RM 150184
FINAL APPROVED PLANS
29 / 3 / 2019

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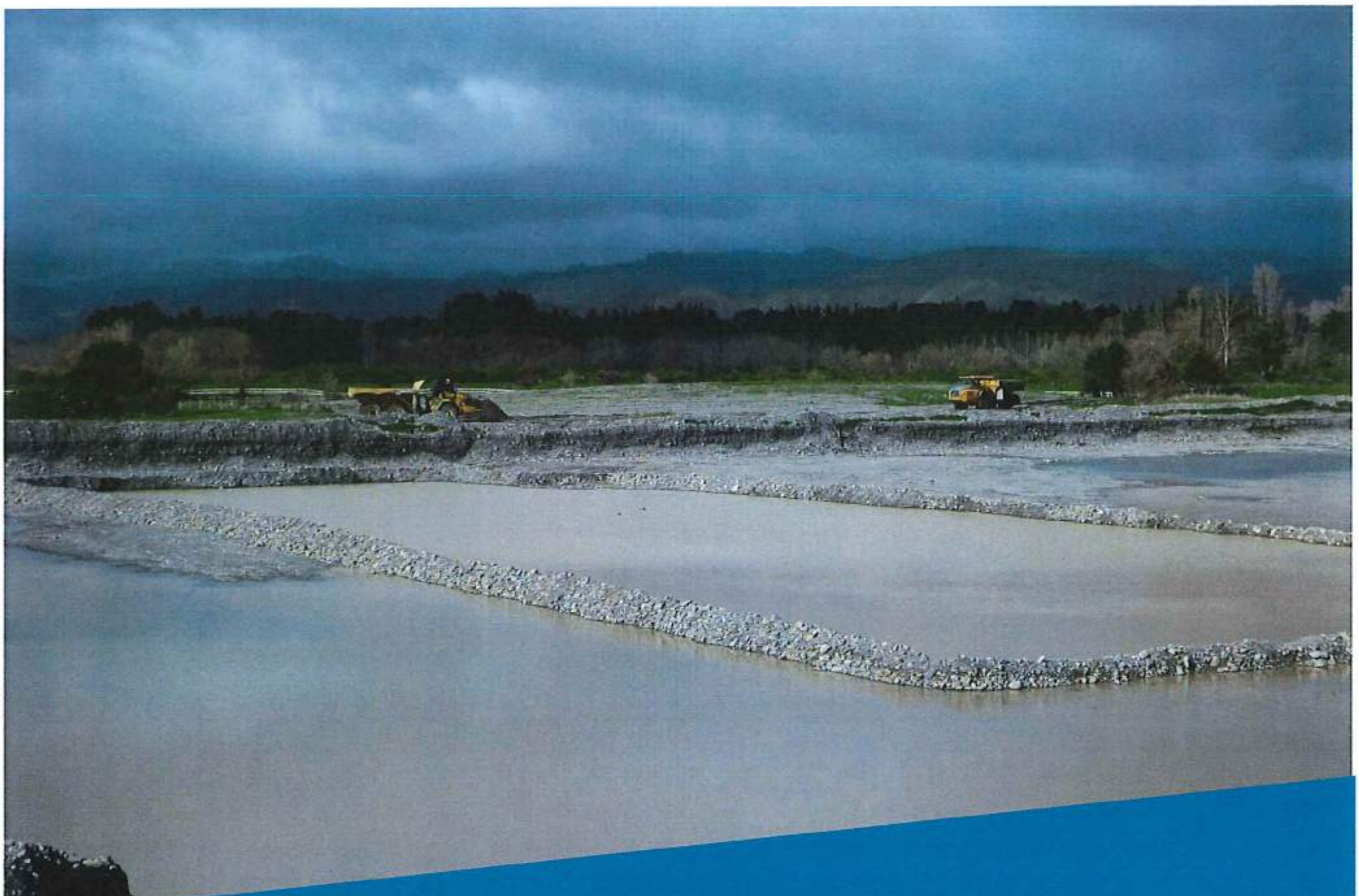
ASHFORD PARK REHABILITATION:

STAGE 1 PLAN

OCTOBER 2018

[THIS PLAN WAS DEVELOPED TO MEET THE REQUIREMENTS OF KCDC LAND USE CONSENT RM150184 , CONDITIONS 47(a)-(f)]



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STAGE 1 PLAN

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FOR: **GBC WINSTONE**

DATE: **OCTOBER 2018**

REFERENCE: BIORESEARCHES (2018). ASHFORD PARK REHABILITATION: STAGE 1 PLAN FOR WINSTONE, 23 PAGES.

COVER ILLUSTRATION: ASHFORD PARK QUARRY

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DOCUMENT APPROVAL

Document title:	Ashford Park Rehabilitation: Stage 1 Plan (Draft)
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REVISION HISTORY

Rev. No.	Date	Description	Author(s)	Reviewer	Approved
1	31/10/2017	1st Draft	S. A. Killick	T. J. Barnett	T. J. Barnett
2	14/03/2018	2nd Draft	S. A. Killick	T. J. Barnett	T. J. Barnett
3	15/10/2018	3rd Draft	D.McGregor		

CONTENTS

1 BACKGROUND

Ashford Park is a former horse stud farm in Ōtaki, Kapiti Coast, purchased by Winstone Aggregates. The park is positioned adjacent to the Ōtaki River and adjoins a gravel extraction and processing site owned by The Greater Wellington Regional Council and operated under licence by GBC Winstone.

The Ōtaki River is the most prominent riverine system in the Kāpiti District, and flows from the TararuaRanges to the Tasman Sea at Ōtaki Beach, and features shifting gravel banks and wetlands.

These properties are adjacent to the Ōtaki river bed. The water table is near to the surface; where extraction has commenced on the existing Ōtaki quarry, and reached the groundwater, large ponds have formed. Although pond waters were initially highly turbid, the sediment has since settled and higher water clarity followed.

A similar gravel extraction quarry has been consented for Ashford Park. Extraction has commenced, exposing groundwater on site (see cover image). The quarry strategy is planned in four stages, with the entire project expected to take 20 years in total. Although there have been Rehabilitation Plans prepared for the overall site, the consenting conditions require stage-specific Rehabilitation Plans to be prepared for each completed stage prior to the commencement of subsequent stages. The stage-specific Rehabilitation Plans are considered important because it is difficult to predict changes that may occur over the twenty year timeframe, and a stage-by-stage plan system allows for any changes to be reflected in the stage-specific strategies. In addition, this staged strategy allows for adaptive management to occur, where past successes and difficulties can be taken into consideration.

Currently, the Ashford Park Quarry is within the first stage of development. This plan will detail the rehabilitation of the riparian margin surrounding the Stage 1 formed lake, which comprises of two sub-stages (1a and 1b).

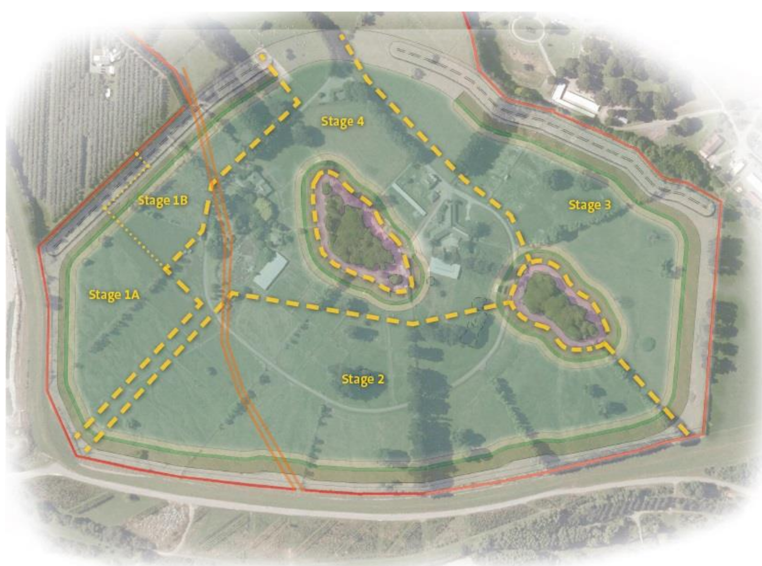

Figure 1: Overview of the Ashford Park Quarry site. Yellow dashed lines indicate stage zones, and the blue overlay indicates expected lake extent. Green area is the approximate riparian area, however the margins will differ from those shown. Map is north-facing.

2 INTRODUCTION

Ashford Park has been extensively modified for its former use as a stud farm, and is largely occupied by sections of fenced pastoral land. These pastoral areas, which are extensive, are of low ecological value.

Throughout the site, there are occasional scattered trees, both native and exotic; exotic shelter belts comprising of pine, poplar, and macrocarpa, and three areas of native forest remnant. These semi-coastal forests are small, but mature, stands of kohekohe-tītoki-tōtara forest. The native forests have a mostly healthy canopy, but show evidence of historic grazing in the understory. This forest type is rare, thus although small, they are significant to the conservation of this forest community type. The two larger remnants are to be retained as islands, which will be surrounded by the lake created by gravel extraction.

The consenting conditions require an Ecological Rehabilitation Plan for each created area must be undertaken prior to the next stage commencing. To meet these conditions, GBC Winstone approached Bioresearches to request the preparation of a first-stage Rehabilitation Plan.

An assessment of the Ashford Park site was undertaken on August the 16th, 2017, to assess the ecological values on-site and compare to those described in an earlier report (Wildlands, 2015). The whole-site Rehabilitation plans (Boffa Miskell Limited, 2016; GBC Winstone, 2016a) and the riparian margin planting plan (GBC Winstone, 2016b) were also reviewed, in order to inform the Stage 1 Rehabilitation Plan. This plan will recommend actions to benefit the ecological aspects of The Project, with the aim of creating the best possible ecological outcomes.

One of the primary considerations in the rehabilitation process is the protection of remaining remnant native vegetation. The isolation of the two primary remnants, and the flooding of areas immediately surrounding them, could have potentially negative effects if not managed appropriately. Although the remnants are already exposed to wind and light along the edges, there is a potential for increased exposure with the removal of the surrounding scattered individual vegetation and buildings. To reduce the potential edge effects, planting around the outer edges will be needed. This will be described in a separate report, 'Island Ecology'.

The buffer vegetation will still sit above the water table, but the lower edges that lead into the lake will be wet in part, and will require flood-tolerance species. There are also some anticipated benefits of the lake to the retained vegetation: although rodents are able to swim well, there is expected to be some decrease in rodent and possum populations, and the lack of grazing pressure will provide a significant benefit to the regeneration of the forest floor.

The second important consideration is the quality of the lake. It is important that the lake is ecologically functional, and does not require substantial management costs.

A well-functioning pond or lake has a low nutrient content (oligotrophic), with cool clear water and the ability to support a diverse assemblage of native flora and fauna. Conversely, signs of an ill-functioning lake include high nutrient concentrations (eutrophic), often associated with algal blooms, warm and murky or cloudy water, and an accumulation of sulphur-smelling oxygen depleted sludge on the lake floor. Eutrophic lakes are aesthetically unpleasing, smell offensive, and are poor for recreational use. Additionally, they are usually unsuitable for supporting native freshwater species, and promote the growth of exotic invasive aquatic plants. It is immensely difficult to return a eutrophic lake to a healthy oligotrophic state, and so every effort must be taken to create and maintain a lake that promotes an ongoing low-nutrient system.

2.1 OBJECTIVES

The long term vision, as detailed in the site-wide plan, is "To facilitate the successful rehabilitation of the site in a manner that will retain and enhance native species on islands and thriving native riparian vegetation along waterbody margins to maintain water quality and long term ecological health and successfully reintegrate quarried areas within the Ōtaki floodplain landscape" (GBC Winstone, 2016a).

Figure 2: Approximate size and placement of Stage 1 of works at Ashford Park Quarry. Blue indicates estimated water body, and green indicates placement of planted riparian area. Margins are indicative.

This report aims to provide direction and recommendations for the Rehabilitation of Stage 1 of the Ashford Park Quarry. This includes the creation of a functioning and resilient lake and riparian area on the north-western corner of the proposed full lake extent. The success of rehabilitation (both freshwater and terrestrial) relies heavily upon the meeting of measurable environmental parameters, as without measurable success criteria, it is not possible to determine whether objectives have been satisfactorily met.

3 LAKE MARGIN FORM AND FUNCTION

When excavating the lake margin, it is important to consider how the shape and slope aspects influence water quality. If the slope is too slight, the lake will be too shallow and prone to warming. This will result in greater concentrations of macrophytes and algae, and may lead to eutrophication. Conversely, if the lake margin is too steep there will be insufficient area to accommodate the riparian plants within the emergent and submerged zones, which are important for providing habitat, diversity, and for filtering runoff before it enters to water body.

The proposed slope aspects are based on the Greater Wellington Regional Council's guide "So you're thinking about a pond…" (2007). The underwater portion is steep (30°) to rapidly increase depth, but the submerged and emergent wet vegetation zone (measuring 12m wide collectively) is at a low angle (7°) to increase habitat area. The upper vegetation bank is raised (18.5°), which will prevent flooding to the bike and footpath, and areas beyond the lake site, as well as encourage water movement into the main lake through the vegetation (Figure 3).

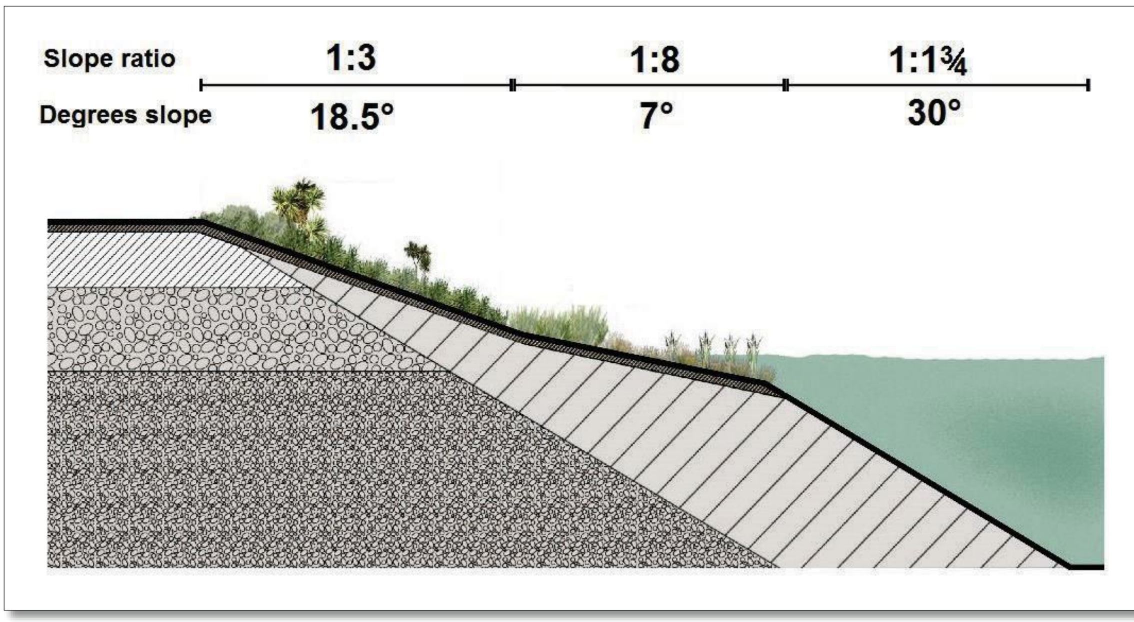

Figure 3: Lake margin slope aspects. Recreated from GBC Winstone (2016a).

The slope angles provided in Figure 3 are a guide to approximate angles expected in each zone, rather than an exact prescription. In creating the lake margin, the machinery operators should be encouraged to be inexact, to create natural variation, particularly with regard to the shapes of the margins. The lake margin should be irregular and scalloped (Figure 4) to allow for increased habitat and plant diversity.

Winstone recognises that the existing quarry lake to the east (see Figure 1) will be progressively rehabilitated over the same general time period as Ashford Park. So as to ensure the two areas are aesthetically and visually aligned, Winstone is proposing to use the same rehabilitation methodology for the existing lake as will be used at Ashford Park.

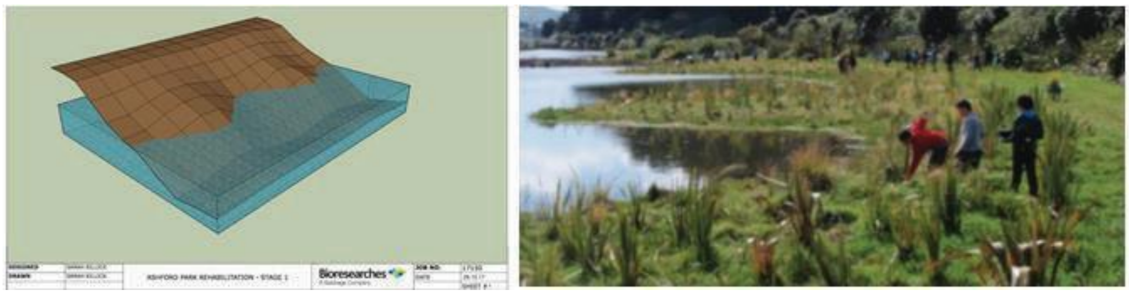

Figure 4: Scalloped margins, modelled left by Bioresearches. Photo on right from GBC Winstone (2016).

In addition, native plant and animal diversity can be increased by providing different micro-habitats surrounding the lake edge, including areas of rocky boulders, overhanging vegetation, or flatter wetland zones. It is recommended that, where low lying structures (such as rocks) are used at the edge of the lake, dense vegetation is planted immediately behind. This will help to discourage access, especially to children.

4 VEGETATION

4.1 Planting Approach

The underlying soils on site are consistent with alluvial gravels and have been described as comprising of "clayey silty gravel and gravel, and cobbles overlaid by topsoil" (Boffa Miskell Limited, 2016). The uppermost 200 mm of topsoil was proposed to be removed and kept in stock piles for rehabilitation purposes, which, based on an estimated area of 32,338 m^2 of earth to be removed from Stage 1 alone, provides approximately 6,468 m^2 of available topsoil.

Planting should occur in two stages: the 'wet zone' planting in summer, and the 'dry zone' planting over winter. The rationale for this is that during summer, the water level is likely to recede, allowing planting to occur in the emergent and submerged zones. Where inundation is unlikely, planting should occur over autumn to early winter to allow the establishment of root systems prior to the hotter summer months and increase plant survivorship.

The Planting, Pest Management, and Maintenance Plan provided in Appendix I provides a greater level of detail regarding the planting approach; however, an in-depth Planting Plan will be required once the measurements of the planting margins are known.

4.2 Species Selection

The species selected for the rehabilitation of the newly formed riparian margin are required to be locally sourced native species that are suitable to the area and the specific conditions on site. A site-wide species list was created to meet the requirements of Condition 49 of the Kapiti Coast District Council Land Use Consent RM150184 (GBC Winstone 2016). The proposed species have been separated into three zones, 'Riparian Dry', 'Emergent', and 'Submerged' zones, based on their profile from within the wetted margin to above the flood plain on dry land. The dry zone will vary in size along the length of the lake, but approximate measures based on the preliminary plan (GBC Winstone, 2016) and aerial imagery measured this zone to be approximately 6.0 m wide.

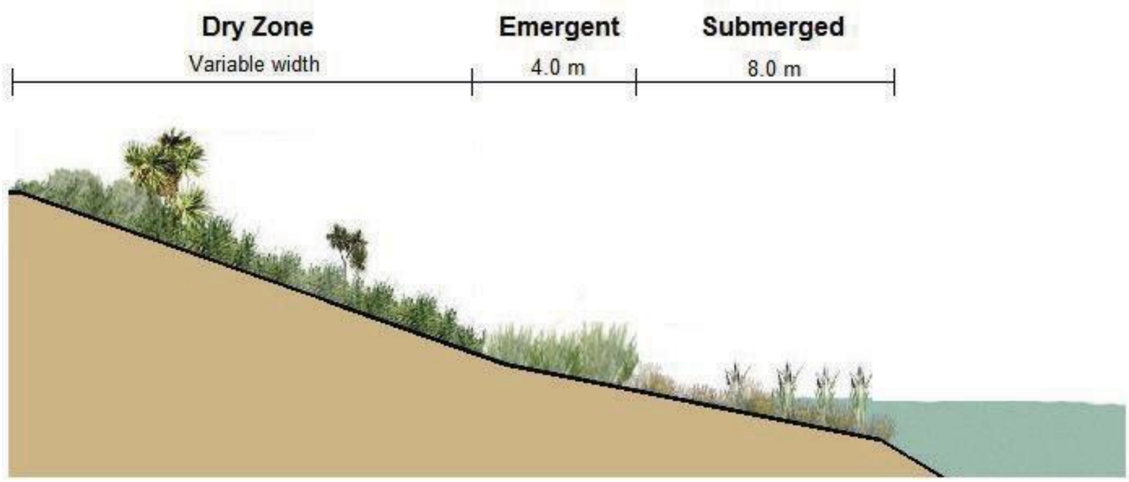

Figure 5: Planting zones, Ashford modified lake riparian margin. Image altered from GBC Winstone (2016a).

Vegetation will vary between zones, but some level of zone blending should occur to increase habitat complexity and provide a more natural look. The species proposed for each zone (as reported in GBC Winstone 2016b) are as follows:

Table 1: Riparian Dry Zone species list

Botanic name	Common name
Coprosma areolata	thin-leaved Coprosma
Coprosma crassifolia	mikimiki
Coprosma repens	taupata
Coprosma rhamnoides	twiggy coprosma
Coprosma rotundifolia	round-leaved Coprosma
Dodonea viscosa	akeake
Dysoxylum spectabile	kohekohe
Elaeocarpus dentatus	hīnau
Geniostoma ligustrifolium	hangehange
Hedycarya arborea	porokaiwhiri, pigeonwood
Knightia excelsa	rewarewa
Leptospermum scoparium	mānuka
Lophomyrtus bullata	Ramarama
Lophomyrtus obcordata	rōhutu
Melicope ternata	whārangi
Melicope simplex	poataniwha
Melicytus ramiflorus	māhoe
Metrosideros robusta	northern rātā
Microlaena stipoides	bush rice grass
Myoporum laetum	ngaio

Myrsine australis	māpou
Neomyrtus pedunculata	rōhutu
Nestegis cunninghamii	black maire
Nestegis lanceolata	white maire
Nestegis montana	narrow-leaved maire
Olearia paniculata	akiraho
Ozothamnus leptophyllus	tauhini
Pennantia corymbosa	kaikōmako
Piper excelsum	kawakawa
Pittosporum eugenoides	tarata, lemonwood
Pittosporum tenuifolium	kōhūhū, black matipo
Podocarpus totara	tōtara
Pseudopanax crassifolius	horoeka
Strebulus heterophyllus	tūrepo

Table 2: Emergent and Submerged Zones species list

Botanic name	Common name	Emergent	Submerged
Austroderia toetoe	toetoe	✓	
Carex buchananii	Buchanans sedge	✓	
Carex lessoniana	swamp sedge	✓	
Carex maorica	Maōri sedge	✓	✓
Carex secta	pūrei	✓	✓
Carex virgata	pūkio	✓	✓
Coprosma robusta	karamū	✓	
Coprosma tenuicaulis	swamp coprosma	✓	
Eleocharis acuta	sharp spike sedge		✓
Eleocharis gracilis	slender spike sedge		✓
Eleocharis sphacelata	kutakuta, spikes of doom		✓
Isolepis prolifera		✓	
Juncus australis	wīwī	✓	
Juncus pallidus	giant rush	✓	
Juncus planifolius	grass-leaved rush	✓	
Juncus sarophorus	fan-flowered rush	✓	
Luzula picta var. picta		✓	
Machaerina tenax		✓	
Melicytus ramiflorus	māhoe	✓	
Phormium tenax	harakeke	✓	
Schoenoplectus tabernaemontani	kaūwa		✓
Schoenoplectus maschalinus	dwarf bog marsh	✓	
Sparganium subglobosum	mārū		✓
Typha orientalis	raupō		✓

The species listed, as reported in the site-wide rehabilitation plan (2016), are appropriately diverse and suitable to the site. Some taxa, such as ngaio, are generally associated with more coastal environments, but are also found in inland lowland forests, and the coastal influences visible in the onsite remnant indicates their suitability for this site. In addition to the list above, we would recommend adding aquatic plants manihi (Potamogeton cheesemanii) and common water milfoil (Myriophyllum propinquum). There is a significant precedence in New Zealand for the deliberate and accidental introduction of exotic plants and fish into water bodies. Although exotic introductions are difficult to avoid, the active establishment of a native aquatic flora may help to prevent establishment and exotic dominance. Additional species suitable for the riparian zone include tī kouka (Cordyline australis) and mingimingi (Coprosma propinqua). Additional suitable species for the dry zone area would include tītoki (Alectryon excelsus), tawa (Beilschmedia tawa), rawiritoa (Kunzea amathicola), puahou (Pseudopanax arboreus), and kōwhai (Sophora microphylla).

4.3 Plant Placement and Spacing

Plants should be positioned in their most appropriate place with regard to the plants' tolerance to moisture gradient, substrate type and incline, and exposure. Although the plant list can be roughly divided into three zones (submerged, emergent, and dry), each zone should blend into the next, in a natural manner, rather than be planted in distinct blocks. In addition to providing a more natural appearance, this will also help to increase habitat complexity and provide a better quality of habitat. Avoid placing trees likely to grow over 5.0 m in height on the north-western corner, as this will impede wind access to the lake. Wind access helps to stir the lake, and improves water quality. Planting taller trees on the northern aspect has beneficial effects from increased shading, and therefore cooling, of the pond.

Plant spacing must be adequate to allow the vegetation to present with a closed canopy within five years from planting. Appropriate spacing will provide protection to the interior plants from exposure; smaller plants, such as sedges, will require less space than large shrubs or trees.

Table 3: Recommended plant spacing and suggested approximate numbers for Ashford Park Stage 1.

Botanic name	Common name	Spacing (m)	Approx. Number
DRY RIPARIAN ZONE			
Coprosma areolata	thin-leaved Coprosma	1	48
Coprosma crassifolia	mikimiki	1	54
Coprosma repens	taupata	1	46
Coprosma rhamnoides	twiggy Coprosma	1	48
Coprosma rotundifolia	round-leaved Coprosma	1	54
Dodonea viscosa	akeake	1.5	37
Dysoxylum spectabile	kohekohe	5	11
Elaeocarpus dentatus	hīnau	5	11
Geniostoma ligustrifolium	hangehange	1	46
Hedycarya arborea	porokaiwhiri, pigeonwood	5	3
Knightia excelsa	rewarewa	5	11

Leptospermum scoparium	mānuka	1	32
Lophomyrtus bullata	Ramarama	1	66
Lophomyrtus obcordata	rōhutu	1	66
Melicope ternata	whārangi	1	54
Melicope simplex	poataniwha	1	54
Melicytus ramiflorus	māhoe	1.5	31
Metrosideros robusta	northern rātā	5	11
Microlaena stipoides	bush rice grass	0.5	92
Myoporum laetum	ngaio	2	23
Myrsine australis	māpou	1.5	32
Neomyrtus pedunculata	rōhutu	2	32
Nestegis cunninghamii	black maire	2	33
Nestegis lanceolata	white maire	2	27
Nestegis montana	narrow-leaved maire	2	40
Olearia paniculata	akiraho	2	40
Ozothamnus leptophyllus	tauhini	1	82
Pennantia corymbosa	kaikōmako	1.5	55
Piper excelsum	kawakawa	1.5	55
Pittosporum eugenoides	tarata, lemonwood	5	8
Pittosporum tenuifolium	kōhūhū	5	17
Podocarpus totara	tōtara	5	16
Pseudopanax crassifolius	horoeka	2	36
Strebulus heterophyllus	tūrepo	1	82
Total			**1354**
EMERGENT ZONE			
Austroderia toetoe	toetoe	1.5	68
Carex buchananii	Buchanans sedge	1	51
Carex lessoniana	swamp sedge	1	51
Carex maorica	Maōri sedge	1	51
Carex secta	pūrei	1	51
Carex virgata	pūkio	1	51
Coprosma robusta	karamū	1.5	54
Coprosma tenuicaulis	swamp Coprosma	1.5	34
Isolepis prolifera		0.5	102
Juncus australis	wīwī	1	81
Juncus pallidus	giant rush	1	51
Juncus planifolius	grass-leaved rush	1	51
Juncus sarophorus	fan-flowered rush	1	51
Luzula picta var. picta		0.5	41
Machaerina tenax		1	51
Melicytus ramiflorus	māhoe	2	25
Phormium tenax	harakeke	2	51
Schoenoplectus maschalinus	dwarf bog marsh	1	20

Total			**935**
SUBMERGED ZONE			
Carex maorica	Maōri sedge	0.7	281
Carex secta	pūrei	0.7	422
Carex virgata	pūkio	0.7	281
Eleocharis acuta	sharp spike sedge	0.7	281
Eleocharis gracilis	slender spike sedge	0.7	281
Eleocharis sphacelata	kutakuta, spikes of doom	0.7	281
Schoenoplectus tabernaemontani	kaūwa	0.7	281
Sparganium subglobosum	mārū	0.7	281
Typha orientalis	raupō	0.5	591
Total			**2983**
GRAND TOTAL			**5272**

4.4 ECOSOURCING

In accordance with Section 50 of the Conditions of Consent (RM150184), all native plants shall be ecosourced from indigenous species from the Wellington Ecological District. Ecodistricts are determined by landscape and plant community similarity rather than local government districts, and allow the preservation of plants adapted to the local conditions. The Ōtaki ecodistrict follows the west coast from just south of Turakina on the north, down to Paekakariki in the south (Figure 6).

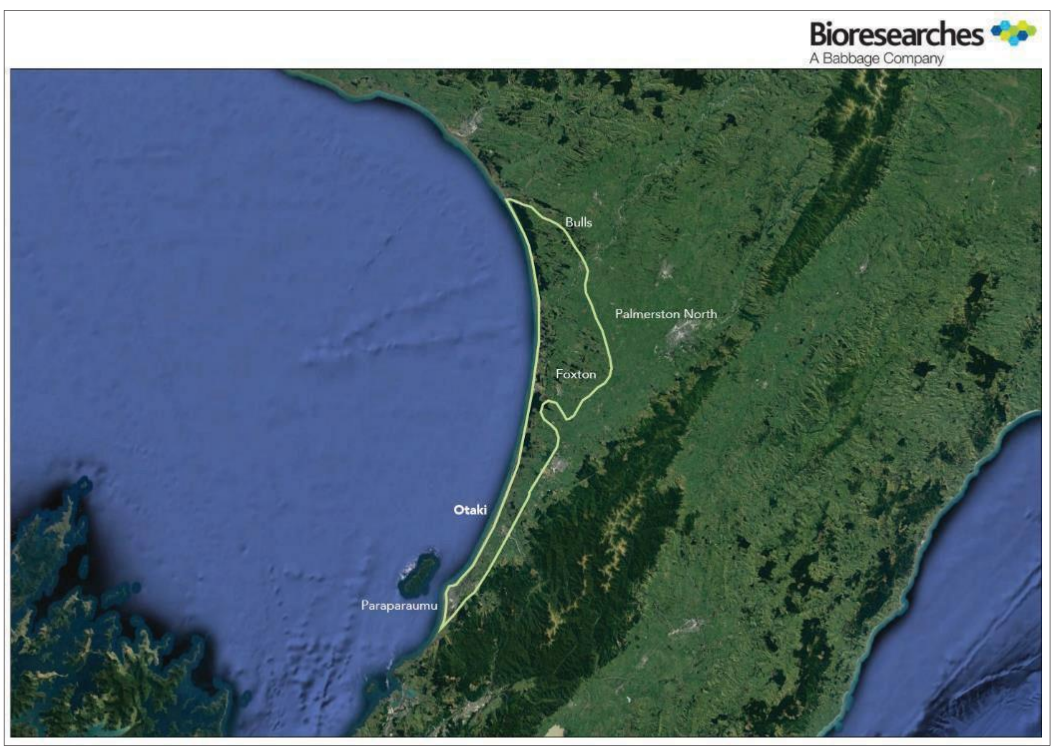

Figure 6: Ōtaki ecodistrict boundaries, based on the Department of Conservation map viewer (maps.doc.govt.nz), accessed 26th September, 2017. Seeds may be sourced from anywhere within the light green boundary.

Ecosourcing maintains the unique characteristics of the local flora, and because local plants are better adapted to the area, they tend to survive better and reduce ongoing maintenance costs. The following guidelines should be followed:

- Collect seed rather than plant cuttings wherever practicable, as this maintains genetic diversity.
- Maternal plants should be uncultivated (wild-sourced) wherever possible.
- Collect no greater than 10% of plants' seeds, and avoid utilizing the same plant multiple times.
- Select seed from multiple plants across different sites. Plants situated closely next to each other are likely to be closely related.
- Always obtain permission from the landowner before collecting seed or other plant material
- Maintain thorough records of seed species collected, source locations, collection dates, and habitat characteristics from the maternal plant site.

4.5 Success Parameters

In ecological restoration, success is often thought of as achieving a greater closeness of the site to its pre-degradation state; however, the Ashford Park project does not aim to replicate the ecosystems present prior to the extraction of gravel on site. Rather, the project seeks to replace the previous ecosystem (primarily low ecological quality pasture) with very different ecosystems - a freshwater lake system and surrounding riparian margins. Therefore, it is more appropriate to describe this project as a 'rehabilitation' of the area, rather than 'restoration'.

The common problem within restoration ecology of a lack of quantifiable success parameters is relevant to this project. Without a definition of success, it is impossible to track progress towards that goal, or to adapt management strategies in future rehabilitation stages in response to past successes or failures (Suding, 2011).

Desired traits	Attribute	Success Criteria	Timeframe
High level of water quality and long term ecological health of the formed lake.	Water depth sufficient to maintain long-term ecological health.	A depth of at least 5.0 m for >25% (but preferably >50%) of the lake area during summer.	Lake formation occurs prior to rehabilitation, but should be measured at the lowest expected water level (summer).
	Phytoplankton concentration in mg/m^3 (milligrams chlorophyll-a per cubic metre)*	Annual median of ≤5, with an annual maximum of ≤25 (Attribute state B or greater).	Within the first year, and each year thereafter.
	Total Nitrogen, measured in mg/m^3 (milligrams per cubic metre)*	Annual median of ≤350, with an annual maximum of ≤500 (Attribute state B or greater).	Within the first year, and each year thereafter.
	Total Phosphorus, measured in mg/m^3 (milligrams per cubic metre)*	Annual median of ≤20 (Attribute state B or greater).	Within the first year, and each year thereafter.
	Ammonia, measured in mg NH_4-N/L (milligrams ammoniacal-nitrogen per litre)*	Annual median of ≤0.24, with an annual maximum of ≤0.40 (Attribute state B or greater).	Within the first year, and each year thereafter.

Water suitable for human recreational use (such as wading, kayaking etc., i.e. not swimming)	*E. coli*, measured in *E. coli*/100 mL (number of *E. coli* per hundred millilitres)*	Annual median of ≤540 (Attribute state B or greater).	Prior to public access, calculated every three years thereafter.
	Planktonic cyanobacteria, measured by biovolume mm^3/L (cubic millimetres per litre) OR cell Count – cells/mL*	80^{th} percentile calculation of ≥12 samples collected over 3 years, measuring ≤1/8 mm^3/L biovolume equivalent of potentially toxic cyanobacteria OR ≤10mm^3/L total biovolume of all cyanobacteria.	Prior to public access, calculated every three years thereafter.
*Meets the National Policy Statement for Freshwater Management (2014) guidelines for lakes.			
Ecologically functional riparian vegetation.	Vegetation dominated in all tiers by native species.	<5% invasive taxa biomass.	From planting completion, and each year thereafter.
	Vegetation density sufficient to provide shading, habitat, and filtering services.	75% canopy coverage (no greater than 25% open areas).	Within 5 years.

4.6 Recreational Values and Access

The end design of the lake includes the lake as a recreational amenity, with walking paths and a cycleway, which will provide beneficial recreational values to the community. In addition to having visual access to the lake, access will be required to the main waterbody for recreational use such as kayaking and for the management of the islands. However, it is important that the need for human movement does not negatively impact the health or functioning of the vegetation.

The vegetation structure should be lower at the north-west and south-east corners and higher in the north-east to allow wind movement to disrupt the water surface and promote water circulation, and maximum shading benefits. This gap in larger vegetation provides a good opportunity to create entrances to the lake.

If a walkway is to be added, it would be preferable to use permeable surfaces rather than traditional concrete, to allow water and oxygen movement into the soils. There are a number of products available that allow permeability, such as Firth EcoPave paving and Stevenson Pervious Concrete.

5 SUMMARY AND RECOMMENDATIONS

The rehabilitation of the gravel extraction quarry at Ashford Park, Ōtaki, in the Wellington Region, will result in the formation of a large lake with two forested islands and a wide surrounding riparian margin.

The quarry is a staged project, set to take place over a twenty year period and the resource consent conditions stipulate that a stage-specific plan must be created for each stage, preceding the commencement of the following stage. This is a good opportunity to adapt management strategies based on the successes over the earlier stages. Currently, the quarry is in the first stage.

To encourage successful rehabilitation in Stage One, the following recommendations have been made:

- Specific goals with measurable ecological outcomes should be used to define success at each stage. These goals and definitions of success have been provided in Section 4.5 and should include water quality levels meeting or exceeding National Policy Statement for Freshwater Management (2014) standards B or greater.

- Ongoing weed management and additional infill planting will be required. Management shall meet the requirements of the Greater Wellington Pest Management Strategy, and supress invasive species to less than 5% relative abundance.

- All plants used should be suitable for the site, and their positioning in the riparian system. Plants must be native, and ecosourced from the Ōtaki ecological region.

- Where vegetation or habitat removal is required, appropriate fauna management and mitigation would be required to ensure no net loss of biodiversity. For example, all clearance of vegetation should be undertaken outside of the main native bird-breeding season (September – December inclusive) to avoid disturbance or harm to nesting birds. Lizard management is not considered necessary where suitable habitat (restricted to the planted riparian margins of Watercourse 2) is retained and protected.

- Bare ground exposed by site works alongside the lake should be stabilised and replanted with appropriate vegetation as soon as possible.

6 REFERENCES

Boffa Miskell Limited. (2016). *Ashford Park Gravel Extraction Rehabilitation Strategy*.

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7 APPENDIX I – PLANTING, PEST MANAGEMENT, AND MAINTENANCE

7.1 Site Preparation

Top soil removed during the excavation process will be used to dress the surface following margin formation. Soil depth should be no less than 300 millimetres. Except as tablets or pellets placed within the holes prior to planting, application of fertilizer to the soils should be avoided as this will enter the lake and promote algal growth.

If soil is to be left for prolonged periods prior to planting, weedy taxa will likely establish. In this case, control weeds prior to the planting seasons. For the riparian (wet) areas, this will be over winter, to ensure readiness for summer planting, but for the dry areas weeding should occur over summer, to allow for planting during autumn to winter.

7.2 Pest Animals

Rabbits and pukeko are likely to provide the greatest pest, especially to the new soft shoots in the young plantings. Control rabbits down to low densities prior to the planting season using Pindone® rabbit pellets in a multi-feeder bait station. Follow dosage and interval instructions provided on the product information, and continue management to maintain low densities throughout the project length.

Although native, pukeko are occasionally considered to be pests, as they will pull-up and eat newly planted vegetation. Plastic tube cloches around young plants have been used successfully as pukeko deterrents and are strongly recommended here. If cloches are not implemented, or in areas close to the lake edge where plastic is inappropriate, ensure plants are firmly planted and are not easy to pull out.

7.3 Planting Methodology

Planting should be undertaken in multiple stages. The first stage uses robust plants that are exposure tolerant. These plants create the first root network system, stabilizing the clay banks, and provide a nursery for the second stage plantings. The second stage can then “infill plant” with plants that require protection from excess heat and wind. The season that planting should occur in both stages differs between vegetation zones. For plants in the water, or in the wet edge, plant in summer. During summer, the water level is likely to be lower, and these areas will be at their most accessible. For drier areas, access isn’t an issue, and the standard autumn to winter planting season should be used. Cooler months are generally used for terrestrial planting because it provides the plants with the greatest possible time to establish their root systems before the hotter months approach.

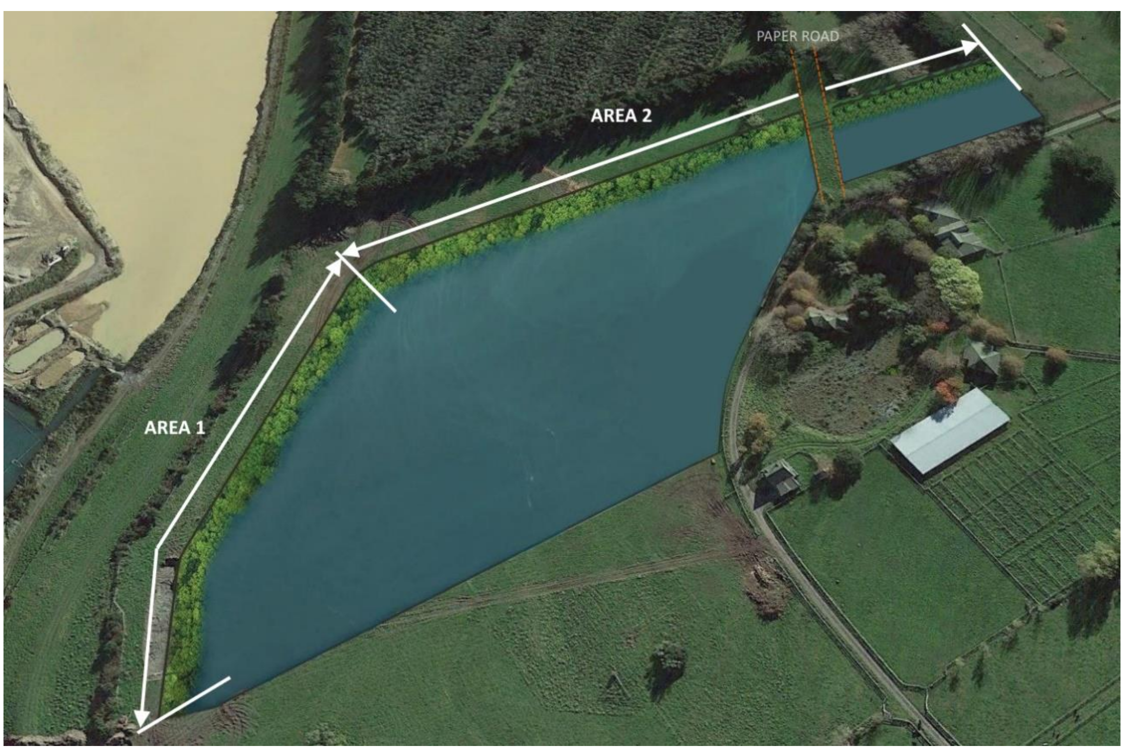
Water plants thoroughly and allow to drain out of direct sunlight. Set them out on site at the distances recommended in Table 3. Dig out a hole at least 1.5 – 2 times larger than the plant root ball. The application of mycorrhizal fungi to the soils during planting will allow strong root growth and increased nutrient uptake, and should be considered. This may be unnecessary if the topsoil has retained the mycorrhizal communities that were likely present prior to excavation. If unsure, trial plants with and without added mycorrhizae in the soil prior to the main planting event. Remove the plant carefully from the bag. If the plant is root bound, untangle the roots carefully to help them to grow. **Do not** do this with mānuka as the roots are very sensitive. Place a plastic cloche over the plant, secured with stakes, to protect the seedling from wind and pukeko browsing.

7.4 PLANTING TIMELINE

The following parameters are relevant to how the planting will occur (see table below):

1. All three planting zones (Dry, Emergent and Submerged) must first be planted with robust species, and then with infill plants once the robust plants have created a root network system.
2. As noted in 7.3 above the Dry and Emergent Zones must be planted during the autumn to winter planting season. The Submerged Zone must be planted in the summer planting season when water levels are lower.
3. To allow for operational requirements, the planting will be split into two areas (see below) with the first area planted in years one and two and the second area in years three and four.
4. It is anticipated that Year 1 will be 2019 (i.e. the first planting will start summer 2019)

		YEAR 1		YEAR 2		YEAR 3		YEAR 4	
		SPRING/SUMMER	AUTUMN/WINTER	SPRING/SUMMER	AUTUMN/WINTER	SPRING/SUMMER	AUTUMN/WINTER	SPRING/SUMMER	AUTUMN/WINTER
AREA 1	DRY ZONE		PLANT ROBUST SPECIES		PLANT INFILL SPECIES				
	EMERGENT		PLANT ROBUST SPECIES		PLANT INFILL SPECIES				
	SUBMERGED	PLANT ROBUST SPECIES		PLANT INFILL SPECIES					
AREA 2	DRY ZONE						PLANT ROBUST SPECIES		PLANT INFILL SPECIES
	EMERGENT						PLANT ROBUST SPECIES		PLANT INFILL SPECIES
	SUBMERGED					PLANT ROBUST SPECIES		PLANT INFILL SPECIES	



7.5 ONGOING MAINTENANCE

Ongoing maintenance is important to ensure plant survivorship and native plant dominance and density. Plants will need to be released from weeds, and any that have died will need to be replaced. If weed release is undertaken using herbicide, extreme care is required to prevent spray drift from reaching the native plants. Only herbicides which explicitly state they are safe for use near waterbodies shall be used. No herbicides should be stored or mixed on site. Maintenance should normally last for at least five years, and decrease in frequency with time.

Year	1	2	3	4	5
Number of maintenance visits	3	3	3	1	1

However, the first stage of rehabilitation will remain the responsibility of GBC Winstone for the remainder of the 20 year project timeframe. It is likely that, over the course of this period, reinvasion will occur. Although smaller annual weeds are less likely to become problematic once canopy coverage has been established, vines (such as Japanese honeysuckle (Lonicera japonica), jasmine (Jasminum polyanthum), and moth plant (Araujia hortorum)) or woody weeds such as Chinese privet (Ligustrum sinense) or woolly nightshade (Solanum mauritianum) endanger native vegetation at all life stages.

7.6 WEED MANAGEMENT

Because the planting site will be sculpted post-excavation, there will be no weedy taxa present in the initial stages. However, there is a well-documented association between weedy species and disturbance, providing a strong likelihood of future invasive. The Greater Wellington Regional Council has assessed weedy taxa of a particular threat to the region, which are discussed within the Wellington Regional Pest Management Strategy (RPMSP) (2009). All species mentioned within the Wellington RPMS should be controlled, however species listed as 'Total Control' or 'Containment' species must be controlled immediately - even if the observation occurs outside of the schedules monitoring and management period. Weed management options can be found at Weed Busters (www.weedbusters.org.nz).

The utmost care must be taken to ensure that only herbicides appropriate for use near waterways is used. Only some foliar herbicides are suitable for use next to waterways, including Diquat and glyphosate products Roundup®, Trounce®, and Zero®. Other herbicides, such as metsulfuron and Tordon® Brushkiller can be applied directly to cut stumps. Herbicide pouring and dilution must not be carried out within 20 m of the stream or any storm water drains, and no herbicides may be used over water unless explicitly recommended on the manufacturer's label. At no point may herbicides be used in any manner which may result in contamination of waterways.

Great care shall be taken to protect all retained vegetation from contact with herbicide. The persons undertaking weed management should be suitably qualified, and be mindful of retained vegetation, potential contamination of waterways and the health of humans and wildlife when using herbicides.

Table 4: Wellington RPMS species

Species	*Common name*	*Wellington RPMS level*
Akebia quinata	Chocolate vine	*Surveillance species*
Alternanthera philoxeroides	Alligator weed	*Surveillance species*
Bomarea caldassi	Bomarea	*Surveillance species*
Bomarea multiflora	Bomarea	*Surveillance species*
Carex longebrachiata	Australian sedge	*Surveillance species*
Gymnocoronis spilanthoides	Senegal tea	*Surveillance species*
Houttuynia cordata	Houttuynia	*Surveillance species*
Lythrum salicaria	Purple loosestrife	*Surveillance species*
Nassella neesiana	Chilean needlegrass	*Surveillance species*
Nassella trichotoma	Nassella tussock	*Surveillance species*
Pennisetum alopecuroides	Chinese pennisetum	*Surveillance species*
Pennisetum setaceum	African fountain grass	*Surveillance species*
Polypodium vulgare	polypodium	*Surveillance species*
Reynoutria japonica	Asiatic knotweed	*Surveillance species*
Reynoutria sachalinensis	Giant knotweed	*Surveillance species*
Sagittaria montevidensis	Californian arrowhead	*Surveillance species*
Sagittaria platyphylla	Delta arrowhead	*Surveillance species*
Sagittaria sagittifolia	Hawaiian arrowhead	*Surveillance species*
Schoenoplectus californicus	Californian bulrush	*Surveillance species*
Solanum linnaeanum	Apple of Sodom	*Surveillance species*
Solanum marginatum	white-edged nightshade	*Surveillance species*
Spartina spp.	Spartina	*Surveillance species*
Tropaeolum speciosum	Chilean flame creeper	*Surveillance species*
Xanthium occidentale	Noogoora bur	*Surveillance species*
Anredera cordifolia	madeira vine	*Total Control species*
Araujia hortorum	moth plant	*Total Control species*
Carthamus lanatus	saffron thistle	*Total Control species*
Celastrus orbiculatus	Climbing spindleberry	*Total Control species*
Passiflora caerulea	Blue passionflower	*Total Control species*
Pennisetum macrourum	African feather grass	*Total Control species*
Solanum mauritianum	woolly nightshade	*Total Control species*
Urtica dioca	perrenial nettle	*Total Control species*
Vallisneria gigantea	eelgrass	*Total Control species*
Vallisneria spiralis	eelgrass	*Total Control species*
Xanthium spinosum	Bathurst bur	*Total Control species*
Zizania latifolia	Manchurian wold rice	*Total Control species*
Ceratophyllum demersum	Hornwort	*Containment species*

Chrysanthemoides monilifera	boneseed	*Containment species*
Polygala myrtifolia	sweet pea shrub	*Containment species*
Rhamnus alaternus	evergreen buckthorn	*Containment species*

7.7 MYRTLE RUST

Some of the plants recommended in this plan (mānuka, ramarama, and rātā) are susceptible to myrtle rust. Myrtle rust is a serious fungal disease that is expected to affect all plants within the myrtle family (Myrtaceae), including mānuka, kānuka, pōhutukawa, rātā, ramarama, feijoa, and eucalyptus. Spores are microscopic and windborne. It generally attacks soft, new growth, including leaves, shoots, buds, flowers, and fruit. This can cause yellow powdery eruptions on the leaves, which may turn into brown or grey pustules in older infections. It may also look like a grey 'fuzzy' growth on the undersides of leaves. If you suspect the presence of myrtle rust, try to take a photo without touching the plant. Touching the plant may release spores into the environment. Then, call MPI immediately on 0800 80 99 66.