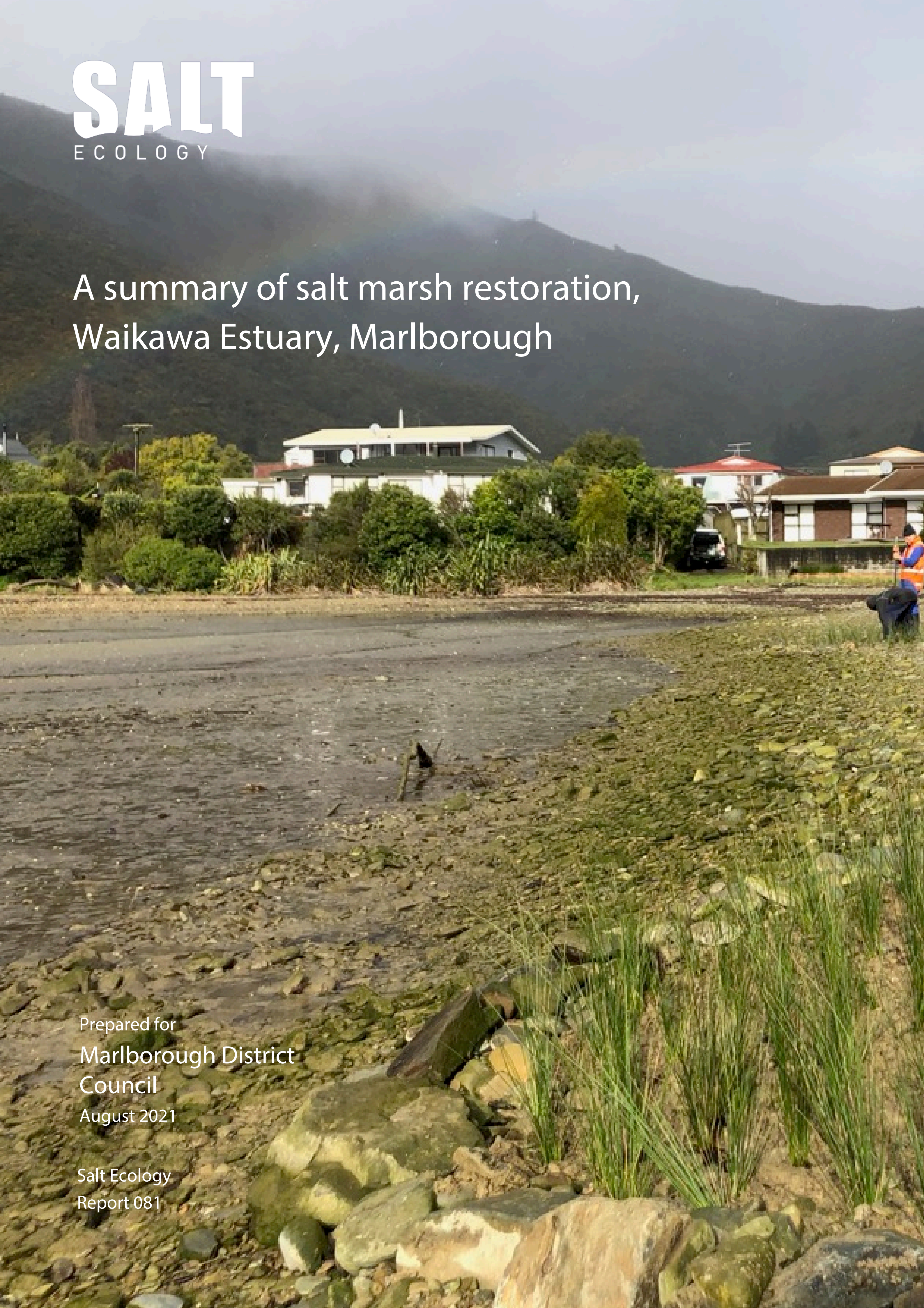

SALT
ECOLOGY

A summary of salt marsh restoration, Waikawa Estuary, Marlborough

Prepared for
Marlborough District Council
August 2021

Salt Ecology
Report 081

RECOMMENDED CITATION

Stevens LM, 2021. A summary of salt marsh restoration, Waikawa Estuary, Marlborough. Salt Ecology Report 081, prepared for Marlborough District Council, August 2021. 14p.

A summary of salt marsh restoration, Waikawa Estuary, Marlborough

Prepared by

Leigh Stevens,

for

Marlborough District Council

August 2021

leigh@saltecology.co.nz, +64 (0)21 417 936

www.saltecology.co.nz

TABLE OF CONTENTS

FIGURES

TABLES

SUMMARY

This short report summarises a ~1400m^2 estuary restoration project undertaken by Marlborough District Council at Waikawa, Picton. The proposal was developed with Te Ātiawa o Waka-a-Māui Iwi, the iwi which holds mana whenua and mana moana in Waikawa Bay and is the kaitiaki of Waikawa Bay and the cultural host to all who live, work and visit there.

The restoration provided offset mitigation for flood control work being undertaken in Waikawa Stream and involved augmentation of cobble and gravel substrate over ~800m^2 of the upper tidal range to reshape the estuary shoreline, construct a buried upper shore rock wall (for erosion protection), the realignment and reinforcement of two small stream mouths to prevent flooding and maintain fish passage, and planting of 2625 rushes and coastal shrubs over an area of 700m^2 including intertidal beds of searush protected with small rock chenier sills.

Schematic outline of the restoration area prior to development (left) and post-restoration reshaping and planting (right)

Restoration planting increased existing salt marsh extent by 350% from 200m^2 to ~900m^2, significantly enhancing biodiversity, reintroducing several historically displaced estuarine plant species, and providing natural protection from shoreline erosion.

Intertidal rushland planted behind chenier sills demonstrated that dense plantings were able to quickly establish and withstand prevailing conditions. Planting well-bedded root trainer specimens close together in deep narrow holes prevented plant erosion losses and rushes quickly grew into dense beds with high survivorship. Wider spaced plantings in more sheltered areas also demonstrated high survivorship. Intertidal plants showed more vigorous growth than plants in the supratidal or terrestrial zones. Glasswort, transplanted from a nearby estuary, was the least successful of the intertidal plantings. Several larger divots survived, but smaller plants separated out from larger divots and planted individually did not. It was unclear whether plants died from transplanting stress, desiccation, erosion or smothering.

Terrestrial plants had ~95% survivorship, assisted in part by the effective use of EmGuard plant guards. Plants were healthy but relatively slow growing, likely a combination of being initially planted in mid-winter when plants were relatively dormant, and then being subjected to a relatively hot and dry summer.

There were no weed problems associated with intertidal plants, but supratidal and terrestrial plants were adversely impacted by summer weed growth. While plant guards minimised smothering, regular weed maintenance was required. Proactive spraying in advance of terrestrial planting and regular grass trimming or maintenance spraying would have improved weed control, as would the use of mulch. Maintenance would also have been assisted by ensuring that all plants were marked with stakes, and by clearly marking planting areas with temporary fencing and/or signage.

In terms of project management, the key insights gained were ensuring planning decisions are guided by stakeholder input, but are ultimately decided by subject experts, and ensuring that the scheduling of physical works allows adequate time to grow plant species to order. The high level of community engagement with the project team and Te Ātiawa o Waka-a-Māui Iwi was a hugely important component of the overall project success. While the ecological improvements were significant in their own right, wider benefits accrued from incorporating Te Ātiawa recommendations on site enhancement to redress historical damage to the estuary, and to demonstrate the effective restoration of salt marsh habitat in a relatively simple and cost-effective manner. Overall, this project typifies how modern holistic environmental and ecological river engineering works can be carried out and should be used as an exemplar for future such works.

To ensure the ongoing success of the plantings it is recommended that 3-6 monthly site maintenance visits are continued over the next 2 years to manage weeds, repair chenier sills, and reset plant guards as necessary.

The site also offers further opportunities for improvement that could potentially be linked to offset restoration for the nearby marina development or future river works.

1. INTRODUCTION

1.1 Overview

This short report provides a brief overview of an estuary restoration project recently undertaken by Marlborough District Council (MDC) within the coastal marine area and on adjacent Council reserve land at Waikawa, Picton. The proposal was developed with Te Ātiawa o Waka-a-Māui Iwi, the iwi which holds mana whenua and mana moana in Waikawa Bay and so, is the kaitiaki of Waikawa Bay and the cultural host to all who live, work and visit there.

The site and the proposed restoration works are summarised in Figures 1 and 2. The project was conceived and initiated by MDC Rivers Operations Engineer David Aires with MDC Environmental Scientist Steve Urlich (now at Lincoln University) providing technical support for the original restoration plan. This followed a 2016 broad scale habitat mapping report (Stevens & Robertson 2016) which recommended replanting estuary salt marsh and margin vegetation to improve ecological values significantly degraded by historical habitat modification.

MDC identified an opportunity to redress some of the past habitat losses when undertaking flood control work in the Waikawa Stream. It was proposed that sediment being dredged from the stream to increase flood capacity could be used to reshape the Waikawa Estuary shoreline by widening the existing upper margin and creating a gently sloping shore profile to dissipate wave energy and allow replanting of intertidal and terrestrial salt marsh (Fig. 1). This would increase ecological biodiversity and resilience and improve amenity values.

The shoreline reshaping also had cost benefits in enabling dredged material to be deposited locally and will result in future savings from preventing or minimising shoreline erosion by dampening wave action and stabilising the shore with salt marsh plantings.

Because this estuary restoration work was the first of its type to be undertaken by MDC, this report provides an overview of the work undertaken and highlights the lessons learned so that future work of this nature benefits from the experience gained.

1.2 Site description

Waikawa Estuary is a small (3.4ha), shallow, well-flushed, seawater-dominated, river delta type estuary that opens to Waikawa Bay in Queen Charlotte Sound. Its substrate largely comprises a sloping berm of coarse material on the upper foreshore, and intertidal sand and mud flats with extensive beds of seagrass in the lower tidal range. A narrow strip of eroding terrestrial grass and weeds, backed by vertical block or wooden retaining walls in many places, is present at the terrestrial margin (Fig. 1).

The ~1400m^2 estuary restoration involved augmentation of cobble and gravel substrate over ~800m^2 of the upper tidal range to reshape the shoreline, construction of a buried rock wall along part of the upper shore (for erosion protection), realignment and reinforcing of two small stream mouths to prevent flooding and maintain fish passage, and planting of 2625 rushes and coastal plants over an area of 700m^2 including intertidal beds of searush protected with small rock chenier sills (Fig. 1).

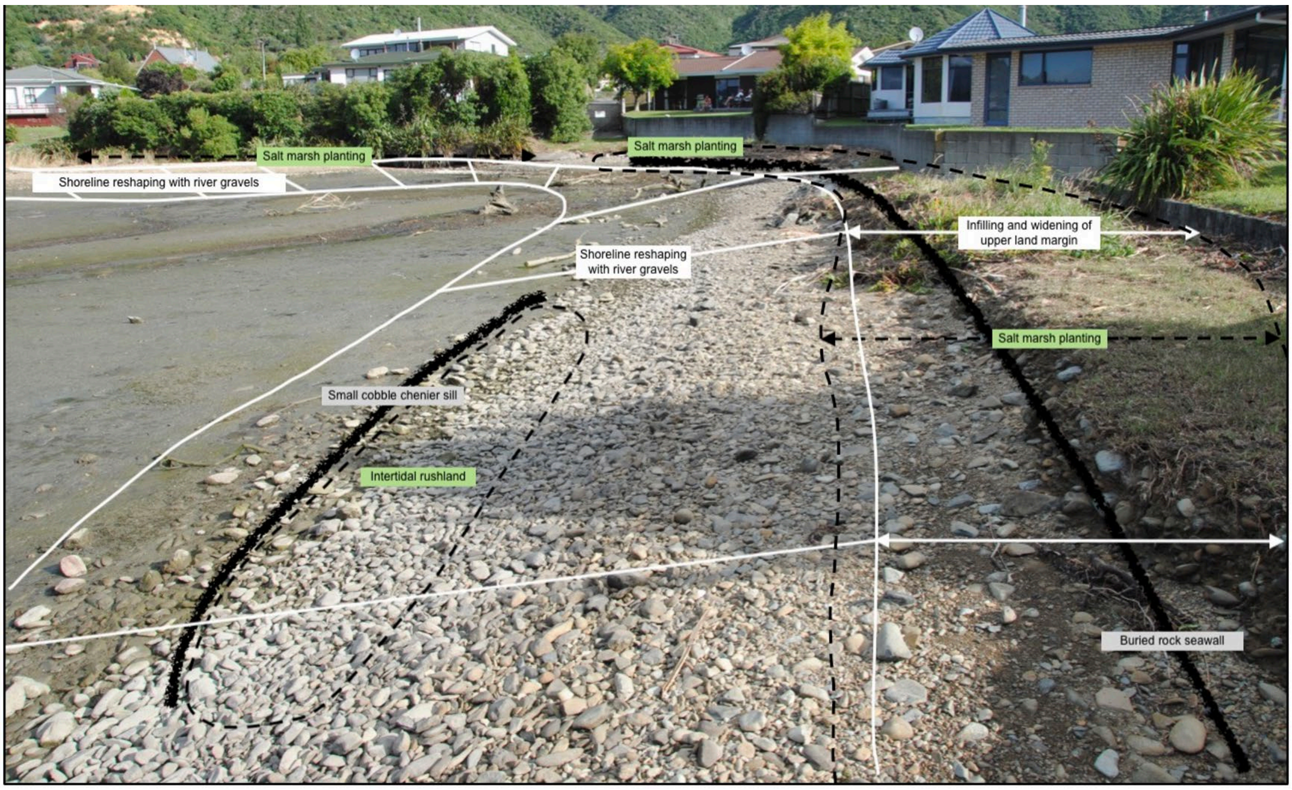

Fig. 1 Schematic outline of the main restoration area showing the general layout of reshaping and planting.

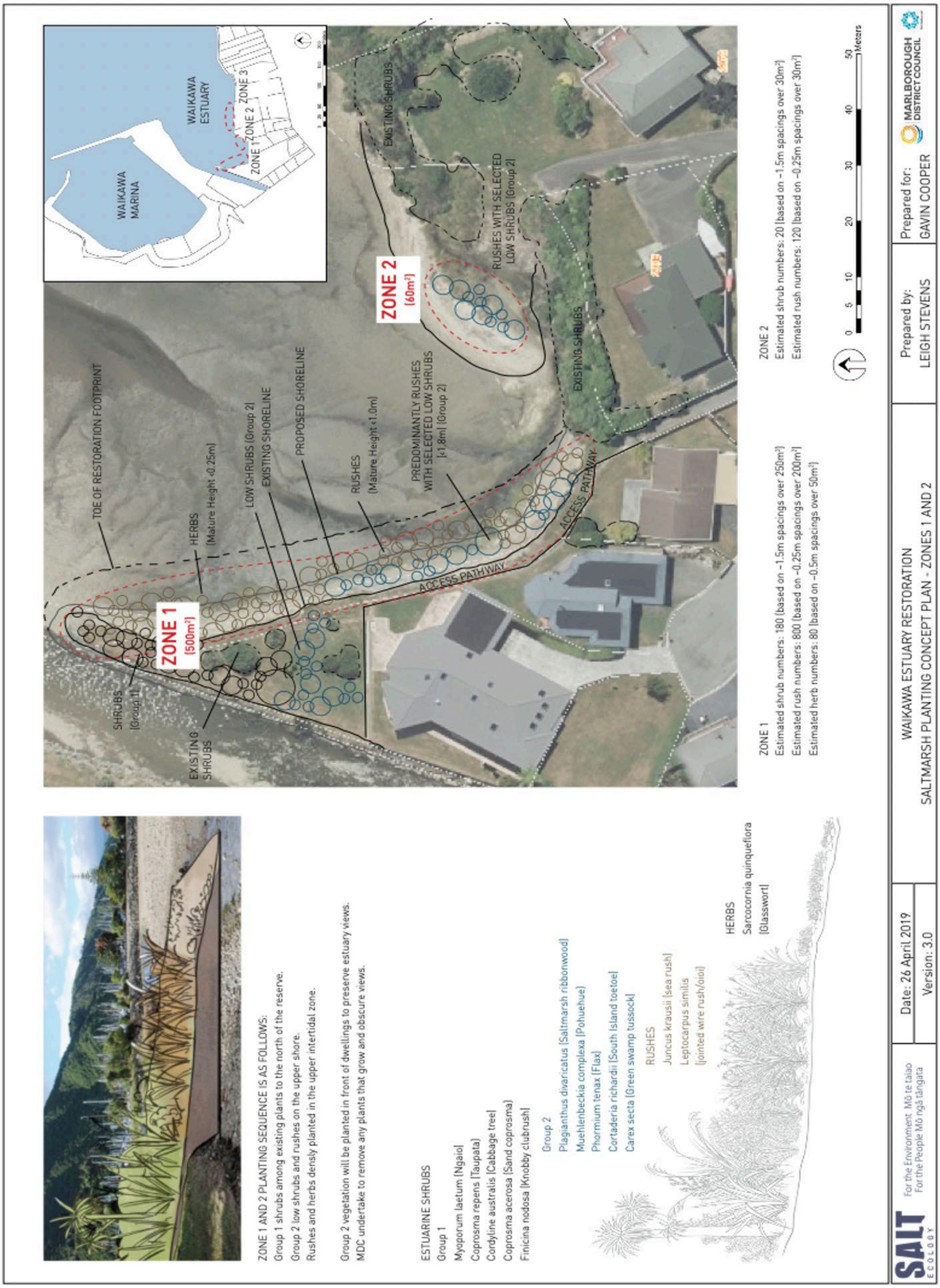

Fig. 2 Landscape design plan prepared for stakeholder consultation.

2. INITIAL PLANNING

2.1 Early scoping

In June 2017, approximately 1 year prior to the flood control and restoration projects commencing, a digger was used to excavate test pits in sediments to be dredged from Waikawa Stream. The purpose was to assess whether there were any contaminants present at concentrations of concern, and to ensure that the material extracted would be fit-for-purpose in reshaping the shoreline, primarily that the sediment mud content was relatively low, e.g. <10%, but that there was still sufficient sand and gravel for planting salt marsh, i.e. not all cobble.

Excavating test pits in Waikawa Stream to assess sediment composition and test for the presence of contaminants

Representative sediment samples were analysed by RJ Hill Laboratories for a suite of common indicators of physical or contaminant conditions, e.g. % mud/sand/gravel, total organic carbon, trace metals, semi-volatile organic compounds, tributyl-tin, and total petroleum hydrocarbons. Results showed that sediments contained no contaminants at concentrations known to pose any ecological risk. The streambed sediment was also considered appropriate for use in shoreline reshaping and restoration of salt marsh habitat with a low mud content (<2%) and a mix of larger grain sizes.

Lesson learnt

By collecting baseline information to address issues that could potentially prevent the activity from commencing, and addressing potential issues up front, initial planning was well informed from the outset. Consequently, subsequent planning effort was cost-effectively focused on relevant issues and specific areas where additional effort/information was needed.

2.2 Project design

Following initial sediment evaluation, a draft landscape design plan was prepared by Salt Ecology of potential shoreline reshaping and salt marsh restoration options (Fig 2). The draft plan was a starting point for consultation with Te Ātiawa-o-Te Waka-a-Māui Iwi, adjoining landowners and other stakeholders. (e.g. Port Marlborough, Waikawa marina) It also contributed to wider consent planning and project design needs, for example, estimates of sediment volumes and plant numbers to provide ballpark estimates of restoration costs. The draft plan was subsequently refined based on feedback and used as part of the resource consent application.

Lesson learnt

The draft concept plan proved helpful in communicating the project to stakeholders, enabled initial costings to be made, and identified specific areas where additional work was needed.

2.3 Consultation and Consenting

Project consultation and a publicly notified consent application was managed by MDC and GDC Consulting. The proposed restoration was on Council reserve land or within the coastal marine area, with specific approval sought from key stakeholders. Early consultation with Te Ātiawa resulted in strong support for the initiative, valuable feedback on the proposed restoration and the identification of areas of significance that required special consideration.

Seeking consent from adjoining landowners was generally straightforward and feedback was positive. However, there was some opposition to the project plan from one absentee landowner. The opposition led to changes in the restoration plan (i.e. inclusion of a grass buffer between the salt marsh and properties), additional consent conditions and commitment to the future removal of plants on council reserve should they exceed agreed heights. The requested changes compromised the restoration goal, lessened the ecological value of the restoration and required iterative changes to the plans which increased cost, delayed the consenting process, and increased long-term maintenance costs (by replacing low maintenance plantings and landscaping with higher maintenance grass strips).

Lesson learnt

After agreement with tangata whenua, restoration plans should be presented to stakeholders (e.g. via workshops) prior to consenting to socialise the purpose of the project and incorporate collective feedback.

Ecological restoration design decisions should incorporate stakeholder feedback but should maintain the integrity of the restoration goal and be determined by subject experts in partnership with tangata whenua and Council.

3. SITE PREPARATION

3.1 Stream dredging

The design and timing of the flood control works were determined by MDC following granting of the relevant resource consents. Consent conditions specified controls for trapping fine sediment and included construction of earth bunds to separate the work area from the estuary, and silt curtains to trap sediment downstream of the site. These conditions allowed machinery to operate within the streambed and to move between the stream work site and the estuary restoration area without transiting through water (see photo below). Work was also undertaken at low tide and during low flow in the stream to minimise the need to work in wetted areas.

Bunds separated the work site from the estuary to prevent off-site sediment impacts. Stream flow was maintained through a pipe passing through a silt trap (foreground).

3.2 Kick-off meeting

At the commencement of the project, an on-site meeting was held on 2 March 2020 with MDC staff, site contractors (Simcox), planners, Te Ātiawa and stakeholders. The purpose was to introduce key people in project management roles, define communication channels, discuss the agreed plans, and walk over the site to ensure there was a mutual understanding of the project scope. The meeting also provided an opportunity for any additional concerns or suggestions to be raised.

Lesson learnt

Defining key roles, contacts and communication channels made it easy to identify project responsibilities and points of contact.

Introducing stakeholders to the project team facilitated engagement and partnership.

3.3 Initial construction

Once sediment was available for use in the restoration, MDC staff, site contractors, planners, Salt Ecology, and iwi representatives walked over the restoration area on 9 March 2020 to discuss the proposed work and to mark out the area for shoreline reshaping. Any areas of ecological significance to avoid, e.g. seagrass beds, were highlighted. Areas of cultural significance were also discussed, and appropriate operating parameters agreed.

Initial reshaping work on the first day of construction was supervised with feedback provided by MDC, Salt Ecology and iwi representatives. This included delineating the shoreward extent of the earthworks for beach reshaping, and the location of the buried rockwall for erosion protection (see photos below).

After this, the site contractors worked independently using the site plans to guide the restoration work. Stream mouth realignment, undertaken on 13 March 2020, was also supervised by MDC, Salt Ecology and iwi representatives.

Before and after photos of the primary work site showing the extent of beach replenishment and buried erosion wall

Modified stream entrance with rock placement to minimise erosion

Despite being inexperienced in restoration work, the site contractors performed to a high standard and the initial time spent discussing both what was required and, more importantly, the reasons for why the work was being done in the way proposed, helped ensure that the intended outcome was delivered.

One direct benefit of initial on-site supervision was the ability to direct machinery to transplant salt marsh that would otherwise have been displaced or buried by the beach reshaping. This prevented loss of habitat, and enabled larges rushes to be strategically relocated where subsequent erosion was unlikely.

There were also situations where additional on-site contractor supervision would have proved beneficial. For example, the widening of the upper shoreline and terrestrial margin area in the south of Zone 1 (see Fig. 2) was greater than depicted in the site plan and also resulted in the unintended compaction and burial of small areas of rushland and seagrass. There were also impacts from machinery tracking through seagrass beds to gain access around the shoreline. While the effects were relatively minor and short-lived, the impacts were largely avoidable through more thorough marking of site boundaries and profiles or direct on-site supervision.

Vehicle tracks through seagrass beds. While resulting in relatively minor impacts, such effects were largely avoidable.

Potentially one of the greatest benefits of the project arose inadvertently during the reshaping of the two small stream mouths to the east of the site, both areas of high cultural significance. Due firstly to a mechanical delay, and then a delay due to high tide, there was a period of wide-ranging discussion between the site contractors, the iwi cultural representative, adjoining landowners and Salt Ecology and MDC staff that promoted a mutually beneficial increase in understanding the various perspectives each had on the restoration. In particular, the site contractor indicated that the increased awareness of ecological and cultural components would carry forward to future work.

Lesson learnt

Clear communication of desired outcomes is essential.

Targeted supervision by a subject expert can avert avoidable impacts or improve outcomes.

Providing context and explaining why work is done in a particular way fosters understanding of different perspectives that can deliver long-term gains.

3.4 Weed and pest control

No initial weed or pest control was undertaken. Existing weeds in the upper terrestrial margin were scraped from the site with a digger and replaced with imported topsoil which was smoothed and planted in grass to prevent soil erosion prior to salt marsh planting. The imported topsoil subsequently proved to be a significant source of weeds to the site.

Lesson learnt

Initial weed spraying prior to planting salt marsh species would have minimised subsequent maintenance reqirements.

4. RESTORATION PLANTING

4.1 Plant sourcing

The mix of plants to be used in the restoration were based on a suite of common salt-tolerant estuarine and coastal species (see Fig. 2 and Tables 1 to 4). Species were selected for their resistance to erosion, aesthetic values, salt and drought tolerance and habitat value. Because of consent constraints, plant height was a major determinant in the type of species planted.

Morgans Road Nurseries, a regular local supplier to MDC, was able to supply most of the plants selected ex-stock. The main exception was sea rush which is not routinely grown for commercial sale and had to be grown from seed specifically for the project. This required a 3-4 month lead-in period to planting.

Constraints were that growing plants from seed is difficult over the winter months (i.e. June-Aug), while delivery times needed to coincide with both the timing of the development as well as optimal planting periods, in particular avoiding planting at the start of summer when heat stress can cause high plant loss.

Plants were predominantly root-trainer size. These are cost-effective (~25% of the cost of larger potted plants), easy to plant and handle, have deep roots and have an additional benefit for intertidal planting in that the relatively small volume of soil within root trainers minimises the risk of plants floating out of the sediment at high tide. However, the trade-off is it takes longer for smaller plants to establish a canopy cover.

Lesson learnt

Early planning allows suppliers to ensure they have the species mix and numbers available when they are needed (i.e. optimal growing season).

4.2 Project timing

Delays to the scheduled commencement of engineering works meant the first batch of plants ordered were ready well prior to the site works commencing. As these plants would have become root-bound if they had been stored until site preparations were completed, they were on-sold for another restoration project.

When the engineering works commenced, there was insufficient notice provided to grow searush from seed in time for immediate planting on the reshaped beach to help stabilise sediments as intended. The delayed timing also pushed the initial planting into mid-winter, which is not optimal as plants are relatively dormant and do not grow vigorously over the colder months.

Inadvertently, there was a positive outcome to the delay in searush being available. Sorting of newly deposited beach material by wave action over the following 2-3 months revealed natural deposition areas of finer sediment ideal for searush planting, and also identified beach wrack deposition zones (e.g. seagrass leaves, driftwood, and river debris) where any restoration planting would likely have been buried. The latter areas were avoided, while the areas of natural fine sediment accumulation were targeted for planting.

Lesson learnt

Ensure that changes in project timing are clearly communicated to all parties.

There is benefit in identifying an alternative planting option in case of project delays.

Where erosion is not an issue, allow sediments to stabilise for 2-3 months before planting to help identify preferred intertidal planting sites and allow plant propagation to match completion of the site works.

4.3 Intertidal planting

The initial planting was undertaken on 17 July 2020 by a mix of contractors (Salt Ecology, FuturEcology), MDC staff and volunteers from Te Ātiawa and Salt Ecology.

To determine the optimal shoreline height to plant intertidal rushland, the point at which the incoming tide reached the lower range of existing rushland was marked in the restoration zone using temporary markers (e.g. cane wands, rocks) the day before planting. Although there are very few salt marsh species present at the Waikawa site, this approach can also be used for different species (e.g. glasswort, remuremu) which have variable tolerances for seawater inundation when they are present. The upper tidal range was evident from where flotsam and driftwood were deposited.

Once intertidal planting zones were marked out, surface cobbles were cleared from the beach surface and used to create small chenier sills on the seaward margin of the planting zone (see following photo). These sills protect plantings from wave erosion and facilitate the trapping of finer sediments. Existing beach contours were followed, or curves created, to help deflect wave energy and ensure chenier sills maintained a natural appearance. Because of the relatively small size of the cobbles used to construct the cheniers, ongoing movement is expected and occasional site maintenance likely to be needed following storm or flood events.

Chenier rock sill seaward of freshly planted searush

Clearing surface cobbles to create chenier sills and prepare site for planting

To facilitate rapid infilling of plants to minimise erosion losses, 900 salt-tolerant rushes (Table 1) were planted at a high density (10-15 plants/m^2, spacings ~20-25cm). Crow bars were used to create deep, narrow holes for planting (see following photos). Root trainer plants had the roots loosened before being firmly bedded in the substrate ensuring that the base of the plant stem was buried within the sediment to prevent plants flopping over when inundated by the tide.

Searush was planted at various tidal heights and in several densities to assess relative success over time and to guide future planting. Oioi was planted in its preferred habitat along the upper intertidal fringe adjacent to the terrestrial margin.

No mulch was used in intertidal areas as it would wash away on the incoming tide.

Table 1. Species and number of intertidal rushes initially planted.

Species	No.
Apodasmia similis (jointed wire rush/oioi)	120
Juncus kraussii (sea rush)	780
	900

Using crow bars to create deep narrow planting holes behind the rock chenier in the upper intertidal zone

Intertidal searush was planted at a high density to facilitate rapid infilling and minimise erosion losses

Lesson learnt

Defining suitable shoreline elevations for planting, which is critical for subsequent planting success, is easily achieved by using the height the incoming tide reaches existing salt marsh.

Crow bars are preferable to spades for digging holes in coarse cobble and gravel sediment.

Root trainer plants are well suited for the small narrow holes which also reduce the potential for tidal washout as plants are easily bedded in.

Due to the hard cobble substrate present, on average it was possible to plant ~200 rushes per person per day.

4.4 Terrestrial margin planting

Terrestrial margin plants included a mix of hardy coastal species commonly found on the coast, as well as less common species such as sand coprosma (Table 2). Shrubs and larger grasses (e.g. toetoe, flax) were planted 1-1.5m apart and rushes and grasses (jointed wire rush, knobby clubrush, swamp tussock) at ~20-25cm spacings. The composition of the plantings was determined in part by height constraints imposed by the resource consent, as well as likely exposure to tidal inundation. The majority of the shrubs were staked and protected by EmGuard plant guards supplied by FuturEcology. Rushes and grasses were not individually marked or protected.

Plants were initially laid out in the locations they were to be planted and then teams of two worked through the site one digging the hole, and one placing and packing the plant and installing the tree guard.

As the margin areas had been recently mown, no additional site preparations were undertaken prior to planting (e.g. weed spraying), and no fertiliser or mulch was applied at the time of planting.

Plants laid out ready for planting on the terrestrial margin

Folding and installing EmGuard plant guards

The involvement of volunteers was greatly beneficial in terms of completing the planting and also in providing a direct connection to the project. When involving volunteers, it is important to ensure that regular breaks are taken, that drinks and snacks are available and there is access to toilet facilities.

During the initial planting, volunteer engagement was limited by work being scheduled on a weekday during poor weather.

Lesson learnt

Laying all plants out in the location they are to be planted ensures the desired groupings and spacings are used.

Using a mix of contracted labour and volunteers to undertake planting is ideal.

Volunteer uptake would likely be improved if planting was on a weekend during good weather.

4.5 Infill planting

Three months after the initial planting was completed, infill planting was undertaken to extend the area of terrestrial planting and to undertake site maintenance. An additional 185 plants were planted (Table 3). All plants were supplied by Morgans Road Nursery except for glasswort which was collected from a nearby estuary the day prior to replanting.

Glasswort was planted in the upper intertidal zone as this species, once likely common in the estuary, was no longer present. It is a very hardy plant and can rapidly re-colonise from existing beds as it grows well from beach-cast fragments. It was hoped that re-establishing this species would facilitate its natural spread. Two approaches were taken. Approximately 90 small plants with active roots were teased apart from larger clumps and planted along the upper strand line, along with 10 larger divots (~20x20cm) containing a group of stems and largely undisturbed root section - see following photo.

Glasswort divot planted in the upper tidal range

Twelve months after the initial planting was completed and following the very good success of the intertidal rushland plantings (see following section), an additional 1000 salt-tolerant searush were planted in the intertidal zone (Table 4).

Table 2. Species and number of plants initially planted along the terrestrial margin.

Species	No.
Plagianthus divaricatus (Saltmarsh ribbonwood)	25
Muehlenbeckia complexa (Pohuehue)	20
Phormium tenax (Flax)	15
Myoporum laetum (Ngaio)	10
Coprosma repens (Taupata)	15
Cordyline australis (Cabbage tree)	15
Coprosma acerosa (Sand coprosma)	20
Cortaderia richardii (South Island toitoi)	20
Ficinia nodosa (Knobby clubrush)	40
Carex secta (Green swamp tussock)	20
Apodasmia similis (jointed wire rush/oioi)	340
	540

Table 3. Species and number of saltmarsh plants added after 3 months.

Species	No.
Plagianthus divaricatus (Saltmarsh ribbonwood)	25
Muehlenbeckia astonii (Shrubby tororaro)	10
Phormium tenax (Flax)	10
Cortaderia richardii (South Island toitoi)	15
Coprosma acerosa (Sand coprosma)	10
Carex secta (Green swamp tussock)	15
Sarcocornia quinqueflora (Glasswort)	100
	185

Table 4. Species and number of saltmarsh plants added after 12 months.

Species	No.
Juncus kraussii (sea rush)	1000

5. PLANTING OUTCOMES

5.1 Plant success

Regular site visits were made after planting to assess success and to undertake site maintenance. The results are shown by way of comparative photos over time of representative parts of the restoration in Figures 3 and 4.

Overall, nursery supplied plants had very low mortality. Within intertidal areas, there was no discernible loss of searush to desiccation or erosion. In the upper swash zone, beach-cast material, in particular seagrass fronds and leaf litter washed downstream from terrestrial areas, periodically smothered some of the searush and oioi plantings. This impact was patchy and uncovering of plants during site maintenance indicated that most plants were able to survive short periods of burial and were able to subsequently recover.

Upper swash zone showing residual organic debris after site clearance. The dark green rushes in the middle of the picture were all buried, but quickly recovered once cleared

Intertidal rushland was very successful. Within 6 months, beds were well established and were forming a canopy cover. Finer sediments were beginning to accumulate within the beds, and the chenier sills had proven to be relatively stable requiring little maintenance.

Dense searush beds with closing canopy cover

Glasswort, transplanted from a nearby estuary, was the least successful of the intertidal plantings. Several of the larger divots survived, but most of the smaller plants that had been separated out and planted individually did not. It was unclear whether plants had died as a consequence of transplanting stress, desiccation, erosion or smothering by debris.

Transplanted glasswort divot

In terrestrial areas, knobby clubrush collapsed within 1 month of planting and ~50% were subsequently lost. Of the other terrestrial shrubs, ~95% appeared to have survived, despite a dry and hot summer following the mid-winter planting. Losses were largely attributable to overgrowth in weeds over the summer (see following section).

Collapsed knobby clubrush one month after planting

In Zone 2, there was also damage to plants from the dumping and burning of green waste in the estuary, from grass mowing and the parking of boats and vehicles in the planting zone.

Green waste dumped in the middle of estuary restoration plantings

	A. West of Zone 1 along the top of the beach	**B.** Reserve adjacent to Waikawa Stream
July 2020		
Aug 2020		
Dec 2020		
April 2021		
July 2021		

Fig. 3. Changes in terrestrial salt marsh over the 12 months since planting. Note weed proliferation in Dec 2020.

	C. Intertidal searush in Zone 1	**D.** Supratidal searush and oioi in Zone 2
July 2020		
Aug 2020		
Dec 2020		
April 2021		
July 2021		

Fig. 4. Changes in intertidal and supratidal salt marsh over the 12 months since planting.

Lesson learnt

Intertidal rush planting densities were appropriate and resulted in dense beds of rushland with deep roots quickly establishing.

Plant guards provide essential protection to young plants. The biodegradable cardboard EmGuards used were simple, effective and proved durable over the 12 months they have been in place.

Weed growth was prolific over the summer (see following section) and site maintenance was required to prevent plant losses.

Delineating planting boundaries, e.g. with a rope fence and using signage to highlight the location of plantings, would reduce unintended plant damage from neighbouring properties or maintenance activities.

The transplanting of small plants of glasswort was largely unsuccessful, but larger divots survived.

5.2 Weed growth

There was little initial weed growth and consequently no spraying was undertaken prior to planting, and no site maintenance was deemed necessary over the subsequent five months. However, by December, five months after initial planting, weeds had begun to grow very extensively throughout the terrestrial areas. Where plant guards were used, it was relatively simple to locate and weed-eat around shrubs. Cut grass was then raked aside and glyphosate sprayed to prevent regrowth.

Weedeating around shrubs to reduce nuisance grass growth prior to spraying

The plant guards provided good protection from spray and controlled weed growth over the following four months (see Fig. 3, B, April 2021). A second spot-spray maintained weed control for the next three months.

Where rushes were planted in high densities it was not possible to weed-eat or spray grass without damaging the rushes.

Dense plantings of rushes (left) were overtaken by grass (right) and were unable to be easily maintained by weedeater or spray methods.

Several toetoe, flax, grasses and shrubs were also overgrown by terrestrial grasses to the south (see Fig 2. Zone 2). Plants not marked with bamboo stakes were very difficult to relocate and several were lost.

Grass overgrowth with red circle showing buried plant guard

Hand weeding was possible but time consuming and because individual rushes were not marked, it was difficult to relocate plants and avoid inadvertent damage while weedeating.

One method considered for weed control was to trial the pumping of seawater through weed-infested saltmarsh, assuming that it would kill terrestrial grass but not salt tolerant plants. Before this could be trialled, a storm surge washed seawater through plantings on the edge of the estuary. This resulted in a substantial die-off of terrestrial grasses suggesting seawater flushing may be a feasible method of weed control where spraying or cutting is not an option.

Lesson learnt

Weed control prior to planting would reduce subsequent maintenance needs and a formalised plant maintenance schedule would assist with timely weed control.

Marking all plants with bamboo states would facilitate plant relocation and inadvertent maintenance losses.

6. SYNOPSIS

The restoration activities undertaken in Waikawa Estuary have increased the width of the upper shoreline by 8-10m and created a wider and shallower-sloped intertidal shoreline, providing increased erosion protection in front of existing housing and creating additional habitat to grow salt marsh.

Restoration planting increased existing salt marsh extent by 350% from 200m^2 to ~900m^2. This has significantly improved the biodiversity of the estuary and reintroduced several historically displaced estuarine plants.

The planting of intertidal rushland behind chenier sills demonstrated that dense plantings were able to quickly establish and withstand prevailing conditions, despite being planted in mid-winter when plant growth is relatively slow. Planting root trainer specimens densely in deep narrow holes with plants well bedded into the sediment prevented losses from erosion in the intertidal area. Less dense plantings in more sheltered areas also demonstrated good survivorship. The intertidal plants showed more vigorous growth than those planted in the supratidal and terrestrial zones at the same time.

Overall terrestrial plants were healthy but relatively slow growing, likely a combination of initially being planted in mid-winter when plants were relatively dormant, and then being subjected to a relatively long and hot summer. Positively, there was good survivorship of most plants, assisted in part by the effective use of EmGuard plant guards.

There were no weed problems associated with intertidal plants, but supratidal and terrestrial plants were adversely impacted by weed growth over the summer period. While plant guards assisted in minimising smothering of plants, regular maintenance of plants is required to prevent them being overtaken. Proactive spraying in advance of initial planting, and regular grass trimming or maintenance spraying among plantings, would have improved weed control, as would the use of mulch. Maintenance would also have been assisted by ensuring that all plants were marked with stakes, and by clearly marking planting areas with temporary fencing and/or signage.

In terms of project management, the key insights gained related to ensuring that planning decisions are guided by stakeholder input but are ultimately decided by subject experts, and ensuring that the scheduling of physical works allows adequate time to grow plant species to order.

The high level of engagement from the wider community, the project team and tangata whenua was a hugely important component of the overall success of the project. While the ecological improvements were significant in their own right, there were also wider benefits from undertaking offset mitigation of necessary flood control works. Particular benefits were being able to incorporate Te Ātiawa recommendations on site enhancement to redress historical damage to the estuary and to demonstrate that restoration of salt marsh habitat could be achieved in relatively simple and cost-effective manner.

Although a detailed cost analysis has not been undertaken as part of the current summary, the river flood control and restoration earthworks cost ~$195,000, consenting was in the range of ~$40,000 to $60,000, and restoration costs were ~$23,000, or ~10% of the total, excluding MDC staff costs. Restoration costs comprised $5,000 for planning and supervision of shoreline recontouring, $7,000 for plants, $10,000 for planting and site maintenance and $1,000 for the summary report.

Restoration costs were offset to some extent by savings made in being able to deposit dredged material locally as part of the shoreline reshaping, and the shoreline re-shaping and salt marsh restoration itself will result in future savings from preventing or minimising coastal erosion.

Overall, this project typifies how modern holistic environmental and ecological river engineering works can be carried out, and should be used as an exemplar for future such works.

7. RECOMMENDATIONS

To ensure the ongoing success of the plantings it is recommended that 3-6 monthly site maintenance visits are continued over the next 2 years to manage weeds, repair chenier sills, and reset plant guards as necessary.

Marking the site boundary of Zone 2 with temporary fencing or signage, and ensuring green waste dumping and burning is discontinued, is also recommended.

The site also offers further opportunities for improvement that could potentially be linked to offset restoration for the nearby marina development or future river works. For example, next time physical works are required in the streamway large rocks could be added to the true right of the Waikawa Stream delta to provide a high tide roost for birds. There is also significant opportunity to restore the southeast of the estuary to mitigate ongoing erosion and further expand salt marsh habitat that has been historically displaced by the marina.

8. REFERENCE CITED

Stevens LM, Robertson BM. 2016. Waikawa Estuary 2016 Broad Scale Habitat Mapping. Prepared for Marlborough District Council. 27p.

9. ACKNOWLEDGEMENTS

The commitment of the MDC Environmental and Engineering teams to help redress past impacts on the estuary have been paramount to the project success. The project was conceived and initiated by David Aires (Rivers Operations Engineer) with Steve Urlich (Environmental Scientist – now at Lincoln University) engaged to assist with providing background technical support and putting the original restoration plan together. Gavin Cooper (GDC Consulting) guided it through the consent process, and Geoff Dick (Rivers and Drainage Engineering Manager) and Richard Coningham, (Assets and Services Manager) sponsored the project.

I would like to particularly acknowledge the contribution of David for being such a strong supporter of the work, to Steve for first asking in 2016 what could be done to improve the estuary, and Gavin for bringing the component parts together to obtain consent approval. The high level of engagement from Council, contractors and community could not have occurred without you.

The engagement and support of Te Ātiawa has been a cornerstone of the project success and has set a template for how collaborative partnerships can achieve beneficial outcomes that extend beyond the sum of the parts. In particular, the kaitiakitanga and mātauranga Māori perspectives of Ian (Shappy) Shapcott and Tom Riwaka, were invaluable and enlightening.

The team at Simcox Construction demonstrated a high level of commitment to the project outcomes and undertook their work to an exemplary standard.

For the on-the-ground effort, many thanks to all who came and added their support in planting, in particular; Te Ātiawa - Karena Martin and Shappy Shapcott; MDC - David Aires, Gavin Cooper, Oliver Wade; the FuturEcology team - Robert, Jan and Bridget; Salt Ecology - Barrie Forrest, Keryn Roberts, Shannon Webster, Sally O'Neill, Thomas Scott-Simmonds and John Price; Hans Frei (Elsmore Mews) who facilitated regular access to the site, and Morgans Road Nursery – Grant and Donna, for the supply of the plants.

Comments on the draft report were provided by David Aires, Gavin Cooper, Shappy Shapcott and Keryn Roberts.

Intertidal rushland planted 20 July 2021


SALT
ECOLOGY
www.saltecology.co.nz