WAIMEHA/WAIMEA INLET ESTUARY RESTORATION

Orchard Stream Mouth

Restoration Options, Plant Schedule, Restoration Guidance

SALT ECOLOGY

CONTENTS

Salt Ecology Report Number 078

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1. PROJECT OUTLINE

Nelson City Council (NCC) are considering restoring a 6500m^2 area of intertidal estuary habitat adjacent to Orchard Stream on the eastern side of Waimeha/Waimea Inlet. The project area (Fig. 1) is next to the shared pathway and adjoins several existing terrestrial restoration plantings. The area has previously been significantly modified by reclamation, stream channelisation with salt marsh loss through displacement and coastal erosion.

To help determine the feasibility of different restoration options, Salt Ecology was contracted to assess the site and provide expert advice on:

- the type of salt marsh species to plant in areas periodically or regularly inundated with seawater to help increase biodiversity and reduce shoreline erosion,
- constructing chenier ridges in the estuary to dampen wave action and provide high tide bird roosts,
- manually re-shaping the relatively steep upper estuary edge to enhance salt marsh habitat and reduce erosion,
- terrestrial margin areas which could be enhanced through weeding and/or the planting of salt-tolerant coastal species (note that this work is already underway),
- adding sediment to intertidal zones to increase the areas suitable for salt marsh expansion.

2. APPROACH

To address these questions, the site was visited in June 2021. Cross-sections of the shore were surveyed at three representative locations (Fig. 2) to determine current salt marsh growing zones, assess possible locations for the construction chenier ridges to mitigate wave erosion, and estimate the area within which salt marsh could potentially grow under different scenarios (see Section 3).

Basic calculations were made to estimate the approximate volumes of infill material needed to alter the seabed level to extend the available planting envelope, and to recontour the shape of the current steep upper shore. Restoration options are presented in Section 3. In addition, a high-level schematic plan was prepared of recommended species mixes and plant densities (Section 4), with guidance provided on site preparation, planting and maintenance (Section 5).

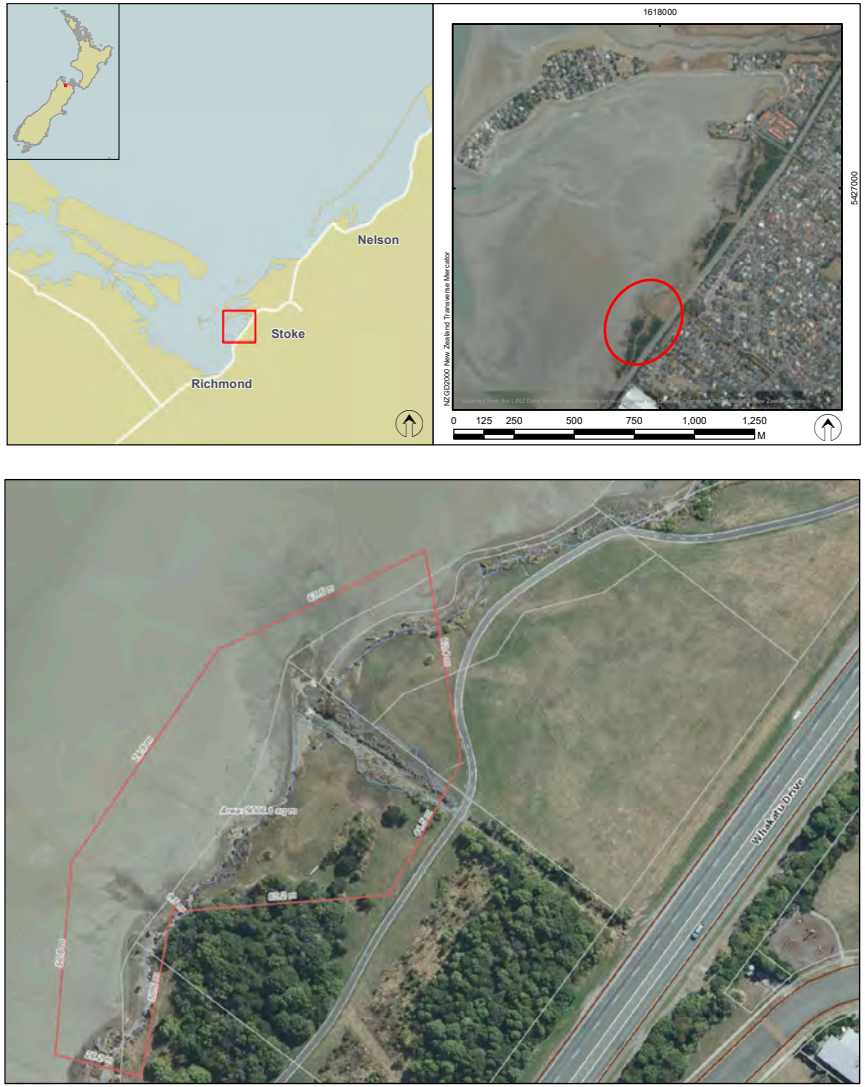


Fig 1. Location of the restoration area near the Orchard Stream mouth as proposed by NCC.

OVERARCHING ESTUARY RESTORATION PLANTING OBJECTIVES

- Use indigenous coastal species to stabilise sediments and mitigate effects of coastal erosion
- Reinstate salt marsh and intertidal habitat previously lost from the estuary through historical reclamation
- Plant from a species palette naturally found at the coastal edge of Waimeha Inlet
- Plant hardy species to maximise planting success
- Plant in naturalistic groupings of species, appropriate to their natural densities and distribution on the shore
- Include species that enhance estuary biodiversity and facilitate natural salt marsh expansion
- Minimise required maintenance through species selection and positioning
- Visually integrate planting as much as possible across the identified planting zones (terrestrial, supratidal, intertidal)

A relatively narrow band of cobble and gravel is present along the upper shore with eroding salt marsh adjacent to existing terrestrial plantings. Soft sandy muds (50-90% mud content) are dominant further seaward.

Planting rushland in intertidal cobble and gravel

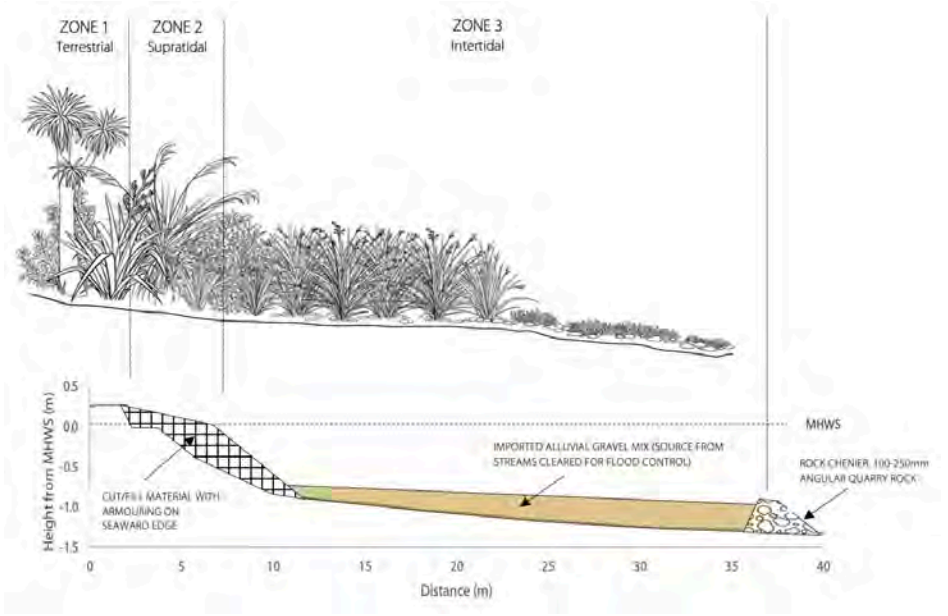
3. RESTORATION OPTIONS

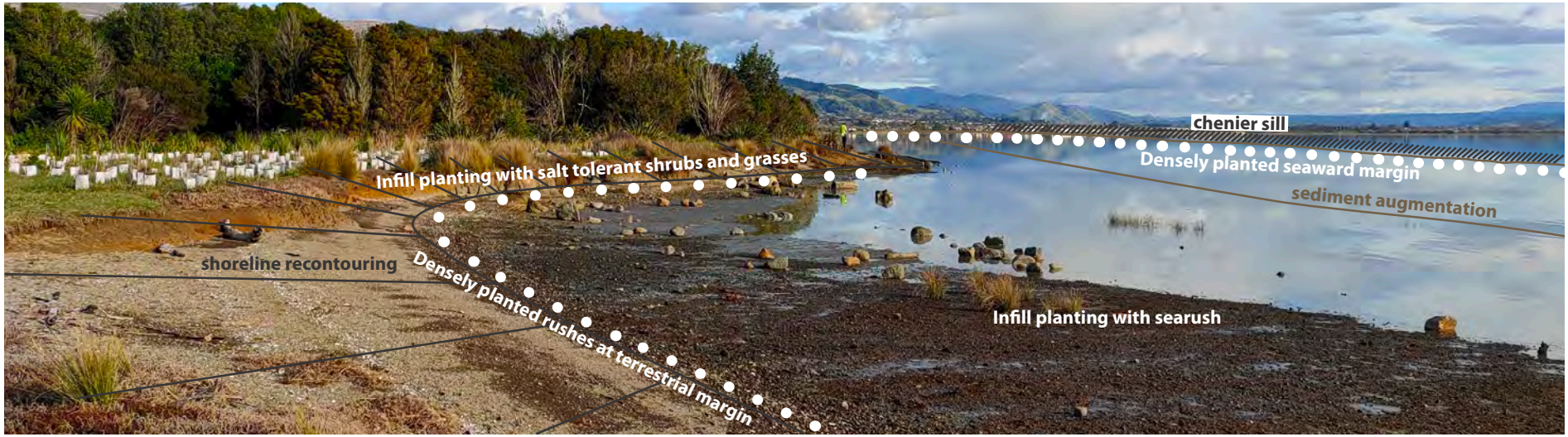
Four options were assessed for planting salt marsh within areas of suitable tidal range, each with variable levels of site preparation, as follows:

1. No site modification.
2. Construction of a small chenier sill to mitigate against wave erosion.
3. Construction of a small chenier sill and reshaping of the upper shoreline.
4. Construction of a small chenier sill, reshaping of the upper shoreline, and the addition of sediment to low-lying areas to increase available planting footprint.

A schematic cross-section of the planting zones and the potential shoreline re-shaping envisaged is presented to the right and shown on the spatial plans prepared for each restoration option described above. The options are proposed independent of likely costs, but some indicative ball-park estimates of plant costs are provided for guidance.

Based on the information presented in this report, Options 1-3 are considered feasible, however Option 3 would require the use of machinery. More detailed guidance to support each option is provided in Section 4 "Planting Schedule" and Section 5 "Restoration Guidance".





3.1 OPTION 1. INFILL PLANTING. NO SITE MODIFICATION

The simplest option for enhancement is to replant salt marsh at suitable tidal elevations within the project boundary. This can be achieved with no specific site preparation other than defining the tidal elevations within which to plant and identifying current threats to salt marsh that might impede planting success (e.g. wave erosion). The cross-sections presented in Fig. 2 indicate shore elevations are generally high enough to support salt marsh growth to a width of ~30-35m from the shore in the north, and ~12m in the south where wave erosion appears to be the most apparent.

A site plan for Option 1 is presented on the following page with planting recommended within suitable elevations inside the project boundary. The suitable planting area is ~3200m^2, in addition to the 650m^2 of existing salt marsh. To re-establish salt marsh within the project area:

- Plant searush at 0.25m spacings (16 plants/m^2) along a 1m wide strip on the seaward edge (~210m) to quickly establish a dense cover that can withstand wave erosion and protect other plants.
- Plant searush shoreward of the 1m buffer strip (2994m^2) at 0.5m spacings (4 plants/m^2). Note full coverage will be achieved faster with more dense planting.

Based on the plan described above, Option 1 would require ~15,336 plants. Assuming $2.50 per plant (root trainer) the plant cost would be ~$38,340. It would be possible to plant approximately ~25% of the project footprint with an initial plant budget of ~$9,000.

CONSTRAINTS

The current absence of salt marsh is likely driven, in part, by wave erosion evident at the site. Consequently, without additional protection (e.g. cheniers), plants will be prone to erosion compromising initial establishment as well as longevity. Gravel fans at the Orchard Stream mouth have created raised sediments that provide some protection to the north (and support remnant salt marsh), however most of the site remains exposed and therefore vulnerable.

RECOMMENDATION

Plant strategically where existing landforms provide optimal wave protection. Plant the seaward edge in an undulating and natural form to provide variable protection from waves and to determine likely efficacy of restoration planting. Avoid areas where wave scouring is evident.

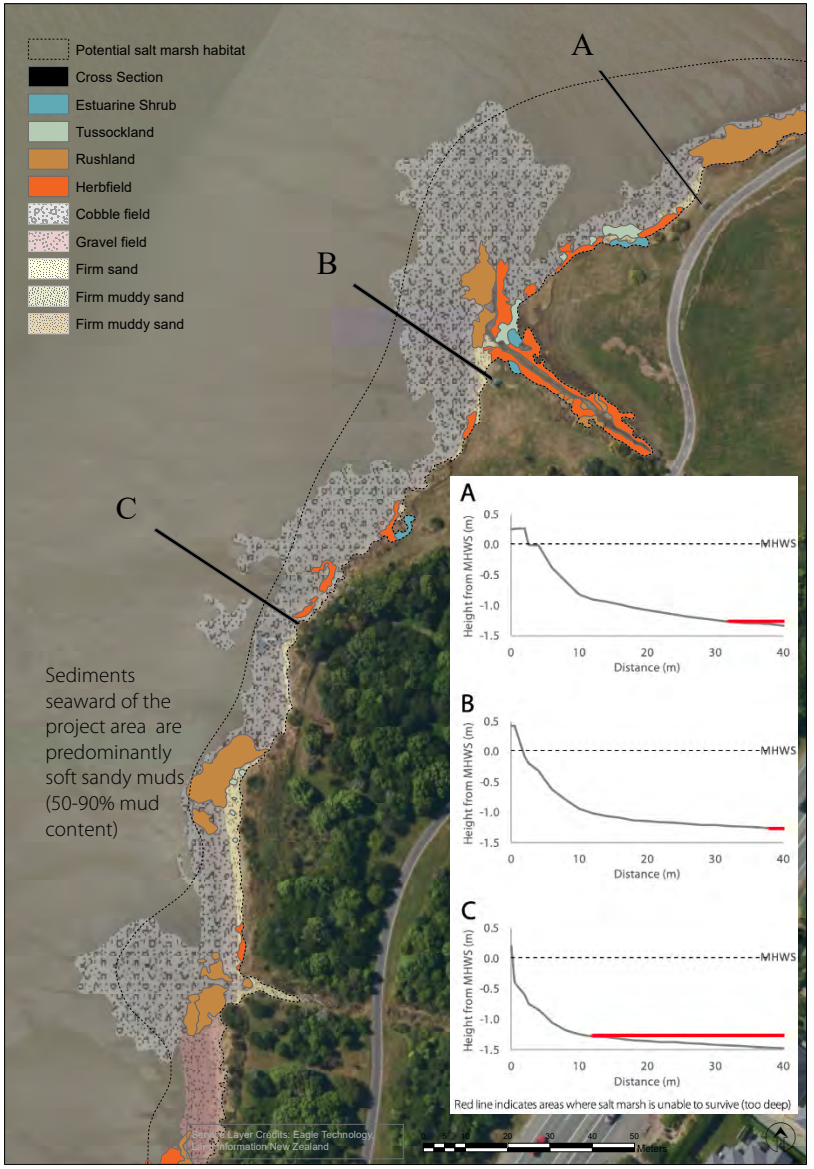
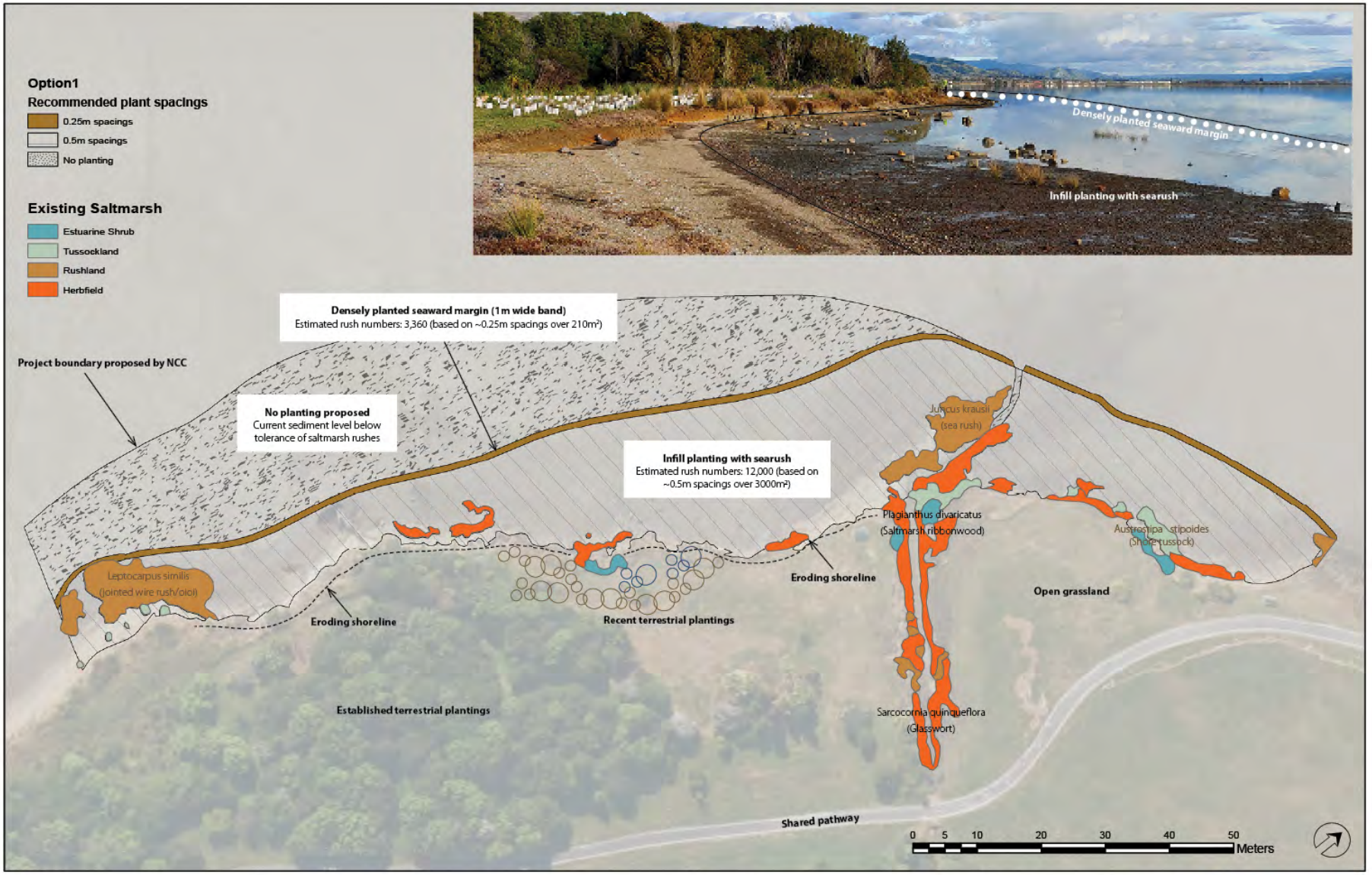


Fig 2. Summary of dominant substrate and salt marsh types and location of cross-sections A-C. Inset figure shows shoreline profiles and seaward extent to which salt marsh can theoretically grow (to start of red line).



SALT ECOLOGY For the Environment Mō te taiao For the People Mō ngā tāngata	Date: 23 July 2021 Version: 1.0	WAIMEHA INLET RESTORATION SALTMARSH PLANTING CONCEPT PLAN - OPTION 1	Prepared by: LEIGH STEVENS	Prepared for: VIKKI AMBROSE Nelson City Council te kaunihera o whakatū

3.2 OPTION 2. CONSTRUCTION OF A SMALL CHENIER SILL

Option 2 extends the planting proposed in Option 1 with the construction of a small, raised chenier sill seaward of the site to help break-up wave energy before it reaches salt marsh plantings. The chenier will also facilitate sediment trapping, gradually increasing the height of the substrate and altering the shape of the shoreline to create a gentle slope over time. It is important to allow for free exchange of seawater through the chenier.

While chenier sills can be constructed from a range of materials, locally sourced river rock and cobble is ideal. There is a trade-off between the size of the material used and its stability. Larger rocks (i.e. >250mm diameter) are more stable and require less maintenance, but generally require machinery to transport and place it. Smaller material e.g. 100-250mm diameter cobble and rock, while suitable for manual placement, is prone to greater movement and requires ongoing maintenance to ensure it remains in place and is effective. Angular material is more stable than rounded material and material can be keyed into the underlying sediment to increase stability.

A site plan for Option 2 on the following page indicates the recommended position of chenier sills and planting at the site.

Small chenier sill protecting newly planted rushland in Waikawa Estuary, Marlborough.

The chenier follows the existing contour marking the lowest tidal elevation supporting salt marsh in this part of the estuary. The suitable planting area is ~3200m^2. To re-establish salt marsh within the project area:

- Build a chenier sill 20-30cm high and 30-50cm wide to protect salt marsh from wave erosion. Using these estimates, the volume of rock needed for the site is likely to be between ~12-30m^3.
- Plant searush at 0.25m spacings (16 plants/m^2) along a 1m wide strip shoreward of the chenier sill to establish a dense cover that will reinforce the protection offered by the chenier sill against wave erosion.
- Plant searush shoreward of the 1m buffer strip at 0.5m spacings (4 plants/m^2), although coverage will be achieved faster with more dense planting.

To build the chenier sill, cobble and rock material compatible with that naturally found in the estuary should be used. At the current site some concrete rubble previously dumped to help mitigate erosion is available to create cheniers and trial plantings. Estimated plant costs are outlined in Option 1 (~15,336 plants @$2.50 per plant = $38,340).

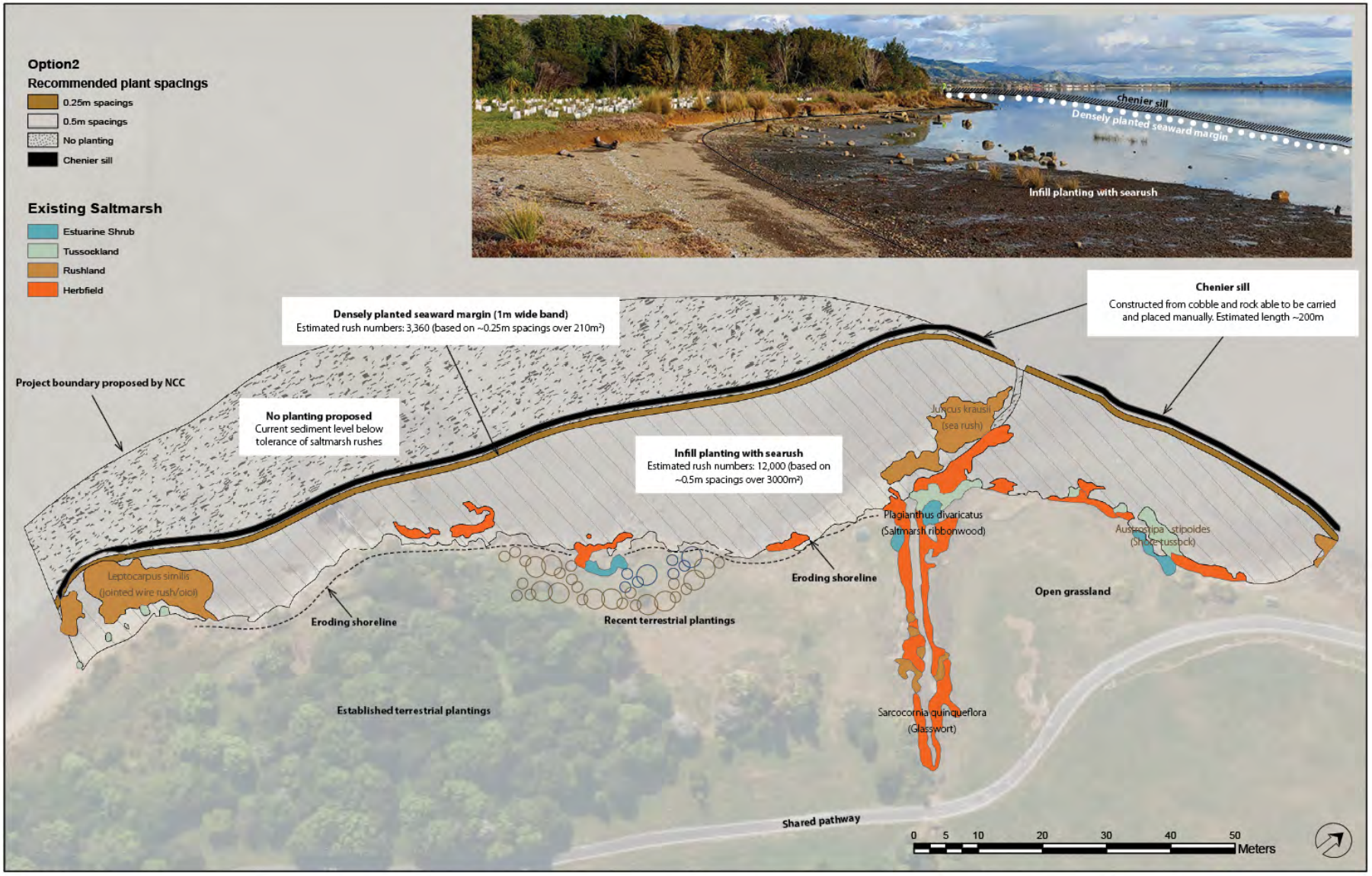
To provide high tide bird roosting habitat, the cheniers would need to extend above MHWS which would require them to be ~1.25m high if they were constructed in their proposed location. This is considered unfeasible at the site due to likely cost as well as the significant change to visual character they would create.

CONSTRAINTS

It is critical to include a chenier sill if attempting to replant salt marsh at this location given the area is prone to wave erosion as discussed in Option 1. If machinery use in the estuary is to be avoided, then to build the chenier sill smaller material will need to be manually carted and placed by hand. This is feasible but may not be suited to volunteer groups. It is noted that there would be limited impact from the use of a small rubber-tracked excavator on the existing gravel and cobble habitat at the site if larger material needed to be placed.

RECOMMENDATION

Relocate existing concrete rubble present on site to the location of the proposed chenier and assess stability. Source additional local material from stream excavations for flood control purposes where possible or import material to the site. Plant behind the chenier sill as outlined in Option 1.



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3.3 OPTION 3. CONSTRUCTION OF A SMALL CHENIER SILL AND RESHAPING OF THE UPPER SHORELINE

Option 3 extends the planting and chenier sill construction proposed in Options 1 and 2 to include reshaping of the upper shoreline. This is to create a gently sloping upper interface to the estuary and allow for planting to transition from true salt marsh species to salt and spray tolerant terrestrial species. This interface represents one of the most heavily modified parts of the estuary, and its restoration would create a transition of salt marsh (intertidal, supratidal, terrestrial) that will have a meaningful contribution to increasing biodiversity and estuary resilience.

Reshaping of the upper shore has been assumed to have a 5m wide x 112m long footprint (560m^2) in order to create a sufficiently shallow slope to limit shoreline erosion (see photo). It has been assumed that the creation of the slope would involve a cut and fill approach, with the existing terrestrial margin lowered and the material used as infill.

Illustrative cut and fill of the upper margin to increase planting habitat and reduce slope

Gravels may need to be introduced to the site to overtop clay fill on the margins and mitigate against the loss of soil, and some form of rock protection at the toe of the reshaped area is also likely to be needed to minimise erosion from wave erosion. Geotextile cells are another option that could be considered for retaining soil although it is beyond the current scope of work to assess their use.

A site plan for Option 3 on the following page builds on Option 2 and includes the recommended area of reshaped shoreline at the site. The overall planting area remains ~3200m^2. To re-establish salt marsh within the project area:

- Reshape the upper shoreline using a cut and fill of the existing terrestrial margin across a ~5m wide footprint to allow for a gentle slope that would minimise shoreline erosion. The estimated volume of fill needed is ~196m^3 based on a shoreline length of ~112m, a footprint width of 5m, and an average height of 0.35m.
- Build a chenier sill 20-30cm high and 30-50cm wide to protect salt marsh.
- Plant searush at 0.25m spacings (16 plants/m^2) along a 1m wide strip on the shoreward edge of the chenier sill. Plant searush shoreward of this 1m buffer strip at 0.5m spacings (4 plants/m^2) up to the toe of the reshaped shoreline.
- Within the reshaped shoreline (750m^2), plant searush and wirerush at 0.25m spacings (16 plants/m^2) along a 1m wide strip on the shoreward edge, and a mix of rushes, and salt tolerant estuary shrubs and grasses at 0.5m spacings (4 plants/m^2) based on the planting schedule in Section 4.

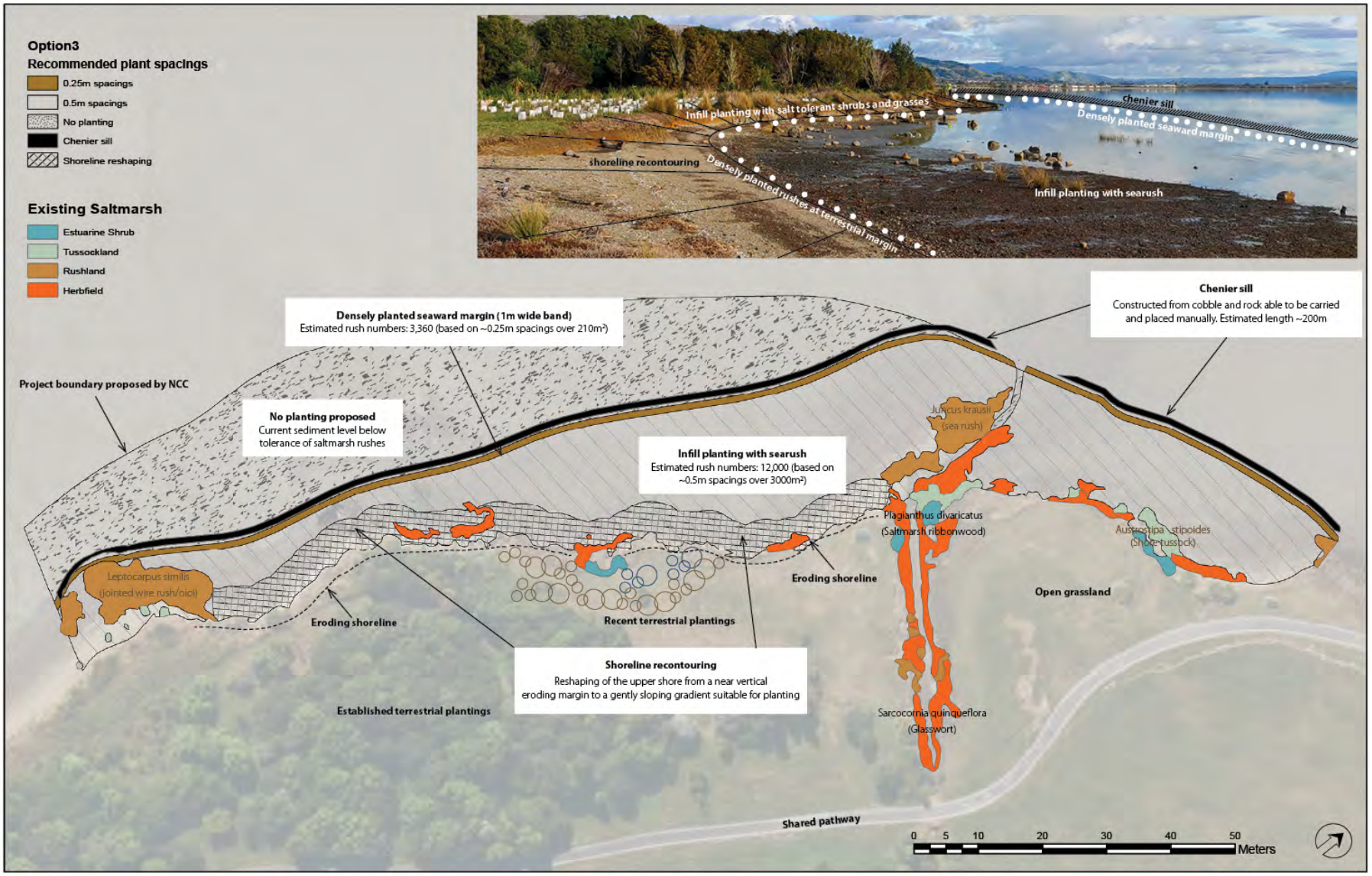
Estimated plant costs are $41,820 comprising 3360 rushes at 0.25m spacings by the chenier sill, 9732 rushes at 0.5m spacings seaward of the upper shoreline reshaping, 1856 rushes at 0.25m spacings along the toe of the shoreline reshaping, and 1780 salt tolerant rushes, shrubs and grasses at 0.5m spacings on the reshaped slope. All estimates assume $2.50 per plant (root trainer). Plants in the upper supratidal and terrestrial zone are more prone to weed incursions, pest grazing and trampling therefore at least $5000 should be allocated for plant guards and weed spray. An ongoing schedule of plant maintenance also needs to be factored in.

CONSTRAINTS

As above for Option 2. In the brief Salt Ecology was asked to assess whether it would be possible to reshape the shoreline by hand. Because of the relatively large area (560m^2) requiring reshaping or infilling, it is not considered feasible to do this manually. Furthermore, any significant modification of the estuary margin, even for improvement purposes, will likely require an assessment of environmental effects and resource consent.

RECOMMENDATION

Shoreline reshaping and replanting is feasible if the use of machinery is an option and there is adequate budget to allow for appropriate assessment of environmental effects and consenting. Note, this Option could be re-evaluated and undertaken after Options 1 and 2 have been completed, noting that the area identified for shoreline reshaping has been recently planted and any reshaping would likely disturb these plants.



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3.4 OPTION 4. CONSTRUCTION OF A SMALL CHENIER SILL, RESHAPING OF THE UPPER SHORELINE. SEDIMENT AUGMENTATION OF THE LOWER SHORE

Option 4 extends the planting and chenier sill construction, and shoreline recontouring proposed in Options 1-3 to include augmentation of sediment in the intertidal area to increase the available area for salt marsh to grow.

If sediment augmentation (i.e. raising of the intertidal flats) was considered in the project area it would increase the available habitat for salt marsh growth by an additional ~2500m^2. However, to achieve this the sediment level would likely need to be raised by ~20cm on average, requiring the addition of ~500m^3 of fill material. Undertaking such works would require significant use of machinery, designated vehicle tracking paths, sediment controls and a source of material compatible with the existing sediments on site (see photo). For the protection of plants in this area, the chenier sill would need to be positioned on the seaward edge, along with a dense buffer of plants.

A site plan for Option 4 on the following page builds on Option 3 and includes the recommended area of reshaped shoreline, the area of sediment augmentation and the updated location of the chenier sill and 1m searush buffer. The suitable planting area is increased to ~5780m^2. To re-establish salt marsh within the project area:

- Reshape the upper shoreline using a cut and fill approach, with the existing terrestrial margin lowered and the material used as infill.
- Using machinery, increase the sediment level of the outer margin (see site plan) by ~20cm on average, requiring the addition of ~500m^3 of fill material.
- Build a chenier sill 20-30cm high and 30-50cm wide on the outer margin of available salt marsh habitat (outer area of sediment augmentation) to protect salt marsh.
- Plant searush at 0.25m spacings (16 plants/m^2) along a 1m wide strip on the shoreward edge of the chenier sill (233m^2). Plant searush shoreward of the 1m buffer strip at 0.5m spacings (4 plants/m^2) up to the toe of the reshaped shoreline (4987m^2).
- Within the reshaped shoreline (560m^2), plant searush and wirerush at 0.25m spacings (16 plants/m^2) along a 1m wide strip on the seaward edge, and a mix of rushes, and salt tolerant estuary shrubs and grasses at 0.5m spacings (4 plants/m^2) shoreward of this based on the planting schedule in Section 4.

Based on these assumptions, the site would require ~27,312 plants, and at $2.50 per plant (root trainer), the plant cost would be ~$68,280. Costs for planting, maintenance and management are additional to this.

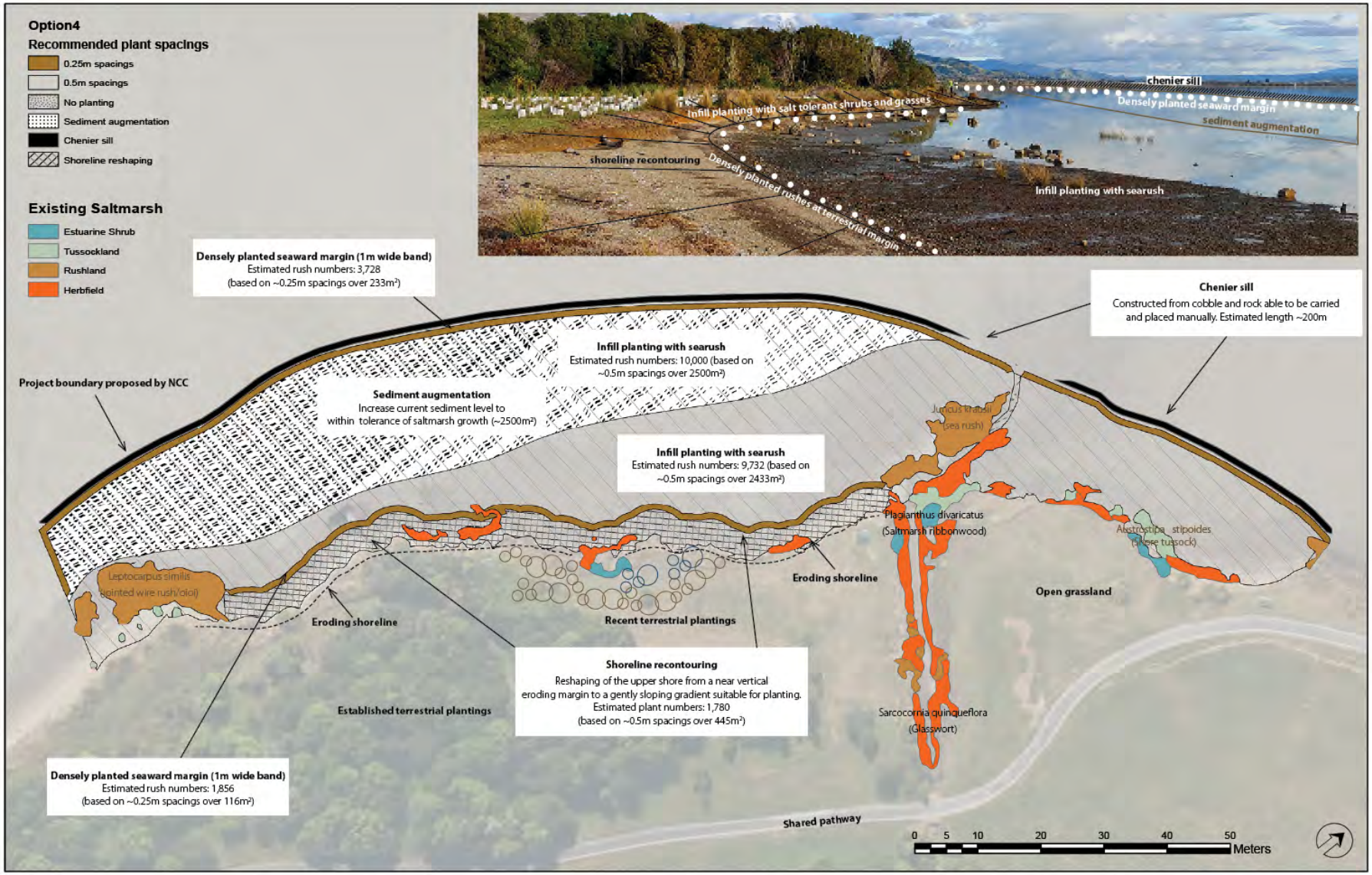
CONSTRAINTS

Sediment augmentation will almost double the area of available salt marsh habitat at the project site however it will require significant earthworks and infill material that could negatively impact the existing tidal flats. Furthermore, as the seaward edge of salt marsh is most susceptible to predicted sea level rise it may be more appropriate to focus on the restoration of salt marsh habitat and sites where managed retreat is possible. While it is feasible to undertake sediment augmentation, futureproofing should be considered and it would require a detailed assessment of environmental effects given the displacement of the existing biota present, and resource consent.

RECOMMENDATION

Option 4 is not recommended because in a local context there may be insufficient benefit from the increase in salt marsh to offset the impacts of the work.

Sediment augmentation requires the use of excavators and trucks



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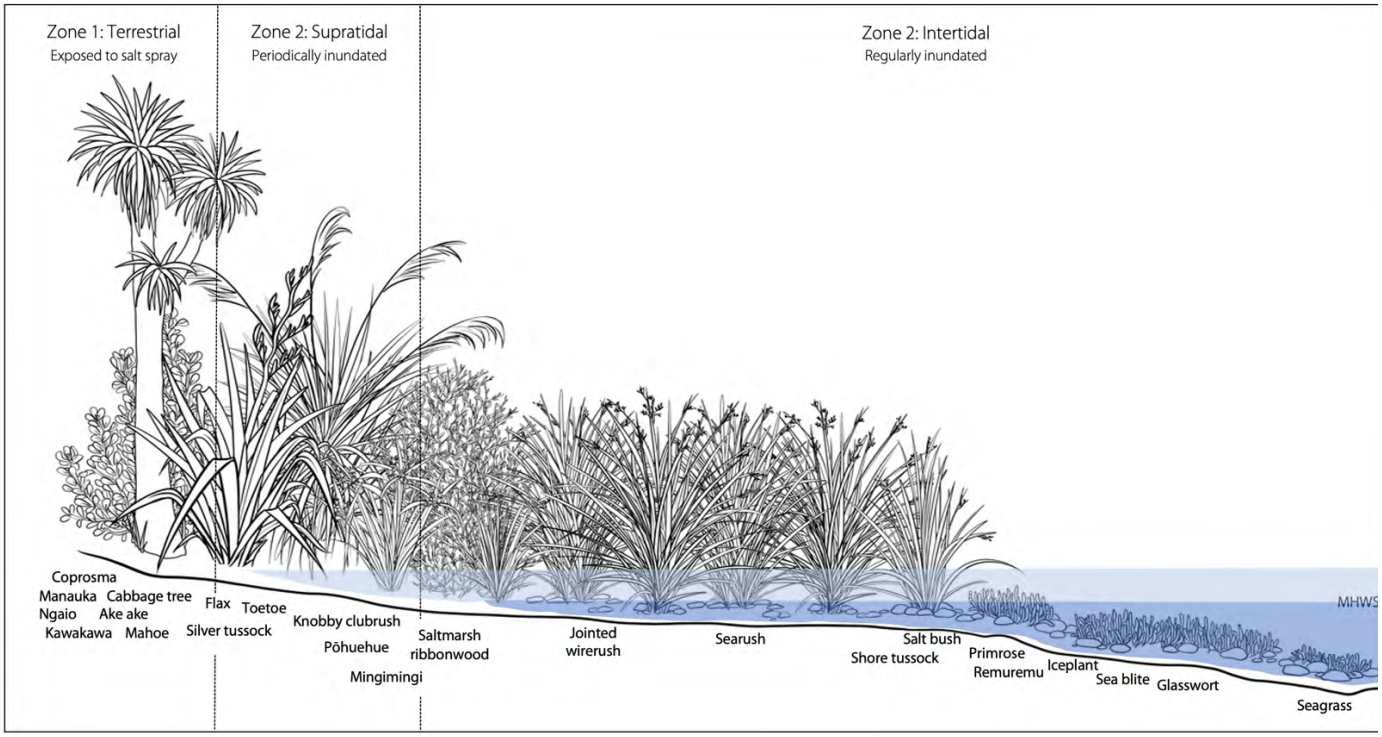
4. PLANT SCHEDULE

A plant schedule (see following page) is proposed to facilitate a range of planting combinations suited to different parts of the proposed restoration. The primary focus is on planting within the intertidal zone with plants naturally adapted to periodic or regular inundation with seawater. These species will comprise a dominant cover of searush, and smaller areas of jointed wire rush and common estuarine herbs.

The supratidal margin allows for a much more varied planting palette and an indicative list of potential salt tolerant plants is included. The latter include fast growing species to provide shade and wind protection, ground covers to minimise weed establishment, hardy wind and drought tolerant plants, deep-rooted plants (to stabilise sediment), and a mix of naturally occurring species that will enhance the biodiversity of the estuary, provide food for birds and insects, and be visually appealing. Some successional planting is envisaged with fast growing shelter species being subsequently thinned or removed once other species establish.

The following scematic and table details the species recommended for planting, and indicates the relative proportion of plants envisaged within each zone.



ZONE 1 Terrestrial
Subjected to salt spray but is not tidally inundated. It includes a mix of common coastal plants and ground covers.

ZONE 2 Supratidal
Subjected to salt spray and periodic inundation by spring tides, waves or storm surges. Plants include a mix of predominantly low growing salt-tolerant species e.g. salt marsh ribbonwood. Occasional taller species e.g. cabbage trees provide naturalistic species groupings and to facilitate sediment stability.

ZONE 3 Intertidal
Regularly inundated by seawater, the dominant cover in the upper reaches is salt marsh ribbonwood and occasional shore tussocks and smaller soft rushes and, in the lower reaches salt-tolerant rushes e.g. searush, jointed wire rush, three-square and low-growing herbfields. Existing beds of seagrass are also found in this zone.

Note: Plant groupings will be determined primarily by tidal elevation, and wave exposure, and will be variable across the planting area. Unvegetated gaps will feature within naturalistic plant groupings.

4.1 GENERAL PLANT MIX

The following species are recommended for planting in the intertidal zone in the current project.

Species	Common Name	Height (m)	Spacing (m)	Distribution (%)	Comment
Intertidal Shrubs					
Plagianthus divaricatus	Saltmarsh ribbonwood	2	1	10	Plant near and above MHWS
Intertidal Rushes					
Apodasmia similis	Jointed wire rush	1	0.25-0.5	5	Plant near freshwater seeps and MHWS
Juncus kraussii	Sea rush	1	0.25-0.5	65	Plant in upper intertidal zone
Intertidal Herbs					
Sarcocornia quinqueflora	Glasswort	0.3	0.5	10	Plant in the upper range of the tide in sand and gravel
Selliera radicans	Swampweed	0.2	0.5	3	
Samolus repens	Primrose	0.2	0.5	3	
Suaeda novaezelandiae	Sea blite	0.2	0.5	2	
Disphyma australe	NZ iceplant	0.2	0.5	2	

Species	Common Name	Height (m)	Spacing (m)	Distribution (%)	Comment
Trees, shrubs rushes and herbs recommended for planting in the supratidal zone					
Cordyline australis	Cabbage tree	15	1	5	Plant above MHWS
Phormium tenax	Flax	2	1.5	15	
Cortaderia richardii	South Island toetoe	3	1.5	5	
Coprosma propinqua	Mingimingi	4	1.5	5	
Plagianthus divaricatus	Saltmarsh ribbonwood	2	1	10	
Ficinia nodosa	Knobby clubrush	0.7	0.5	10	
Carex secta	Green swamp tussock	1	0.5	10	
Coprosma acerosa	Sand coprosma	0.5	1	5	
Poa cita	Silver tussock	0.5	1	5	
Poa billardierei	Sand tussock	0.75	1	5	
Carex litorosa	Sea sedge	0.8	0.5	5	
Atriplex cinerea	Grey salt bush	1.5	0.5	10	
Isolepis cernua	Slender clubrush	0.2	0.5	5	
Euphorbia glauca	Sea spurge	1.0	0.5	5	

Cabbage tree
Cordyline australis

Flax
Phormium tenax

South Island toetoe
Cortaderia richardii

Mingimingi
Coprosma propinqua

Saltmarsh ribbonwood
Plagianthus divaricatus

Sand coprosma
Coprosma acerosa

Silver tussock
Poa cita

Sand tussock
Poa billardierei

Sea sedge
Carex litorosa

Grey salt bush
Atriplex cinerea

Slender clubrush
Isolepis cernua

Sea spurge
Euphorbia glauca

Knobby clubrush
Ficinia nodosa

Green swamp tussock
Carex secta

Jointed wire rush
Apodasmia similis

Sea rush
Juncus kraussii

Glasswort
Sarcocornia quinqueflora

Swampweed
Selliera radicans

Primrose
Samolus repens

Sea blite
Suaeda novaezelandiae

NZ iceplant
Disphyma australe

5. RESTORATION GUIDANCE

The following sections are intended to illustrate some of the considerations needed to implement Options 1 to 4 described above. These would be specifically refined at the planning stage. While the brief was to consider options for hand reshaping and sediment augmentation there is reference to machinery in the following based on the recommendations provided in Options 3 and 4.

5.1 PROJECT MANAGEMENT

It is recommended a suitably qualified Restoration Manager be appointed to oversee the restoration. This is essential to make sure suitable planting areas, reshaping and appropriate placement of infill material occurs on site. The site plans should be reviewed regularly, and the Restoration Manager should approve all areas prior to spreading of topsoil or alluvial material, or planting to increase the success of the restoration project.

5.2 SITE PREPARATION

This section describes preparation of the site prior to planting including any infilling material and its placements in addition to reshaping and building chenier sills. Careful consideration should be given to the source of materials to minimise the impact on the environment and closely match the substrate already present on the project site.

5.2.1 Planting Zones 1 & 2 (Terrestrial and Supratidal)

Reshaping

In the options presented above, reshaping the shoreline was proposed. It was recommended that given the scale of earthworks required that this be performed using machinery. If machinery is to be used on site, important habitats should be identified in the site plans to minimise the effect on the surrounding habitat with designated vehicle tracks defined for use.

Reshaping the shoreline will likely lead to loss of some remnant salt marsh plants remaining on the eroding shoreline. These plants can be removed carefully and transplanted to other areas of the site (e.g. herbs or rushes can be successfully translocated). The shoreline should be reshaped to follow natural contours creating a gently sloping gradient. Additional infill material may be required to achieve the optimal shoreline shape.

It is essential to have a Restoration Manager on site with the site plans to direct machine operators when reshaping the shoreline because it is easy to create unnatural shoreline shapes (e.g. straight lines), and the final shore heights will influence drainage patterns, planting zones and overall success. Shore profiles may be required after reshaping to confirm planting zones.

Stone/Debris picking

If topsoil is to be added following the shaping of the shoreline, all stones, grass sods and other debris larger than 75mm in any dimension, and all roots in excess of 15mm diameter or 200mm length, should be first removed from planting area.

Preparation of sub-soil

In preparation for planting, the ground surface where imported topsoil is to be spread should be scarified prior to topsoil spreading, to ensure a good "key" between sub-soil and placed topsoil. Existing cover, e.g. weeds/naturalised growth, should be removed prior, where this would make it difficult to work/apply topsoil.

Imported topsoil

If topsoil is sourced off site it should be a clay loam. It should be clean and free of stones, rubble, organic material, contaminants, stumps, branches and construction debris. Any imported materials to the site should be approved by the Restoration Manager to ensure it is suitable for placement.

Spreading of topsoil

Topsoil should be applied prior to the planting season and spread to a depth of no less than 300mm. Do not place and spread topsoil when the ground or topsoil are excessively wet or in a condition which would be detrimental to the work. Carry out final grading of the top 100-150mm to ensure a true specified level and slope, and to avoid hollows or other depressions where water may collect. Loosen unduly compacted areas (such as in traffic routes) by ripping or dicing prior to final levelling. No topsoil is to be placed in Zone 3 i.e. below MHWS.

Pre-cultivation herbicide

To minimise weeds, a pre-planting glyphosate spray should occur ~1 month before planting being undertaken, either prior to the application of topsoil, or to control weed growth on topsoil prior to planting. No pre-planting spray should occur within Zone 3 i.e. below MHWS.

Spraying should target actively growing leafy weeds when no rain is expected for at least twelve hours. Weed species that are not susceptible to glyphosate should be removed by other approved means (e.g. hand pulling).

No cultivation or planting should take place until the symptoms of herbicide effects are visible throughout the treated area.

5.2.2 Planting Zone 3 (Intertidal)

Chenier sills

The chenier sills should be constructed before planting because they are designed to protect the site from wave erosion and facilitate the natural accrual of sediments. If sedimentation augmentation is undertaken the chenier sill will also mitigate the risk of alongshore sediment loss due to coastal processes.

To minimise the impact of construction, the following is recommended. Chenier sills should be constructed sequentially by placing rock/cobble and gravel material along the designated site location, with the sill used as an access path for the delivery of additional material. This is to avoid multiple transits through soft sediment areas. Direct access from the shoreline is possible where sediments are firm e.g. over cobble or gravel beds. Material can be collected on site where available (e.g. concrete fragments) or imported to the site. Hand placement of small rocks is the only feasible option if machinery is to be avoided. However small rock cheniers (see photo) may require ongoing maintenance in areas of high wave energy.

Sediment augmentation

If sediment augmentation is undertaken, imported alluvial material should be sourced from a river or marine source with a mud fraction (<63µm) not exceeding 20%. Imported alluvial material should be stored in local site stockpiles and either be end-tipped along the foreshore, or end-tipped from discrete locations at the top of the slope prior to spreading and reshaping. It is not recommended for this to be completed by hand given the scale of the proposed area.

Small chenier built by hand from rock imported onto the site, Waikawa Estuary, Marlborough

Spreading of alluvial material

To minimise the impact of construction, the spreading of material should be undertaken in discrete zones. After establishment of an initial working zone where imported material is placed, the surface sediments (and associated marine biota) from the next working zone should be scraped to a maximum depth of 15cm and spread evenly over the zone where sediment augmentation and shaping has occurred. Foot or vehicle tracking shall be minimised to avoid undue sediment compaction, and track rolling of spread material is not proposed. Material should only be placed where it is protected by the seaward chenier sill and should be contained within each working zone to mitigate any risk of being outflanked by wave action during construction.

Sediment settling

Material deposited within intertidal Zone 3 should be allowed to settle and sort under prevailing tidal and wave conditions for 1-2 months prior to planting unless there is an undue risk of sediment erosion from the site.

Areas to avoid

No work shall be undertaken within seagrass beds and seagrass beds are to be clearly marked to prevent inadvertent damage.

5.3 PLANTING

5.3.1 Supply

Plants are to be eco-sourced and ordered sufficiently in advance of scheduled planting to ensure that specified plants are available for planting as needed. Where plant species are unavailable they can be substituted for another plant type suitable for the zone, however any changes substitutions should be overseen by the Restoration Manager.

5.3.2 Inspections

All plants should be inspected before planting. To increase the likelihood of success plants should be first class specimens, true to name and type with a well-developed and well-shaped trunk or stem and head. They should be hardened off to cope with the climatic conditions of the site, and free from pests and disease.

The roots shall have a high percentage of fibrous roots that are just touching the edge of their containers or, to the bottom of root trainers. Plants with roots that are wound round their containers in circular fashion should be rejected. Plants should be free from disfiguring knots, bark abrasions, wind, or freezing injury or other disfigurements and shall bear evidence of proper pruning.

Planting should occur at the spacings specified in the tables in Section 4. Smaller spacings may be required to enhance plant establishment and facilitate erosion protection in certain locations, as determined by the Restoration Manager.

5.3.3 Timing

Planting should occur only within the optimal growing season from April - September. Planting in Zones 1 and 2 should occur within 2 months of topsoil being placed. In intertidal Zone 3, sediments should be allowed to settle and sort under prevailing tidal and wave conditions for 1-2 months prior to planting unless there is an undue risk of sediment erosion from the site.

5.3.4 Personnel

All personnel undertaking planting shall be experienced planting contractors or trained volunteers.

Planting rushes grown in root trainers

5.4 PLANTING INSTRUCTIONS

5.4.1 Planting Method

Zones 1 and 2: (Terrestrial and Supratidal)

Planter holes shall be at least twice the radius and depth of the plant container, with the bottom of the hole loosened and the hole filled with topsoil (growing media) at the time of planting.

When planting, carefully remove the plant container, spread roots out in their natural position and plant.

Backfill with topsoil (growing media) and apply suitable slow-release fertiliser tablet as per manufacturer's instructions mixed with the topsoil backfill for each plant.

Firm each plant into the ground, ensuring the topsoil level is even with ground level and that the stem is not buried.

Zones 3 Intertidal (MHWS to chenier sill)

Holes for intertidal rushes and herbs should be prepared using a crow bar or similar to create a deep narrow hole with minimal disturbance of surrounding sediment.

Root-trained plants should have the roots slightly loosened and be planted so that the entire root base and lower part of the plant is within the sediment.

Zone 3 plants should be planted so the roots are not visible at the surface and the base of the stems are covered as they are susceptible to erosion and die off if not planted correctly.

Sediment shall be packed firmly to ensure plant stability.

5.4.2 Plant Protection

Plant guards (see photo) should be used for trees and shrubs as needed to protect against weed invasion, pest browsing and weed spraying. Biodegradable products should be used where there is any risk of guards being washed or blown into the estuary. Plant guards should not be used in Zone 3.

Using a crow bar to plant searush

Existing terrestrial planting with plant protection

5.4.3 Fertiliser

Terrestrial and supratidal plantings should use a well-balanced 6-month slow-release fertiliser including nitrogen, phosphorus and potassium plus magnesium and trace elements. To allow distribution through the backfill–topsoil mix, fertiliser should be mixed evenly with the backfill at a rate recommended by the supplier.

Re-application should be as per manufacturer's instructions, i.e. to each plant at 12, 24 and 36 months after planting.

5.4.4 Mulch

Within the terrestrial planting zone (Zone 1), a thick layer of bark mulch should be placed to a depth of 75mm over the planting area, around plants and up to the plant stems, in such a way as to cover the ground surface around the plant.

Within the supratidal planting zone (Zone 2), a layer of pebble or shell mulch may be placed to a depth of 75mm over the planting area, and around plants and up to the plant stems, in such a way as to cover the ground surface around the plant. Bark mulch, with a potential to wash away, should not to be used in Zone 2 or 3.

5.5 MAINTENANCE

5.5.1 Maintenance Period

The planting areas should be maintained for at least three years (36 months) unless full canopy cover (closure of plants over the ground surface) is achieved in advance.

The maintenance period for each planting area should start from the date that the planting is completed for that planting area.

5.5.2 Weed Control

Plant mats and plant stems are to be kept free of all weeds and grass throughout the maintenance period. For example, grass or weeds should not be allowed to grow or overhang a 300mm minimum area (measured from the stem) around any plant.

If maintenance is contracted out, the maintenance contractor shall undertake any operation or action in accordance with accepted normal horticultural practice to ensure the survival, health and optimum growth of all plants within the contract site as necessary. Any native trees or shrubs damaged by weed control shall be replaced by the maintenance contractor at the Contractor's expense.

5.5.3 Weed Spraying

Use of chemical herbicides is restricted to terrestrial areas within Zones 1 and 2. Herbicide should not be applied to plants below MHWS.

Use of chemical herbicides shall conform in every respect to the mixture required and be applied strictly in accordance with the manufacturer's instructions. All spraying equipment must be calibrated to prevent under or over-dosing.

All chemical herbicides used are to be non-toxic to people, birds and animals under normal use and only those chemical herbicides registered under the Pesticides Act may be used. No herbicide containers, empty or full, are to be left on site at any time.

When applying, spray drift should be minimised because it could damage any native trees or shrubs, or salt marsh.

Where a translocated herbicide such as glyphosate is used around plants in leaf, an adequate guard must be used for all spraying.

5.5.4 Replacements

Where possible, any plants which die or are significantly damaged should be replaced annually during the maintenance period.

The replacement plant should follow the inspection and planting guidance above. Replacements should be planted at the same location using species and varieties as shown in the tables in Section 4

At the end of the planting and maintenance period, all plants shall be healthy, vigorous, of a size suitable for their age, and growing in weed free conditions in accordance with the requirements of this specification.

5.5.5 Rubbish

All rubbish and debris resulting from planting is to be continually collected and removed from site.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