MAHINGA KAI AND ECOLOGICAL RESTORATION PLAN FOR COLDSTREAM 1, RANGITATA RIVER, SOUTH CANTERBURY

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MAHINGA KAI AND ECOLOGICAL RESTORATION PLAN FOR COLDSTREAM 1, RANGITATA RIVER, SOUTH CANTERBURY

An unnamed stream at Coldstream 1, South Canterbury. 9 July 2021

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1. INTRODUCTION

The Rangitata River and its catchment have been identified as a priority under the Department of Conservation Nga Awa source to sea restoration programme[1]. The programme will provide a multi-agency approach to managing the Rangitata River. The agencies involved include the Department of Conservation, Te Rūnanga o Arowhenua, Fish and Game – Central South Island Lakes, Ashburton District Council, Timaru District Council and Environment Canterbury and they have formed a steering group (the Rangitata Steering Group) to oversee the restoration work. The Rangitata Steering Group has identified six sites within the lower Rangitata River catchment as initial priorities for restoration, and commissioned Wildland Consultants Ltd to develop high level ecological and mahinga kai restoration plans for these sites.

This report provides a restoration plan, to be implemented over a four-year timeframe, for the Coldstream 1 site. This river terrace and spring-fed stream system is situated on the north side of the Rangitata River, approximately 14 kilometres upstream from the river mouth/hāpua. A key consideration for the site is the potential restoration of braid plain habitat (Rangitata Steering Group, pers comm). Aerial images indicate that the site was a significant braid of the river from at least the 1930-1980s. Wildlands has prepared similar plans for the five other Rangitata sites: McKinnons Creek, Coldstream 2, Rangitata Hāpua, Ealing Springs, and the main stem of the Rangitata River.

2. SITE GOALS

Overarching project goals and objectives are needed to provide guidance for the ecological restoration works at Coldstream 1. These goals have been aligned with those identified by the Rangitata Steering Group.

2.1 Ecological restoration project goals

- To implement a robust ecological restoration plan that will increase the mauri and ecological integrity within the Coldstream 1 site.
- Either (1) return the site to a dynamic braided river habitat that contains streams and wetlands for the restoration of indigenous ecosystems and freshwater mahinga kai species[2], or (2) restore dryland and riparian indigenous forest, and wetland habitats that incorporate mahinga kai resources.
- The integral role that Te Rūnanga o Arowhenua play as kaitiakitanga over the Rangitata River is respected and incorporated in the restoration plan and project.

[1] See: https://www.doc.govt.nz/our-work/freshwater-restoration/nga-awa/

[2] The Steering Group has subsequently selected to pursue Option 1 following submission of the draft restoration plan.

2.2 Ecological restoration project objectives

By the end of the four year timeframe of the project, the following will be achieved:

- Detailed ecological surveys have been completed and there is a high degree of understanding regarding the ecological values that are present at the site.
- Feasibility planning for restoring braided river habitat has been undertaken and, where possible has been implemented. Alternatively, dryland and riparian indigenous forest, and wetland are being actively restored at the site.
- If dryland and riparian indigenous forest, and wetland restoration is undertaken, 30% of the project site has been planted in indigenous vegetation by the end of the four years. This will include vegetation types such as lowland podocarp forest, harakeke (*Phormium tenax*) flaxland and raupō (*Typha orientalis*) reedland.
- Habitat for indigenous fauna such as fish, lizards, avifauna and invertebrates is enhanced.
- The main threats at the site (e.g. pest plants and animals) are being actively managed in cost effective ways.
- Mahinga kai species have been translocated to the site following Department of Conservation protocols and Te Rūnanga o Arowhenua tikanga.
- Ongoing management decisions are informed by a robust monitoring programme that is implemented at appropriate timeframes.
- The ecological importance of the site is highlighted to the wider community through public engagement (e.g. volunteer planting days, website updates).

3. METHODS

Ecological and mahinga kai values, threats and restoration opportunities that are present at the Coldstream 1 site were identified by the Rangitata Steering Group and provided as written summaries.

Additional information was gathered during a site visit and meeting on 9 July 2021. Participants included two Wildlands ecologists and representatives from the Department of Conservation. The purpose of the meeting was to discuss the key attributes and opportunities for restoration at Coldstream 1, particularly the potential to restore braided river habitat. A cross-section of the southeastern section of the site was traversed on foot along a recently bulldozed track, while the southern perimeter of the northern part of the site was inspected by car. The site was not surveyed in detail during the field meeting but, where possible, vegetation and habitat types, and potential restoration areas were mapped on aerial photos. The vegetation and habitats within unsurveyed areas were assessed using Google Earth and imagery captured using a drone in August 2021 (provided by the Rangitata Steering Group).

4. SITE DESCRIPTION

The site consists of 86 hectares of river terrace (formally river-braid) centered around a spring-fed stream, situated within a larger section of river terrace. To the best of our knowledge the stream is unnamed. The site is situated within the Rangitata River Conservation Reserve (Department of Conservation) with private land on the riverside of the reserve. The dominant vegetation at the site includes forest that contains poplar (*Populus* sp.) and crack willow (*Salix* x*fragilis*), and dense areas of shrubland that contains species such as gorse, Scotch broom and blackberry.

5. ECOLOGICAL VALUES

5.1 Vegetation and habitat types

Nine vegetation and habitat types were identified during the site visit. Further field surveys are needed to identify additional vegetation and habitats, and the species they contain at the site. The vegetation and habitat types are listed below. Descriptions of these types, and their distribution, is provided in Appendix 1.

1. Radiata pine treeland
2. Radiata pine-poplar/willow forest
3. Poplar/willow forest
4. Willow/blackberry-gorse-Scotch broom shrubland treeland and shrubland
5. Gorse-Scotch broom shrubland
6. Blackberry-gorse-Scotch broom shrubland
7. Gravelfield
8. Wetland or pond
9. River/streams

5.2 Notable habitat

Spring-fed streams are important aquatic habitats in braided river systems. They seldom flood and therefore have greater algal and aquatic plant growth, which supports higher overall biodiversity (Instream 2019). This habitat type is relatively rare in the lower Rangitata River catchment.

5.3 Notable flora

The site appears to retain a low diversity of indigenous plant species. As such, no notable plant species were recorded at the site during the brief survey. However, two species that have been identified as mahinga kai resources, rārahu (bracken; *Pteridium esculentum*) and tī kōuka (cabbage tree; *Cordyline australis*), were recorded at the site. Due to the limited area surveyed during the site inspection, it is possible that Threatened or At Risk indigenous plant species (as per de Lange *et al*. 2018) may still persist at the site.

5.4 Avifauna

Nineteen indigenous and 16 exotic bird species were recorded on eBird within ten kilometres of the project area (species listed in Appendix 2). Two species listed as Threatened (as per Robertson *et al*. 2021) have been recorded near the State Highway bridge: tara piroe/black-fronted tern (*Chlidonias albostriatus*; Threatened – Nationally Endangered) and taranui/Caspian tern (*Hydroprogne caspia*; Threatened – Nationally Vulnerable). A further two species that are listed as At Risk have been recorded near the site: tōrea/South Island pied oystercatcher (*Haematopus finschi*; At Risk – Declining), and torea pango/variable oystercatcher (*Haematopus unicolor*; At Risk – Recovering). South Island pied oystercatcher and variable oystercatcher are likely to be present, at least periodically, at the Coldstream 1 site, especially where the site meets the river. Although not recorded on eBird, banded dotterel (*Charadrius bicinctus bicinctus*; At Risk – Declining), black-fronted dotterel (*Elseyornis melanops*; At Risk – Naturally Uncommon), tarāpuka/black-billed gull (*Larus bulleri*; At Risk – Declining) and wrybill (*Anarhynchus frontalis*; Threatened – Nationally Increasing) may also be present on occasions.

Although matuku/Australasian bittern (*Botaurus poiciloptilus;* Threatened – Nationally Critical), koitareke/marsh crake (*Porzana pusilla affinis*; At Risk – Declining), and pūweto/spotless crake (*Porzana tabuensis*; At Risk – Declining) were not detected in the eBird search, these species may be present in the peripheral wetland areas. These species are highly cryptic and difficult to detect. They are sparsely yet widely distributed in wetlands within areas of raupō, *Carex* species and reed beds (Heather and Robertson 2015).

5.5 Freshwater fauna

There are no freshwater fauna records for the Coldstream 1 site. Several species found in the middle reaches or throughout the Rangitata River could be present including tuna (*Anguilla* spp.).

6. CULTURAL VALUES

6.1 Significant sites

Hamu kaika, a significant cultural site, is located within the Coldstream 1 site.

6.2 Mahinga kai species

Te Rūnanga o Arowhenua identified four indigenous and one exotic plant, two indigenous birds, one freshwater fish, and one indigenous freshwater mussel species as significant mahinga kai resources that could be reintroduced at the Coldstream 1 site. These species are listed in Appendix 3. Testing of mahinga kai to ensure safety should be conducted before harvest (e.g. heavy metal contamination of freshwater mussels or watercress).

7. ECOLOGICAL THREATS

7.1 Environmental pest plants

Environmental pest plants[1] are a primary threat to riparian margins, wetlands and braided river habitats and the indigenous fauna species they support (Maloney *et al*. 1999). In addition, the pest plants at Coldstream 1 will directly compete with existing areas of indigenous vegetation and restoration plantings, inhibit the recruitment of indigenous seedlings and saplings, and act as a propagule source for nearby areas. Ten environmental pest plants present at Coldspring 1 are listed in Appendix 4. All of these species should be controlled within the site as time and finances allow. Four of the environmental pest plant species recorded at the site are included in the Canterbury Regional Pest Management Plan 2018-2038 (Environment Canterbury 2018).

7.2 Pest animals

Introduced mammal species are likely negatively impacting indigenous vegetation and the population density and persistence of terrestrial indigenous vertebrate and invertebrate species at the site. This is a cumulative pressure given indigenous fauna are restricted at this site by habitat availability. Specifically, the pest animals may be having the following impacts:

- Rats (*Rattus* spp.), mustelids (*Mustela spp.*), feral cats (*Felis catus*), and brushtail possums (*Trichosurus vulpecula*), and European hedgehogs (*Erinaceus europaeus*) are likely to be negatively impacting the population density and persistence of terrestrial indigenous fauna. Brushtail possums can also negatively impact indigenous vegetation.

- Rabbits (*Oryctolagus cuniculus cuniculus*), hares (*Lepus europaeus*), and possums may be impacting indigenous flora at the site.

- Feral pigs (*Sus scrofa*), feral goats (*Capra hircus*), and deer (most likely red deer; *Cervus elaphus scoticus*) may periodically occur within the corridor of the Rangitata River, and therefore may access the Coldstream 1 site. Pigs can cause considerable damage to the margins of wetlands and streams, while goats and deer are capable of causing the localised decline of palatable indigenous plant species.

7.3 Flooding and erosion by the river

Flooding is a natural consequence of dynamic river flows. High flow events may change the course of the braided river, and alter other natural features within the river system. High flow events and flooding have capacity to induce change, both destructively and creatively. They may remove some habitat features in some areas at the same time as creating others. Flooding could potentially negatively impact populations of indigenous plants and animals that occur within the site, and it could impact restoration works. Flooding is therefore a potential risk for the restoration area and restoration works. That risk needs to be weighed against the desire to reinvigorate what are naturally dynamic systems.

[1] Pest plant species that are known to have demonstrable negative impacts.

7.4 Fire

The extensive areas of flammable exotic plant species such as gorse (*Ulex europaeus*) and Scotch broom (*Cytisus scoparius*) present at the site means that the area is a high fire risk. Wildfires within the margins of the Rangitata River could cause the local extirpation of indigenous plants and animals (particularly lizards and non-volant invertebrates) at the site.

7.5 Climate change

NIWA climate change modelling predicts that the eastern South Island will have progressively hotter, dryer summers over the next 35 years due to global climate change (NIWA 2020). This could potentially increase the incidence of fires and reduce the diversity of indigenous plant and animal species at the site due to more severe and prolonged summer droughts. Conversely, the increased frequency of extreme precipitation events, and associated high river flows, may lead to increased seasonal changes to the extent and morphology of the river and its braid plain, which could impact, either negatively or positively, the available habitat for indigenous flora and fauna. Addressing climate change implications for Coldstream 1 is beyond the scope of the restoration plan, although any actions to improve ecological resilience will likely confer improved capacity to accommodate climate change impacts, at least over short-medium time scales.

The following reports provide a starting point for longer-term climate change resilience planning for Coldstream 1:

- Macara G. *et al*. 2020: Climate change projections for the Canterbury Region. *NIWA Client Report No. 2019339WN*. Prepared for Environment Canterbury. 156 pp.

- Awatere S. *et al*. 2021: He huringa ahuarangi, he huringa ao: A changing climate, a changing world. 2021. *Manaaki Whenua Client Report*. Prepared by for Nga Pae o te Maramatanga. 61 pp.

8. MANAGEMENT ACTIONS

Two broad options exist for the ongoing management of the site:

1. Restore a tributary braid of the main stem of the river
2. Maintain site in present topographic state and undertake ecological restoration of indigenous dryland and riparian forest, and instream wetland habitats.

The Steering Group has advised that Option 1 is preferred. However, the management actions for the two options are provided below. Under both scenarios, detailed vegetation and habitat, freshwater fauna, bird and lizard surveys are needed. This is particularly the case for Option 1, as the reclamation of river bed within the site will greatly alter or destroy the habitat for existing indigenous species.

The following sections outline management actions[1] required to achieve the goals and objectives listed in Section 2. They encompass the entire site which is split into management units, and are presented in order of priority. Therefore, if funding is limited and time is constrained, actions can be scaled back or selected habitats prioritised. Management actions targeting indigenous aquatic values, water quality, enhancement of wetland and riparian habitats, weed control, and plantings to establish propagule supplies of indigenous species characteristic of braided river environments are priorities. A workplan summarising the priority management actions, and areas, is presented in Appendix 6.

8.1 Option 1: Restore braid plain habitat within the site

8.1.1 Undertake feasibility assessments for braid plain restoration

An assessment should be undertaken to determine if braid plain restoration is feasible within the footprint of the site. This will require hydrological and geomorphological assessments to determine the potential effects of creating the braid plan. Ideally, the land immediately northeast, east and southwest of the site, including the area of grazing land, should be included within the restoration area. However, this would require negotiations with landowners within the ultimate footprint of the restoration area.

Reestablishing braid plain within and near the site would have several ecological and land management benefits. First, it would remove a significant area of exotic vegetation from the margins of the river. This would reduce the fire risk within this reach of the river and prevent the area acting as a source of flood debris. Second, the creation of braid plain will provide additional habitat for indigenous fauna, such as Threatened and At Risk bird, fish, lizard and insect species. Thirdly, braid plain restoration would reduce the erosion of the true right bank of the river by reestablishing a broader floodplain.

Potential negative effects of restoring the braid plain include the loss of stream and wetland habitat for certain indigenous freshwater fish, and terrestrial and aquatic bird species. The restoration would also likely lead to the short-term sedimentation of the river downstream of the site.

8.1.2 Obtain resource consent for the clearance of vegetation at the site

The restoration of braid plain at and near the site will require modifications to the landscape and waterways within the project footprint, thereby triggering the need for a resource consent. Obtaining these consents should be incorporated into project timelines.

8.1.3 Control pest plants, clear exotic vegetation, and restore braid plain

The removal of exotic vegetation within the site and any nearby areas will require the initial control of the exotic vegetation by helicopter spraying and clearance of the vegetation using heavy earthmoving equipment (e.g. excavators and bulldozers). An assessment would need to be completed regarding the feasibility of either windrowing

[1] Resource consent are required for some proposed actions within this site.

the material on elevated margins of the braid plain, burying it on-site, or transporting the material off site. As an approximate estimate, 200 ha of exotic vegetation would need to be cleared to create a braid plain tributary 300 meters in width.

The degree of earthmoving required to restore the braid plain would be guided by the hydrological and geomorphological assessments. However, it is likely that stream channels will need to be dug, which will require the destruction of the road that passes though the northwestern end of the site, as well as the loss of some or all of the existing streams within the project footprint.

8.1.4 Create habitat for aquatic fauna

The restoration of the braid plain would provide opportunities for the creation of indigenous fish and invertebrate habitat on the margins of the main waterways within the site. This could include the creation of pools, slow-flowing side streams, and wetlands within existing tributary streams, and should specifically target the creation of habitat for mahinga kai species such as kanakana/lamprey (*Geotria australis*; Threatened – Nationally Vulnerable[1]) and kākahi/freshwater mussel (*Echyridella menziesii*[2]; At Risk – Declining). All freshwater fish habitat restoration should be guided by a collaboration between an experienced freshwater ecologist, Department of Conservation and Te Rūnanga o Arowhenua. Once the site is better connected to the active braid plain reworking and modification of habitats is expected to occur as a result of high flow events. In the medium to long term management priorities should shift toward facilitating natural processes of plant and animal colonisation and establishment in reworked habitats following high flow events.

8.1.5 Undertake ongoing pest plant control within the braid plain restoration area

Once restored, the undisturbed margins of the braid plain would require ongoing pest plant control to prevent the reestablishment of exotic vegetation. This could be achieved through periodic (at least every five years) ground or aerial spraying operations. The monitoring programme may help to guide the frequency of control (see Section 10) but will ultimately be determined by site dynamics. Mechanical weed control may also be a viable method for ongoing weed control if implemented regularly.

Undertaking ongoing pest plant control within the site will ensure that the open braid plain continues to provide habitat for indigenous ground-nesting birds (e.g. black-fronted tern, banded dotterel, wrybill, and black-billed gulls), lizards and invertebrates.

8.2 Option 2: Restore dryland and riparian forest within the site

8.2.1 Aerially spray the site in advance of restoration plantings

Following confirmation that there are no Threatened and At Risk plant populations present at the site, the site could be aerially sprayed using a helicopter. A buffer of existing exotic vegetation should initially be left on the margin of the braid plain at the

[1] As per Dunn *et al*. (2018).
[2] As per Grainger *et al*. (2018).

northwestern end of the site to prevent erosion. In time, this buffer vegetation could be replaced with plantings of indigenous species. Dryland indigenous forest restoration areas could be mechanically mulched prior to planting the species listed in Appendix 5 in a staged manner (by management unit) over the initial four-year life of the project. These mulched areas should include a firebreak around each planting area and care must be taken not to cause large influxes of wood debris into the braid plain. Exotic vegetation (primarily crack willow forest) on the margins of streams and wetlands should be mechanically controlled.

8.2.2 Undertake restoration plantings of dryland forest within sections of the site

Restoration plantings of dryland podocarp forest species could be planted in a staged manner throughout the site (Figure 1), leading to naturally regenerating forest and shrubland habitats. Over the longer term, these restoration areas would be expanded to eventually encompass all dryland areas of the site. Restoration areas would require ongoing control of all environmental pest plants, as well as protection from rabbits and hares through the construction of rabbit proof fences, poisoning and night shooting.

8.2.3 Undertake restoration plantings of riparian forest, flaxland and sedgeland on stream margins and in wetlands

Pest plants within riparian margins and in and around wetlands at the site should be controlled and restoration plantings of appropriate indigenous species undertaken. The goal should be to restore indigenous riparian forest, primarily containing kahikatea (*Dacrycarpus dacrydioides*), along stream margins, and areas of indigenous flaxland, sedgeland and reedland within wetlands to provide habitat for indigenous fauna (e.g. raupō reedlands for the Threatened – Nationally Critical Australasian bittern. These restoration plantings will reduce aquatic weed growth and improve indigenous fish habitat.

8.2.4 Undertake targeted environmental pest plant control across the wider site on an ongoing basis

Crack willow (and grey willow (*Salix cinerea*), if present), radiata pine (*Pinus radiata*), poplar and any other invasive trees recorded during the vegetation survey should be controlled on an ongoing basis throughout the wider site.

8.2.5 Undertake pest animal control

Monitoring should be conducted at the site to determine the fauna values and pest animal species that are present, and the likely impacts these pests are having on indigenous plants and animals at the site (see Section 10). Rabbit and hare proof fences could be constructed around the margins of restoration sites, if it is anticipated that these lagomorph species will impact plantings. Possums should be controlled if they heavily browse palatable indigenous plant species as they mature and when fully established.

8.2.6 Establish access tracks through the site

A vehicle track may need to be constructed to provide access to the southeastern half of the site. Walking tracks may also need to be cut through the dense vegetation to provide access to restoration sites.

8.2.7 Develop a fire plan and maintain firebreaks

A fire management plan should be developed to guide management decisions to prevent and contain wildfires at the site. Firebreaks, at least six metres wide, should be cut around the perimeter of each restoration area.

8.2.8 Develop site- and species-specific restoration plans

The results of the fauna and vegetation surveys should be used to inform native freshwater biodiversity and site-specific restoration plans. The species-specific plans should target Threatened, At Risk and mahinga kai species (e.g. kanakana/lamprey; Threatened – Nationally Vulnerable, and kākahi/freshwater mussel; At Risk – Declining) and should be guided by Department of Conservation translocation protocols and the tikanga of Te Rūnanga o Arowhenua. Te Rūnanga o Arowhenua have identified nine mahinga kai species that could be restored at the site (provided in Appendix 3).

8.2.9 Identify management units

To facilitate the timely implementation of management actions we have broken the wider site into four management units (Figure 1). These management units could potentially be further subdivided in the future in line with available resources. Section 9 summarises the potential actions for the two management options. Section 12 provides a suggested four-year workplan to achieve the actions within the two management options.

9. SPECIFIC MANAGEMENT ACTIONS REQUIRED WITHIN THE MANAGEMENT UNITS

Table 1 outlines the specific management actions that are required for the implementation of either Option 1 or Option 2 at the site.

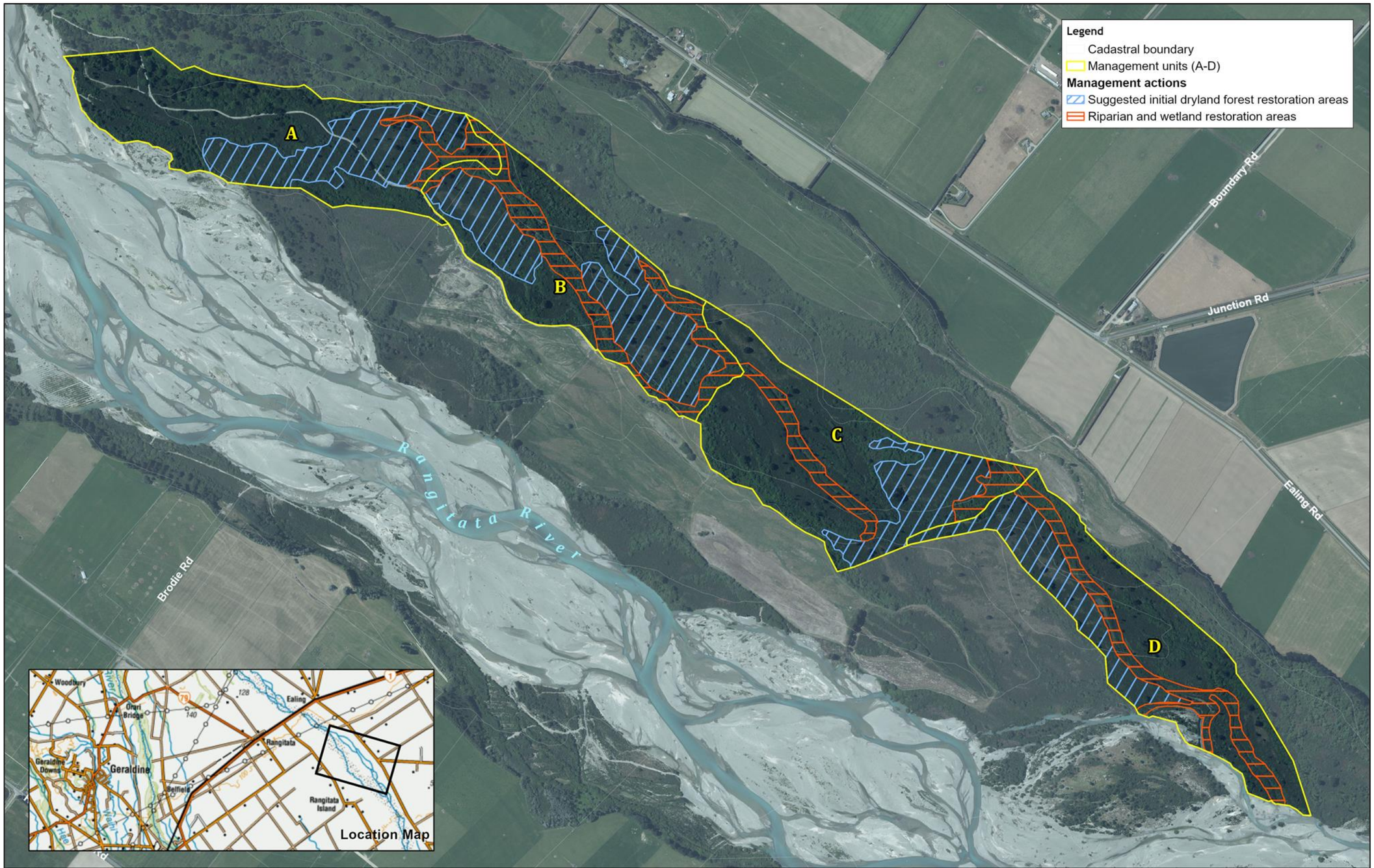

Figure 1. Management units and select management actions at Coldstream 1, Rangitata River, South Canterbury

Table 1: Management actions required for the implementation of either Option 1 or Option 2 at the Coldstream 1 site.

Option	Size (ha)	Current Vegetation and Habitat Type	Intended Vegetation and Habitat Type	Suggested Management Actions
One (all management units)	121.0	• Radiata pine treeland • Radiata pine-poplar/willow forest • Poplar/willow forest • Willow/blackberry-gorse-Scotch broom shrubland treeland and shrubland • Gorse-Scotch broom shrubland • Blackberry-gorse-Scotch broom shrubland • Gravelfield • Wetland or pond • River/streams	River and braid plain	• Undertake detailed vegetation, bird and aquatic fauna surveys • Complete hydrological and geomorphological assessments • Obtain resource consent for the removal of exotic vegetation and earthworks at the site • Aerially spray entire site • Remove exotic vegetation from the site and dispose of material • Undertake earthworks to form river channels and aquatic fauna habitat • Control pest plants within the braid plan on an ongoing basis • Continue to graze unmanaged areas of the unit
Two (all management units)	A – 32.3 B – 30.1 C – 31.1 D – 27.5	• Radiata pine treeland • Radiata pine-poplar/willow forest • Poplar/willow forest • Willow/blackberry-gorse-Scotch broom shrubland treeland and shrubland • Gorse-Scotch broom shrubland • Blackberry-gorse-Scotch broom shrubland • Gravelfield • Wetland or pond • River/streams	Indigenous dryland and riparian forest, flaxland, reedland and sedgeland	• Undertake detailed vegetation, bird and aquatic fauna surveys • Establish vehicle and walking tracks through the site to facilitate management actions • Control pest plants within dryland areas and along the margins of riparian and wetland areas within each management unit • Mulch dryland planting areas prior to planting with indigenous forest and scrub species that are capable of surviving seasonal drought (see Appendix 5) • Plant riparian margins with indigenous riparian forest, harakeke, and indigenous sedges and rushes (see Appendix 5) • Undertake pest plant control around restoration plantings until canopy closure occurs. This activity may need to continue for longer than four years unless all planting is carried out in the first year of the project. • Maintain firebreaks around restoration areas

Option	Size (ha)	Current Vegetation and Habitat Type	Intended Vegetation and Habitat Type	Suggested Management Actions
				• Control crack willow, grey willow (if present), wilding conifers and poplar across the wider site on an ongoing basis • Incorporate mahinga kai species within plantings, where possible • Undertake introductions of freshwater mahinga kai species (e.g. freshwater crayfish; *Paranephrops zealandicus*) if there is sufficient habitat • Monitor for and undertake pest animal control, if needed (see Section 10) • Develop a fire management plan for the site
Total at site	**121.0**			

10. MONITORING

Monitoring should be regularly undertaken at the site to inform and improve the implementation of management actions and measure restoration success. The monitoring should be carried out throughout the four-year project and continued on an ongoing basis thereafter. Monitoring should be more frequent immediately after implementation to track changes in response to restoration to the point where the site stabilises to a restored state, after which monitoring frequency could be reduced.

Photopoints

Photographs taken at specific points and at set timeframes, are an efficient way to monitor gross changes in vegetation composition and structure within a defined viewpoint. It is recommended that at least ten photopoints are established at the site. The location of each photopoint should be recorded with a handheld global positioning system (GPS). A compass should be used to gauge a bearing to the center of the frame of the photopoint. The photos should then be printed to provide a reference for future revisits. The photopoints should be resampled every year in sites where frequent management actions are occurring (e.g. ongoing pest plant control).

Pest Plants and Restoration Plantings

If Option 2 is selected, monitoring operations should be undertaken at least every three months during the growing season to track the proportions of pest plants killed via control work and the survival rates of restoration plantings. Walk through transects should be established through the larger restoration areas. The results of this monitoring should be used to improve management decisions regarding factors such as herbicide choice and the density and species selection of future restoration plantings.

Natural and Reintroduced Populations of Threatened Species

All populations of naturally occurring and reintroduced threatened species should be regularly monitored to build a better understanding of their habitat requirements, determine the limitations to restoration success, and identify future management actions. The monitoring regime will vary by species and should be undertaken by biologists who have experience working with the target species.

Pest Animals

If Option 2 is selected, small mammal predators (rats, mustelids, cats, hedgehogs and possums) should be monitored, to guide their control, if surveys indicate that there are populations of vulnerable indigenous fauna species at the site. Rabbits, hares and possums should be monitored prior to and after restoration plantings are established. All pest monitoring should follow the best practice guidelines provided on the Bionet website (https://www.bionet.nz/library/).

11. CONSTRAINTS

The successful ecological restoration of the Coldstream 1 site is potentially constrained by a number of factors. These constraints, and their potential solutions, are outlined in Table 2.

Table 2: Potential constraints and solutions for the implementation of the two management options at the Coldstream 1 site.

Potential Constraint	Relevant Option	Potential Solutions
Proposed braid plain restoration considered unfeasible due to surrounding land uses (i.e. potential flooding of grazing land, loss of access)	Option 1	• Undertake negotiations with land owners to acquire land for ecological restoration purposes (if required) or mitigate impacts on private land or existing grazing lease. • Incorporate stop banks within braid plain design • Control exotic vegetation by periodic aerial spraying operations or implement Option 2
Lack of ongoing funding beyond the four-year timeframe	Both Option 1 and Two	• Begin applying for further funding within the first two years of the project • Hire a dedicated project manager to successfully implement the project • Widely publicise the work of the project to build a profile and community support
Ongoing environmental pest plant invasion	Both Option 1 and Two	• Undertake ongoing pest plant control • Ensure maintenance teams are experienced and follow best practice protocols • Where feasible, undertake restoration in the wider area to reduce pest plant propagule pressure • Undertake ongoing pest plant monitoring to improve the efficiency and effectiveness of control efforts (see Section 9 below)
Failure of restoration plantings	Option 2	• Only contract reputable native plant nurseries who have a track record of growing high quality plants • Ensure planting teams are experienced and follow best practice protocols • Undertake regular maintenance of plantings in the first year after planting • Undertake regular monitoring to inform ongoing restoration actions (see Section 9 below)
Failure of species reintroductions	Both Option 1 and Two	• Seek the advice of technical experts to ensure reintroductions follow best practice guidelines • Undertake regular monitoring to inform future reintroduction efforts • Undertake regular monitoring following species reintroductions to determine ongoing management actions (see Section 9 below)
Changes in course of river	Option 2	• Maintain a buffer of existing vegetation along the margins of the braid plain. • Where possible, ensure the upstream areas of the river are maintained free of large woody debris. • Adopt an adaptive management approach to landscape changes.
Flood loss of the restoration sites	Option 2	• Recognise and promote dynamism. • Limit investment in planting and other restoration actions in flood prone areas.
Fire	Option 2	• Maintain firebreaks around restoration areas • Develop a fire management plan for the site • Where possible, control flammable exotic plant species (principally gorse and Scotch broom) throughout the site

Potential Constraint	Relevant Option	Potential Solutions
Competing resource values (e.g. recreational fishing vs. species and habitat restoration)	Option 1	• Consult with recreational users (e.g. anglers, jet boaters) to inform them about the goals of the project • Install informational signage at the restoration site • Prohibit resource collection at the site through take restrictions (implemented by Environment Canterbury or the Department of Conservation) or a rāhui (implemented by Te Rūnanga o Arowhenua) until populations of key species have established
Climate change	Both Option 1 and Two	• Plan future land development proactively to ensure sustainable water extraction rates • Implement the management actions outlined in this report • Adopt an adaptive management approach to adjust to environmental changes

12. TIMELINE AND INDICATIVE COSTS FOR THE IMPLEMENTATION OF MANAGEMENT ACTIONS

The following workplans outline the timeline and indicative costs for the two management options. The timeline for the implementation of Option 1 includes feasibility assessments, resource consent applications and the implementation of site works (Table 3). The timeline for Option 1 assumes that braid plain restoration is feasible and that resource consent would be obtained within an 18 month period. The ecological management actions for Option 2 are staggered by management unit over the four-year life of the project (Table 4). Costs for pest animal control for Option 2 should be determined through monitoring and therefore have not been included. The 12 month period for the implementation of management actions within the four years begins in November 2021.

Table 3: Timeline and indicative costs for the implementation of ecological restoration actions for Option 1 at the Coldstream 1 site.

Management Action	Timing	Price Estimate
Year 1		
Undertake feasibility assessments for braid plain restoration (e.g. hydrological and geomorphological assessments)	Throughout the year	Exact costs to be determined. However, is likely be $100,000 or more
Initiate landowner consultation and negotiations regarding land purchase or transfer	Once feasibility assessment is complete	Exact costs to be determined
Initiate process for obtaining resource consent	Once feasibility assessment is complete	Exact costs to be determined
Year 2		
Continue and complete landowner consultation and negotiations regarding land purchase or transfer	Once feasibility assessment is complete	Exact costs to be determined
Continue and complete process for obtaining resource consent	Once feasibility assessment is complete	Exact costs to be determined
Establish photopoints	November 2022-May 2023	$1,500
Detailed vegetation and habitat survey	November 2022-February 2023	$10,000
Bird survey	November 2022-February 2023	$6,000
Freshwater fauna survey	November 2022-February 2023	$7,000

Management Action	Timing	Price Estimate
Lizard survey	November 2022-February 2023	$7,000
Invertebrate survey	November 2022-February 2023	$7,000
Aerially spray exotic vegetation over entire site	March-April 2023	$50,000
Year 3		
Remeasure photopoints	November 2023-May 2024	$1,000
Clear exotic vegetation and create river and stream channels (including freshwater fauna restoration sites)	November 2023-May 2024	Exact costs to be determined. However, is likely be greater than $300,000
Begin planning for species translocations to site	Throughout the year	$15,000
Year 4		
Remeasure photopoints	November 2024-May 2025	$1,000
Pest plant control within braid plain	November 2024-April 2025	$15,000
Undertake species translocations and follow-up monitoring	Throughout the year (depending on species)	$10,000
		Overall costs to be determined

Table 4: Timeline and indicative costs for the implementation of ecological restoration actions for Option 2 at the Coldstream 1 site.

Management Unit	Management Action	Timing	Price Estimate
Year 1			
All Management units	Vegetation and habitat survey	November 2021-May 2022	$6,000
	Freshwater fauna survey	November 2021-April 2022	$9,000
	Establish photopoints where ecological restoration will occur	November 2021-May 2022	$1,500
	Order eco-sourced plants and planting materials for dryland forest and riparian forest areas (plant guards etc.)	November 2021	$406,000
	Aerially spray exotic pest plants over entire site	February 2022	$50,000
A	Mechanically mulch planting sites containing dense areas of exotic shrubland (section of unit only)	April 2022	$15,000
	Prepare planting sites	April 2022	$15,000
	Planting	May and June 2022	$153,000
	Order infill plants	October 2022	$40,600
Year 2			
A and B	Remeasure photopoints	November 2022-May 2023	$1000
A	Pest plant control within restoration sites (including within firebreaks)	Two times: November 2022, March 2023	$90,000
B	Order eco-sourced plants and planting materials for dryland forest and riparian forest areas (plant guards etc.)	November 2022	$406,000
	Mechanically mulch planting sites containing dense areas of exotic shrubland (section of unit only)	March 2023	$15,000
	Undertake site preparation in advance of planting dryland forest and riparian forest areas	April 2023	$15,000

Management Unit	Management Action	Timing	Price Estimate
	Plant a section of the management unit in dryland forest and riparian forest areas	May and June 2023	$153,000
	Order infill plants	October 2023	$40,600
Year 3			
A, B, C	Remeasure photopoints	November 2023-May 2024	$1000
A and B	Pest plant control within restoration sites (including within firebreaks)	Two times: November 2023, March 2024	$90,000
B	Infill planting	May and June 2024	$17,600
C	Order eco-sourced plants and planting materials for dryland forest and riparian forest areas (plant guards etc.)	November 2023	$406,000
	Mechanically mulch planting sites containing dense areas of exotic shrubland (section of unit only)	March 2024	$15,000
	Undertake site preparation in advance of planting dryland forest and riparian forest areas	April 2024	$15,000
	Plant a section of the management unit in dryland forest and riparian forest areas	May and June 2024	$153,00
	Order infill plants	October 2024	$40,600
Year 4			
All management units	Remeasure photopoints	November 2024-May 2025	$1000
A, B, C	Pest plant control within restoration sites (including within firebreaks)	Two times: November 2024, March 2025	$90,000
C	Infill planting	May and June 2025	$17,600
D	Order eco-sourced plants and planting materials for dryland forest and riparian forest areas (plant guards etc.)	November 2024	$406,000
	Mechanically mulch planting sites containing dense areas of exotic shrubland (section of unit only)	March 2025	$15,000
	Undertake site preparation in advance of planting dryland forest and riparian forest areas	April 2025	$15,000
	Plant a section of the management unit in dryland forest and riparian forest areas	May and June 2025	$153,000
Total			**$2,699.500**

13. CONCLUSIONS

In order to meet the Rangitata Steering Groups overarching goals of habitat enhancement, species recovery and identification of opportunities for restoring mahinga kai resources at the Coldstream 1 site, ecological values, threats and management actions have been identified. The site is covered in exotic vegetation and the primary threats to the system are from pest plants, pest animals and fire. Two options were identified for the ecological restoration of the site: 1) braid plain restoration, or 2) indigenous dryland and riparian forest, and wetland restoration. Undertaking Option 1 will require detailed feasibility assessments and a resource consent, as well as

landscape-level earthworks. Depending on the option that is implemented, management actions include conducting pest plant control, creating habitat for freshwater fauna, undertaking restoration plantings of ecologically appropriate indigenous plant species, conducting pest animal control, and instigating fire management protocols. Implementing either management option will greatly enhance the ecological integrity and mauri of the Coldstream 1 site, and ensure that the site provides mahinga kai for Te Rūnanga o Arowhenua for future generations.

ACKNOWLEDGMENTS

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VEGETATION AND HABITAT TYPES RECORDED AT COLDSTREAM 1, RANGITATA RIVER

The vegetation and habitat types recorded at Coldstream 1 during the July 2021 site visit and by analysis of aerial imagery are listed below. The distribution of these vegetation and habitat types at the site is illustrated in Figure 2.

1. **Radiata pine treeland**

   Two small areas of what appears to be radiata pine treeland are located within the site. The radiata pine trees within the areas are mature.

2. **Radiata pine-poplar/willow forest**

   Two areas of forest that appear to contain radiata pine, poplar and crack willow are located at the northern-most end of the site. Small patches of shrubland that likely contain blackberry (*Rubus fruticosus*), gorse and Scotch broom appear to be present within areas of the forest.

3. **Poplar/willow forest**

   Areas of forest that contain emergent poplar over crack willow area scattered throughout the site.

4. **Willow/blackberry-gorse-broom treeland and shrubland**

   Patches of willow treeland occur in the southeastern half of the site. These areas of treeland appear to contain dense blackberry, gorse and broom.

5. **Gorse-broom shrubland**

   Large areas of shrubland that contains either both gorse and Scotch broom or mainly Scotch broom are scattered throughout the site.

6. **Blackberry-gorse-Scotch broom shrubland**

   Shrublands that appear to contain blackberry, gorse and Scotch broom occur in the southeastern half of the site.

7. **Gravelfield**

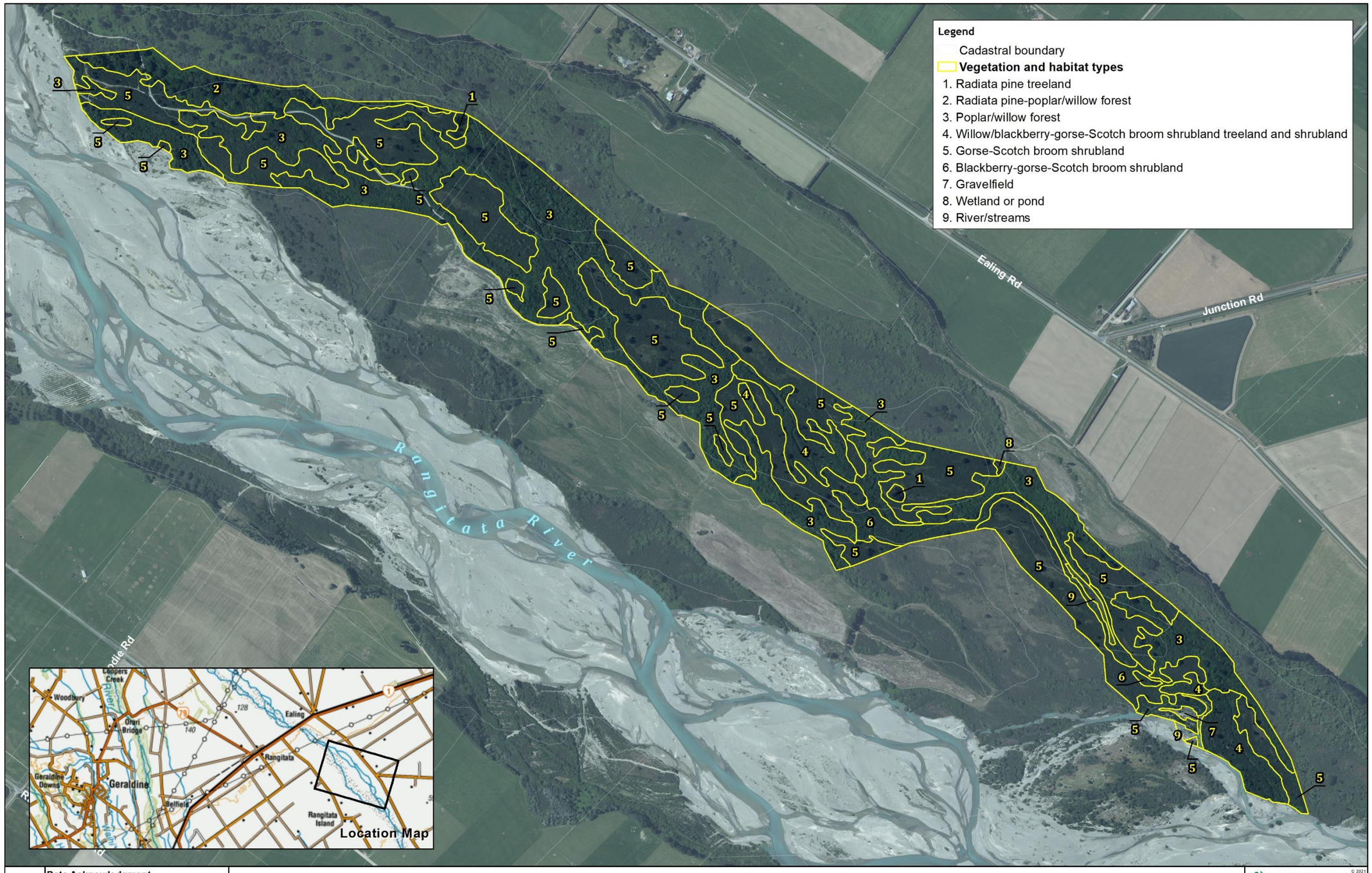
   Small areas of semi-active gravelfield occur around active river channels at the eastern end of the site. The areas of gravelfield appear to contain plants of young Scotch broom.

8. Wetland or pond

A wetland or pond is located on the northeastern boundary of the site in the eastern-most third of the site. The wetland/pond appears to be surrounded by poplar/willow forest, and gorse-broom shrubland.

9. River/streams

Sections of river and streambed are present at the eastern end of the site.



Data Acknowledgment
Map contains data sourced from LINZ
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2021 Imagery source: https://gisimagery.ecan.govt.nz

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Figure 2. Vegetation and habitats at Coldstream 1, Rangitata River, South Canterbury

0 200 400 m

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Scale: 1:10,000
Date: 29/09/2021
Cartographer: FM
Format: A3R

AVIFAUNA SPECIES RECORDED ON EBIRD WHICH OCCUR WITHIN A 10 KILOMETRE RADIUS OF COLDSTREAM 1, RANGITATA RIVER

Scientific Name	Common Name	Threat Classification[1]
Indigenous		
Anas gracilis	grey teal	Not Threatened
Anas superciliosa × *platyrhynchos*	grey duck x mallard hybrid	Not Threatened
Chlidonias albostriatus	black-fronted tern	Threatened – Nationally Endangered
Circus approximans	swamp harrier	Not Threatened
Cygnus atratus	black swan	Not Threatened
Egretta novaehollandiae	white-faced heron	Not Threatened
Haematopus finschi	South Island pied oystercatcher	At Risk – Declining
Haematopus unicolor	variable oystercatcher	At Risk – Recovering
Himantopus himantopus leucocephalus	pied stilt	Not Threatened
Hirundo neoxena neoxena	welcome swallow	Not Threatened
Hydroprogne caspia	Caspian tern	Threatened – Nationally Vulnerable
Larus dominicanus dominicanus	southern black-backed gull	Not Threatened
Phalacrocorax melanoleucos melanoleucos	little pied shag	Non-resident Native – Vagrant
Porphyrio melanotus	Pūkeko	Not Threatened
Rhipidura fuliginosa fuliginosa	South Island fantail	Not Threatened
Tadorna variegata	paradise shelduck	Not Threatened
Todiramphus sanctus vagans	New Zealand kingfisher	Not Threatened
Vanellus miles novaehollandiae	spur-winged plover	Not Threatened
Zosterops lateralis lateralis	silvereye	Not Threatened
Exotic		
Alauda arvensis	Skylark	Introduced and naturalised
Anas platyrhynchos	mallard	Introduced and Naturalised
Branta canadensis	Canada goose	Introduced and naturalised
Carduelis carduelis	goldfinch	Introduced and naturalised
Carduelis chloris	greenfinch	Introduced and naturalised
Cereopsis novaehollandiae	Cape Barren goose	Introduced and naturalised
Columba livia	rock pigeon	Introduced and naturalised
Corvus frugilegus	Rook	Introduced and naturalised
Cygnus olor	mute swan	Introduced and naturalised
Emberiza citronella	yellowhammer	Introduced and naturalised
Fringilla coelebs	chaffinch	Introduced and naturalised
Gymnorhina tibicen	Australian magpie	Introduced and naturalised
Passer domesticus	house sparrow	Introduced and naturalised
Prunella modularis	dunnock	Introduced and naturalised
Sturnus vulgaris	Starling	Introduced and naturalised
Turdus merula	blackbird	Introduced and naturalised

[1] Robertson *et al*. 2021.

POTENTIAL MAHINGA KAI RESOURCES THAT COULD BE ESTABLISHED AT COLDSTREAM 1, RANGITATA RIVER

Species	Common Name	Threat Status	Mahinga Kai Resource
Plant			
Cordyline australis	tī kōuka, cabbage tree	Not Threatened	Numerous medicinal, food, fibre uses[1].
Coriaria spp.	Tutu	Not Threatened	Used in medicine, beverages, dyes and crafts. Almost all parts of plant are toxic[1].
Nasturtium officinale	kōwhitiwhiti, watercress	Introduced and Naturalised	Edible leaves, used medicinally for headaches[1].
Phormium tenax	harakeke, flax	Not Threatened	Numerous medicinal, food, fibre, dyes, and construction uses[1].
Typha orientalis	raupō, bullrush	Not Threatened	Numerous medicinal, food, hunting, and construction uses[1].
Birds			
Anas superciliosa	pārera/grey duck	Threatened – Nationally Vulnerable	Food and feathers (historically), [2]
Botaurus poiciloptilus	Matuku, matuku-hūrepo	Threatened – Nationally Critical	Food and feathers (historically). Included within oral histories[3]
Freshwater fish			
Geotria australis	kanakana, piharau, lamprey	Threatened – Nationally Vulnerable	Food[4]
Freshwater invertebrate			
Echyridella menziesii	kākahi, freshwater mussel	At Risk – Declining	Mussel flesh used as food and medicine. Shells used as tools[5].

1. Further information at (requires a search of individual plant species): https://maoriplantuse.landcareresearch.co.nz/WebForms/default.aspx
2. Source: Phillips (1947).
3. https://www.doc.govt.nz/nature/native-animals/birds/birds-a-z/australasian-bittern-matuku/
4. https://niwa.co.nz/our-science/freshwater/tools/kaitiaki_tools/species/piharau
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APPENDIX 4

ENVIRONMENTAL PEST PLANTS OBSERVED AT AND NEAR COLDSTREAM 1, RANGITATA RIVER

Scientific Name	Common Name(s)	Status in the RPMP
Buddleja davidii	Buddleia	Not listed
Clematis vitalba	Old man's beard	Sustained Control
Cytisus scoparius	Scotch broom	Sustained Control
Dryopteris filix-mas	Male fern	Not listed
Leycesteria formosa	Himalayan honeysuckle	Not listed
Pinus radiata	Radiata pine	Not listed
Populus sp.	Poplar	Not listed
Rubus fruticosus	Blackberry	Organism of Interest
Salix xfragilis	Crack willow	Not listed
Ulex europaeus	Gorse	Sustained Control

GUIDELINES FOR PLANTING AND MAINTAINING INDIGENOUS PLANT SPECIES AT COLDSTREAM 1, RANGITATA RIVER

OVERVIEW

The following section provides an overview of the management actions required for the successful planting and establishment of indigenous species at Coldstream 1.

SPECIES SOURCES AND SELECTION

- All indigenous plant species should occur naturally in similar sites within the Low Plains Ecological District.
- All plants should be sourced from the Low Plains Ecological District genetic stock or from nearby ecological districts and should generally have been grown from seed to maximise potential genetic diversity.
- A range of indigenous species with different attributes were identified for the plantings (listed in Tables 5 and 6). These include:
    - Trees that will form a mature canopy.
    - Fast growing early successional species.
    - Shrubs that will provide diversity in the understorey.
    - Raupō, harakake and a range of sedges and rushes for planting on riparian margins and in wetlands.
    - Mahinga kai species.
    - Nationally Threatened/At Risk (as per de Lange *et al.* 2018) and locally uncommon species, to enhance conservation values. Nationally threatened species include hook grass (*Carex strictissima*) and New Zealand verbena (*Teucridium parvifolium*) have been included. The historical distribution of these species is not known with certainty, but it is very likely they were more widely distributed in the ecological district prior to European colonisation.
    - Vigorous indigenous species that will quickly colonise the planting areas (e.g. toatoa, *Haloragis erecta*; karamū; and koromiko, *Veronica salicifolia*).
    - Fleshy-fruited species, to provide food for indigenous fauna and to facilitate their dispersal by birds.

PLANT GRADES

- Planter bag (PB) plant grades (ideally 2/3) should preferably be used for most of the plantings as their stature and robustness reduces their vulnerability to light or incidental browsing by herbivorous animal pests (e.g. rabbits, possums), and they are more resilient to frosts and other environmental extremes.
- PB grade plants should also be used for enrichment plantings.
- Where pre-planting site preparation and post-planting monitoring and maintenance are carried out to a high standard, plants in root trainers (RTs) can be used instead of larger (more costly) plants in individual PBs.

PLANT SPACINGS

- Plant trees at 1.5-2 metre spacings (depending on species).
- Plant shrubs at one to two metre spacings (depending on species).
- Sedges, rushes and grasses should generally be planted at 0.5 metre spacings with the exception of species such as pūrei, swamp sedge and toetoe (*Austroderia richardii*) which should be planted at 1 metre spacings.
- Plants should be set back from stock fences by 1.5 metres to prevent livestock browse.

SITE PREPARATION PRIOR TO PLANTING

- Planting areas should be prepared in mid to late autumn, ideally four to six weeks prior to planting. Individual planting sites should have vegetation cover reduced by spraying 0.4 metre round areas with 10% glyphosate in water.
- Herbicide should be applied by a qualified applicator (Growsafe and Approved Handler certified).
- It is important that existing naturally-occurring indigenous vegetation (especially containing Nationally Threatened/At Risk or locally uncommon species) is not adversely affected by the planting programme. Plantings should be integrated with and enhance existing indigenous vegetation as much as possible, therefore no indigenous vegetation should be removed to facilitate planting.

TIMING OF PLANTING

- In dryland areas, timing of planting will be dictated by the rainfall patterns in the intended planting season but, in general, should be planted from late autumn, once soil moisture levels reach field capacity, through to mid-winter.
- In wetland areas, planting should be undertaken in early-mid spring (September or October, depending on winter rainfall) once standing water in flooded areas has begun to recede. Site visits should be conducted at the wetland restoration areas to determine the timing of planting during the spring when it is planned.

PLANT GUARDS

- In dryland areas, newly-planted trees and shrubs can be decimated by rabbit and hare browse, so protection against browse is critical.
- Individual plant guards should be used to protect each plant if browsing is an issue. They also provide shelter, increased humidity, reduction of moisture loss, and help to prevent unintended herbicide damage.
- Guards should be removed and reused once the foliage of the plants grows out of the top of the guard.

MAINTENANCE OF PLANTS

- In the first 12 months following planting operations, assess plant condition and weed competition every three months.
- For the first two years following planting, plants should be released from environmental weeds a minimum of three times a year by hand weeding or spraying with selective herbicides.
- For up to five years following the planting, further releases from environmental weeds may be required once or twice a year during the growing season by hand weeding or spraying with selective herbicides. When plants are emergent above the surrounding vegetation (typically a grass sward), little further management is required. However, ongoing control of pest plants will be required, particularly before canopy closure is achieved.
- Infill planting to replace plants that have died may be required and should be undertaken during the second or third year after the original planting.

Table 5: Indigenous plant species to be planted in dryland areas of the Coldstream 1 site, Rangitata River.

Scientific Name	Common Name	Conservation Status[1]	Spacing (m)	Percentage (%)	Quantity per Hectare
Anemanthele lessoniana	Wind grass	At Risk – Relict	1	1	100
Coprosma crassifolia	Thick-leaved coprosma, mikimiki	Not Threatened	1	2	200
Coprosma propinqua	Mingimingi, mikimiki	Not Threatened	1	5	500
Coprosma robusta	Karamū	Not Threatened	1	1	100
Cordyline australis[2]	Cabbage tree, tī kōuka	Not Threatened	1.5	1	44
Elaeocarpus dentatus	Hinau	Not Threatened	1.5	2	89
Griselinia littoralis	Broadleaf, kāpuka	Not Threatened	1.5	3	133
Hoheria angustifolia	Narrow-leaved lacebark, houhere	Not Threatened	1.5	4	178
Kunzea robusta	Kānuka, rawirinui, kopuka	Threatened – Nationally Vulnerable	1.5	15	667
Leptospermum scoparium	Mānuka, tea tree	Not Threatened	1.5	15	667
Olearia paniculata	Akiraho	Not Threatened	1.5	5	222
Pittosporum eugenioides	Tarātā	Not Threatened	1.5	1	44
Pittosporum tenuifolium	Kōhūhū, black matipo	Not Threatened	1.5	2	89
Plagianthus regius	Lowland ribbonwood, mānatu	Not Threatened	1.5	2	89
Podocarpus totara	Lowland tōtara	Not Threatened	1.5	15	667
Prumnopitys taxifolia	Matai, black pine	Not Threatened	1.5	15	667
Pseudopanax crassifolius	Lancewood, horoeka	Not Threatened	1.5	5	222
Sophora microphylla	Small-leaved kōwhai	Not Threatened	1.5	3	133
Teucridium parvifolium	NZ verbena, teucridium	At Risk – Declining	1	1	100
Veronica salicifolia	Koromiko	Not Threatened	1	2	200
				100	**5,112**

2 Mahinga kai species.

[1] As per de Lange *et al*. (2018).

Table 6: Indigenous plant species to be planted on riparian and wetland margins within the Coldstream 1 site, Rangitata River.

Scientific Name	Common Name	Conservation Status[1]	Spacing (m)	Percentage (%)	Quantity per Hectare
Drier Riparian Areas					
Aristotelia serrata	Wineberry, makomako	Not Threatened	1.5	2	89
Coprosma propinqua	Mingimingi, mikimiki	Not Threatened	1.5	2	89
Coprosma virescens	Mikimiki	Not Threatened	1.5	2	89
Cordyline australis[2]	Cabbage tree, tī kōuka	Not Threatened	1.5	5	222
Coriaria sarmentosa[2]	Tutu	Not Threatened	1	2	200
Dacrycarpus dacrydioides	Kahikatea, white pine	Not Threatened	2	15	375
Eleocharis acuta	Sharp spike sedge	Not Threatened	0.5	1	400
Griselinia littoralis	Broadleaf, kāpuka	Not Threatened	2	2	50
Haloragis erecta	Toatoa	Not Threatened	2	2	50
Leptospermum scoparium	Mānuka, tea tree	Threatened –Nationally Vulnerable	1.5	10	445
Sophora microphylla	Small-leaved kōwhai	Not Threatened	2	5	125
Teucridium parvifolium	NZ verbena, teucridium	Not Threatened	1.5	1	45
Veronica salicifolia	Koromiko	Not Threatened	2	2	50
Wetland Riparian Areas					
Austroderia richardii	Toetoe	Not Threatened	1	2	200
Blechnum minus	Swamp kiokio	Not Threatened	0.5	1	400
Carex buchananii	Cutty grass, matirewa	At Risk – Declining	0.5	2	800
Carex coriacea	Cutty grass, rautahi	Not Threatened	0.5	2	800
Carex geminata	Cutty grass, rautahi	Not Threatened	0.5	2	800
Carex maorica	Cutty grass, rautahi	Not Threatened	0.5	2	800
Carex secta	Pūrei, pūkio	Not Threatened	1	10	1,000
Carex strictissima	Hook grass	Threatened –Nationally Endangered	0.5	2	800
Carex virgata	Swamp sedge	Not Threatened	0.5	2	800
Coriaria sarmentosa[2]	Tutu	Not Threatened	1	2	200
Eleocharis acuta	Sharp spike sedge	Not Threatened	0.5	1	400
Juncus edgariae	Leafless rush, wī	Not Threatened	0.5	2	800
Juncus pallidus	Giant rush, leafless rush, wī	Not Threatened	0.5	2	800
Juncus sarophorus	Leafless rush, wī	Not Threatened	0.5	2	800
Phormium tenax[2]	Lowland flax, harakeke	Not Threatened	1	10	1,000
Typha orientalis[2]	Raupō, bull rush	Not Threatened	0.5	5	2,000
Total				**100**	**12,400**

1 Mahinga kai species.

APPENDIX 6

SUMMARY OF MANAGEMENT ACTIONS AND PRIORITIES FOR COLDSTREAM 1 RESTORATION WORK PLAN

Key Objectives and Actions for Management Zones identified in Figure 3

The following workplan provides actions for Option 1: Restore a tributary braid of the main stem of the Rangitata River.

1. River braid restoration area: recognise and promote dynamism, manage to restore active river braid and associated habitats, further survey is required to identify suitable areas for braid plain restoration and opportunities for co-protection of existing ecological values.

2. Existing streams: survey for freshwater fauna and significant habitats (wetlands, springs), identify areas for protection or for conversion to active river braid.

3. Freehold land: outside restoration area, communication with landowner required.

4. Grazing concession: management actions unlikely to impact leased areas, communication with leaseholder required.

5. Whole area: predator control, control grey willow and other pest plants identified as conservation priorities, monitor, survey for additional threats and unknown habitats and values, work with Te Rūnanga o Arowhenua to identify and implement other actions to enhance the ecological integrity, mauri and provision of mahinga kai, implement other actions as identified in the Main Stem restoration plans.

Activity/Task	Area/Zone (Refer Figure 3)	Activity Required	Timing	Objective/Reason
Note: Knowledge gaps including the condition of current site and existing values need to be addressed before a detailed braid plain restoration plan can be developed. Opportunities for complementary restoration works (i.e. planting areas, freshwater habitat requiring protection) may be present and should be incorporated into the restoration plan.				
Feasibility assessments for braid plain restoration	Braid plain restoration area / Zone 1	Hydrological and geomorphological assessments of proposed braid plain restoration area.	ASAP	Identify and prioritise restoration areas Required to determine likelihood of success and location and scale of works required, and potential impacts on ecological values and adjacent farm land.
Freshwater fauna and habitat survey	Streams & wetlands	Detailed survey of freshwater fauna and habitats	ASAP	Fill knowledge gap regarding freshwater faunal values of site. Critical for assessment of effects of proposed braid plain restoration. Opportunities to protect or restore key habitats complementary with braid plain restoration should be considered.
Terrestrial flora, fauna and habitat survey	Braid plain restoration area / Zone 1	Detailed survey of terrestrial flora, fauna and habitat survey – including lizards, invertebrate and avifauna.	ASAP	Fill knowledge gap regarding terrestrial values of site. Critical for assessment of effects of proposed braid plain restoration. Opportunities to protect or restore key habitats complementary with braid plain restoration should be considered.
Determine planting areas	All areas	Define planting areas, plant numbers, and appropriate species list.	After habitat and feasibility surveys	Planting areas may not be compatible with dynamic braid plain restoration. If implemented, focus on stable higher ground (i.e. terrace scarps) or areas of high ecological value (i.e. wetlands) outside the foot print of the braid plain
Refine restoration plan after survey	All areas	Define restoration areas, priorities, planting areas (if any) and required workstream.	After habitat and feasibility surveys	Detailed restoration plan is required once knowledge gaps are filled.
Development ecological management plans	Priority areas or species identified during surveys	Develop Lizard Management Plans and Freshwater Fish Management Plans.	After refining restoration plan	Management plans to mitigate the impacts of restoration actions will be required for resource consent or priori to habitat disturbance (i.e. lizards).
Order eco-sourced plants and planting materials	Planting areas (tbd)	Order eco-sourced plants and planting materials (plant guards etc.) Refer to Appendix 5 table 5 & 6 for suitable planting species.	ASAP after refining restoration plan	Eco-sourcing is important for the local ecological integrity. Eco-sourcing plants can be a long process. Plants need to be ordered as soon as possible. Not all species will need to be guarded.

Activity/Task	Area/Zone (Refer Figure 3)	Activity Required	Timing	Objective/Reason
Landowner consultation and negotiations	Braid plain restoration area / Zone 1	Initiate landowner consultation and negotiations regarding land purchase or transfer	Once feasibility assessment is complete	Landowner consultation and lease negotiation required to offset adverse impacts of restoration works. Communication to be ongoing.
Resource consent	Braid plain restoration area / Zone 1	Initiate process for obtaining resource consent	Once feasibility assessment is complete	Resource consent may be required for some actions.
Note: The following workplan assumes braid plain restoration occurs by herbicide control of woody weeds followed by manual clearance. Alternative methods may be more appropriate and the workplan revised accordingly.				
Establish photopoints	All areas	Establish photopoints where ecological restoration will occur	Prior to restoration	Good monitoring tool to observe progress and help with future restoration projects. Undertake regular monitoring as outlined in Section 10.
Implement Ecological Management plans	Braid plain restoration area / Zone 1	Remove vulnerable species or other actions as specified in Management Plans	Prior to restoration	Species translocations may be required to prevent adverse effects.
Spray woody weeds	Braid plain restoration area / Zone 1	Aerially spray exotic vegetation over footprint of restoration area.	March-April 2023	Herbicide allows for large areas of potential braidplain to be treated. Alternative treatment methods may be desirable near waterways.
Clear exotic vegetation	Braid plain restoration area / Zone 1	Remove or mulch sprayed exotic vegetation from the braidplain footprint and dispose of material	November 2023-May 2024	This is important to create open braid plain habitat and reduce downstream debris impacts.
Create river and stream channels	Braid plain restoration area / Zone 1	Earthworks to create river and stream channels	After clearance of vegetation November 2023-May 2024	The degree of earthmoving required to restore the braid plain would be guided by the hydrological and geomorphological assessments.
Pest plant control	Braid plain restoration area / Zone 1	Periodic (at least every five years) ground or aerial spraying operations	November 2024-May 2025 - ongoing	Required to prevent the reestablishment of exotic vegetation.
Begin planning for species translocations to site	Braid plain restoration area / Zone 1	Initiate process for reintroducing indigenous species to new braid plain habitat.	Once braidplain habitat is established (May 2025 – ongoing)	Species reintroductions may be required where dispersal limitation barriers are present.
Pest fauna control	Braid plain restoration area / Zone 1	Black back gull and other pest control (as needed)	As needed to protect new braid plain habitats.	Black-back gulls are a dominant species and will displace At-Risk and Threatened indigenous braided river bird species. If required, control should be undertaking in spring during the early part of the black back gull breeding season.

Activity/Task	Area/Zone (Refer Figure 3)	Activity Required	Timing	Objective/Reason
Note: Planting may not be desirable or achievable within the scope of the restoration works. Planting and site preparation efforts should be located in existing dryland forest/wetland areas not at risk of disturbance following braidplain restoration. Additional areas may be identified as planting areas following braid plain restoration.				
Mark out planting zones	Dryland forest / Zone 1a Other suitable sites.	Suitable areas for planting within dryland zones outside Zone 2 braid plain restoration area to be identified and marked out	Summer/Autumn 2022/2023	Planting clumps or strips of indigenous vegetation within these zones will provide seed source to promoted natural regeneration into the surrounding pest plant control zones. Areas with greatest soil depth and leaf mulch should be selected for planting to ensure maximum survival. Low lying areas prone to flooding should be avoided. Existing naturally-occurring indigenous vegetation should be re-identified and flagged (if flagging no longer present) Where possible planting should be integrated with existing indigenous vegetation.
Planting site preparation	Dryland forest / Zone 1a Other suitable sites.	Follow up control of any pest plants that have survived or regenerated following initial control – within planting zones. Spot spray planting sites (0.4 metre round areas with 1% glyphosate or other suitable herbicide depending on target species and time of year).	Mid to late autumn. At least one month prior to planting	This is important for successful establishment of planted species and makes it easier and/or more efficient for planting. **All pest plant control should be undertaken by experienced Growsafe certified operators.**
Planting	Dryland forest / Zone 1a Other suitable sites.	Plant and guard species were necessary. Plant at 1 – 1.5 m spacing for shrub/tree species. Refer: Appendix 5, Table 5 – for planting list and specifications.	Autumn 2023 At least one month after site preparation	Create a seed source for future natural regeneration, and enhance current habitats. In dryland areas planting should be undertaken from late autumn through to mid-winter. Once soil moisture levels reach full capacity.
Planting site maintenance	Dryland forest / Zone 1a	Spray (Glyphosate) or hand release plants from weeds and pest plants as required.	At least 3-4 visits over Spring-Summer for the first 3 years - after planting. Then ongoing as required until plantings have established	This is vital for the successful establishment of the planting areas. Invading weeds can quickly establish and complete/outgrown planted species.
Identify other planting areas	Zone 1: braid plain restoration area	Prepare and plant as above.	Following braidplain restoration	Opportunities to establish indigenous vegetation cover may develop once the braidplain restoration is completed.

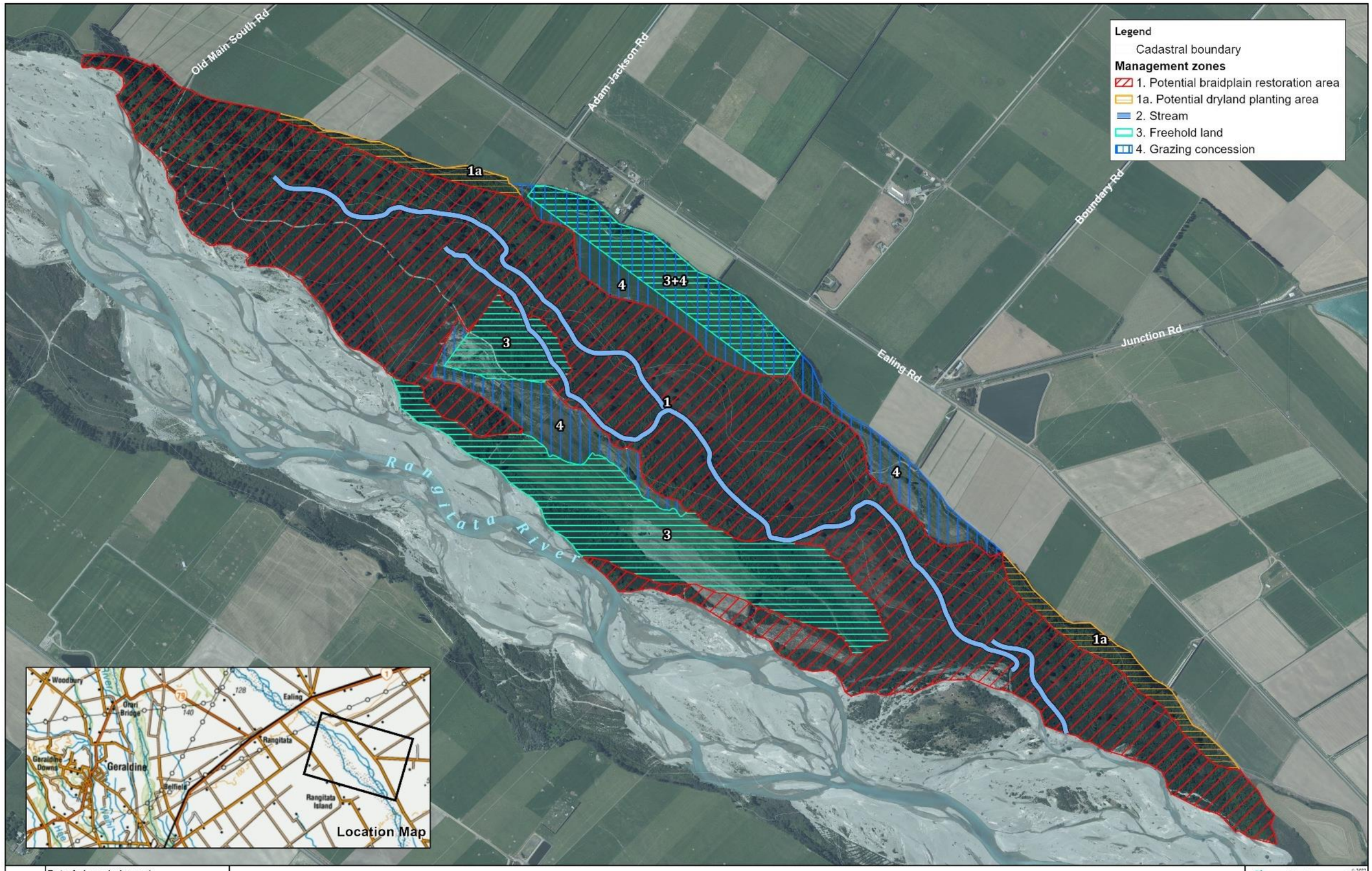

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Figure 3. Priority areas at Coldstream 1, Rangitata River, South Canterbury

0 250 500 m

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Scale: 1:13,500
Date: 9/03/2022
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APPENDIX 7

SITE PHOTOGRAPHS

Plate 1: The northwest margin of the site that contains dense Scotch broom, gorse and willow, with emergent scattered poplar, radiata pine and tī kōuka. 9 July 2021.

Plate 2: Extensive areas of dense willow forest occur on riparian margins and around wetlands at the site. Under both Options 1 and 2, these areas of willow forest should be removed. 9 July 2021.

Plate 3: Much of the site contains exotic shrubland that comprises gorse (pictured above), Scotch broom or blackberry. These shrublands could be progressively controlled and planted with indigenous dryland forest (Option 2). 9 July 2021.

Plate 4: Until relatively recently (until the 1980s) the site contained active riverbed, visible in the image above. 9 July 2021.

Plate 5: An ephemeral wetland at the Coldstream 1 site. Indigenous ferns are visible on the margins of the wetland. 9 July 2021.

Plate 6: One of the main streams at the Coldstream 1 site. Streams such as this one offer excellent opportunities for the restoration of mahinga kai species. 9 July 2021.

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