

ecoLogical Solutions

Environmental Consultants



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Wetland Construction and Riparian Planting Plan

Submitted to:
TiGa Minerals and Metals Limited



water



fauna



flora



land

1.0 Quality Assurance

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Appendices

Appendix A – Sample Restoration Planting Monitoring Sheet

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2.0 Introduction

2.1 Background

TiGa Minerals & Metals Limited ('TiGa') proposes to construct and operate a mineral sand mine located north of Canoe Creek and west of State Highway 6 on the Barrytown Flats approximately 36km north of Greymouth. The location of the proposed mine is shown in Figure 1.

The mine would be set back from State Highway 6 and the property at 3261 Coast Road. TiGa also proposes a setback of 20 m from Collins Creek, the property boundaries and the coastal lagoon. Vegetation throughout the area to be mined comprises farm pasture growing on land which has previously been 'humped and hollowed' to improve drainage for farming.

This plan specifies the planting for the constructed wetlands (feature 4) and riparian mitigation planting along Collins Creek and the Northern Drain as shown in Figure 2. Note that although additional planting at the site is proposed to provide for visual screening from the lagoon and from the coast as shown in Figure 2, this planting is not provided for in this plan. The reason for excluding this area is that the purpose of that planting is primarily visual screening, although it will also have some habitat value since it comprises indigenous species and adjoins existing habitats near the lagoon edge.

The purpose of the wetland construction and riparian planting is to enhance wetland and aquatic habitats and increase the extent of wetlands at the site in accordance with the National Policy Statement for Freshwater which took effect on 3 September 2020.

2.2 Relevant Consent Conditions

The relevant consent conditions are set out below:

19.3	<i>No later than 12 months after the completion of mining, the remaining areas of the proposed wetland area shown in the attached "Landscape Mitigation Plan" prepared by Glasson Huxtable Landscape Architects dated April 2023 shall be constructed and planted.</i>
19.4	<i>The consent holder shall source plants required for the planting and wetland area required from within the Punakaiki Ecological District or North Westland Ecological Region in order of preference. Where this is unable to be achieved, the consent holder shall notify the Council and work with the Council and a suitably qualified practitioner to determine an appropriate alternative plant source.</i>
19.5	<p><i>The wetland construction and Collins Creek and Northern Boundary Drain riparian planting shall be undertaken in accordance with the Wetland Construction and Riparian Planting Plan (WRPP) prepared by Ecological Solutions Ltd and dated April 2023</i></p> <p>Advice Note: All Management Plans are required to adhere to the requirements of Condition 6.0.</p>

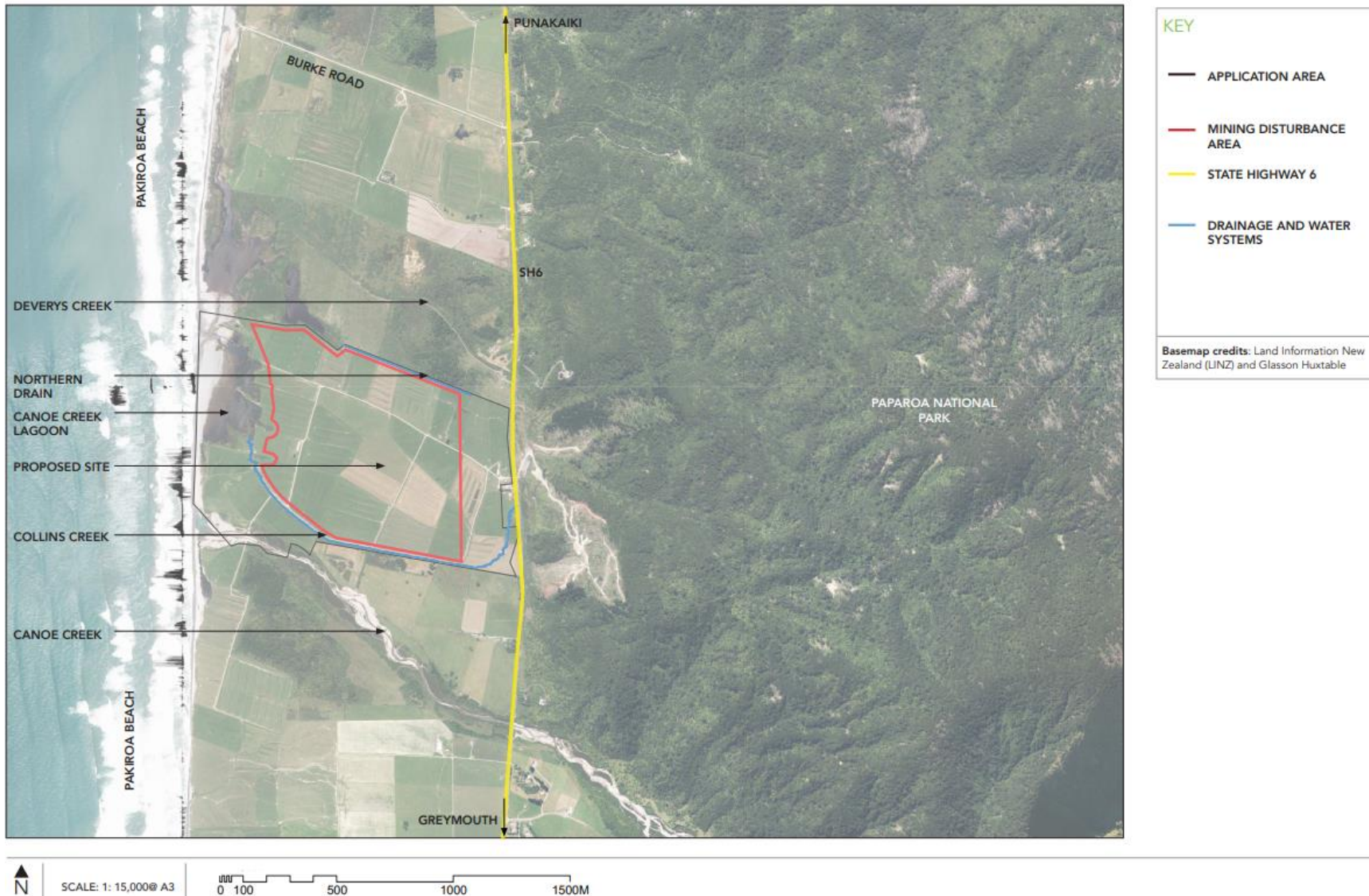
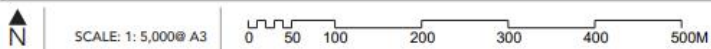
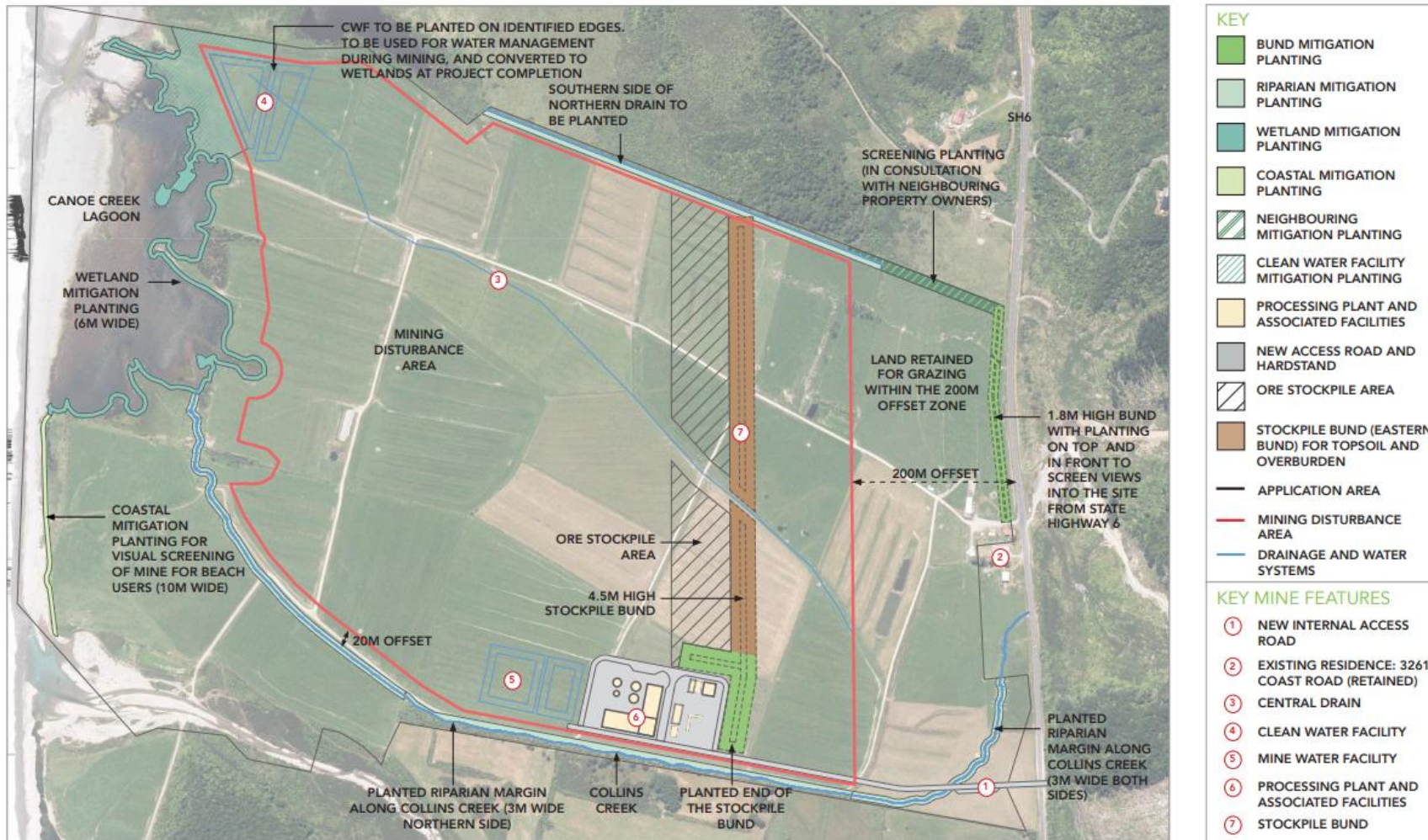


Figure 1: Location of proposed mineral sand mine, Barrytown (from Glasson Huxtable Landscape Architects 2023).



Note: Refer to the plans and cross sections on the following pages which provide more details on the proposed landscape mitigation.

Map credits: Land Information New Zealand (LINZ) and Glasson Huxtable

2003_Barrytown JV Limited, Barrytown Mineral Sands Mining Project, by Glasson Huxtable Ltd. 31

Figure 2: Proposed landscape plan for Barrytown JV Limited mineral sand mine (From Glasson Huxtable Limited).



2.3 Goal and Objectives

The goal of this wetland construction and riparian management plan is to establish a self-sustaining native vegetation community at the restoration sites which is ecologically appropriate and once established, requires minimal further management.

The objectives of this planting plan are:

- To revegetate the constructed wetland and both edges of the part of Collins Creek and the Northern Drain shown in Figure 2 with ecologically appropriate species and restore indigenous vegetation to at least 50% cover at 1 m height as demonstrated in plots across both wetland sites.
- Manage exotic pest plants (particularly woody weeds identified in this plan) over the restoration sites to a level of less than 5% cover as demonstrated in wetland monitoring plots across both wetland sites (refer to section 5.1.2).
- Improve terrestrial and wetland habitat quality and create corridors for wildlife movement.
- Encourage natural ecosystem processes including the regeneration and dispersal of indigenous fauna and flora.
- Improve water quality and aquatic habitats in Collins Creek and the Northern Drain.

These objectives will be achieved by:

- Removal of unwanted plant pest species from within the areas identified for restoration.
- Revegetating the areas intended for restoration with eco-sourced, pioneer plants to establish a nurse crop into which light and moisture sensitive species will spread and establish via natural means of dispersal.
- Promoting ecological succession by including in the revegetation areas terminal plant species (*kahikatea*, *Dacrycarpus dacrydioides*) to initiate and promote successional processes in conjunction with natural dispersal.
- Monitoring and active control of plant and animal pests within the areas intended for restoration as required.

Plantings will be maintained for two years and management will be reviewed regularly in response to monitoring outcomes. This plan will be reviewed as required.

3.0 Background

3.1 Ecological Context

The site is located within the Punakaiki Ecological District, most of which remains in indigenous forest except for extensive pakihi in logged areas of the Tiropahi Valley, the strip of coastal flats near Barrytown and some lower valley flats and coastal gullies which are either farmed or have been modified by coal or gold mining.

The Barrytown Flats are comprised of a complex sequence of old dune ridges and alluvial deposits, which originally would have been entirely covered in lowland (coastal) forest and wetland. Nearly all of the Barrytown Flats have been modified by forest clearance and drainage for timber harvesting, mining, and farming, although remnants of wetland and forest remain. Since approximately 2010, there has been a concerted effort to rehabilitate sand plain forest on the 80 ha former Rio Tinto property at the northern end of the Barrytown Flats (adjoining Nikau Scenic Reserve and known as Te Ara Tāiko Nature Reserve) with the aim

of restoring ecological connection between the coast and habitats inland.

There are two ponded areas located outside the site which were created as a result of mining activities between 1932 and 1948. These areas are located to the north and west of the application site and are included within an area identified by Boffa Miskell as Barrytown Flats, Canoe Creek Lagoon (Site PUN-W034). Site PUN-W034 as defined by Boffa Miskell originally covered 40 ha, including the area immediately around the lagoon to the west of the proposed mine site and two other wetlands to the north.

3.2 Site Description

The site has been substantially modified for farming and other land uses and currently contains no habitats comprising predominantly indigenous vegetation. Approximately 1.5 km of Collins Creek flows around the southern boundary of the site to the lagoon area.

Collins Creek appears to have been channelised throughout much of its length and the riparian vegetation on the true right (north) of the upper parts of the stream has been removed by grazing. Closer to the lagoon both sides of the stream are devoid of any riparian shrubland. Livestock currently have access to the stream and stream bank erosion is evident at some locations.

The Northern Drain has been channelised throughout its length and has no indigenous riparian vegetation on the southern (true left) bank.

Because of the topography and elevation of the site, original freshwater habitats in the area would have been characterised by low order, moderate energy watercourses connected to large wetland swamps and perhaps fens. The steep upper catchments would have increased water velocity in streams, whilst nearer the coast, occasional flooding combined with poorly drained soils and high ground water would have maintained large wetland areas. These wetland areas functioned to attenuate water flows and acted as slow-release water storage areas reducing sediment load at the coast and minimising flooding. Wetland areas would have harboured a variety of native terrestrial and aquatic flora and fauna, including a high diversity of native macroinvertebrates and fish species.

Any original wetlands have been reclaimed by 'humping and hollowing' for agricultural purposes. These modifications have resulted in a near complete loss of wetland ecosystem types from the area. The ecosystem services provided by wetland systems including flow attenuation and water quality improvement have also been lost.

3.3 Wetland construction

3.3.1 Overall Outcome

At the conclusion of mining, the water treatment pond referred to as Pond 4 will be retained and converted to a permanent wetland. The wetland will cover 1.9 ha in total and include the following habitats:

- An island of 2,000 m²
- At least 5,000 m² open water up to 2m deep
- At least 5,000 m² of shallow water (0.5m deep)
- At least 5,000 m² of water 0.5 m – 2 m deep planted primarily in raupō
- At least 1,000 m² of wet edge planting comprised primarily of rushes and sedges (*Juncus* spp., *Carex* spp.) and shrubs such as mikimiki (*Coprosma propinqua*).
- A plant density of no less than 5,000 stems per hectare.

The wetland will include open water, an island and raupō and flaxland vegetation around the

water margins. The open water will be constructed to have a natural edge providing embayments and sheltered areas as well as more exposed edges and will vary in depth including shallow areas and areas up to 2 m deep. Edges will include shallow banks as well as deeper areas to provide diverse habitat for birds using the site. The island will be planted and include shallow banks to allow easy access for birds from the water.

3.3.2 Methods of Construction

The pond will be constructed as part of the water treatment infrastructure at the commencement of mining.

[Additional detail to come]

3.4 Area to be Planted

The areas to be planted are shown in Figure 2. The collective areas cover approximately 24,775 m² (2.48 ha), including 6,000 m² at the constructed wetland, 1,755 m² at the Northern Drain and 7,260 m² at Collins Creek as follows:

- Upper Reach (both banks) = 324 m (1,944 m² to be planted)
- Middle section (one bank) = 640 m (1,920 m² to be planted)
- Lower section (both banks) = 566 m (3,396 m² to be planted)

The approach taken at the terrestrial sites will be to plant at a density of between 5,000 and 10,000 stems/hectare or 1 plant per 2 m² and 1 per m² in both the riparian areas and the wetland areas. For open water areas planted with raupō, plantings will be localised in small nodes throughout the planted area which are expected to spread naturally over time. A total of 14,015 plants comprising at least 17 species will be required.

3.5 Plant Selection

The plant species proposed to be used are shown in Table 1, although other similar species may be used in addition to those listed (e.g., if a particular species is unavailable). Plant species known to have occurred within the site, that occur in similar habitats nearby and that would most likely have historically occurred on the site have been selected. The species mix has been designed to take into account the natural characteristics and variations across the site (e.g., in drainage, aspect, shelter, contour, etc.). Sufficient species diversity is present in the mix to allow the person doing the planting to use their knowledge and experience to locate plants in their preferred 'micro-zone'. Guidance for each 'micro-zone' is included in the comment section of the species list tables.

Plants have been considered for each area based on their ability to:

- Establish quickly and provide a suitable nursery crop to allow natural revegetation/ecological succession to develop;
- Grow in a high light situation;
- Tolerate the coastal location and the flooding and other water / drainage regime expected;
- Reliably establish in revegetation plantings elsewhere; and
- Contribute to natural ecological processes such as bird dispersal.

Table 1: Plant species proposed for use at TiGa restoration sites, Barrytown.

Common Name	Scientific Name
makomako, wineberry	<i>Aristotelia serrata</i>
rautahi	<i>Carex geminata</i>
pūrei	<i>Carex secta</i>
pūkio	<i>Carex virgata</i>
karamū	<i>Coprosma robusta</i>
mikimiki	<i>Coprosma propinqua</i>
ti kouka, cabbage tree	<i>Cordyline australis</i>
tutu	<i>Coriaria arborea</i>
kahikatea	<i>Dacrycarpus dacrydioides</i>
wīwī	<i>Juncus</i> spp.
māhoe	<i>Meliccytus ramiflorus</i>
harakeke, korari, New Zealand flax	<i>Phormium tenax</i>
tarata	<i>Pittosporum eugenioides</i>
kōhūhū	<i>Pittosporum tenuifolium</i>
kāmahi	<i>Pterophylla racemosa</i>
nīkau	<i>Rhopalostylis sapida</i>
raupō	<i>Typha orientalis</i>

With respect to the pond, areas destined to be open water and shallow water edges would include raupō, whilst wet edges on the landward side would include a high proportion of species such as rushes and sedges (*Juncus* spp., *Carex* spp.), with the areas further from the wet edge including harakeke, kahikatea (*Dacrycarpus dacrydioides*), tī kouka (cabbage tree *Cordyline australis*) and mikimiki. Across the different zones the species would be intergraded to create a natural progression from wetter areas to dry. The island would primarily be planted with flax, rushes and sedges.

In riparian areas the immediate stream edge would include rushes and sedges, grading to kamahi, makomako and *Pittosporum* species.

4.0 Site Preparation

4.1 Fencing

The reaches of Collins Creek, the southern side of the Northern Drain and the constructed wetland area will require fencing to exclude livestock prior to planting. Two wire electric fencing will be used to exclude livestock prior to the commencement of planting. The fence will be checked periodically and any maintenance carried out as required to ensure it remains stock proof.

4.2 Pest Plant Control

Any pest plants identified in the West Coast Regional Council's Regional plan as well as any

pest plant species known to occur either within or near the restoration sites will be controlled. A list of weed species identified within the site, and recommended control methods for these species is provided in Table 2.

Table 2: Plant species to be controlled within and immediately adjacent to the wetland restoration and riparian planting area.

Common Name	Scientific Name	Control method
blackberry	<i>Rubus fruticosus</i> agg.	Dig out small patches or stem scrape and paint with glyphosate or cut and paint stumps
gorse	<i>Ulex europaeus</i>	Cut and paint stumps or spray with herbicide

The area subject to planting will need to be free of weeds and invasive grasses in preparation for successful plant establishment and subsequent weed control.

If required (i.e., if dense vegetation cover is already present), establishment of a suitable planting area will be achieved by either applying weed mat at the time of planting or applying commercial herbicides at prescribed rates (either Roundup (glyphosate) at 1% or Galant (haloxyfop) at 0.5%) to control grasses and herbaceous weeds. Planting locations will be spot sprayed within the area to be planted with an area of up to 1 m² treated for each individual plant. Full foliar cover with herbicide will be achieved.

Weed spaying operators will need to take appropriate precautions to protect non-target plants.

4.3 Animal Pest Control

Hares (*Lepus europaeus*), rabbits (*Oryctolagus cuniculus*) and possums (*Trichosurus vulpecula*) have the potential to adversely affect newly establishing plants. Native birds such as pūkeko (*Porphyrio melanotus*) and western weka (*Gallirallus australis australis*) can also reduce planting success by removing or browsing newly planted plants.

Use of plant protectors is proposed to protect establishing plants from these browsing pests as required. It remains unknown whether control of herbivores such as rabbits, hares and possums would be required in addition to the use of plant protectors in order to protect plantings and this decision can be informed via monitoring of newly planted areas. If required hares, rabbits and possums will be controlled by shooting, spotlighting, trapping or poisoning as appropriate.

If required pest animal control should aim to:

- Maintain low numbers of rabbits, hares and possums so that loss of planted plants due to interference by these species is less than 1%.
- Reduce pūkeko and weka interference or damage to less than 5%.

If plant damage exceeds these thresholds, pre-control monitoring will be carried out to establish a baseline for pest numbers and to track the impact of pest control measures. The results of control outcomes will be measured via kill data (for mammals) and plant survival rates. Assessing both aspects will provide a strong justification for whether management actions are cost-effective and achieving their goals. Monitoring of plant survival is provided for in Section 5.0 below.

4.4 Plant Selection

All plants selected are to be sourced from the Punakaiki Ecological District (or the North Westland Ecological Region in order of preference) where possible and true to their name and species, healthy and free of disease and / or injury at the time of planting. Plant numbers and species indicated may vary depending on availability.

Plants will be well-hardened root trainer ('RT'), ½ L, 1 L, PB2 or PB3 in size (i.e., 20 – 60 cm tall at the time of planting) with no visible weed contamination.

Any myrtle species should be certified free of myrtle rust.

4.5 Planting Density and Layout

Planting density will determine a number of factors such as the overall number of plants required and the ability to establish canopy cover quickly and eliminate weed species. Higher planting densities do incur a higher cost upfront, but will need less ongoing management costs in subsequent years. Low density plantings spread the cost out, with lower upfront costs but more ongoing maintenance required in later years, but also delay the time taken to achieve an ecologically sound and visually appealing planting.

TiGa are seeking to establish these plantings and achieve self-sustainability as soon as is reasonably practicable. A final planting density of 1/m² with common colonist species is proposed for riparian plantings, whilst a planting density of either 1 per m² or 1 plant per 2 m² is proposed for wetland areas as shown in Table 3. This may be achieved by planting at lower densities initially, followed by in-fill planting later. The riparian plantings will be spread over up to three years beginning prior to the commencement of mining so as to minimise the risk of adverse weather events in any one-year compromising planting success. Plantings will be supported by weed control and implementing supplementary planting amongst the established plantings after Year 1.

In order to facilitate natural regeneration and quickly achieve a natural / unmanaged aesthetic for the planting, the planting layout should mimic a natural planting regime as much as possible. In particular, large native trees (e.g., kahikatea) should be planted in small groups (3 – 5 trees) within the wider plantings. For these groups, allow larger spaces between them to provide room for them to spread as they grow and ensure they are not overtopped.

4.6 Plants Required

A total of approximately 14,015 plants is required as shown in Table 3.

Colonising plants are typically different from those which come to dominate the canopy over time, in part because they are adapted to growing in different environments (high light versus low light). Plant numbers and species indicated may vary depending on availability.

Table 3: Plant species proposed for use at TiGa Sand Mine, Barrytown, divided by location.

Common name	Scientific name	Percentage of Planting	Habitat	Number required
Wetland Areas				
rautahi	<i>Carex geminata</i>	10	wet soils	500
purei	<i>Carex secta</i>	10	wet soils	500
pukio	<i>Carex virgata</i>	10	wet soils	500
mikimiki	<i>Coprosma propinqua</i>	5	margins	150
ti kouka, cabbage tree	<i>Cordyline australis</i>	4	margins	200
kahikatea	<i>Dacrydium dacrydioides</i>	4	margins	200
wīwī	<i>Juncus</i> spp.	5	wet soils	250
harakeke, lowland flax	<i>Phormium tenax</i>	50	margins	2500
raupō	<i>Typha orientalis</i>	2	open water	100
Total wetland plants		100		5,000
Stream Riparian Areas				
Stream Edge				
rautahi	<i>Carex geminata</i>	30	Stream edge	902
purei	<i>Carex secta</i>	10	Stream edge	301
pukio	<i>Carex virgata</i>	30	Stream edge	902
wīwī	<i>Juncus</i> spp.	30	Stream edge	902
Total for Stream edge				3,005
Upper banks				
makomako, wineberry	<i>Aristotelia serrata</i>	10	Bank	601
tutu	<i>Coriaria arborea</i>	5	Mid bank	301
tī kouka	<i>Cordyline australis</i>	5	Mid and upper bank	301
karamū	<i>Coprosma robusta</i>	15	Mid and upper bank	902
kahikatea	<i>Dacrydium dacrydioides</i>	10	Mid and upper bank	601
māhoe	<i>Meliccytus ramiflorus</i>	15	Upper bank	902
harakeke, flax	<i>Phormium tenax</i>	5	Mid bank	301
tarata	<i>Pittosporum eugenioides</i>	5	Upper bank	301

kohuhu	<i>Pittosporum tenuifolium</i>	10	Upper bank	601
kāmahi	<i>Pterophylla racemosa</i>	10	Upper bank	601
nīkau	<i>Rhopalostylis sapida</i>	10	Upper bank	601
Total for Upper banks				6,010
Total Riparian Plants				9,015
Grand Total				14,015

The number of plants required divided by species is shown in Table 4.

Table 4: Plant species proposed for use at wetland and riparian plantings, TiGa Sand Mine, Barrytown, divided by species.

Common Name	Scientific Name	Number required
makomako, wineberry	<i>Aristotelia serrata</i>	601
rautahi	<i>Carex geminata</i>	1,402
purei	<i>Carex secta</i>	801
pukio	<i>Carex virgata</i>	1,402
karamu	<i>Coprosma robusta</i>	902
mikimiki	<i>Coprosma propinqua</i>	250
ti kouka, cabbage tree	<i>Cordyline australis</i>	501
tutu	<i>Coriaria arborea</i>	301
kahikatea	<i>Dacrycarpus dacrydioides</i>	801
wīwī	<i>Juncus spp.</i>	1,152
māhoe	<i>Melicetyus ramiflorus</i>	902
harakeke, New Zealand flax	<i>Phormium tenax</i>	2,500
tarata	<i>Pittosporum eugenioides</i>	301
kohuhu	<i>Pittosporum tenuifolium</i>	601
kāmahi	<i>Pterophylla racemosa</i>	601
nīkau	<i>Rhopalostylis sapida</i>	601
raupō	<i>Typha orientalis</i>	100
Total		14,015

4.7 Planting Method

All riparian margin plants will be planted with a slow-release fertiliser tablet beneath the root mass as shown in Figure 3. Wetland plants will be planted in a similar way without a fertiliser tablet.

All plants will be planted to the same depth as their growing container and care will be taken to avoid damaging roots during planting.

Plants may be mulched with coarse sawdust, bark or other material to a depth of 100 mm at the time of planting in order to control sediment runoff, conserve moisture and suppress

weeds if required. Alternatively, weed mat may be used. Once planted, plant protectors will be installed as required.

Within the planting zones outlined, species should be targeted towards the most favourable microsites possible for establishment.



Soak the plant before removing from the bag / pot. Ensure the hole is 3x the diameter of the root mass (cover with dirt) and the depth is 1.5x the root mass. Place a fertiliser tablet in the hole (Dryland and Riparian areas only).

Ensure the fertiliser tablet does not directly touch the plant's root mass with dirt. Ensure dirt is not sitting around the base of the plant's stem.

Figure 3: Proposed planting method.

5.0 Monitoring and Maintenance

5.1 Monitoring

5.1.1 Plant Establishment

The aim of monitoring plant survival is to ensure that sufficient plants survive (or are replaced) to ensure that the ecological outcomes (50% canopy cover, ecological connection restored) will be achieved and provide an informed basis for ongoing management (e.g., implementation of pest control or supplementary planting).

Plants will be inspected three months after planting to determine their initial survival and establishment. Any plants which fail to establish will be replaced as required, although they may not be replaced at exactly the same microsite or with the same species. Replacement plants will be planted according to the guidelines provided above in the period between May and August following the discovery of dead plants.

Once plantings have established (after six months), monitoring will be undertaken at least twice annually for the next year (during spring and autumn).

Monitoring shall include, but not be limited to, the following:

- Success rates, including survival rate and the number of plants lost.
- Achievement of canopy closure, including notes on growth rates and natural ecological processes such as the use of the area by birds and presence of natural native seedling establishment. The target for closure (i.e., cessation of management) is 50% canopy cover at 1m height.
- Plant health, noting any indicators of ungulate, insect or disease damage or presence.
- Consideration of any follow-up maintenance required in terms of weed control, animal pest control, plant replacement, plant disease control and fence maintenance.

Monitoring will be summarised in an annual summary sheet to provide for any later reporting.

A sample monitoring field sheet for restoration planting can be found in Appendix A.

5.1.2 Wetland Quality

The aim of the wetland monitoring is to provide quantitative and repeatable data to ensure that the proposed wetland restoration is resulting in improved ecological condition and progressing towards self-sustainability, as well as provide a basis for ongoing management.

Wetland quality monitoring will consist of two 5 m by 5 m monitoring plots based on the methodology described in “A Handbook for Monitoring Wetland Condition” (Clarkson et al. 2004), where vegetation is estimated over different wetland tiers depending on complexity (i.e., canopy, sub-canopy, ground cover). The location of the plots will be selected at random using a method of random point generation. Discretion will be used on site to shift monitoring plots if required (e.g., if a particular location is unsafe or if a particular site would provide biased results). The monitoring will exclude soil core and foliage laboratory analysis.

A minimum of four permanent photo points will be established at appropriate locations to visually demonstrate the restoration over time.

Monitoring will be undertaken six months after the initial planting has been undertaken following wetland construction. Monitoring of wetland condition and photographs at photo points will then be undertaken annually until closure is achieved. Review of this plan will include consideration of whether the objectives set out in Section 2.3 have been achieved or if further actions are required.

A Wetland Condition Assessment, including one Wetland Record Sheet for each site and two Wetland Plot sheets for each site will inform a brief monitoring report to be prepared after each monitoring occasion detailing results, outlining conclusions and providing recommendations as necessary.

5.2 Maintenance

General plant maintenance may involve the following (depending on requirements):

- Watering of all new plants at the frequency and amount required to sustain healthy development.
- Control of insects and disease by treatment with an appropriate chemical.
- Removal of any damaged or diseased plant material (to prevent further spread).
- Fill of any soil compaction and sinkage around plants (common post planting once the soil has settled).
- Plant releasing as required.

Plant releasing is the process of releasing young plants from competition due to surrounding growth of grasses and weeds until they can either compete effectively, or have over topped fewer desirable species.

Plants will be released using the following methods:

- Hand/manual releasing, which can involve the use of a scrub bar or hand tools to cut back grass and weed growth around plants which have or are at risk of becoming suppressed. This method is labour intensive but low risk to plant health.
- Spray releasing with herbicide, this method depends on the herbicide to be used and the skill of the contractor. Typically, selective herbicides such as Galant™ are able to be applied safely around/over most native species (excluding monocots such as cabbage tree, flax and *Carex*, *Juncus* and *Cyperus* species). In the instance where spray releasing can reduce labour, incompatible species can be manually cleared as

per manual release above.

- Non-selective herbicides (such as glyphosate) will not be used due to the high risk of spray drift and associated non-target mortality.

If spray releasing with herbicide is the method selected, operators will be required to have completed the relevant GROWSAFE course.

5.3 Plant Replacement

A 5–10% mortality rate is typical in the first year following revegetation plantings due to natural causes such as insect damage, frosts and drought along with mortality from animal pest damage and spray drift. Plant mortality of 5% is expected in the first year post planting, followed by 3% in the second year. Species used to replace dead plants will be consistent with the species selection and proportions noted in Tables Table 3 and Table 4, respectively.

5.4 Animal Pest Monitoring

Animal impacts on plants will be monitored during each monitoring round. If plant losses to herbivore or other animal damage exceed 1% (in the case of rabbits, hares and possums) or 5% (for all other species) then appropriate animal control or other methods of pest exclusion will be instigated.

5.5 Weed Monitoring

The goal of weed monitoring is to ensure that undesirable plants are identified as quickly as possible and removed before establishing a local population. In most plantings, woody weeds (i.e., shrubs and trees) are of more concern than grasses or herbaceous weeds.

Monitoring of woody weeds is to be carried out twice annually in spring and autumn (at the same time as weed control) and will involve walking across as much of the restoration sites as practicable (including all tracks and the parts of the site without established tracks) ensuring that as much of the area is visited as possible and looking for weeds, recording their presence and where possible removing or otherwise treating them immediately.

In order to ensure consistent monitoring coverage, the restoration sites will be systematically searched for woody weeds by walking around the sites and looking for weeds either as new arrivals (at ground level) or as more established examples (within the canopy or emerging from it). Those doing the monitoring will either carry a GPS or plot the track walked on an aerial image or map of the property so as to record the survey coverage and allow any areas missed to be identified and visited later. The location of any weeds encountered will be recorded as they cross the site. A sample data sheet which can be adapted for the site is included in Appendix B.

All woody weed species found will be recorded, along with the approximate size of the population (either number of plants or area covered) and the management treatment applied. Where herbicide is applied a follow-up visit will be planned to confirm that it has been effective and to note whether additional applications might be required (e.g., due to regrowth).

5.6 Weed Management

The objectives of this plan relating to weed management are to:

- Prevent the establishment of new woody weed species which would impair natural succession of native vegetation within the planted areas of the restoration sites.
- Minimise the spread of existing woody weeds within or into the restoration sites.

- Maintain the distribution and abundance of weeds at the sites at low levels so that weeds do not impair natural succession of native vegetation cover in the medium to long term.

Weed control measures are based on four principles:

1. Preventing establishment of new weed species and populations. This involves site hygiene and measures to prevent propagules arriving on site and site management to reduce suitable habitat for weeds that breach the borders.
2. Minimising the spread of weed populations within the site. This involves systematically monitoring the spread of weed populations and preventing their growth and reproduction.
3. The planting of desirable (including native) species or non-invasive species into previously cleared or unused areas allowing them to get a “head start” over the weeds and prevent them colonising.
4. Monitoring to ensure weeds are not compromising the desired outcomes.

Effective weed control requires identification of weed species, locating individual colonies and then extermination of the weeds using appropriate methods, followed by revegetation with desirable plants and monitoring to ensure the weeds do not return. There are a number of management techniques that improve the success of weed control and provide a degree of certainty about the outcome of a weed control programme. The spread of weed populations within the property will be minimised by:

- i. Use of appropriate methods (including herbicide, manual or mechanical techniques) for the target species. Advice on control methods for particular species is available at www.weedbusters.org.nz.
- ii. Regular systematic recording of known weed colonies and control efforts throughout the planted areas.
- iii. Monitoring of weeds and undertaking weed control before seeding.
- iv. Undertaking regular (twice yearly) monitoring and inspection of planted areas. In order to minimise the establishment of weeds, inspection staff will routinely carry herbicide wands or backpacks, so that, weather permitting, any plants that cannot be manually removed are treated as they are identified. The location of these plants will be recorded as part of the monitoring programme to allow identification of at-risk areas.
- v. Annual checks for weeds and hand pulling or spraying will be carried out as appropriate on the undisturbed ground near roads and working areas.

The amount of time taken to carry out weed control and monitoring will decrease over time as target species are eradicated and replaced by desirable vegetation.

6.0 Proposed Timeline

It is proposed to spread plantings in the riparian area over a period of up to three years, although the majority of the planting will be completed within the first two planting seasons. The reason for spreading the plantings is to reduce the risk of adverse weather events (e.g. droughts, flooding, cyclones) affecting newly planted plants. At the wetland restoration area planting will be completed in one year. A suggested planting regime over the course of the next few years is suggested in Table 5 below.

In addition, in order to be most successful, planting and weed control should be undertaken at particular times throughout the year. For example, planting is best undertaken in late autumn and winter so that plants are well established before the summer dry period arrives,

whilst weed control is best undertaken in autumn (when plants are most visible because they are often flowering or fruiting) and spring (when plants are most actively growing and before they set seed).

Table 5 sets out the window of time annually within which particular management actions relating to weed control, planting and monitoring should be completed over the three years.

Table 5: Proposed programme of works for restoration at TiGa Mineral Sand Mine, Barrytown.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Year 1	-	-	-	-	SP	SP	-	P	P PM APC PM	OP M APC PM	OP M APC PM	-
Year 2	-	-	PM WC	PM WC	SP PR	SP PR	-	P	P OP PM	OP AP PM WC	OP WC	-
Year 3	-	AP CM	WC PM M	WC PM M	PM SP	-	-	P PR WC	P WC M PM APC	M PM APC	M P WC	-

Note: OP = Order any plants required, SC = Collect seed or other propagules as required and commence propagation, SP = Site preparation, includes initial weed control and any required earthworks, P = Planting as per species lists (in Year 1 these plants will have to be purchased), M = Monitoring- assess plant survival in order to respond to any required actions such as weed or animal control, APC = Animal pest control (of rabbits, hares, and/or possum if required), PM = Plant maintenance, including manual releasing (if required), WC = Weed control (if required), PR = Replacement planting (if required).

7.0 References

- Clarkson, B.R., Sorrell, B.K., Reeves, P.N., Champion, P.D., Partridge, T.R., Clarkson, B.D. 2003. Handbook for Monitoring Wetland Condition. Revised edition 2004. Landcare Research, Hamilton, New Zealand.
- McEwen, W.M. 1987. (Editor). Ecological Regions and Districts of New Zealand (third revised edition in four 1:500,000 maps). New Zealand Biological Resources Centre publication no. 5. Department of Conservation, Wellington.

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APPENDIX A
Sample Restoration Planting Monitoring Sheet



MONITORING FIELD SHEET FOR RESTORATION PLANTING

Sample field sheet for completion annually to inform annual report.

Date (d/m/y) _____ Date of last monitoring _____

Consent number _____

Address _____

Property owner and contact details:

Has property changed owners in the last year? YES / NO

If yes, who was previous owner?

Survival Rate

Percentage survival _____

Growth estimate (cm/year) _____

Percent ground cover _____

Canopy closure achieved YES / NO

Approximate canopy cover _____

Fertilizer

Date applied _____

Product used _____

Areas applied _____

Quantity used _____

Weed control

Date undertaken _____

Sprays used _____

Application Rate _____

Weeds targeted _____

Areas targeted _____

Replacement planting

Date undertaken _____

Species being replaced _____

Species planted _____

Number of plants replaced _____

Problems

Are certain weeds proving difficult to control and detrimental to the planting, are animal pests causing significant problems?

Nature of problem(s):

Possible solutions:

Analysis of plant losses

Are losses greater than expected, are there any obvious reasons, are losses in certain areas, are certain species showing high losses, what are possible solutions?

State of fence

Is the fence still secure? Has any maintenance of the fence been undertaken? Is any required?

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APPENDIX B
Sample Weed Monitoring Sheet



