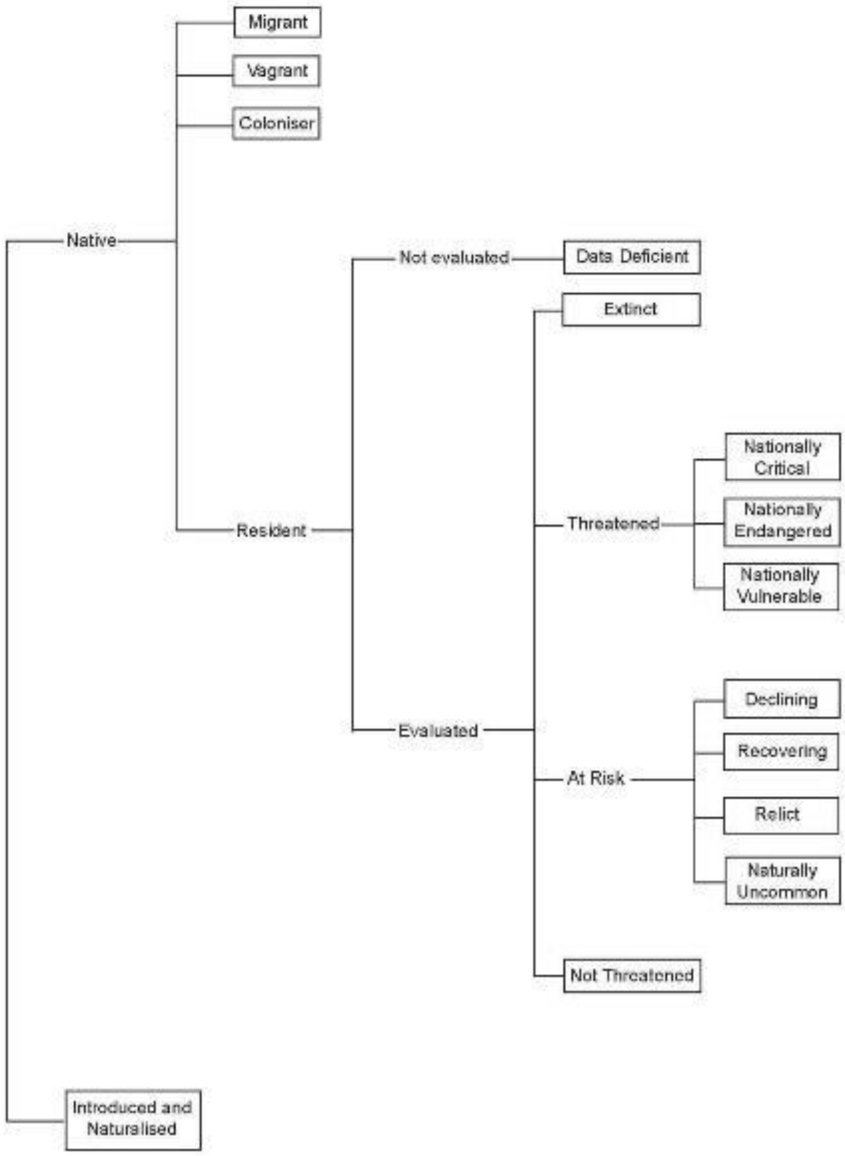


Figure 1: The New Zealand Threat Classification System (after Townsend *et al.* 2008)

The process of risk assessment involves consultation with experts, derivation of a list and then circulation of the draft list to expert panel members and Department of Conservation conservancies before final lists are published. The categories are:

Data Deficient - Where information is so lacking that an assessment is not possible, the taxon is assigned to the Data Deficient category. Where sufficient data exists, the taxon is assigned to one of the following categories:

Extinct

Beyond all reasonable doubt no individuals of the species remain

Not Threatened - Taxa that are assessed and do not fit any of the Threatened categories.

Threatened Categories:

Threatened species are facing a very high risk of extinction in the wild (i.e. can be regarded as acutely threatened). There are three sub-categories:

Nationally Critical – those with a very small population or a very high rate of decline.

Nationally Endangered – those with either a small population with a moderate to high recent or predicted decline or a small to moderate population with a high recent or predicted decline.

Nationally Vulnerable - Small to moderate population and moderate recent or predicted decline.

At Risk

At risk species are facing extinction, but are buffered slightly by either a large population or a slow rate of decline (i.e. chronically threatened). This includes three categories:

- *Declining*

  Declining species represent those species for which populations continue to decline within a national context. This is generally represented by those species which have the following:

  - 5000 – 20,000 mature individuals, 10 – 30% population decline within 10 years or three generations (whichever is the longer).
  - 20,000 – 100,000 mature individuals, 10 – 50% population decline within 10 years or three generations (whichever is the longer).
  - >100,000 mature individuals, 10 – 70% population decline within 10 years or three generations (whichever is the longer).

- *Recovering*

  Species which have a limited number of mature individuals, but where populations are regarded as increasing within a national context. These species fit the following criteria:

  - 1000 – 5000 Mature individuals, >10% population increase within 10 years or three generations (whichever is the longer).
  - 5000 – 20,000 Mature individuals, >10% population increase within 10 years or three generations (whichever is the longer).

- *Relict*

  Relict taxa are defined as species which have lost the majority of their original range and occupy <10% of this range. These species are either:

- 5000 – 20,000 Mature individuals, stable population; or
- >20,000 Mature individuals, stable or increasing population.

Naturally Uncommon

Naturally uncommon species are those that were probably never common prior to human settlement. This includes taxa whose distribution is naturally confined to specific substrates (e.g., ultramafic rock), habitats (e.g., high alpine fellfield, hydrothermal vents), or geographic areas (e.g., subantarctic islands, sea-mounts), or taxa that occur within naturally small and widely scattered populations. This distribution is not the result of past or recent human disturbance. Populations may be stable or increasing. Note that a naturally uncommon taxon that has fewer than 250 mature individuals qualifies for 'Nationally Critical' status. Taxa that have more than 20 000 mature individuals are not considered 'Naturally Uncommon', unless they occupy an area of less than 100 000 ha (1000 km^2).

Regionally significant species are not part of the New Zealand Threat Classification framework, but are those recognised as threatened or uncommon within a region as determined by the local Department of Conservation conservancy.