

Southshore and South New Brighton Park Flood Protection Works

Ecological Impact Assessment
Prepared for Christchurch City Council

1 December 2023





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Cover photograph: Saltmeadow (with planted sea rush) at the edge of the estuary mudflat, Southshore. © Boffa Miskell 2022.

Executive summary

Christchurch City Council (CCC) is planning to undertake works along the eastern edge of the Avon-Heathcote Estuary / Ihutai to address erosion and flood risk at South New Brighton Park (SNBP) and Southshore. The project involves the construction and maintenance of the following structures along the estuary edge:

- Approximately 570 m of coastal erosion protection structures (revetments, gabion baskets and cobble beach) at SNBP.
- Approximately 640 m of inundation bund at SNBP, located between 40 to 180 metres behind the estuary edge.
- Approximately 1,580 m of coastal erosion protection structures (revetments and cobble beach) at Southshore.
- Approximately 2,050 m of inundation bund at Southshore, with a 5 m set back from the estuary edge.

Boffa Miskell was engaged to prepare an ecological impact assessment considering the potential effects of the proposed works on the ecological values of the project site.

In relation to terrestrial vegetation and habitats this assessment has identified that:

- Impacts to Exotic Grassland / Herbfield, which (aside from the presence of southern grass skink) is not ecologically significant, are of a **Very Low** level of effect. On the other hand, a substantial planting plan in this area, when implemented, would constitute an overall Positive magnitude of effect and hence a **Net Gain**.
- Construction of the inundation bund at SNBP will involve clearance of a corridor of planted and / or exotic vegetation, somewhat fragmenting a currently continuous area of forest / treeland habitat. The corridor follows an existing track, minimising this impact. Infill and supplemental planting proposed via the project's landscape plan (over a larger area) remedies or mitigates vegetation losses to achieve an overall Positive magnitude of effect and hence a **Net Gain**.
- Impacts to sea rush plants (that cannot be avoided), although Negligible (**Very Low** level), at the edge of an ecologically significant area of saltmarsh vegetation must be remedied¹ via replanting,

¹ This recommendation is in accordance with the statutory direction of the Canterbury Regional Policy Statement to achieve **no net loss**, even if ecological effects are very low.

because the statutory context dictates that the project achieve *no net loss and preferably a net gain* in saltmarsh vegetation extent.

- Any loss of indigenous herbs, rushes and shrubs within a significant coastal grassland area (Saltmarsh Ribbonwood / Marram Grass Grassland) at the south end of the project site, while of Negligible magnitude (**Very Low** level), must be remedied via replanting. This is to ensure *no net loss and preferably a net gain* in the significant indigenous vegetation component of this habitat.
- Low-Moderate magnitude impacts to significant saltmeadow vegetation (of Moderate ecological value) cannot be avoided despite design changes and all the factors that influence the design. **Low-Moderate** level effects, i.e., net loss of the values of this area cannot be remedied or mitigated and an offset of at least 0.25 ha of saltmeadow is required to achieve *no net loss or preferably a net gain*. The offset is proposed and detailed in a separate Saltmeadow Restoration Plan, and following implementation would achieve an overall **Net Gain**.

In relation to estuarine species and habitats, this assessment has identified that, both at SNBP and Southshore:

- The hard-bottom habitat provided by the existing erosion protection structures along the estuary edge is artificial and the result of significant habitat modification. It is occupied by common estuarine species which are present in low abundance. This habitat is of low ecological value.
- The soft-bottom habitat on the estuary bed is characterised by mostly medium and fine sand, low levels of contaminants and some habitat modification in proximity of the estuary edge due to the release of rock material from the armouring structures. Infaunal communities have moderate species richness, diversity and abundance, with both tolerant and sensitive taxa present. The surface of the seabed is colonised by epibenthic communities typical of estuarine habitats. While at SNBP the seabed is mostly unvegetated, at Southshore there are areas dominated by different types of intertidal vegetation, including macroalgae, seagrass and saltmarsh. There is no seagrass or saltmarsh at SNBP.
- The ecological value of the soft-bottom habitat is assessed as moderate for the areas of mudflat habitat (i.e., the soft-bottom habitat which is either unvegetated or presents limited cover of macroalgae, both at SNBP and Southshore) and as high for the areas of seagrass and saltmarsh (at Southshore).
- The project will involve both reclamation and declamation of soft-bottom mudflat habitat. Areas of mudflat reclamation and declamation will be scattered across the project site. Overall, through the removal of the existing erosion protection structures and a landward shift in the position of the new structures where this is achievable, there will be an 879 m² increase in the availability of mudflat habitat along the estuary edge across the project site. The

level of effect associated with the increase in the extent of mudflat habitat is assessed as a **Net Gain**.

- The project will also result in a 705 m² increase in the availability of artificial hard bottom habitat across the project site. The level of effect associated with the increase in the extent of hard-bottom habitat is assessed as **Very Low**.
- Permanent habitat modification through shading of both mudflat and hard-bottom habitat by a new jetty at Southshore will be limited to a small area of the project site and is assessed as having a **Very Low-Low** level of effect.
- While there is only minimal overlap between the project footprint and the seagrass habitat at Southshore, it may not always be possible to remove the existing structures without impacting small patches of seagrass growing in close proximity. With the recommended avoidance and remediation measures in place, along with the impact management measures already included in the project design and construction methodology, small-scale seagrass habitat disturbance and seagrass mortality are assessed as having a **Very Low** level of effect.
- Disturbance of the mudflat habitat to accommodate the new structures throughout the project site is assessed as having a **Very Low** level of effect because, with the impact management measures included in the project design and construction methodology, the reinstated mudflat habitat is expected to be analogous to the existing one and to be colonised by the same suite of benthic organisms which is currently present.
- Common species of macroalgae and benthic invertebrates will suffer mortality during the removal of the existing erosion protection structures and as part of the reclamation and disturbance of the mudflat habitat throughout the project site. With the impact management measures included in the project design and construction methodology, the mortality of estuarine organisms is assessed as having a **Very Low** level of effect as the new erosion protection structures and the reinstated mudflat habitat are expected to be colonised by the same suite of benthic organisms which is currently present. In addition, the net gain in the extent of mudflat habitat across the project site will provide additional benthic habitat to infauna and epibenthic organisms.
- Other construction effects including resuspension of benthic sediments and contaminants, runoffs of terrestrial sediment and contaminants, as well as noise and vibration are assessed as having a **Very Low** level of effect, provided that such effects are avoided/minimised with stringent adherence to the impact management measures included in the construction methodology.
- Following construction, erosion at the base of the new erosion protection structures could affect the ability of epibenthic and infaunal animals to occupy the area at the toe of the new structures.

This is assessed as having a **Very Low** level of effect based on the findings of the Coastal Processes and Natural Hazards Assessment.

- Following construction, the mobilization of cobble beach material (particularly in the event of large storms) may impact the adjacent mudflat (both at SNBP and Southshore) and saltmarsh habitat (at Southshore). Based on the infrequent nature of large storm events and on the low energy environment of the estuary, this is assessed as having a **Very Low** level of effect on both habitat types with the mitigation measures recommended in this report in place.
- Increased public access to the estuary bed is a further post-construction effect which could result in increased trampling and harvesting of estuarine organisms and littering. This is also assessed as having a **Very Low** level of effect with the mitigation measures recommended in this report in place.
- Coastal squeeze in response to sea level rise is a longer-term post-construction effect. The project will introduce additional coastal squeeze in one area of mudflat habitat at SNBP and one area of saltmarsh habitat at Southshore. In the two areas, cobble beach structures will replace the “soft”, unarmoured edge which is currently present. Considering the spatial extent of the area affected, the composition of the estuarine communities that would be affected and the widespread hardening of the estuary edge, both at the scale of the project site and of the estuary, coastal squeeze is assessed as having a **Very Low** level of effect on the mudflat habitat at SNBP. The impact of coastal squeeze introduced by the project is also likely to be small for the saltmarsh habitat at Southshore. However, given the many areas of uncertainties involved in this assessment, we were not able to establish the magnitude/level of effect of the coastal squeeze on the saltmarsh habitat. The report provides impact management measures to monitor and address this effect on the saltmarsh habitat.
- Although the project will add to a long history of developments and habitat modification along the shorelines of the Avon-Heathcote Estuary / Ihutai, it will increase the extent of mudflat habitat along the estuary edge and will not affect key elements and features of the existing baseline conditions which contribute to the ecological value of the estuary. Therefore, the level of cumulative effects of the project on the ecological values of estuarine species and habitats is assessed as a **Net Gain**.

In relation to herpetofauna this assessment has identified that:

- Southern grass skink are present within the project site, including utilising habitats within the project footprint. This is an At Risk – Declining species, which is protected under the Wildlife Act 1953.
- A Lizard Management Plan (LMP) and Wildlife Act Authority will need to be prepared by a suitably qualified and experienced herpetologist and submitted to the Department of Conservation prior

to any vegetation clearance and earthworks commencing for this project.

- The LMP will describe the management approach required to ensure any effects on the southern grass skink are appropriately avoided or mitigated, resulting in a no net loss and preferably a net gain for this species.

In relation to avifauna this assessment has identified that:

- The terrestrial species avifauna assemblage recorded within and adjacent to the project site is comprised of species assigned Low or Negligible ecological value.
- The intertidal mudflats of the Estuary are considered to be of Very High value based on the presence of a number of Threatened and At Risk species utilising that habitat. However, the avifauna species utilising the area are assigned Very High to Low ecological value.
- In terms of habitat loss, the direct loss of terrestrial habitat will result in an overall **Very Low to Low** levels of effect on avifauna species.
- The project will in result in the overall net gain of 879 m² of extra mudflat area, and therefore a **Net Gain** in habitat for coastal species.
- The overall level of effects associated with disturbance during both the construction and operational phases is considered to be **Very Low to High**. However, impact management measures have been identified to avoid the Moderate and High levels of effects.
- The potential for mortalities and injuries of breeding birds is possible, with the overall level of such effects ranging from **Very Low to Low**.
- The overall level of effects associated with potential impacts on coastal avifauna food supply and foraging ability during the construction of the project are considered to be **Very Low to Low**.
- There is no lighting associated with the project and, therefore, no potential effects on avifauna.
- No cumulative effects on avifauna were identified as a result of this project.

Overall, if the impact management measures recommended in this report are carried out to a suitable standard, the overall level of effect of the erosion and inundation protection works at Southshore on the of ecological values of terrestrial and estuarine habitats, avifauna and herpetofauna is expected to be **Very Low to Low**, or a **Net Gain**.

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Appendix 5: Epibenthic organisms

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Appendix 8: Saltmeadow Offset Plan

1.0 Introduction

1.1 Background

The Christchurch City Council (CCC) is planning to undertake works along the eastern edge of the Avon-Heathcote Estuary / Ihutai (the Estuary) to address erosion and flood risk at South New Brighton Park (SNBP) and Southshore. Issues with erosion and flooding in this area were exacerbated by the 2010-2011 Canterbury Earthquake Sequence (CES), which caused land subsidence and damage to private erosion protection structures. The scope of the project is to address earthquake legacy issues by reinstating pre-earthquake conditions and to provide erosion and tidal inundation protection along the SNBP and Southshore estuary edge over a nominal 20-year period while longer-term adaptative planning responses to climate change and sea level rise are developed (see Sections 1, 4, 8 and 10 of the AEE).

As outlined in Figure 1, the project involves the construction and maintenance of the following structures along the estuary edge:

- Approximately 570 m of coastal erosion protection structures at SNBP, tying into existing gabion baskets and reno mattresses at its northern and southern extents.
- Approximately 640 m of inundation bund at SNBP, tying into high ground at its northern and southern extents.
- Approximately 1,580 m of coastal erosion protection structures at Southshore, nominally from Godwit Street to south of Tern Street, tying into existing coastal erosion protection structures along Ebbside Street.
- Approximately 2,050 m of inundation bund at Southshore, with a 1.5 m wide shared user track formed along the bund crest, tying into an existing inundation bund along Caspian Street and into high ground south of Tern Street.



Figure 1. Extent of the proposed structures along the South New Brighton Park and Southshore estuary edge.

1.2 Scope

Boffa Miskell was engaged by the CCC as a subcontractor to Jacobs New Zealand Ltd to prepare an ecological impact assessment (EclA) considering the potential effects of the proposed works on the ecological values of the project site.

The scope of this report is to describe the existing ecological environment that would be affected by the proposed works, and to assess the effects of those works on the ecological values of terrestrial and intertidal estuarine habitats, including avifauna and herpetofauna at the project site and in the ecological context of the Estuary.

1.3 Report structure

This report:

- Outlines the methodology used to undertake the assessment (Section 2.0),
- Describes the existing environment (Section 3.0), including an assessment of the site significance (Section 3.6) and a summary of ecological values (Section 3.5),
- Describes the original project design (Section 4.0), the describes changes made through the design shaping process (Section 5.0) and outlines the confirmed project design (Section 6.0), and
- Assesses the ecological effects of the project (Section 7.0), and provides impact management recommendations (Section 8.0) and Conclusions (Section 9.0).

2.0 Methodology

We used a combination of desktop assessments and site investigations to gather information on the existing ecological values within the project site. The following sections first describe the existing information relied on for the desktop assessments and then detail the methodologies used as part of field investigations, for each area of ecology investigated.

Sections 2.8 and 2.9 describe the methodology used to assess the ecological values and ecological significance of the terrestrial, estuarine, avifauna and herpetofauna found within the project site.

2.1 Definitions and naming conventions

The terms used to refer to the project locations and activities follow the Environment Institute of Australia and New Zealand's (EIANZ) EclA guidelines (Roper-Lindsay et al., 2018). Key terms are:

- The 'project site' (the zone of influence), which refers to all land, water bodies, and receiving environments that the project could potentially affect. It includes the proposed erosion protection and inundation bund construction footprints and any environments

beyond the construction footprints where indirect effects may extend. The project site includes both SNBP and Southshore.

- The 'project footprint', which encompasses the maximum extent of all works associated with the construction of the erosion protection and inundation bunds at SNBP and Southshore, both permanent and temporary, and therefore defines the limit of direct effects on the project site's ecology.

2.2 Supporting information

In addition to the information collected through the desktop and ecological field investigations, this assessment has been based on the following information on the original project design provided to us by Jacobs:

- Technical Experts Scoping Document provided in December 2021.
- Draft Basis of Design Report provided in January 2021.
- Georeferenced layout of the envelopes of target habitat for the ecological assessment provided in January 2022. The envelopes encompass the terrestrial and intertidal estuarine habitat originally expected to be affected by the works.
- Draft construction methodology provided in May 2023.
- Georeferenced layout of the proposed structures and calculations (m²) of their footprint provided between May and October 2023.
- Preliminary Design Report provided in October 2023.

Further details on the original project designs are included in Section 4.0.

2.3 Terrestrial vegetation and habitats

2.3.1 Desktop review

Desktop information on terrestrial ecology values (indigenous vegetation and habitats of terrestrial fauna and terrestrial species, whether in terrestrial areas, inland salt meadow wetlands, and estuarine saltmarsh wetlands) likely to occupy habitats within and adjacent to the project site were gathered from the following sources:

- Aerial imagery, including high-resolution orthorectified UAV imagery provided by Jacobs on 18 March 2022.
- GIS (Geographic Information System) databases including:
 - o Threatened Environment Classification (Walker et al., 2015) GIS Layer
 - o Christchurch City Council Sites of Natural Significance GIS Layer
 - o Environment Canterbury (ECan) 'Canterbury Coastal Wetland Vegetation' and 'Canterbury Regional Wetlands' GIS layer (the latter is no longer publicly available but was downloaded in May 2019).
- Existing ECan reports, CCC reports, and published papers from scientific journals.

2.3.2 Site investigation

Dr Jaz Morris conducted a walk-through survey of the terrestrial vegetation and habitats within the project site on 23 March 2022. This survey assessed terrestrial vegetation, including salt meadow wetlands and estuarine saltmarsh wetlands.

During the vegetation surveys:

- The plant communities at the project site were classified using the classification system and naming conventions developed by Atkinson (1985). A handheld Garmin Global Positioning System (GPS) was also used to mark plant community boundaries where necessary.
- Plant species, and their cover (using the 'DAFOR' scale) was recorded in each of the plant communities.
- General notes were made on the condition of the plant communities and habitats present.
- Jaz Morris undertook two further site investigations, to:
 - o undertake four 2x2 m vegetation plot measurements within a representative saltmeadow area at Southshore and to visit potential offsetting sites at Jellicoe Marsh and Southshore Spit Reserve, where saltmeadow could be established or expanded to offset adverse effects. This visit took place on 6 October 2023, with Mike Pentecost and Tim Reed (Landscape Architects, CCC) also in attendance.
 - o re-visit Southshore Spit Reserve (the preferred offset site), and to visit other sites around the Avon-Heathcote Estuary / Ihutai where CCC saltmeadow creation projects have occurred. This visit took place on 27 October 2023, with Mike Pentecost and Andrew Crossland (Ecologist, CCC) also in attendance.

2.4 Estuarine species and habitats

2.4.1 Desktop review

Desktop information on the ecological values of estuarine species and habitats within and adjacent to the project site were gathered from the following sources:

- New Zealand estuaries spatial database²;
- Christchurch District Plan³;
- The Regional Coastal Environment Plan for the Canterbury Region⁴;
- Unpublished reports and published papers from scientific journals.

² <https://www.doc.govt.nz/nature/habitats/estuaries/estuaries-spatial-database/>

³ <https://districtplan.ccc.govt.nz/pages/plan/book.aspx?exhibit=DistrictPlan>

⁴ <https://www.ecan.govt.nz/your-region/plans-strategies-and-bylaws/regional-coastal-environment-plan-for-the-canterbury-region/>

2.4.2 Site investigation

Dr Tommaso Alestra carried out site surveys at low tide on 14, 15 and 16 March 2022, to investigate the intertidal estuarine habitats and species present at the project site.

The design of the surveys was based on habitat envelopes delineating the intertidal estuarine habitat expected to be either permanently or temporarily impacted by the construction of the erosion protection structures according to the original project design (see Figure 2 & Figure 3 and further details in Sections 2.2 and 4.0).

2.4.2.1 Transect sampling

The surveys were carried out along transects perpendicular to the shoreline, established by laying a transect tape on the seabed with the starting point located by the estuary edge.

At SNBP, we used five 20 m transects (labelled T1 to T5), spaced approximately 100 m apart. Sampling within a 20 m band from the estuary edge out into the estuary allowed us to encompass the entire width of the intertidal habitat expected to be impacted by the erosion protection works within the largest habitat envelopes (Figure 2). Sampling of the soft sediment habitat was carried out at four sampling points located 1 m, 7 m, 13 m, and 19 m from the estuary edge along each transect.

At Southshore, twelve 12 m transects (labelled as T1 to T12) were spaced approximately 120 m apart along the estuary edge. Sampling within a 12 m band from the estuary edge out into the estuary allowed us to encompass the entire width of the intertidal estuarine habitat expected to be impacted by the erosion protection works proposed for most of the Southshore shoreline (Figure 3). Along each of the transects, sampling of the soft-bottom habitat was carried out at three sampling points located at 1 m, 6 m, and 11 m from the estuary edge.

The original sampling design for Southshore included three additional transects (T4b, T5b and T6b) located towards the outer edge of a habitat envelope originally designated for the construction of an offshore breakwater to enhance the existing saltmarsh habitat (pink shape in Figure 3 and further details in Section 4.1). The data collected along T4b, T5b and T6b are not included in this report because design changes implemented to minimise impacts on estuarine habitats (see Section 5.0) mean the breakwater is no longer part of the proposed activity and these transects are no longer within the project footprint.

At each sampling point along each transect at SNBP and Southshore we carried out the following:

- A 0.5 m x 0.5 m quadrat (0.25 m²) was placed on the seabed and all species visible on the surface were identified, and their abundance recorded on site. Abundances were expressed as percentage cover for sessile organisms and as counts for mobile animals. Large rocks or debris (defined as having a minimum short axis of approximately 10 cm) within the quadrat were overturned and inspected for visible species.
- A 15 cm deep x 13 cm diameter infauna core sediment sample was collected and sieved (0.05 mm sieve mesh) on site. All retained material including macroinvertebrate infauna was then stored in 70% ethanol before being processed in Boffa Miskell's taxonomy laboratory. In the lab, the infauna was sieved through Endecott sieves (progressively from 4 mm to 0.5 mm mesh size), identified to the lowest practical taxonomic level and counted.
- Surface sediment samples (top 2 cm) were collected for sediment quality analyses.

- At SNBP, sediment samples from the four sampling points along transects T1, T3 and T5 were combined into two composite samples per transect (one for grain size and one for contaminant analyses). Only one composite sediment sample was collected from transects T2 and T4 and used for grain size analyses.
- At Southshore, sediment samples from the three sampling points along transects T1, T3, T5, T8, T10 and T12 were combined into two composite samples per transect (one for grain size and one for contaminant analyses). Only one composite sediment sample was collected from the other transects (T2, T4, T6, T7, T9, T11) and used for grain size analyses.
 - o Grain size samples were stored chilled prior to analysis by the University of Waikato. The abundance of different grain size fractions (an indicator of habitat quality for infaunal macroinvertebrates) was assessed using a Malvern Mastersizer 3000.
 - o Contaminant samples were stored chilled prior to analysis by Hill Laboratories. Concentrations of heavy metals zinc (Zn), lead (Pb), copper (Cu) and polyaromatic hydrocarbons (PAHs; normalised to 1% Total Organic Carbon) were analysed. The results were compared with the sediment quality guidelines of Australian and New Zealand Governments (2018).

Sampling of the hard-bottom habitats present along the estuary edge was also carried out, by placing one 0.5 m x 0.5 m quadrat (0.25 m²) on the hard substrate adjacent to the starting point of each transect. At SNBP, along T1, T3 and T4, one additional quadrat was sampled on the hard-bottom substrate of existing remanent reno mattresses located several meters away from the estuary edge (see Section 3.2.1). Within each quadrat, all visible species were identified, and their abundance recorded on site. Abundances were expressed as percentage cover for sessile organisms and as counts for mobile animals. The abundances of drift algae (i.e., not attached to the hard substrate) and of the algae growing attached to the rock were quantified separately.

During the surveys, notes were made on species or ecological features that were incidentally observed, but not present within the transects and photographs were collected.

2.4.2.2 Seagrass mapping

At Southshore, the eastern boundary (closest to the Southshore estuary edge) of meadows of the seagrass *Zostera muelleri* (a marine plant classified as an At Risk – Declining species; de Lange et al., 2018) was mapped using a hand-held GPS. A first round of seagrass mapping was carried out in March 2022 in concomitance with the transect sampling. Seagrass mapping was repeated in April 2023 to obtain updated information at the end of the summer peak growth period.

Seagrass is not present at SNBP.





Southshore Transect Locations

Figure 3

2.5 Herpetofauna

The following is a summary of the methodology for this survey, carried out by Dr Mandy Tocher of Lizard Expert NZ. Refer to Appendix 1 for full details.

In February 2022, Dr Tocher carried out a five-day lizard survey of areas within the project site and adjacent areas (Figure 4).

A range of methods were employed to detect and capture lizards over the survey area, including:

- Setting Gee minnow traps (GMT), baited with tinned pear, across 13 sites in areas where hand-searching would have been ineffective, and in areas of representative habitats of the survey extent. GMTs were deployed in groups of up to 11 at each of the 13 sites.
- Slowing walking through areas of vegetation and over rock / cobble conducting a visual search for lizards.
- Turning over rocks, and logs/fence posts and any litter wherever they were encountered, in search of lizards and / or lizard sign.
- Searching for skink faecal pellets on top of any litter present, the remains of garden fences and walls, fence stays/posts and rocks, and under rocks.
- Re-searching areas thought to have lizard habitat and lizards present at different times of the day to increase the chances of detection / capture of lizards.

Weather conditions during the survey were suitable for lizard activity.



Figure 4. Lizard survey areas spanning across the project site. South New Brighton Park (top panel), Southshore (bottom panel).

2.6 Avifauna

2.6.1 Desktop review

Desktop information on avifauna values within and adjacent to the project site was gathered from the following sources:

- New Zealand Birds Online species data for the Estuary location⁵.
- Christchurch District Plan.
- ECan Regional Coastal Environment Plan for the Canterbury Region.
- Unpublished reports and published papers from scientific journals.

2.6.2 Site investigation

Dr Leigh Bull established the field methodology, and undertook a site visit on 20 April 2022 to familiarise herself with the site and to assist with the nesting / roosting tree survey (refer to Section 2.6.2.3 below). Scott Hooson undertook the field surveys and met Dr Bull on site during her site visit to discuss the results collected to date and key avifauna features within and adjacent to the project site.

2.6.2.1 Terrestrial bird species

On 20 April 2022 (between 11.55 am and 2.06 pm), five-minute bird counts (5MBC) were completed at 16 pre-determined count stations spaced approximately 200 m apart. Count Stations 1-6 were located at South New Brighton Park; Count Stations 7-16 were located along the estuary edge at Southshore (Figure 5). Five-minute bird counts followed the standard 5MBC methodology (Dawson and Bull 1975). All terrestrial birds seen and heard on the landward side of the mean high-water spring (MWHS) (i.e., excluding coastal birds using the Estuary) were recorded during counts, including both indigenous and introduced and naturalised species. The weather was overcast and dry with mild to warm temperatures and a moderate north-easterly wind (2 on the Beaufort Scale).

2.6.2.2 Coastal bird species

Between 16 February and 29 April 2022, six fortnightly counts of coastal birds using four zones along the eastern side of the Estuary within and adjacent to the project site were completed (Figure 5). Due to the size of the zones (refer to Figure 5 and Table 1) and visibility constraints, counts for each zone were undertaken from more than one location to ensure all birds using each zone were counted. Count locations were chosen based on field of view (i.e., good visibility), accessibility, and proximity to features of interest within the zone (e.g., high-tide roost sites, shell banks, sand banks, etc.). Within each zone, as far as possible, bird counts were undertaken at low, mid and high tides, but at times the length of time required to record all birds within a zone meant that not all zones could be surveyed during each of the three tidal stages.

During each survey, all indigenous coastal birds within each zone were recorded (introduced and naturalised bird species were not recorded). The purpose of the counts was to obtain information on how different indigenous bird species utilise the estuarine habitat adjacent to the

⁵ https://nzbirdsonline.org.nz/location-search?field_location_term_id=293&field_location_term_value=Avon-Heathcote%20Estuary

project site throughout the tidal cycle. During each survey, bird species, numbers of birds of each species, the locations of birds, their behaviour (foraging, roosting or other) and the tidal stage (low, mid or high) was recorded directly into the ArcGIS online software programme 'Collector' on an iPad. Weather conditions (cloud cover, temperature, wind speed and precipitation) were also recorded during the surveys.

Table 1. The 2022 coastal avifauna count zone areas.

COUNT ZONE	AREA	
	m ²	hectare
1	848,126.3	84.8
2	718,981.5	71.9
3	1,158,196.0	115.8
4	642,450.4	64.2

2.6.2.3 Nesting / roosting habitat

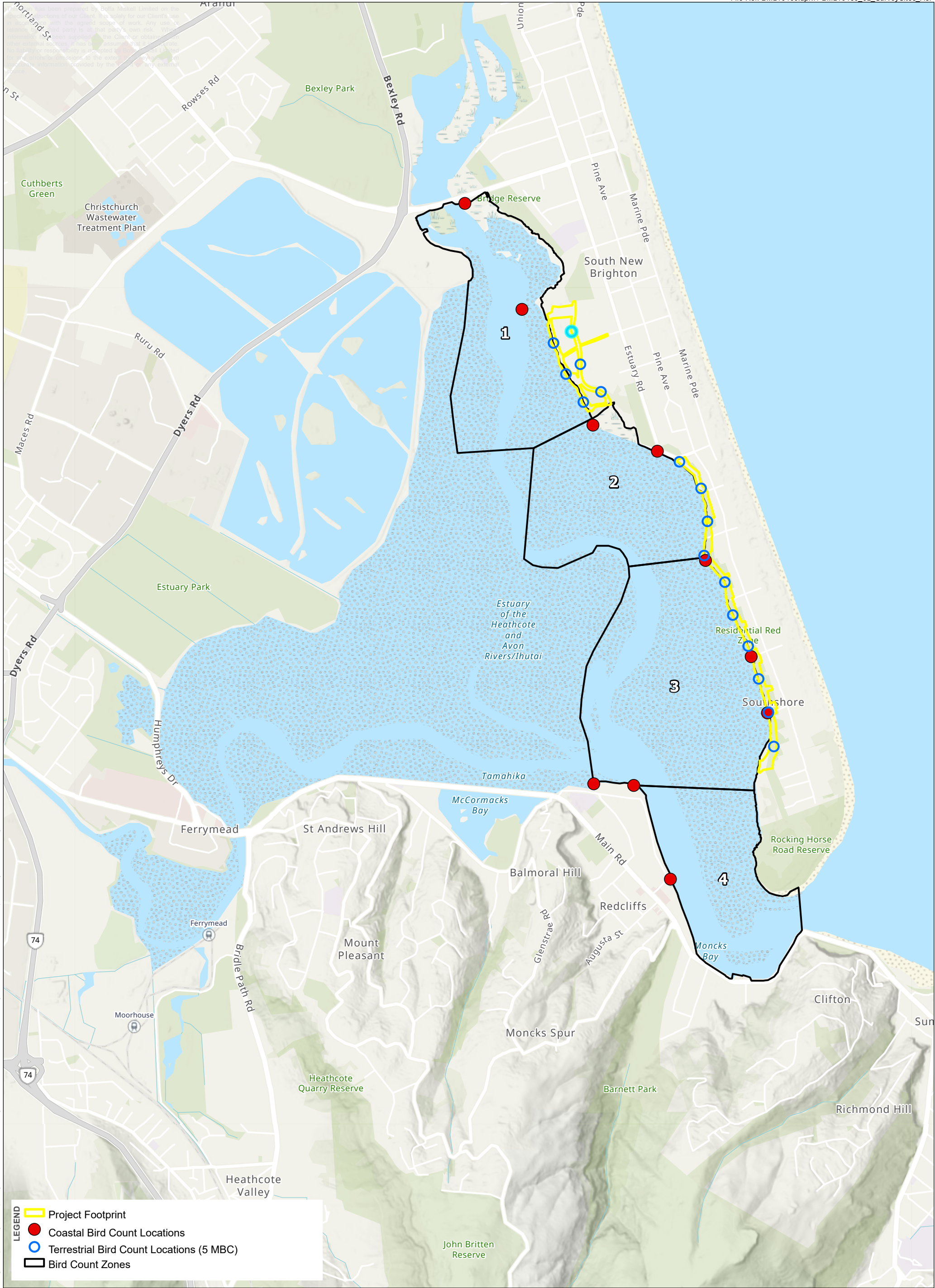
A survey for nesting and roosting trees was completed on 20 April 2022, outside the main bird breeding season. During the survey, trees were searched by eye and using binoculars for roosting birds and signs that trees were being used, or had been used, for roosting and previous nesting. Signs of roosting and previous nesting included presence of guano in the trees and on the ground as well as nests from previous breeding seasons. At Southshore, all trees along the estuary edge within the project site were searched. At South New Brighton, trees along the estuary edge, and trees adjacent to the project footprint further inland, including the proposed bund corridor, were searched.

This survey was repeated using the same method by Dr Bull on 26 November 2023, during the main bird breeding season. The survey commenced at the South New Brighton pier at 10 am and over the ensuing 3 hours the entire coastline was traversed down to Southshore Spit Reserve and back again. In addition, consideration was given to the potential for NZ pipit to be nesting within the Southshore residential red zone (RRZ), particularly in areas of rank grass; all such habitat was observed for the presence of breeding birds.

2.6.2.4 Incidental observations

Incidental observations of terrestrial bird species seen and heard outside of the formal 5MBC periods (i.e., when walking between count sites) were also recorded. A handheld GPS was used to mark locations of interest including trees used for roosting (e.g., for kingfisher) and bird nests.

This plan has been prepared by Boffa Miskell Limited on the specific instructions of our Client. It is solely for our Client's use in accordance with the agreed scope of work. Any use or reliance by a third party is at that party's own risk. Where information has been supplied by the Client or obtained from other external sources, it has been assumed that it is accurate. No liability or responsibility is accepted by Boffa Miskell Limited for any errors or omissions to the extent that they arise from inaccurate information provided by the Client or any external source.



2.7 Limitations and assumptions

2.7.1 Terrestrial vegetation

The GIS mapping of boundaries of vegetation types were determined using high-resolution drone imagery of the project site, in conjunction with field notes and GPS waypoints recorded during field investigations. Wetland vegetation plots or other similar measurements were not employed during delineation of the saltmeadow areas. This is because the boundaries of this vegetation type were readily apparent on site and in imagery, and plot-based delineation methods were not considered necessary for accurate wetland boundary determination. However, as outlined in Section 2.3.2, plot measurements have been made for the purpose of understanding saltmeadow vegetation composition; these plots also confirmed the wetland status of all areas checked.

2.7.1 Avifauna

2.7.1.1 Terrestrial avifauna

Only one session of 5MBCs were conducted to inform this assessment. As such, temporal and seasonal variability in the avifauna assemblages has not been accounted for and it is likely that additional species that weren't recorded will utilise the project site over the course of the year.

2.7.1.2 Cryptic marshbirds

Surveys for cryptic marshbirds, such as marsh crake (*Zapornia pusilla*) and Australasian bittern (*Botaurus poiciloptilus*), were not conducted for this assessment. Peak survey periods for such species are September to November (O'Donnell & Williams, 2015). As such, a conservative approach has been taken whereby if potential habitat for such species was identified, it has been assumed that those species could be present.

2.7.1.3 Nesting / roosting trees

Only two nesting / roosting tree surveys were conducted, and as such the data collected during those surveys provides a snapshot at that time. The April survey was conducted outside the general avifauna breeding period, while the November survey was conducted within that period.

2.7.1.4 Coastal avifauna

In New Zealand, general peak periods of migration movement of national migrant shorebirds and international (trans-equatorial) migrant shorebirds are as follows (also refer to Table 2):

- **December to March:** NZ pied oystercatcher, pied stilt, wrybill, banded dotterel (moving northward for the autumn).
- **March and April:** Bar-tailed godwit, lesser knot, turnstone, other arctic migrants (depart New Zealand for the northern hemisphere breeding grounds).
- **June to September:** NZ pied oystercatcher, pied stilt, wrybill, banded dotterel (moving southwards to breed over winter and spring).

- **September to November:** Bar-tailed godwit, lesser knot, turnstone (arrive in New Zealand from the northern hemisphere).

Thus, while field surveys were conducted over the different tidal cycles to account for temporal variability in patterns of use, the surveys were only conducted over a single season in 2022 and, therefore, cannot account for seasonal variability in the species assemblage that is likely to occur.

Table 2: Migratory movements for eight shorebird species. Blue is the period where the majority of movements occur in most years, grey indicates the time range of migration activity.

SPECIES	NATIONAL MIGRANTS				TRANS-EQUATORIAL MIGRANTS			
	NZ pied oyster-catcher	Pied stilt	Banded dotterel	Wrybill	Bar-tailed godwit	Lesser knot	Turnstone	Golden plover
Dec								
Jan								
Feb								
Mar								
Apr								
May								
June								
July								
Aug								
Sept								
Oct								
Nov								

2.8 Assessing ecological value and ecological effects

To follow a robust and repeatable process, we used the EIANZ EcIA guidelines (Roper-Lindsay et al., 2018) to assess ecological values (Table 3, Table 4, Table 5, Table 6), the magnitude of potential effect (Table 7) and the overall level of effect (Table 8) of the proposed activities on terrestrial vegetation and habitats, estuarine species and habitats, avifauna (terrestrial and coastal) and herpetofauna.

The EIANZ EcIA guidelines use the New Zealand threat classification system as the criteria for assigning ecological value to species (Table 6). The most current versions of these as used in this report are:

- Plants: de Lange et al. (2018)

- Birds: Robertson et al. (2021)
- Reptiles: Hitchmough et al. (2021)
- Marine invertebrates: Funnell et al. (2023)
- Macroalgae: Nelson et al. (2019).

We further note that the threat classifications that are captured under the Very High, High or Moderate ecological value criteria for species (Table 6) are the same as those identified in Policy 11a(i) of the New Zealand Coastal Policy Statement (NZCPS), that is, *Threatened* or *At Risk* species in the New Zealand Threat Classifications System lists.

When assigning magnitude of effect, we used the criteria and descriptions as shown in Table 7. We assessed the magnitude of effect for each component of ecology at the following scales:

- Vegetation and habitats: Low Plains Ecological District (in the Canterbury Plains Ecological Region)
- Estuarine habitats and species: the Estuary scale
- Avifauna: the Estuary scale

We have also taken a species (for avifauna) focus and applied the criteria or proportion thresholds below, to assist with determining the magnitude of effect (text italicised and bolded in Table 7):

- Very High: >50% of the population⁶ affected or habitat lost.
- High: 20-50% of the population affected or habitat lost.
- Moderate: 10-20% of the population affected or habitat lost.
- Low: 1-10% of the population affected or habitat lost.
- Negligible: <1% of the population affected or habitat lost.

The EIANZ EcIA guidelines note that the level of effect can then be used as a guide to the extent and nature of the ecological management response required (including the need for biodiversity offsetting). For example:

- **‘Very High’** represents a level of effect that is unlikely to be acceptable on ecological grounds alone (even with compensation proposals). Activities having very high adverse effects should be avoided.
- **‘High’ and ‘Moderate’** represents a level of effect that requires careful assessment and analysis of the individual case. Such an effect could be managed through avoidance, design, or extensive offset or compensation actions.
- **‘Low’ and ‘Very Low’** should not normally be of concern, although normal design, construction and operational care should be exercised to minimise adverse effects. If effects are assessed taking impact management measures developed during project shaping into consideration, then it is essential that prescribed impact management is carried out to ensure low or very low-level effects.
- **‘Very Low’** level effects can generally be classed as ‘not more than minor’ effects.

When considering appropriate impact management measures, it’s also important to consider ecological significance and higher-order policies such as the National Policy Statement for

⁶ At the scale of the Avon-Heathcote Estuary / Ihutai.

Freshwater Management (NPS-FM), the National Environmental Standards for Freshwater (NES-F) and the NZCPS, and any regulatory need to consider no net loss or net gain.

Table 3. Matters to be considered when assigning ecological value to terrestrial vegetation / habitats / communities (from Roper-Lindsay et al., 2018).

MATTERS	ATTRIBUTES TO BE CONSIDERED - TERRESTRIAL
Representative-ness	Criteria for representative vegetation and aquatic habitats: • Typical structure and composition • Indigenous species dominate • Expected species and tiers are present • Thresholds may need to be lowered where all examples of a type are strongly modified Criteria for representative species and species assemblages: - Species assemblages that are typical of the habitat - Indigenous species that occur in most of the guilds expected for the habitat type
Rarity/ distinctiveness	Criteria for rare/distinctive vegetation and habitats: - Naturally uncommon, or induced scarcity - Amount of habitat or vegetation remaining - Distinctive ecological features - National priority for protection Criteria for rare/distinctive species or species assemblages: - Habitat supporting nationally Threatened or At Risk species, or locally uncommon species - Regional or national distribution limits of species or communities - Unusual species or assemblages - Endemism
Diversity and pattern	- Level of natural diversity, abundance and distribution - Biodiversity reflecting underlying diversity - Biogeographical considerations – pattern, complexity - Temporal considerations, considerations of lifecycles, daily or seasonal cycles of habitat availability and utilisation
Ecological context	- Site history, and local environmental conditions which have influenced the development of habitats and communities - The essential characteristics that determine an ecosystem's integrity, form, functioning, and resilience (from "intrinsic value" as defined in RMA) - Size, shape and buffering - Condition and sensitivity to change - Contribution of the site to ecological networks, linkages, pathways and the protection and exchange of genetic material - Species role in ecosystem functioning – high level, key species identification, habitat as proxy

Table 4. Matters to be considered when assigning ecological value to a marine site or area, based on criteria developed by Dr Sharon De Luca (Boffa Miskell Ltd, Marine Ecologist) for estuarine / marine environments⁷.

VALUE	CHARACTERISTICS
Very High	- Benthic invertebrate community typically has very high diversity, species richness and abundance for the habitat type - Benthic invertebrate community contains dominated taxa that are sensitive to organic enrichment and mud - Marine sediments typically comprise <25% smaller grain sizes - Surface sediment oxygenated with no anoxic sediment present - Contaminant concentrations in surface sediment significantly below ANZG DGV effects threshold concentrations - Invasive opportunistic and disturbance tolerant species absent - Native estuarine vegetation sequences intact and provides significant habitat for native fauna - Habitat unmodified
High	- Benthic invertebrate community typically has high diversity, species richness and abundance for the habitat type - Benthic invertebrate community contains many taxa that are sensitive to organic enrichment and mud - Marine sediments typically comprise <50% silt and clay grain sizes - Surface sediment oxygenated - Contaminant concentrations in surface sediment significantly below ANZG DGV effects threshold concentrations - Invasive opportunistic and/or disturbance tolerant species largely absent - Estuarine vegetation dominated by native species - Habitat largely unmodified
Moderate	- Benthic invertebrate community typically has moderate species richness, diversity and abundance for the habitat type - Benthic invertebrate community has both (organic enrichment and mud) tolerant and sensitive taxa present - Marine sediments typically comprise less than 50-70% silt and clay grain sizes - Shallow depth of oxygenated surface sediment - Contaminant concentrations in surface sediment generally below ANZG DGV effects threshold concentrations - Few invasive opportunistic and/or disturbance tolerant species present - Estuarine vegetation a mixture of native and exotic species - Habitat modification limited

⁷ No regional or national guidelines or criteria have been developed to date in New Zealand for the assessment of marine ecological values. The criteria used in this assessment have been developed by Dr Sharon De Luca, (Boffa Miskell Ltd, Marine Ecologist), to guide valuing estuarine environments and to provide a transparent and repeatable approach. This approach has been used and accepted in previous Board of Inquiry consenting processes, including for major roading projects for Waka Kotahi NZTA such as Pūhoi to Warkworth, Waterview Connection, Transmission Gully, Mackays to Peka Peka and East West Link.

VALUE	CHARACTERISTICS
Low	- Benthic invertebrate community degraded with low species richness, diversity and abundance for the habitat type - Benthic invertebrate community dominated by organic enrichment tolerant and mud tolerant organisms with few/no sensitive taxa present - Marine sediments dominated by silt and clay grain sizes (>70%) - Surface sediment predominantly anoxic (lacking oxygen) - Elevated contaminant concentrations in surface sediment, above ANZG DGV effects threshold concentrations - Invasive, opportunistic and/or disturbance-tolerant species dominant - Estuarine vegetation dominated by exotic species - Habitat highly modified
Very Low / Negligible	- Benthic invertebrate community degraded with very low species richness, diversity and abundance for the habitat type - Benthic invertebrate community dominated by organic enrichment tolerant and mud tolerant organisms with no sensitive taxa present - Marine sediments dominated by silt and clay grain sizes (>85%) - Surface sediment anoxic (lacking oxygen) - Elevated contaminant concentrations in surface sediment, above ANZG Default Guideline Values (DGV) effects threshold concentrations⁸ - Invasive, opportunistic and disturbance tolerant species highly dominant - Native estuarine vegetation absent - Habitat extremely modified

Table 5. Scoring for sites or areas combining values for four matters in Table 3 (from Roper-Lindsay et al., 2018).

VALUE	DESCRIPTION
Very High	Area rates High for 3 or all of the four assessment matters listed in Table 2 and Table 3 Likely to be nationally important and recognised as such
High	Area rates High for 2 of the assessment matters, Moderate and Low for the remainder; or Area rates High for 1 of the assessment matters, Moderate for the remainder Likely to be regionally important and recognised as such
Moderate	Area rates High for one matter, Moderate and Low for the remainder; or Area rates Moderate for 2 or more assessment matters Low or Very Low for the remainder Likely to be important at the level of the Ecological District
Low	Area rates Low or Very Low for majority of assessment matters and Moderate for one Limited ecological value other than as local habitat for tolerant native species
Negligible	Area rates Very Low for 3 matters and Moderate, Low or Very Low for remainder

⁸ ANZG (2018) Australian and New Zealand Guidelines for Freshwater and Marine Water Quality (replaced previous ANZECC guidelines).

Table 6. Assigning ecological value to species (from Roper-Lindsay et al., 2018).

VALUE	SPECIES
Very High	<i>Nationally Threatened</i> (Nationally Critical, Nationally Endangered, Nationally Vulnerable, Nationally Increasing ⁹) species found in the ZOI ¹⁰ either permanently or seasonally
High	Species listed as <i>At Risk – Declining</i> found in the ZOI either permanently or seasonally
Moderate	Species listed as any other category of <i>At Risk</i> (Recovering, Relict, Naturally Uncommon) found in the ZOI either permanently or seasonally; or Locally (ED) uncommon or distinctive species
Low	Nationally and locally common indigenous species
Negligible	Exotic species, including pests, species having recreational value

Table 7. Criteria for describing magnitude of effect (from Roper-Lindsay et al., 2018).

MAGNITUDE	DESCRIPTION
Very High	Total loss of, or very major alteration, to key elements/ features of the baseline conditions such that the post development character/ composition/ attributes will be fundamentally changed and may be lost from the site altogether; AND/OR <i>Loss¹¹ of a very high proportion of the known population or range of the element / feature</i>
High	Major loss or major alteration to key elements/ features of the existing baseline conditions such that the post-development character, composition and/or attributes will be fundamentally changed; AND/OR <i>Loss¹¹ of a high proportion of the known population or range of the element / feature</i>
Moderate	Loss or alteration to one or more key elements/features of the existing baseline conditions, such that post-development character, composition and/or attributes will be partially changed; AND/OR <i>Loss¹¹ of a moderate proportion of the known population or range of the element / feature</i>
Low	Minor shift away from baseline conditions. Change arising from the loss/alteration will be discernible, but underlying character, composition and/or attributes of the existing baseline condition will be similar to pre-development circumstances/patterns; AND/OR <i>Having a minor effect on the known population or range of the element / feature</i>
Negligible	Very slight change from existing baseline condition. Change barely distinguishable, approximating to the “no change” situation; AND/OR <i>Having a negligible effect on the known population or range of the element / feature</i>

⁹ Nationally Increasing is category that was devised by DOC (Michel, 2021) in 2021 to resolve a problem that would arise if the population of a taxon assessed as At Risk Recovering A should stabilise. Threatened – Nationally Increasing is assigned to “Small population that have experienced a previous decline (or for which it is uncertain whether it has experienced a previous decline) and that is forecast to increase >10% over the next 10 years or 3 generations, whichever is longer” (Rolfe et al. 2021). Thus, while such a threat category is not identified in Roper-Lindsay et al. (2018), we have included it along with all other *Threatened* classifications in to the Very High ecological value category.

¹⁰ Roper-Lindsay et al. (2018) define the Zone of Influence (ZOI) as “the areas/resources that may be affected by the biophysical changes caused by the proposed project and associated activities.”

¹¹ In the context of mobile fauna, the term “loss” can include displacement from an area.

Table 8. Matrix of level of effect modified from Roper-Lindsay et al., (2018).

LEVEL OF EFFECT		Ecological &/or Conservation Value				
		Very High	High	Moderate	Low	Negligible
Magnitude	Very High	Very High	Very High	Very High	Moderate	Low
	High	Very High	Very High	Moderate	Low	Very Low
	Moderate	High	High	Moderate	Low	Very Low
	Low	Moderate	Low	Low	Very Low	Very Low
	Negligible	Low	Very Low	Very Low	Very Low	Very Low
	Positive	Net gain	Net gain	Net gain	Net gain	Net gain

2.9 Assessing ecological significance

Section 6(c) of the Resource Management Act 1991 (RMA) requires identification and protection of sites of significant vegetation and significant habitats of flora and fauna. Much of the project site (the Estuary up to MHWS, including some terrestrial areas) has already been assessed as significant and included in the Christchurch District Plan. It is listed as a Site of Ecological Significance (SES) (Avon Heathcote Estuary/Ihutai & Environs, SES 14) (Shadbolt, 2015).

For areas not included in SES 14, the significance of terrestrial communities and habitats was assessed against the criteria for determining significant indigenous vegetation and significant habitats of indigenous biodiversity listed in Appendix 3 of the Canterbury Regional Policy Statement (CRPS) (Environment Canterbury, 2013) and Appendix 1 of the National Policy Statement for Indigenous Biodiversity 2023 (NPS-IB; Ministry for the Environment, 2023).

Following CRPS Policy 9.3.1(3), areas or habitats are significant under the CRPS criteria if they meet one or more of the criteria in Appendix 3 of the CRPS. Following Appendix 1 of the NPS-IB, an area qualifies as an SNA if it meets any one of the attributes of the four criteria, being representativeness, diversity and pattern, rarity and distinctiveness, and ecological context.

3.0 Existing environment

3.1 Terrestrial vegetation and habitats

3.1.1 Ecological context

The project site adjoins residential areas and council-managed reserves, and is located within the Low Plains Ecological District (ED) in the Canterbury Plains Ecological Region (McEwen, 1987). The Canterbury Plains Ecological Region is now among one of the most modified regions in New Zealand, with much of the natural, pre-Polynesian vegetation having been cleared (Leathwick et al., 2002; McEwen, 1987). The original vegetation of the Low Plains ED has been substantially depleted by human induced fire and land clearance for agriculture and settlement. Nearly all of the ED is built or intensively farmed (Harding, 2009) and only 0.5% of the Low Plains ED is still covered in indigenous vegetation (Ecroyd & Brockerhoff, 2005).

In terms of the Threatened Environment Classification 2012¹², the project site is within land environment B9.1a, which is classified as having <10% indigenous cover left (Walker et al., 2015). Protecting indigenous vegetation on land environments with <20% indigenous vegetation cover is a priority in the Canterbury Biodiversity Strategy (Environment Canterbury, 2008) and a National Priority for Protection (Ministry for the Environment & Department of Conservation, 2007).

At SNBP, mixed age native plantings, an older stand of tall exotic conifer species, and park and grassland areas separate residential areas from the Estuary. None contain originally remnant or naturally occurring regenerating indigenous vegetation. At Southshore, between existing residential areas and the estuary mudflat, the narrow coastal margin that includes the project site is a modified habitat highly altered by former residential use (following the Canterbury earthquakes it is now referred to as 'RRZ' land). Based on analysis of historic aerial imagery, prior to residential development in the mid-20th century, small areas of saltmarsh habitats naturally occupied parts of the estuary edge along Southshore and SNBP. However, except for Jellicoe Marsh and two remaining areas near Penguin Street and 172 Rocking Horse Road, these have never been extensive. None were as large as the very large areas of saltmarsh that still persist further up the Estuary, above Bridge Street.

3.1.2 Vegetation types, and ecological value

This section describes terrestrial habitats at the project site. It describes the variety of vegetation types within the project site and environs and includes vegetation types that are wholly or exclusively outside the project footprint. Vegetation types have been aggregated for simplicity, but important distinctions between subtypes are noted.

Following a description of each vegetation / terrestrial habitat type, its ecological value is assessed following Table 5. A statutory assessment of the ecological significance of combined habitat areas is provided in Section 3.6. A map of vegetation types is included in Figure 6 and Figure 7.

Where possible, common names for plants have been used in this report. Where a species does not have a common name, or its common name cannot be used to identify the species without ambiguity, scientific names have been used. A list of the plant species (common and scientific names) recorded during the project site visit is provided in Appendix 2.

3.1.2.1 Exotic grassland / herbfield (various types and locations)

a) *Exotic grass grassland* (SNBP and environs, including track edges) .

These park and track areas are mown or otherwise maintained, with species comprised exclusively of exotic grasses with various exotic pasture herbs. In places along track edges, at the Estuary edge, couch and other exotic grasses are dominant but scattered; very scarce native herbs (glasswort) may be present.

b) *Indigenous shrubs / exotic grass grassland or shrubland* (SNBP: west of cricket field, and in other small community planting areas near the Pleasant Point Yacht Club).

Some track edge areas near the Estuary comprise grasslands with scattered shrubs or small trees including ngaio species (exotic Tasmanian ngaio, indigenous ngaio, and possibly hybrids)

¹² The Threatened Environment Classification 2012 is a combination of three national databases: Land Environments of New Zealand, Land Cover Database (Version 4.0) and the Protected Areas Network. It shows how much indigenous vegetation remains within land environments, how much is legally protected, and how the past vegetation loss and legal protection are distributed across New Zealand's landscape.

or non-local indigenous species such as karo and taupata. Exotic tree lupin is patchy. Between the Estuary and a cricket field, community plantings have been undertaken in recent years. Most planted specimens are still quite small (up to 2 m but typically much less), include a variety of indigenous species (e.g., tī kōuka, tauhinu), and are scattered among exotic cocksfoot grasslands with patchy blackberry and tree lupin. Some small areas meet the definition of shrubland.

c) Exotic herb herbfield (29 Ebbitide St to Estuary Rd).

Includes mown roadsides where salt-tolerant exotic herb cover slightly exceeds exotic grass cover, and includes vegetation that has established recently on rock revetment at the Estuary Edge. Buckshorn plantain, clover species, mallow species and couch dominate roadside areas, and Chilean iceplant, and couch dominate revetment areas.

d) Exotic grassland / treeland (Southshore Red Zone).

The 'RRZ' behind the estuary edge at Southshore contains retained trees and shrubs from former residential gardens but is, in the main, an area of mown exotic grass. The presence of any indigenous plant species among the former garden plantings is incidental and not considered of ecological value.

3.1.2.1.1 Ecological Value

This vegetation type is not representative, rare, diverse or important in terms of the ecological context. While the exotic grassland provides suitable habitat for southern grass skink (At Risk – Declining), in terms of values for indigenous vegetation it is of **Negligible** ecological value.

3.1.2.2 Exotic forest / treeland (various types and locations)

a) Radiata pine / tree lucerne treeland (Pleasant Point Yacht Club area).

To the east of the Estuary walkway an area of treeland is dominated broadly either by patchy tree lucerne (tagasaste) or radiata pine. This vegetation type includes scattered planted indigenous species (such as tī kōuka and harakeke) and other indigenous species that may have self-established, such as poroporo. The understory is dominated by exotic grasses (e.g., cocksfoot, veldt grass, Yorkshire fog), herbs (e.g., mallow), and woody weeds including tree lupin and blackberry.

b) Radiata pine / exotic grass treeland, radiata pine / Tasmanian ngaio - taupata treeland (Estuary edge areas of SNBP / Jellicoe Marsh).

At the Estuary edge, scattered large radiata pine (and some macrocarpa) trees have a patchy understory of ngaio species, and non-local taupata and karo. Several shrubs of saltmarsh ribbonwood and a small number of patches of knobby clubbish are the most notable naturally occurring / remnant indigenous species in this vegetation type. Otherwise, the understory is exotic grass or herbs, but scattered native spinach *Tetragonia trigyna* is present.

c) Radiata pine - macrocarpa / karo - taupata forest (South New Brighton Holiday Park).

South of South New Brighton Holiday Park, a tall forest of radiata pine and macrocarpa has been established for many decades. The understory is largely non-local karo and taupata, with scattered more recent plantings of more appropriate (local) indigenous species including akeake. Various weeds are also present in the understory, including blackberry, lily of the valley vine, boxthorn, and very scarce boneseed.

3.1.2.2.1 Ecological Value

Overall, none of these forest / treeland areas contain representative or distinct vegetation, they do not include nationally rare plant species, and the habitat diversity is low. The presence of several saltmarsh ribbonwood shrubs and small patches of knobby clubrush near the Estuary edge is the most notable component of the vegetation, as they are likely naturally occurring and are located on a land environment with less than 10% indigenous vegetation remaining. Further, this forest / treeland collectively covers a large area (>10 ha) and contains a well-developed canopy in many places. Thus, while exotic / non-local species are totally dominant, it is likely one of the better habitats available for the remaining indigenous forest bird species of the South New Brighton area. Little shag (At Risk – Relict) and pied shag (At Risk – Recovering) are known to roost (and may breed) in macrocarpa trees on the estuary edge. Attempted kereru breeding has been recorded in areas of tall vegetation in SNBP in recent years. In the context of the low local population of this species (this species is locally uncommon in the Low Plains ED and at the Estuary scale (Crossland 2014, 2020)) and the limited breeding habitat in low-lying areas in Christchurch, this is noteworthy. It also provides habitat for a small range of typical, widespread, and common indigenous bird species for the area (such as fantail and grey warbler), likely supports a small range of indigenous invertebrates, and is therefore overall of low-moderate rarity and of high importance as habitat for terrestrial bird species in the local (South New Brighton) ecological context. In places it supports southern grass skink (At Risk – Declining). It is of **Moderate** ecological value.

3.1.2.3 Exotic herb cobblefield / 'sparsely vegetated backshore'

Along much of the project site's estuary edge extent, the banks and backshore areas above the regularly inundated mudflat contain various (often eroding) debris and are sparsely vegetated with couch grass, herb species including exotic mallow, beet, orache, and indigenous species including glasswort and sea blite.

3.1.2.3.1 Ecological Value

Despite glasswort and sea blite being representative estuary edge species, the overall area is not a representative estuarine vegetation type. It does not include rare species, is not diverse, and is unimportant in terms of ecological context. The exotic herb cobblefield / mudfield is of **Low** ecological value.

3.1.2.4 Saltmarsh ribbonwood / marram grass grassland (Southshore)

Overall, the following vegetation type is a grassland. Two slightly different sub-types are described.

- a) *Saltmarsh ribbonwood / marram grass shrubland* (south end of project near Mermaid Place).

This shrubland occurs on low sand dunes comprising saltmarsh ribbonwood, taupata and occasional exotic shrubs / small trees (e.g., macrocarpa, elder, sycamore) largely among exotic marram grass. Indigenous knobby clubrush and New Zealand celery are scarce. Exotic Siberian lyme grass, Chilean iceplant and trailing African daisy are present among marram grass, and thistles, fennel, and exotic grasses are present in smaller cleared areas. It is probable that the saltmarsh ribbonwood and other indigenous species are a remnant of the original dune / estuarine vegetation that has been continuously present at the site but has been invaded by marram. Whilst this overall vegetation type is within the project footprint, the vast majority of the saltmarsh ribbonwood shrubs within it occur >20 m to the south of the project footprint and are considered outside of the project site (i.e., would be beyond the zone of influence of the proposal).

b) *Iceplant - marram grass grassland* (south end of project site near Mermaid Place).

This grassland is much like the vegetation type described above, except that it occupies the area closest to the mudflat and lacks saltmarsh ribbonwood. It was likely naturally much more sparsely vegetated in the past, prior to the establishment of marram.

3.1.2.4.1 Ecological Value

Representativeness: The overall vegetation is dominated by exotic species, and while grassland areas are not at all representative, the shrubland areas are moderately representative in that they are a modified remnant of the former vegetation of the site. **Rarity / Distinctiveness:** The small percentage of indigenous species present naturally occur on a land environment with less than 10% indigenous vegetation remaining, meaning that although no plant species are rare (nationally Threatened or At Risk, or locally uncommon) the overall vegetation is moderately rare. This habitat supports moderate numbers of southern grass skink (At Risk – Declining). The site overall scores moderate for rarity. **Diversity and Pattern:** Diversity and habitat pattern is low. **Ecological Context:** These vegetation types within the project site connect with much larger areas across Southshore spit, so while they are vulnerable to loss (due to erosion, because they are narrow) and there is little buffer from adjacent modified RRZ and residential areas, they score moderate in terms of ecological context. The saltmarsh ribbonwood / marram grass grassland is, therefore, of **Moderate** ecological value overall, with indigenous saltmarsh shrubs and indigenous skinks the main features that contribute to this value assessment.

3.1.2.5 Saltmarsh herbfield ('saltmeadow')

Saltmarsh herbfields (or 'saltmeadows') are a distinct and highly salt-tolerant vegetation type characterised by low-growing and often succulent herbs. Although saltmarsh herbfields are typically dry, in the estuarine context they receive infrequent saline inundation, such as during spring or perigean tides. In estuaries, saltmarsh herbfields typically occur as part of an overall saltmarsh¹³ ecotone (gradient) of vegetation that includes taller rushes in areas lower down the shore, below MHWS.

Previous surveys in the Estuary have classified different saltmarsh vegetation types. For example, Jupp et al. (2007) describe twelve estuarine saltmarsh vegetation types, of which the saltmeadow at Southshore best fits a so-called "Type 3 'Salt marsh herbfield'". Saltmeadow at Southshore fits a "Type 1.01 'Mixed saltmarsh herbfield, glasswort present'" vegetation type as described by Grove et al. (2012). Orchard (2020) recognises this vegetation type as a 'mixed saltmarsh herbfield' typically found in the mid-marsh zone at the Estuary.

a) *Saltmarsh ribbonwood / couch / sea blite - buckshorn plantain shrubland* (SNBP near Jellicoe Marsh footbridge).

A very small backshore area dominated by salt-tolerant herbs and couch grass and fringed by saltmarsh ribbonwood occupies the Estuary edge landward of a reno mattress (coastal armour) near the Jellicoe Marsh footbridge. Judging by the abundance of typical indigenous salt meadow species (sea blite, glasswort, bachelors buttons, and saltgrass) its composition is likely driven by occasional estuarine influence. It is likely very infrequently inundated or otherwise receives splash inputs from very high tides and / or large waves.

b) *Sea rush / glasswort - sea blite - buckshorn plantain herbfield* (Southshore Red Zone).

¹³ In this report, 'saltmarsh herbfield' refers to low stature vegetation above MHWS and the term 'saltmarsh rushland' is used to refer to areas of sea rush on the estuary mudflat, largely below MHWS. Both are saltmarsh vegetation types.

Several small (c.5 m x 20 m areas) saltmarsh herbfield patches are present in the RRZ behind (landward of) the hard edge of existing ad hoc coastal armour structures. These are estuarine marsh wetlands entirely above MHWS.

Saltmeadow patches in the RRZ are generally dominated by salt-tolerant herbs and grasses, with glasswort, sea blite, bachelor's button, and exotic couch grass forming variable cover (frequent to abundant overall); saltgrass (*Puccinellia stricta*) is patchy (occasional to frequent). Many areas have been deliberately and inappropriately planted into with sea rush¹⁴, but the underlying herbfield has very likely arisen naturally. Many areas have an almost entirely indigenous cover, typically in lower areas that are more frequently inundated. This saltmeadow vegetation appears to have naturally established since the Christchurch Earthquake Sequence in former residential areas, in areas where slumping of (or breaks in) the existing ad hoc coastal armour permits inundation, and / or where episodic wave conditions allow for splash inputs above MHWS.

3.1.2.5.1 Ecological Value

Representativeness: The overall vegetation is dominated by indigenous species, and while it has very likely or certainly established recently (i.e., post-earthquake, given that previously these were generally private backyards) it comprises essentially representative plant assemblages.

Rarity / Distinctiveness: While this vegetation occurs on highly modified and essentially artificial landforms, wetlands are themselves naturally rare, and estuaries are considered naturally uncommon ecosystem types (Williams et al., 2007). Hence, estuarine wetland vegetation should be considered at least moderately rare, and these areas are an example of post-earthquake regeneration. It is assessed as being moderately rare / distinct. Were the vegetation a remnant of the original flora of the area or on an unmodified landform, rather than a very recent feature on modified / artificial landforms, it would be highly rare.

Diversity and Pattern: This vegetation, in all locations, contains a typical level of indigenous plant species diversity (estuarine saltmarsh herbfield vegetation is typically comprised of only a small number of plant species in any given location). However, there is little natural habitat pattern, as these areas are isolated indigenous vegetation types among otherwise exotic areas, and they do not occur as part of a typical sequence of estuarine habitat. Diversity and habitat pattern is overall low. **Ecological Context:** These areas are extremely small, isolated from their typical context as part of an ecotone of estuarine vegetation types, and vulnerable to loss in their current locations. They are likely far too small to represent an additional or specialised type of habitat for fauna in the wider area, and hence score low for ecological context. The saltmarsh herbfield (saltmeadow) areas are, therefore, of **Moderate** ecological value overall.

3.1.2.6 Saltmarsh rushland

Saltmarsh rushland areas in the SNBP and Southshore areas are dominated by sea rush and are partly or wholly inundated by high tides. They are estuarine marsh wetlands mostly below MHWS, but some areas are just above MHWS.

In terms of previous studies that have occurred in the Estuary, the vegetation types described below correspond to type 2 'sea rush rushland' (Jupp et al., 2007), type 5.01 'sea rush essentially alone' by Grove et al. (2012), and 'sea rush essentially alone' by Orchard (2020), who recognises this vegetation type as a vegetation typically found in the low-marsh zone at the Estuary.

¹⁴ Inappropriate considering these areas are physically separated from the estuary (being located landward of the existing hard edge). Sea rush typically grows in areas around MHWS, in areas that are connected to (and form an ecotone with) the estuary and that receive frequent tidal inundation.

Overall, the following vegetation type is a rushland. Slightly different sub-types are described.

- a) *Sea rush rushland* (estuary mudflat at Southshore, largely at Penguin Street).

Sea rush rushland areas at Penguin Street contain essentially pure sea rush, with a very small number of saltmarsh ribbonwood and jointed rush plants in upper areas, and scattered exotic herbs (mallow and orache) also in upper areas.

- b) *Sea rush rushland* and *glasswort - bonking grass herbfield* (Jellicoe Marsh and Southshore at 172c Rocking Horse Road).

At Jellicoe Marsh and near 172c Rocking Horse Rd, pure stands of sea rush grades to saltmarsh herbfield (see 3.1.2.5 above). These areas are overall diverse, with herbs including glasswort, bonking grass, and sueda forming a turf among and above the sea rush zone. Jellicoe Marsh has historically been modified by formation of coastal defences, but installation of a drain in the 1980s permitted tidal inundation and allowed for the expansion of / establishment of sea rush areas. Following the CES, revetment was constructed seaward of a walking path, and designed in a way to allow regular tidal inundation, and the condition of Jellicoe Marsh may have improved since this time. At 172c Rocking Horse Road, the vegetation pattern is highly natural for the area, despite the small size of this vegetation patch.

3.1.2.6.1 Ecological Value

Representativeness: The overall vegetation is dominated by representative indigenous species assemblages but has suffered from human modification to landforms and exotic species invasion. Overall representativeness is moderate-high. **Rarity / Distinctiveness:** Wetlands and more specifically estuaries are a naturally uncommon ecosystem type (Williams et al., 2007), and estuarine rushlands, being on the coastal fringe, are often subject to loss via reclamation and similar works. Hence, representative estuarine wetland vegetation is considered highly rare, despite the fact that no nationally Threatened, At Risk, or locally uncommon species are known to be present. **Diversity and Pattern:** This vegetation, in all locations, contains a typical level of plant species diversity, with a moderate degree of natural habitat pattern in areas where rushland grades to herbfield. **Ecological Context:** These areas are of very small-moderate size, and most pure rushland areas appear somewhat highly vulnerable to loss in their current locations. Jellicoe Marsh likely provides very high-quality foraging habitat for fauna (including abundant mud crabs). These rushland areas are small but are likely to contribute to coastal erosion mitigation and form a natural part of a sequence of estuarine habitat. Overall, this broad vegetation type scores moderate for ecological context. These areas of saltmarsh rushland are, therefore, of **High** ecological value overall.

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3.2 Estuarine species and habitats

3.2.1 Site description: South New Brighton Park

At SNBP, the estuary edge is occupied by cobble material retained by reno mattress in various states of disrepair. There are also large amounts of cobbles no longer retained by reno mattress. Cobbles dot the seabed adjacent to the estuary edge along with finer rock fractions likely released from the eroding estuary edge (Figure 8). Where the erosion is more pronounced, the estuary edge has receded by several meters and new areas of seabed have developed behind the damaged reno mattresses (Figure 9). In these areas, the seabed is slightly higher compared to the surrounding mudflat habitat located in front of the mattresses, and the eroding estuary edge is characterized by an unstable, near-vertical bank and exposed tree roots. Geotextile sand containers have been deployed in places to protect the adjacent pathway, but several of these have washed onto the seabed. A few meters away from the estuary edge, the seabed is generally uniform and populated by mud snails, with very sparse macroalgal cover (Figure 10).



Figure 8. Cobble material (either loose or retained by reno mattresses) along the estuary edge and on the adjacent seabed at South New Brighton Park.



Figure 9. Erosion resulting in the formation of new areas of seabed behind the reno mattresses used to protect the former shoreline at South New Brighton Park.



Figure 10. Uniform seabed habitat populated by mud snails at South New Brighton Park.

3.2.2 Site description: Southshore

At Southshore, the estuary edge along the project site is occupied by the remaining of a variety of structures, which formed part of former residential properties. These include seawalls, revetments, boat ramps and jetties. Debris from these structures litter the adjacent seabed (Figure 11), along with finer rock fractions likely released from the eroding estuary edge. Small pockets of estuary edge without shoreline hardening are found only in the saltmarsh area by Penguin Street (within the pink shape in Figure 3).

In addition to the saltmarsh, the vegetation growing on the estuary seabed at Southshore includes macroalgae and seagrass, which have a patchy distribution across the project site (Figure 12).



Figure 11. Examples of artificial structures along the estuary edge, with debris littering the seabed.



Figure 12. Examples of vegetation occupying the seabed: saltmarsh (top) and patches of green algae and seagrass (bottom).

3.2.3 Habitat Substrate / Grain Size

The artificial structures present along the estuary edge both at SNBP and Southshore provide hard-bottom habitat with some interstitial spaces for intertidal organisms. On the estuary seabed, medium and fine sand make up the largest proportion of the grain size composition of the soft-bottom habitat both at SNBP and Southshore (Figure 13). At SNBP, grain size analyses showed that medium and fine sediment accounted for 80-90% of the sediment composition across the five transects, and silt and clay were scarcely abundant (between 7-17%; Figure 13). At Southshore, grain size analyses showed that the proportion of medium and fine sand was above 70% along all transects, aside from T4 and T5 (Figure 13). Transects T4 and T5 had the lowest content of medium and fine sand (57% and 69%, respectively) and the highest proportion of silt and clay (32% and 23%, respectively; Figure 13). These two transects crossed areas of saltmarsh, where the dense vegetation likely facilitates the accumulation of these finer sediment fractions (i.e., silt and clay).

Full results of the sediment grain size analyses are provided in Appendix 3.

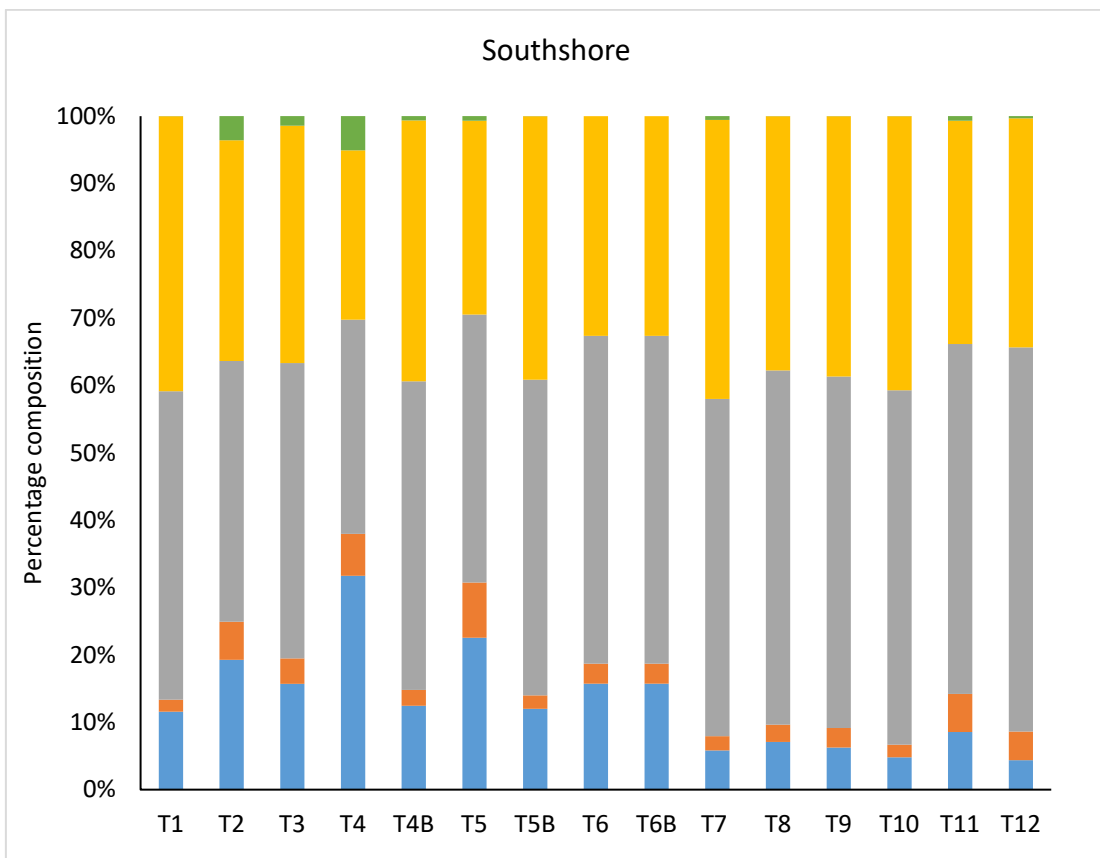
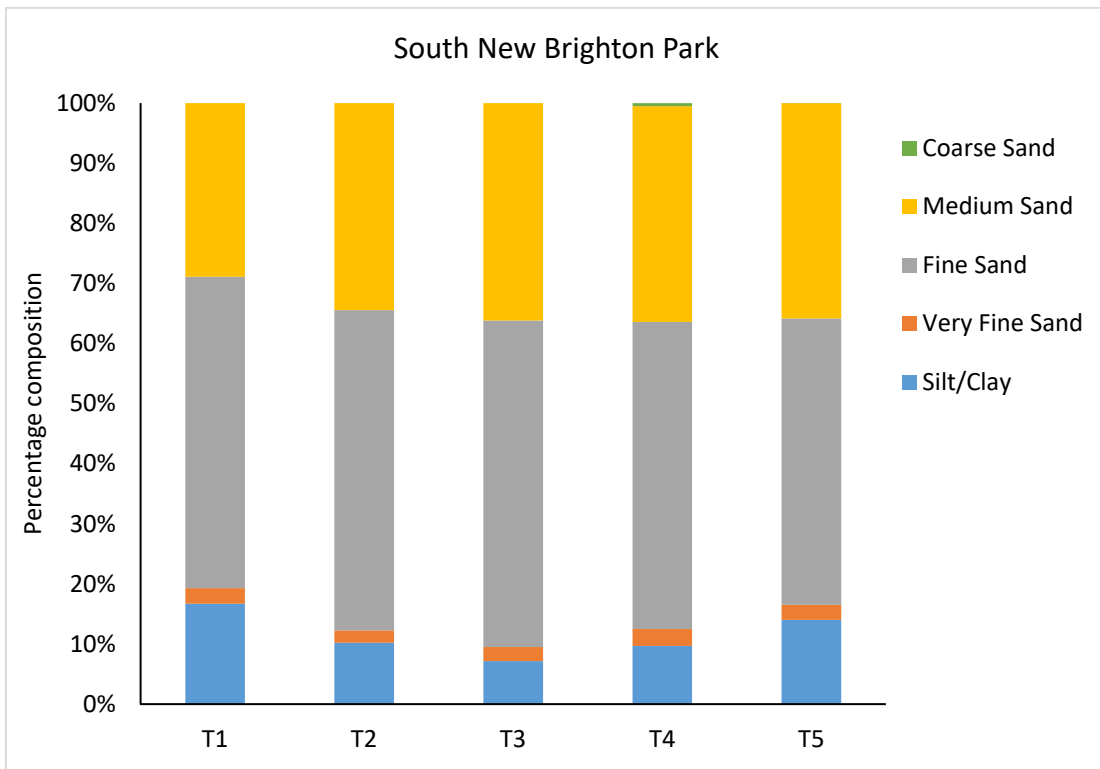


Figure 13. Sediment grain size composition along each transect at South New Brighton Park and Southshore.

3.2.4 Sediment contaminants

Results of the contaminant analyses showed that concentrations of copper, lead and zinc and high molecular weight polyaromatic hydrocarbons (HMW PAHs) within the seabed were below the default guideline values (DGV) in all samples both at SNBP and at Southshore (Figure 14). Full results of the sediment contaminant analyses are provided in Appendix 4.

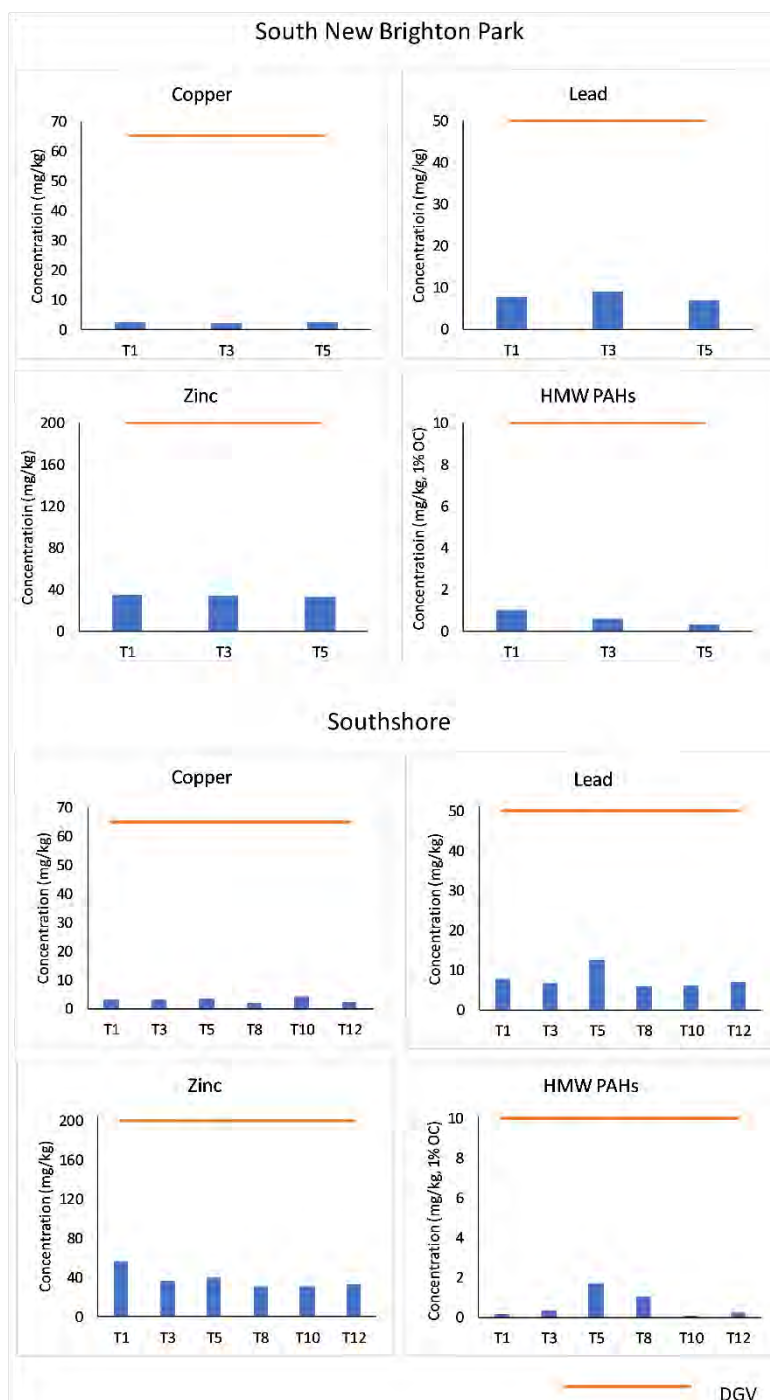


Figure 14. Concentrations of sediment contaminants in composite samples collected at South New Brighton Park (from three transects) and at Southshore (from six transects). Default guideline values (DGV) are included in each panel. The concentration of high molecular weight polycyclic aromatic hydrocarbons (HMW PAHs) was normalised to 1% of the total content of organic carbon.

3.2.5 Species composition

3.2.5.1 Epibenthos

The results of our field surveys showed that the artificial structures present along the estuary edge (or on the damaged reno mattresses in proximity of the edge at SNBP) host benthic communities characterised by very low diversity (average of two taxa per quadrat at both locations, with a total of 9 and 12 taxa identified at SNBP and Southshore, respectively; see Appendix 5 for full details). At both locations, macroalgae were scarcely abundant and represented only by common, stress-tolerant green algae. The beaked barnacle *Austrominius modestus* and the little black mussel *Limnoperna pulex* were the only sessile invertebrates colonising the hard substrate, always in small aggregations. Common estuarine mobile invertebrates like limpets of the genus *Notoacmea* and *Onchidella*, and the snails *Cominella glandiformis*, *Littorina amphipodum* and *Micrelenchus tenebrosus* all had average densities of less than one individual per quadrat. Sand hopper amphipods were found in aggregations of several tens of individuals in some of the plots (Appendix 5).

In the soft-bottom habitat, the organisms living on the surface of the seabed comprised 12 taxa at SNBP and 15 at Southshore (Appendix 5). SNBP had very low cover of green (*Ulva* spp.) and red algae (*Gracilaria chilensis*) along all transects (Figure 15). Green algae were more abundant at Southshore than SNBP, where the vegetation also included seagrass (*Zostera muelleri*) and saltmarsh (dominated by sea rush). Patterns of abundance of macroalgae, seagrass and saltmarsh at Southshore were variable across the project site (Figure 15). Detailed mapping of the areas occupied by seagrass is included in Section 3.2.6.

The epibenthic fauna was similar at SNBP and Southshore. Animals found on the surface of the seabed along most transects included bivalves (mostly small cockles - *Austrovenus stutchburyi*), crabs (*Austrohelice crassa*), limpets, (*Notoacmea* sp.), and snails (mostly *Amphibola crenata*, *Diloma subrostratum* and *Micrelenchus tenebrosus*; Appendix 5). Patterns of abundance of these taxa were variable across transects (Figure 16). Large clusters of sand hopper amphipods were observed occasionally in association with drift algae (Figure 16; Appendix 5).

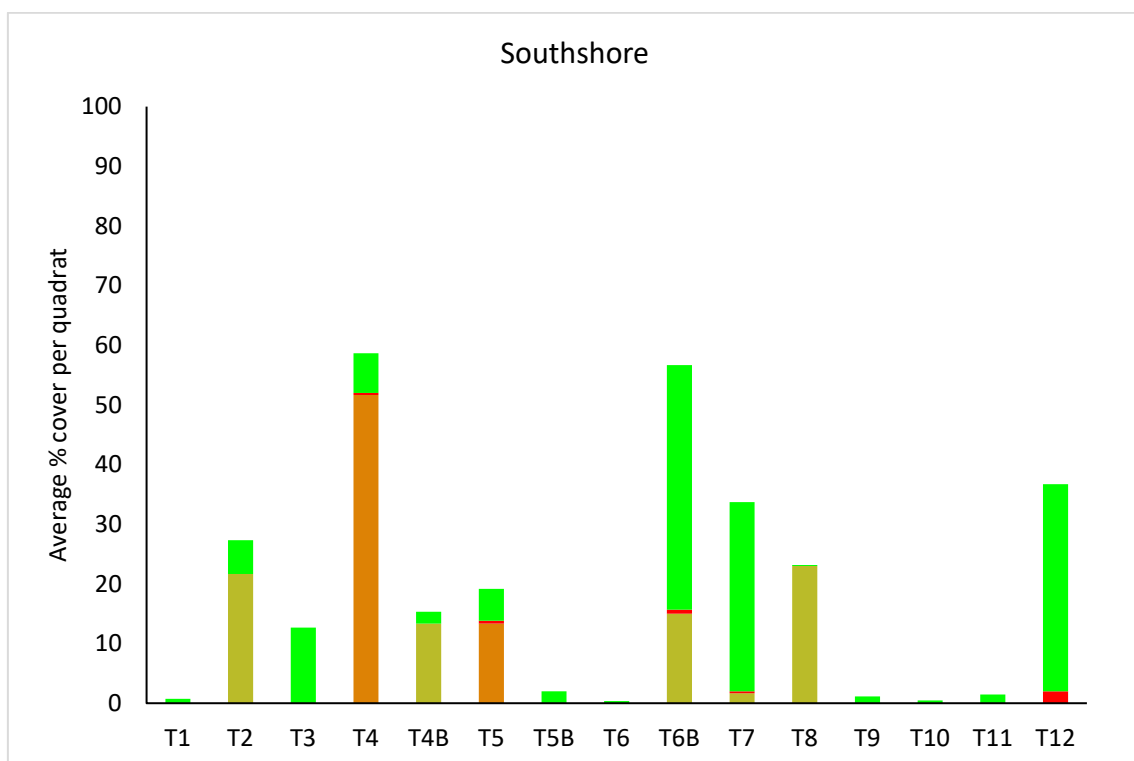
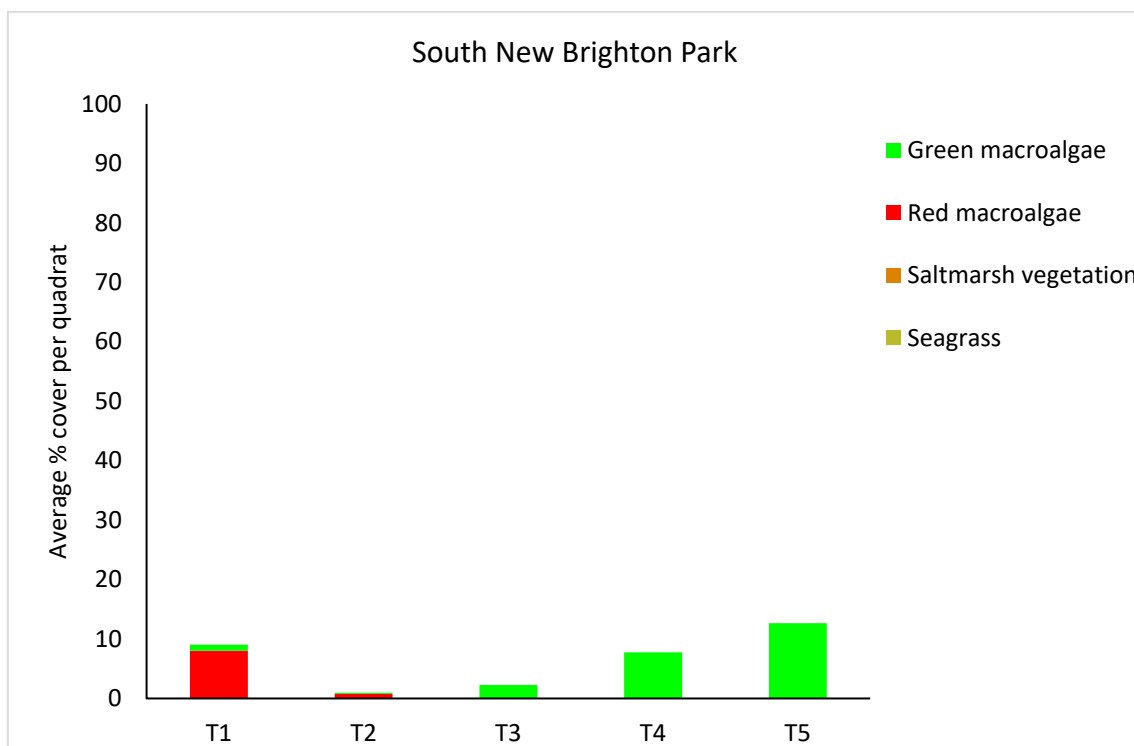


Figure 15. Composition of the intertidal vegetation growing on the seabed along each transect at South New Brighton Park (4 quadrats per transect) and Southshore (3 quadrats per transect). Seagrass was absent from South New Brighton Park.

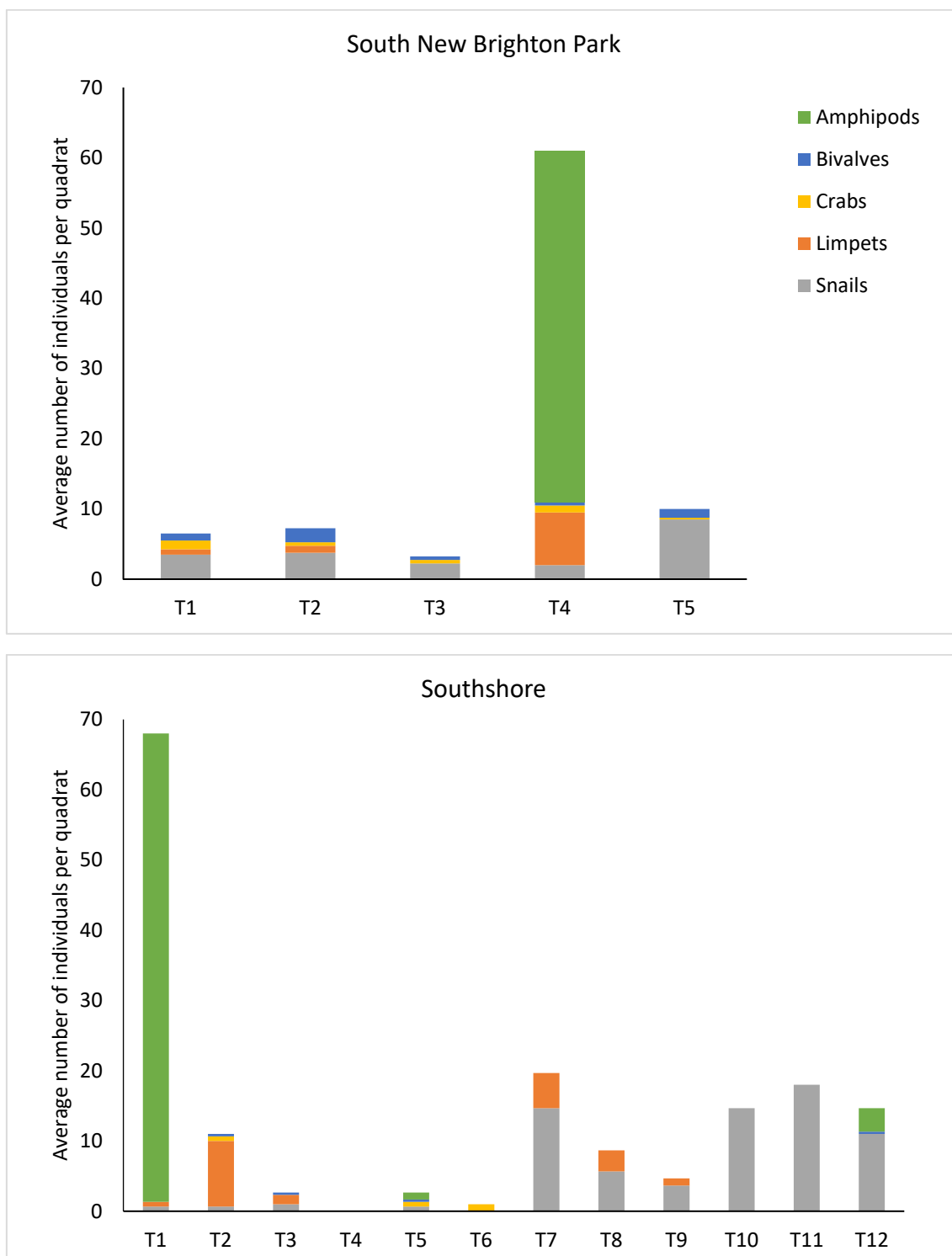


Figure 16. Composition of the epibenthic fauna present on the seabed along each transect at South New Brighton Park (4 quadrats per transect) and Southshore (3 quadrats per transect).

3.2.5.2 Infauna

The macroinvertebrate infauna (i.e., the macroinvertebrates living amongst the estuary bed materials, below the estuary bed) comprised 35 taxa at SNBP and 40 at Southshore (Appendix 6). At both locations, the infauna was dominated by stress-tolerant polychaete worms (58% and 70% of the total number of animals recorded at SNBP and Southshore, respectively; Figure 17; Appendix 6). The most abundant polychaete at both locations was *Scolecoplepides benhami*, a species tolerant to poor habitat quality, with an average of 12 and 10 individuals per core at SNBP and Southshore, respectively. Other stress tolerant polychaete species found in large numbers included *Capitella* sp., *Ledomas cylindrifer* and nereid worms. Oligochaete worms were also abundant at Southshore (Appendix 6). At both locations, the stress-sensitive polychaetes *Aonides* sp. was present in very low numbers (less than 1 per core; Appendix 6).

Bivalves were the second most abundant group of infaunal animals at SNBP (20% of the total number of animals; Figure 17; Appendix 6), followed by gastropods (8% of the total number of animals; Figure 17; Appendix 6). The stress-tolerant bivalve *Arthritica bifurca* accounted for about 75% of the total number of bivalves at SNBP, although most of the individuals of this species were concentrated in just two cores collected along T1 (Appendix 6). The remaining 25% comprised sensitive species such as cockles (*Austrovenus stutchburyi*), wedge shells (*Macomona liliana*) and pipis (*Paphies australis*; Appendix 6). Gastropods included both tolerant (e.g., the mud snail *Amphibola crenata*) and sensitive species present (e.g., limpets of the genus *Notoacmea*; Figure 17, Appendix 6).

At Southshore, amphipods (mostly *Paracalliope novizealandiae*) and other small crustaceans were the second most abundant taxonomic group (10% of the total number of animals; Figure 17; Appendix 6), followed by gastropods and bivalves (representing approx. 4% and 5% of the total number of animals, respectively; Figure 17; Appendix 6). Bivalves were equally represented by stress-tolerant (*Arthritica bifurca*) and sensitive species (cockles, wedge shells, and pipis; Figure 17; Appendix 6). Gastropods included both tolerant (e.g., the mud snail *Amphibola crenata*) and sensitive species present (e.g., limpets of the genus *Notoacmea*; Figure 17, Appendix 6).

At both locations, the remaining infaunal organisms included stress-tolerant nemertean and nematod worms, and crabs represented by a mix of stress-tolerant (e.g., *Austrohelice crassa*) and sensitive species (e.g., *Halicarcinus whitei*; Figure 17, Appendix 6). The “Other taxa” group included anemones, mites, insect larvae and small arthropods (springtails and centipedes; Figure 17, Appendix 6).

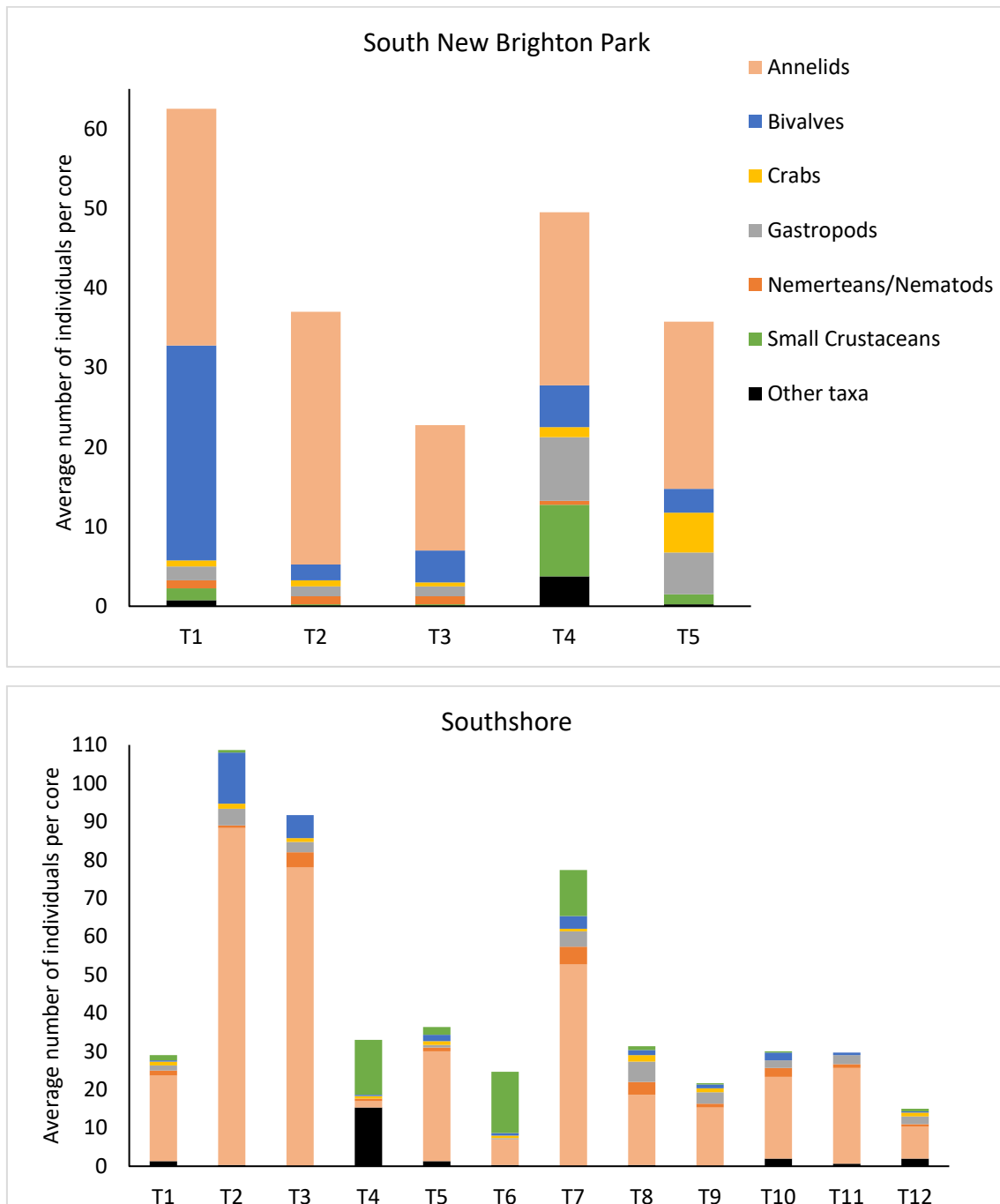


Figure 17. Composition of the macroinvertebrate infauna recorded within the seabed along each transect at South New Brighton Park (4 quadrats per transect) and Southshore (3 quadrats per transect).

At SNBP, all transects had moderate¹⁵ levels of abundance (23-63 animals per core on average), richness (8-12 taxa per core on average) and Shannon Wiener diversity (between 1.6 and 2 on average; Figure 18). On average, the cores collected in 1 m from the estuary edge had the lowest abundance and richness of infaunal animals (Figure 18). This is because three of

¹⁵ Due to the lack of marine assessment criteria and guidelines in New Zealand, assessments of low, moderate and high infauna abundance, richness and diversity are based on our expert judgement and experience.

the five cores collected within 1 m of the estuary edge (at T1, T3 and T4) were located in areas of erosion where the estuary edge has receded behind the damaged reno mattresses (see Section 3.2.1).

These new areas of seabed have lower abundance and diversity of infaunal animals (Appendix 6) because of their recent formation and also because of the higher elevation of the seabed (see Section 3.2.1). Nonetheless, the data collected from the sampling points located in the areas of erosion show colonisation by estuarine infauna and communities, and these communities are likely to become more diverse as the erosion continues and the new habitat becomes more similar to the surrounding mudflat.

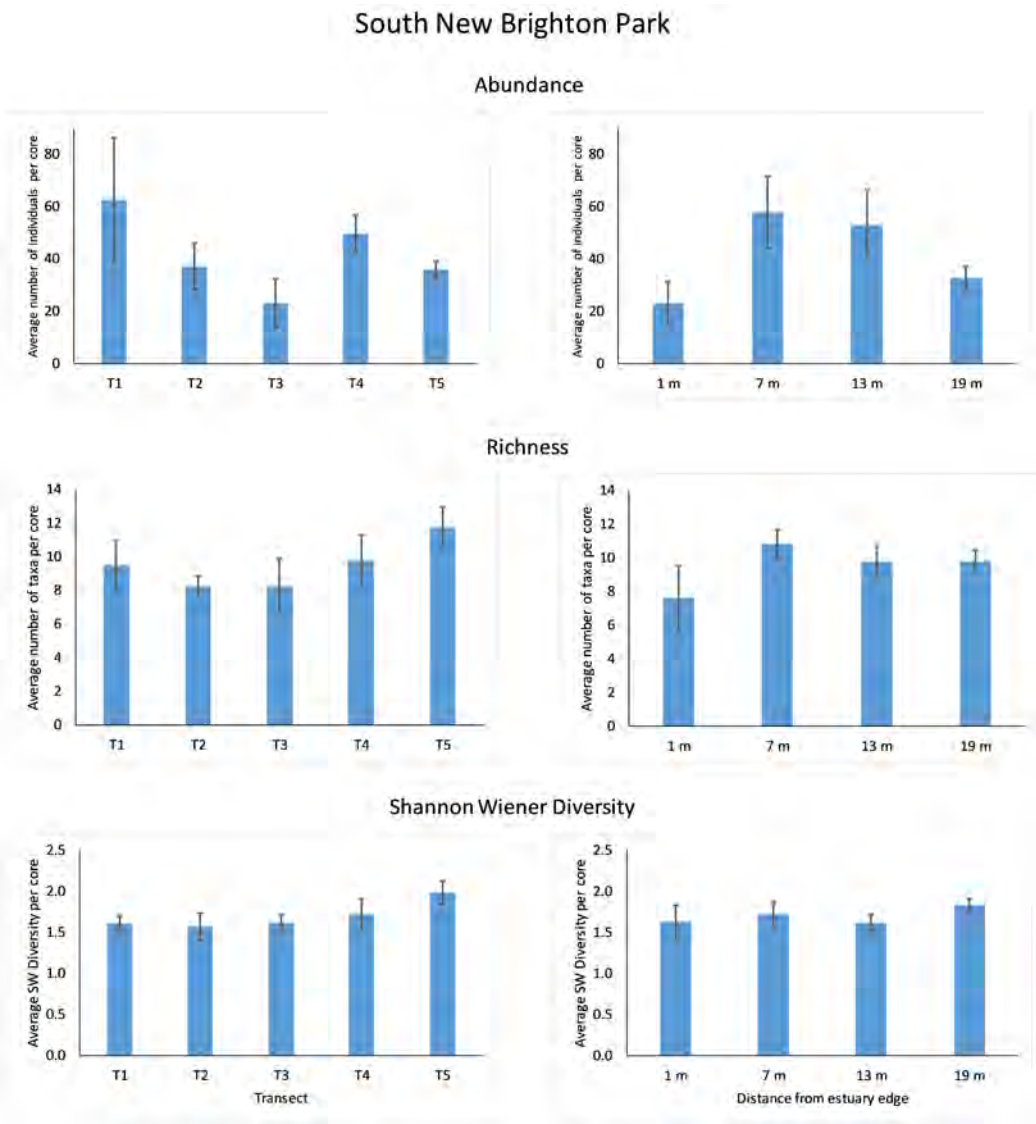


Figure 18. Mean abundance, richness and diversity ($\pm$ SE) of the macroinvertebrate infauna across transects (left-side panels; 4 cores per transect) and increasing distances relative to the estuary edge (right-side panels; 5 cores per distance) at South New Brighton Park.

At Southshore, all transects had moderate¹⁶ levels of abundance (22-92 animals per core on average) aside from T2 and T12 (Figure 19). T2 had an average of 109 individuals per core (high abundance¹⁶) mostly because of very high numbers of the polychaete *Scolecopides benhami* (Appendix 6). T12 had an average of 15 individuals per core (low abundance¹⁶) and there was no clear domination of a single taxonomic group (Appendix 6). All transects had moderate¹⁶ levels of richness (7-14 taxa per core on average) and Shannon Wiener diversity (between 1.2 and 1.9 on average; Figure 19). T8 was the only transect with high¹⁶ Shannon Wiener diversity (2.1; Figure 19). Abundance, richness and Shannon Wiener diversity were variable among replicate cores within transect, but there was no clear pattern that could be attributed to distance from the estuary edge (Appendix 6).

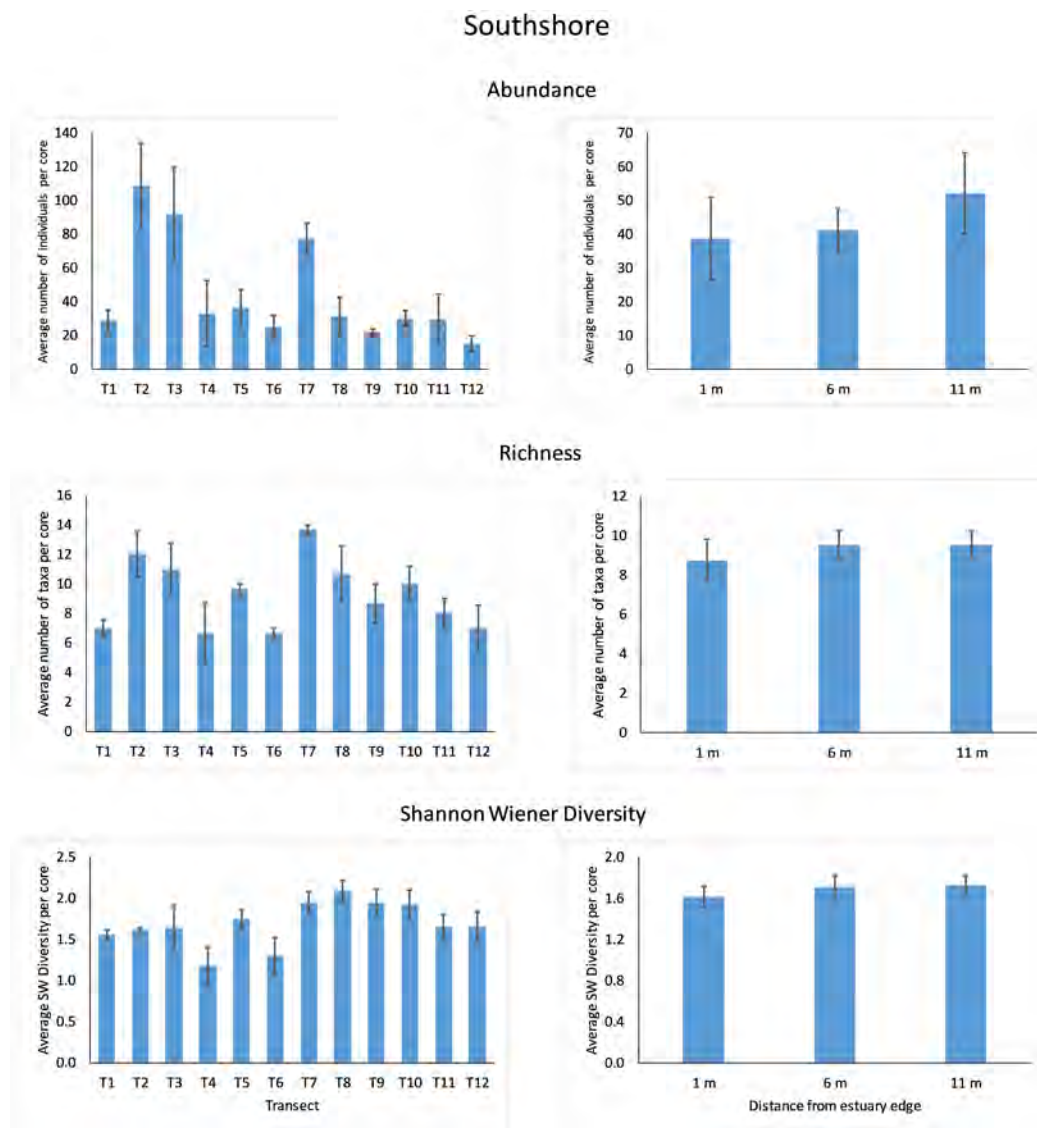


Figure 19. Mean abundance, richness and diversity ($\pm$ SE) of the macroinvertebrate infauna across transects (left-side panels; 3 cores per transect) and increasing distances relative to the estuary edge (right-side panels; 12 cores per distance) at Southshore.

¹⁶ Due to the lack of marine assessment criteria and guidelines in New Zealand, assessments of low, moderate and high infauna abundance, richness and diversity are based on our expert judgement and experience.

3.2.6 Seagrass distribution

The distribution of seagrass *Zostera muelleri* along the project site at Southshore in March 2022 and April 2023 is displayed in Figure 20, along with the habitat envelopes provided as part of the original project design (see Section 4.1).

A large seagrass meadow is present close to the Southshore estuary edge, and from there it extends westward into the Estuary. To inform our assessment, we mapped the eastern boundary (closest to the Southshore estuary edge) of the meadow in March 2022 and again in April 2023 (Figure 20). Dense cover of seagrass is present west of the mapped boundary of the meadow. Small patches or isolated plants of seagrass separated from the main meadow are displayed in Figure 20 as isolated shapes and dots, respectively.

Overall, the 2022-2023 mapping show that seagrass is present within the habitat envelopes provided as part of the original project design (see Section 4.1), and that it extends up to the base of the existing structures in certain areas (Figure 20).

Comparisons between the 2022 and the 2023 mapping show only small changes in the eastern boundary of the main meadow (closest to the Southshore estuary edge). However, in 2023 there was a large number of isolated patches and plants separated from the main meadow and occupying areas where seagrass was not present in 2022 (Figure 20). This is consistent with ongoing trends of seagrass expansion across the Estuary (Gibson & Marsden, 2016, Berthelsen et al., 2022).

Note that the 2023 mapping of seagrass includes records of seagrass south of Plover Street that were not shown in the 2022 mapping; Figure 20). However, this is not indicative of changes in seagrass cover as these areas south of Plover Street were not mapped in 2022.

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LEGEND

- Seagrass 2022
- Seagrass 2023
- Rock Revetment
- CobbleBeach and Breakwater
- Road Boundaries

Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors

3.2.7 Ecological value

Both at SNBP and at Southshore, the hard-bottom habitat along the estuary edge and on the damaged reno mattresses in proximity of the edge at SNBP is artificial and the result of significant habitat modification. It is occupied by tolerant species common in estuarine environments. There are no invasive or Threatened / At Risk species. There is little diversity of macroalgae. When present, macroalgae provide minimal habitat for native fauna. The benthic invertebrate community also has low species diversity and abundance. The ecological value of the hard-bottom habitat that would be affected by the project is assessed as **Low**.

Both at SNBP and at Southshore, the soft-bottom habitat is characterised by mostly medium and fine sand, low levels of contaminants and some habitat modification in proximity of the estuary edge due to the release of rock material from the armouring structures (and because of the presence of damaged reno mattresses at SNBP). Infaunal communities have moderate species richness, diversity and abundance, with both tolerant and sensitive taxa present. The surface of the seabed is colonised by epibenthic communities typical of estuarine habitats. While at SNBP the seabed is mostly unvegetated, at Southshore there are areas dominated by different types of intertidal vegetation, including macroalgae, seagrass and saltmarsh. The ecological value of the soft-bottom habitat that would be affected by the project is assessed as:

- **Moderate** for the areas of mudflat habitat (i.e., the soft-bottom habitat that is either unvegetated or presents limited cover of macroalgae) both at SNBP and Southshore.
- **High** for the areas of seagrass habitat at Southshore, with the seagrass being an At Risk- Declining species (de Lange et al., 2018).
- **High** for the areas of saltmarsh habitat at Southshore, as outlined in Section 3.1.2.6.

3.3 Herpetofauna

The following is a summary of the lizard survey conducted by Dr Tocher. Refer to the full report in Appendix 1.

3.3.1 Lizard habitats

Five major lizard habitats were identified across the project site:

- **Rank exotic grassland.** Exotic grassland contained a mix of exotic grass species including browntop over less disturbed areas, and cocksfoot where some disturbance had taken place in the recent past. Occasional indigenous shrub species were also present, including both naturally occurring and planted shrubs.

Rank exotic grassland was extensive over some areas (e.g., adjacent to the sports field at the end of Jellicoe Road), and pockets were present in Southshore over the southern part of the project site adjacent to areas of regularly mown grass.

Along the estuary edge, thin bands of rank grass (<2 m wide), at times, provided habitat for grass skink, while at 78 Rocking Horse Road, an empty section was fully covered in rank grass but no skinks were detected (see Section 3.3.2).

Parts of the survey area had rank exotic grassland that was shaded (e.g., near the Pleasant Point Yacht Club) or experienced heavy foot traffic. Over these areas, southern grass skinks were not detected (see Section 3.3.2).
- **Exotic grassland with saltmarsh ribbonwood.** A small area of exotic grassland with saltmarsh ribbonwood was present near the main track adjacent to the large saltmarsh, south of South Brighton Holiday Park. Whilst this was a small area (c.80 m²) relative to the survey area, high densities of southern grass skinks were present (see Section 3.3.2).
- **Marram grassland.** Marram grassland was most prevalent over a small part of the survey area c.220 m south of Tern Street, where the spit widens and eventually becomes the Southshore Spit Reserve. Here, marram exists with other vegetation communities towards the estuary, and woody weeds are common here. No southern grass skinks were detected here (see Section 3.3.2).
- **Estuary edge lyme grass grassland.** Lyme grass, a sand-loving exotic grass species, was common along the estuary edge either as a single species or growing with other lower-growing exotic grasses. Almost all areas trapped had southern grass skinks present (see Section 3.3.2).
- **Abandoned gardens with greywacke river cobble mulch and occasional rocks.** Abandoned gardens were a feature of the survey area, and where suitable cover was present, were searched for lizards. No lizards were found in gardens despite appropriate habitat being present (see Section 3.3.2). On completion of the survey, a local resident reported a skink at 26 Ebbside Street (between Caspian and Godwit Street), in a garden where greywacke river cobble suitable for southern grass skink habitat was present (see Section 3.3.2).

3.3.2 Lizard captures and sightings

Southern grass skink (*Oligosoma* aff. *polychroma* clade 5) was the only lizard species detected over the survey area, and a mix of striped and speckled patterned skinks were captured. Southern grass skinks are currently classified as an At Risk – Declining species (Hitchmough et al., 2021).

Skinks were sighted (separate from trapping) very rarely at the project site (four locations, a total of six skinks; Figure 21), despite suitable weather for skink activity occurring during the survey period.

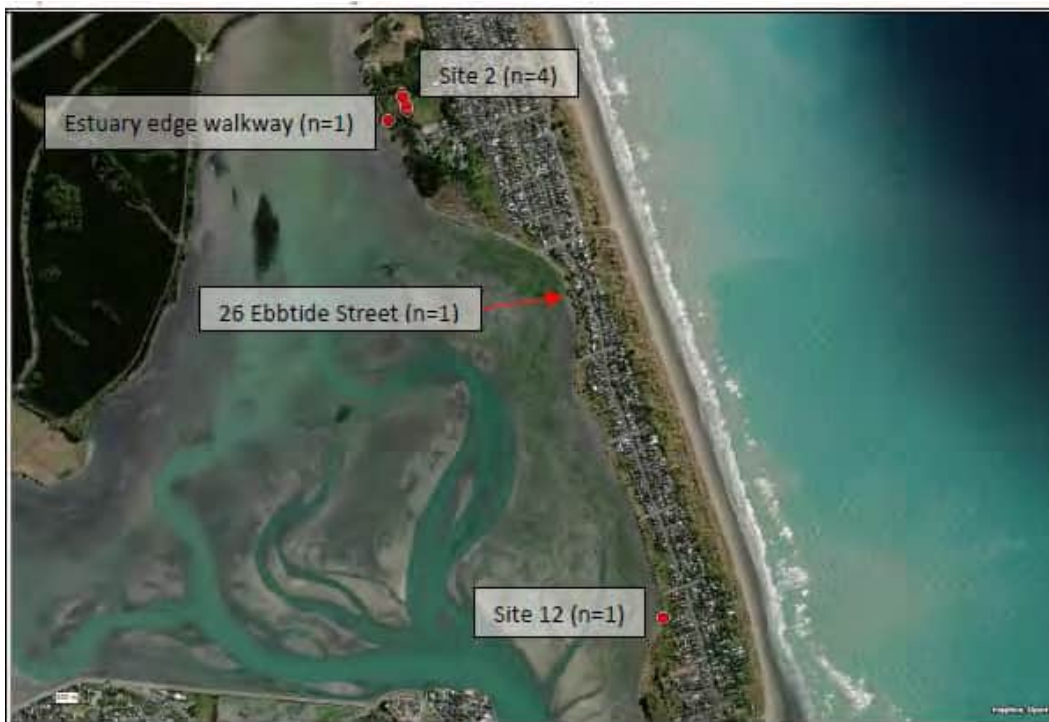


Figure 21. Locations (n=4; red dots) where a total of six southern grass skinks were observed actively foraging over the project site in Southshore and SNBP. The additional sighting of local Lee Osborn, at 26 Ebbitide Street is also included (red arrow).

The majority of skinks detected during the survey (82%) were captured in Gee minnow traps. A total of 29 skinks were captured from sites within the project site (Table 9), ranging in size from adult to sub-adult (Appendix 1). No new-born skinks were captured and 66% of captured skinks had regenerating tails indicating levels tail loss that were not notable (Appendix 1). Trapping rates (skink captures per trap per day) were highest at Sites 5 and 6 (Table 9, Figure 22 and Figure 23), but these data are too few to determine actual densities. Site 2 had a high number skink captures, and at Sites 2 and 5 (on more than one night) multiple skinks were captured in each trap. Habitat at Site 5, where skinks were very abundant, was saltmarsh ribbonwood (Section 3.3.1). Habitat at Site 6, located just north of the project site, consisted of two very small, isolated marram grass / exotic grass islands surrounded by paths and roads (Appendix 1). Here one trap caught two skinks over two nights, but the limited habitat meant that the skink population was small despite the trapping rate (Table 9, Figure 22 and Figure 23).



Figure 22. Locations of the 13 lizard trapping sites at South New Brighton Park (Sites 1-5) and Southshore (Sites 6-13).

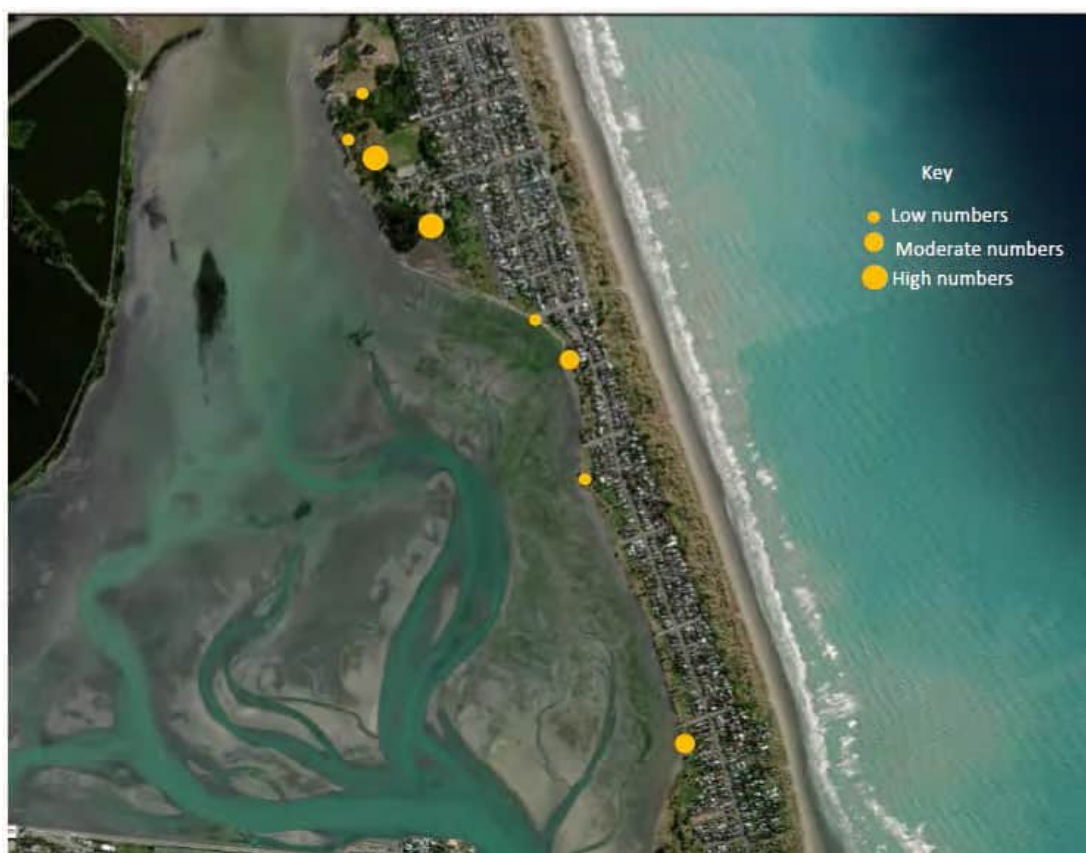


Figure 23. Overview of skink captures & sightings and perceived relative abundances (based on captures, sightings, and quality / extent of habitat present) across sites.

Table 9. Details about lizard trapping effort and captures, for SNBP (Sites 1-5) and Southshore (Sites 6-13). Site locations are shown in Figure 22.

Dates	No. days trapping	Site	Number of traps deployed	Skink captures	Skink captures per trap day
17-21 Feb 2022	4	Site 1	10	1	0.02
17-21 Feb 2022	4	Site 2	10	8	0.20
17-21 Feb 2022	4	Site 3	6	0	0.00
20-21 Feb 2022	1	Site 4	4	0	0.00
17-21 Feb 2022	3	Site 5	4	12	1.00
19-21 Feb 2022	2	Site 6	1	2	1.00
17-19 Feb 2022	2	Site 7	3	2	0.33
17-19 Feb 2022	2	Site 8	4	0	0.00
17-21 Feb 2022	4	Site 9	3	2	0.16
17-21 Feb 2022	4	Site 10	1	0	0.00
17-21 Feb 2022	4	Site 11	6	0	0.00
17-21 Feb 2022	4	Site 12	5	2	0.10
17-21 Feb 2022	4	Site 13	6	0	0.00
Totals	42		63	29	

3.3.3 Ecological value

The habitats present within the project site support southern grass skink, an At Risk – Declining species. According to its New Zealand Threat Classification (as per the EIANZ EclA guidelines as shown in Table 6), this species is considered to be of **High** ecological value. Southern grass skinks are protected under the Wildlife Act (1953), administered by the Department of Conservation (DOC). A Wildlife Act permit from DOC will be required to carry out the proposed works.

3.4 Avifauna

A compiled list of avifauna species recorded through the desktop and field investigations, along with their NZ threat classifications, is provided in Appendix 7.

3.4.1 Terrestrial birds

A description of the terrestrial vegetation at the project site is provided above in Section 3.1.2. As noted, the project site adjoins residential areas and council-managed reserves. The RRZ behind the estuary edge at Southshore contains retained trees and shrubs from former residential gardens but is in the main an area of mown exotic grass.

The terrestrial avifauna species recorded during the 5MBC very much reflect the modified and exotic habitat that dominate the area, with the majority of species recorded being common native (Not Threatened) or introduced species (refer to Appendix 7 and Figure 24). Those species recorded from the counts conducted within the project site are provided in Table 10, with the species assemblage and number of birds recorded at each count site shown in Figure 25.

Table 10. Avifauna species recorded during the 5MBC within the project site.

SPECIES	NZ THREAT CLASSIFICATION	SOUTH NEW BRIGHTON	SOUTHSHORE
Red-billed gull	At Risk - Declining	✓	
Bellbird	Not Threatened	✓	
Fantail	Not Threatened	✓	
Grey warbler	Not Threatened	✓	
Kereru	Not Threatened ¹⁷	✓	
Kingfisher	Not Threatened	✓	✓
Silvereye	Not Threatened	✓	✓
Welcome swallow	Not Threatened		✓
White-faced heron	Not Threatened	✓	
Blackbird	Introduced & Naturalised	✓	✓
Chaffinch	Introduced & Naturalised	✓	✓
Dunnock	Introduced & Naturalised	✓	✓
Goldfinch	Introduced & Naturalised	✓	
Greenfinch	Introduced & Naturalised	✓	
House sparrow	Introduced & Naturalised	✓	✓
Magpie	Introduced & Naturalised	✓	
Starling	Introduced & Naturalised	✓	✓

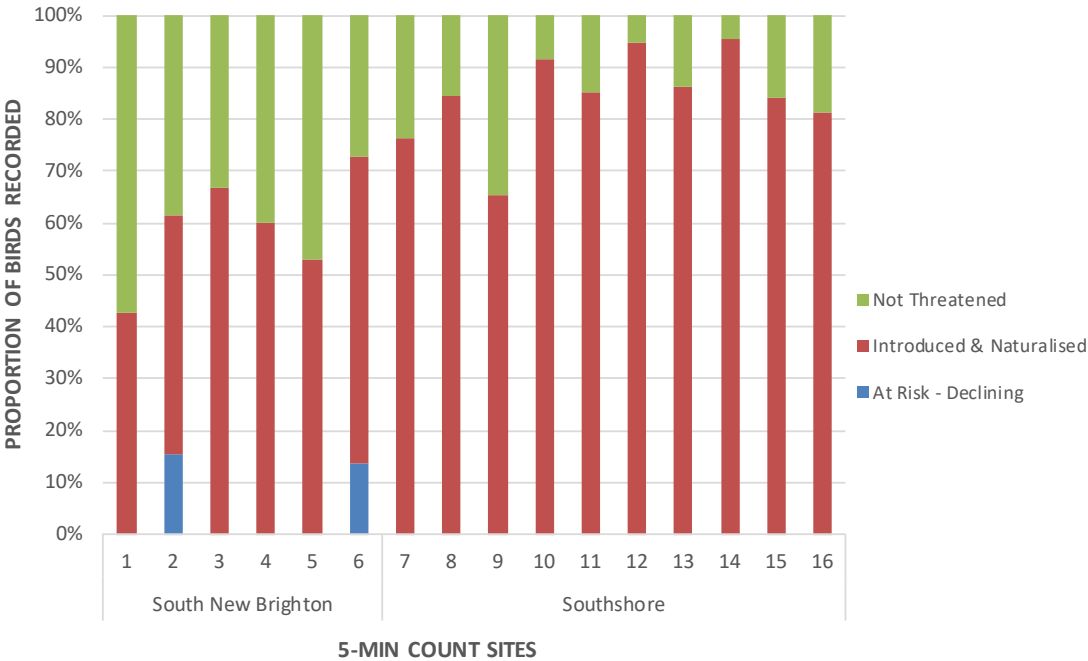


Figure 24. Threat classification composition of all birds recorded during the 5MBCs.

¹⁷ Kereru is locally uncommon in the Low Plains ED and at the Estuary scale (Crossland (2014, 2020)).

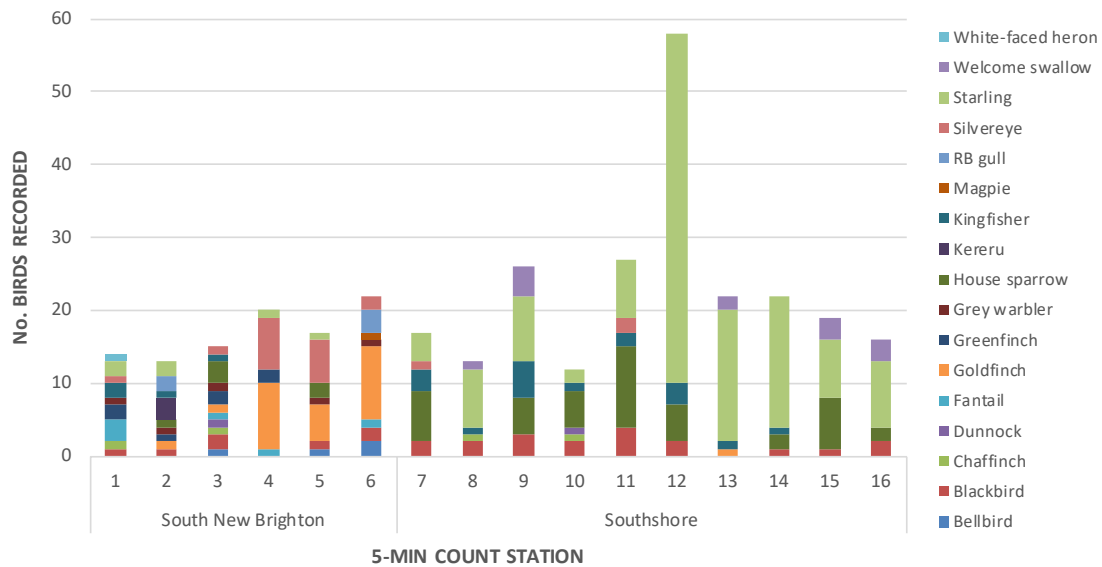


Figure 25. Avifauna species composition and abundance recorded at each five-minute count station. RB gull = red-billed gull.

Along the Southshore end, kingfisher (Not Threatened) were recorded perching on trees and coastal structures, including the existing rock revetment. Several Phoenix palms were observed to have crevices that are likely to be used by nesting kingfisher (Figure 26); the majority of these palm are located outside of the design footprint but on the edge of the earthworks zone. While NZ pipit (At Risk – Declining) were not detected during the 5MBC, they have been recorded on the eastern shoreline of the Estuary by Crossland (2022) and are likely to be present within the project site. We note that Crossland (2022) did not record pipit breeding, and none were observed during the November 2023 site visit when the area was surveyed for breeding birds.



Figure 26: Kingfisher nest holes in Phoenix palm along Southshore coastline.

In comparison, the terrestrial habitat within SNBP comprises a tall forest of radiata pine and macrocarpa that has been established for many years. The 5MBC within that habitat (stations 1-6) detected several native species (Not Threatened) that were not recorded in the Southshore part of the project site, including bellbird, kereru, fantail and white-faced heron (Figure 25). Kereru have been recorded¹⁸ attempting to nest within the South New Brighton domain by the car park on the east side of the track towards Bridge Street. In addition, the written submission of Mr Butcher on this project (dated 17 June 2023) identifies areas of trees at the southern end of SNBP (north and east of Jellicoe Marsh) as breeding habitat for kereru. This area was included in the nesting survey on 26 November 2023, during which kereru were not observed. Nevertheless, it is possible other indigenous forest bird species (e.g. fantail, grey warbler) are breeding within the project footprint, but based on the habitat present, likely in low numbers.

On the coastal margins of that forest during the April 2022 survey, a number of little shag (At Risk - Relict) were recorded roosting in a macrocarpa tree (Figure 27), while white-faced heron (Not Threatened) were recorded roosting in a radiata pine (Figure 29). However, during November 2023 site visit, the shag roost tree was found to no longer have branches (Figure 28), while the white-faced heron roost tree had been removed completely (Figure 30). In fact

¹⁸ [Kereru nesting in South New Brighton Domain - BirdingNZ.net](https://www.birdingnz.net/kereru-nesting-in-south-new-brighton-domain)

during the November 2023 survey, no roosting or breeding birds were observed in the coastal trees along SNBP.



Figure 27. Shags roosting in a macrocarpa over-hanging estuary at SNBP in April 2022



Figure 28. Shag roost tree November 2023



Figure 29. White-faced heron in the canopy of radiata pine at SNBP in April 2022



Figure 30. Location of white-faced heron roost tree, November 2023

3.4.2 Coastal / estuarine birds

The Estuary and its immediate surroundings are a nationally important area for coastal, estuarine and wetland birds (Crossland, 2013, 2020; Riegen & Sagar, 2020; Southey, 2009). The Estuary regularly supports peak numbers of upwards of 30,000 waterfowl, wading, and other wetland birds, and 3,000 or more individuals of other species (including shags, gulls, terns, swallows, spoonbills, herons, kingfishers, coots and pūkeko) feeding on the estuary mudflat and adjoining habitats that include the Linwood Paddocks and the Bromley Oxidation Ponds (Shadbolt, 2015). One hundred and forty-nine bird species have been recorded in the wider Avon Heathcote Estuary / Ihutai and its immediate surroundings, between 1840 and 2020 (Crossland, 2020). Of these, 54 are indigenous species which are: a) resident all year round; b) resident and breeding; c) resident with seasonal population influxes; and 27 further species are seasonal or regular visitors (Crossland, 2020). A large number of these species are classified as either nationally Threatened or At Risk (Robertson et al., 2021).

Monitoring of the wetland birds at the Estuary and Bromley Oxidation Ponds by Crossland (2013) between August 2009 and July 2010 recorded a peak of 36,000 individuals in the month of January 2010 (Figure 31; refer to Appendix 7 for species list and threat classifications). As noted by Crossland (2013), the high number of birds recorded between December and April (Figure 31) represents the annual peak period when there is an influx of birds as part of the moulting, post-breeding flocking and migration strategies of many species. Conversely, lowest numbers were recorded in September 2009 (Figure 31), which coincides with many native species being away on inland breeding grounds and is immediately prior to the arrival of the migratory eastern bar-tailed godwit (Crossland, 2013).

Crossland (2013) recorded 10 species in numbers that met or exceeded the 1% Ramsar international significance criterion: pied cormorant, paradise shelduck, grey teal, New Zealand shoveler, New Zealand scaup, South Island pied oystercatcher (SIPO), variable oystercatcher, eastern bar-tailed godwit, black-billed gull and Caspian tern. In 2017, the Estuary was designated an East Asian – Australasian Flyway Network site, owing to its particular importance for eastern bar-tailed godwits.

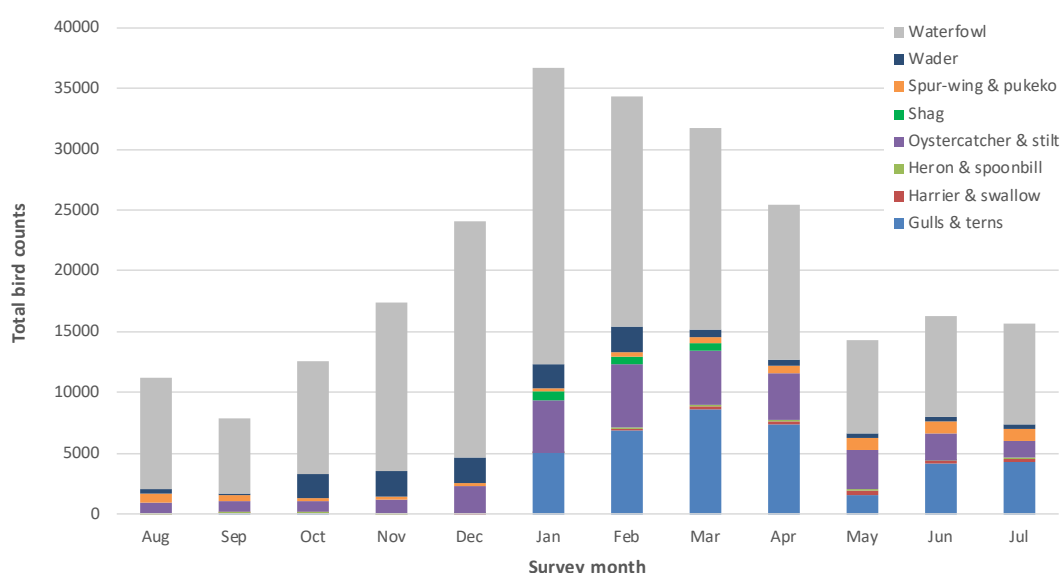


Figure 31. Seasonal pattern of wetland bird abundance and diversity recorded by Crossland (2013) at the Avon-Heathcote Estuary and Bromley Oxidation Ponds between: August 2009 and July 2010.

Crossland's (2013) study provides an overall picture of species abundance and diversity of wetland birds recorded over the course of a year (albeit a decade ago) at the Estuary and Bromley Oxidation Ponds. However, we have used the data collected for the purpose of this assessment to provide details of species abundance and diversity at the scale of the project site and footprint during the survey period. As outlined previously, the 2022 surveys were only conducted over a period of several months (mid-February to end of April). As such, these results represent a snapshot of the species composition and abundance that utilise the Estuary during that period, and will not be representative of year-round patterns, including the arrival and departures of national and international migrants.

A total of 26 species were recorded during the 2022 surveys (refer to Table 11 and Appendix 7), 13 of which have Threatened or At Risk classifications. The species assemblage comprised gulls, terns, shags, oystercatcher, stilt, heron, spoonbill, waterfowl and kingfisher. The predominant groups comprised oystercatcher, gulls and waterfowl (Figure 32). Overall, the most abundant species recorded during the survey period was SIPO (n=22,071), followed by red-billed gull (n=13,247) (Table 11).

The highest density of birds was recorded in count zone 3 (213 birds / ha) and the lowest in count zone 1 (92 birds / ha) (Table 11; count zones are shown in Figure 5).

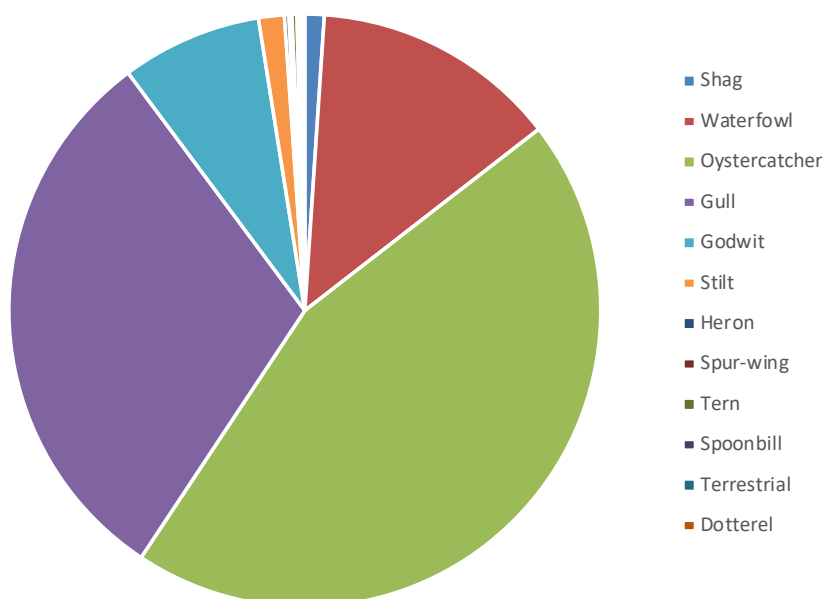


Figure 32. Avifauna assemblage composition recorded during the 2022 Estuary surveys, within the four zones adjacent to South New Brighton Park and Southshore.

Table 11. Avifauna species and numbers recorded during the 2022 Estuary surveys, ordered most to least abundant (refer to Figure 5 for extent of survey).

SPECIES	NZ THREAT CLASSIFICATION	Zone 1	Zone 2	Zone 3	Zone 4	TOTAL	MAXIMUM COUNT
SIPO	At Risk - Declining	239	1,964	11,806	8,062	22,071	1,000
Red-billed gull	At Risk - Declining	1,927	2,914	6,165	2,241	13,247	3,450
Black swan	Not Threatened	2,968	1,181	1,569		5,718	251
Bar-tailed godwit	At Risk - Declining	34	1,080	2,746	213	4,073	600
Black-backed gull	Not Threatened	608	80	1,604	626	2,918	250
Variable oystercatcher	At Risk - Recovering	3	11	284	1,399	1,697	111
Grey teal	Not Threatened	919	40			959	140
Pied stilt	Not Threatened	91	320	337		748	68
NZ shoveler	Not Threatened	411				411	155
Pied shag	At Risk - Recovering	237	6	21	68	332	25
White-faced heron	Not Threatened	50	43	25	8	126	12
Little shag	At Risk - Relict	36	15	24	34	109	6
Little black shag	At Risk - Naturally Uncommon	74			31	105	28
Spur-winged plover	Not Threatened	35	7	32	15	89	7
Caspian tern	Threatened - Nationally Vulnerable	20	15	39	6	80	7
Royal spoonbill	At Risk - Naturally Uncommon	33	25	11		69	15
Black-fronted tern	Threatened - Nationally Endangered		58		1	59	41
Kingfisher	Not Threatened	22	18	14		54	4
Banded dotterel	At Risk - Declining		53			53	17
Pukeko	Not Threatened	48				48	6
Paradise shelduck	Not Threatened	42	4			46	3
Spotted shag	Threatened - Nationally Vulnerable	1			13	14	12
Feral goose	Introduced	4				4	1
Harrier	Not Threatened	2		1		3	1
White-fronted tern	At Risk - Declining	1			2	3	1
NZ scaup	Not Threatened	2				2	1
TOTAL BIRDS		7,807	7,834	24,678	12,719	53,038	3,450
AVERAGE BIRD DENSITY / Ha		92	109	213	198		

During low- and mid-tides, foraging occurs over much of the intertidal flats as well as some of the deeper channels. Conversely, as the tide rises, the higher points on the mudflats and coastal edges are used for roosting and loafing. Figure 33 to Figure 40 provide a graphical presentation of the distribution and abundance of the species recorded during the surveys:

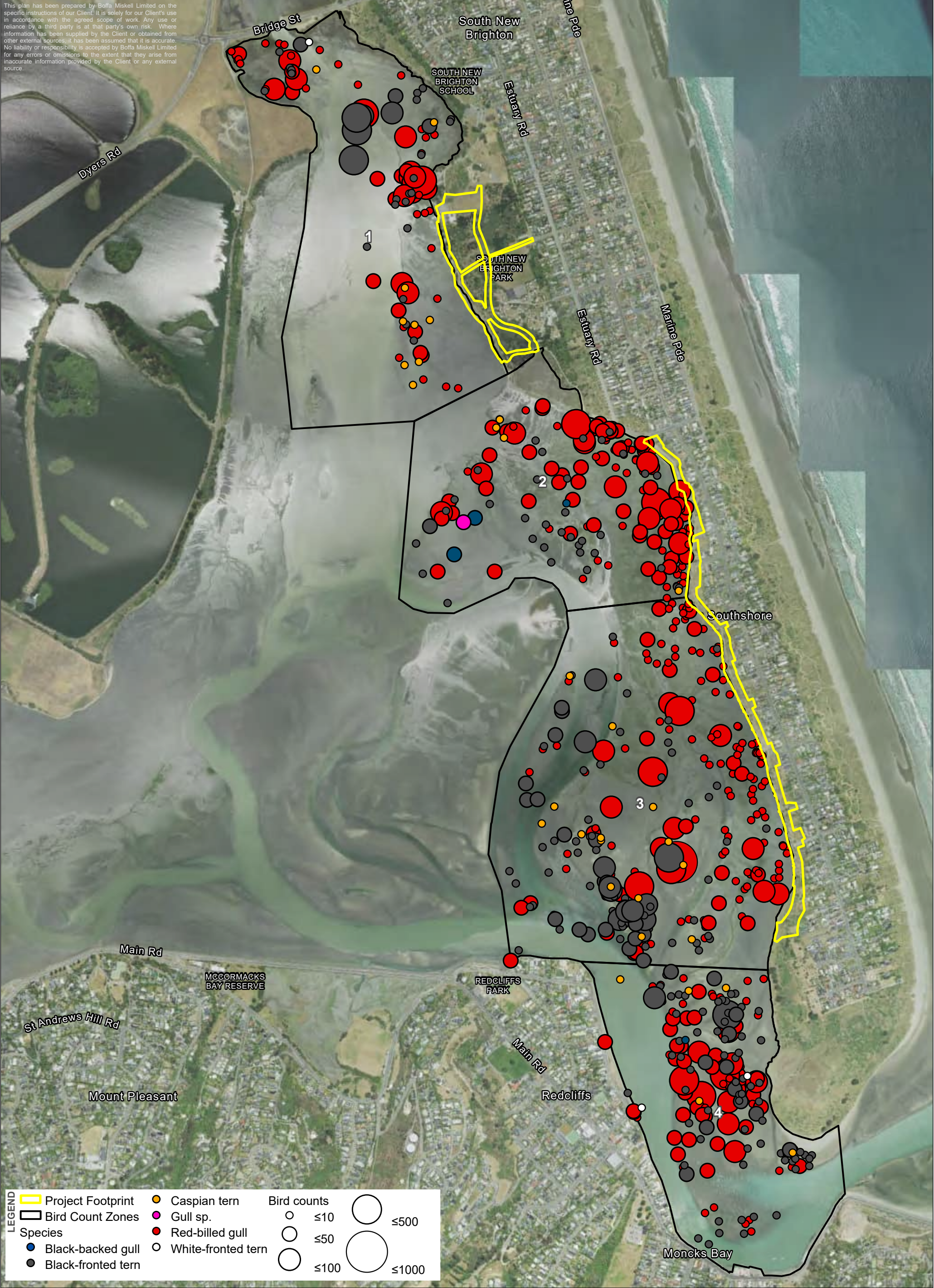
- While recorded in all four count zones, the majority of godwit observations were recorded in the central zones (Figure 33). All banded dotterel records were from count zone 2 (Figure 33).
- Red-billed gulls were widely distributed along the survey sites, with larger concentrations recorded in count zones 2 and 4, while black-backed gulls were primarily observed in count zones 3 and 4 (Figure 34).
- Caspian tern were recorded in low numbers within each count zone, and generally away from the estuary edge (Figure 34).
- The majority of white-faced heron and royal spoonbill were observed in count zones 1-3, both along the estuary and channel edges (Figure 35).
- Kingfisher were observed in count zones 1-3 and primarily along the estuary edge (Figure 36).
- While SIPO were recorded in every count zone, higher numbers were observed in the southern two zones (Figure 37). Variable oystercatcher were primarily recorded in the southern count zone, while pied stilt were recorded in zones 1-3. All three species were recorded along the estuary margins as well as on the mudflats (Figure 37).
- Shag species were recorded in all four count zones, but in higher numbers at the northern and southern ends (Figure 38). Little shag were recorded along the Southshore estuary edge (Figure 38), while all shag species were recorded over deeper estuarine / channel waters.
- Spur-wing plover were recorded on both the intertidal mudflats and estuary edges (Figure 39).
- Waterfowl species were only recorded in count zones 1-3 (Figure 40), with the majority of observations being of black swan on both the intertidal mudflats and deeper waters. Scaup and shoveler were only recorded in the northern two count zones. Paradise shelduck and grey teal were recorded along the Southshore estuary margin (Figure 40).

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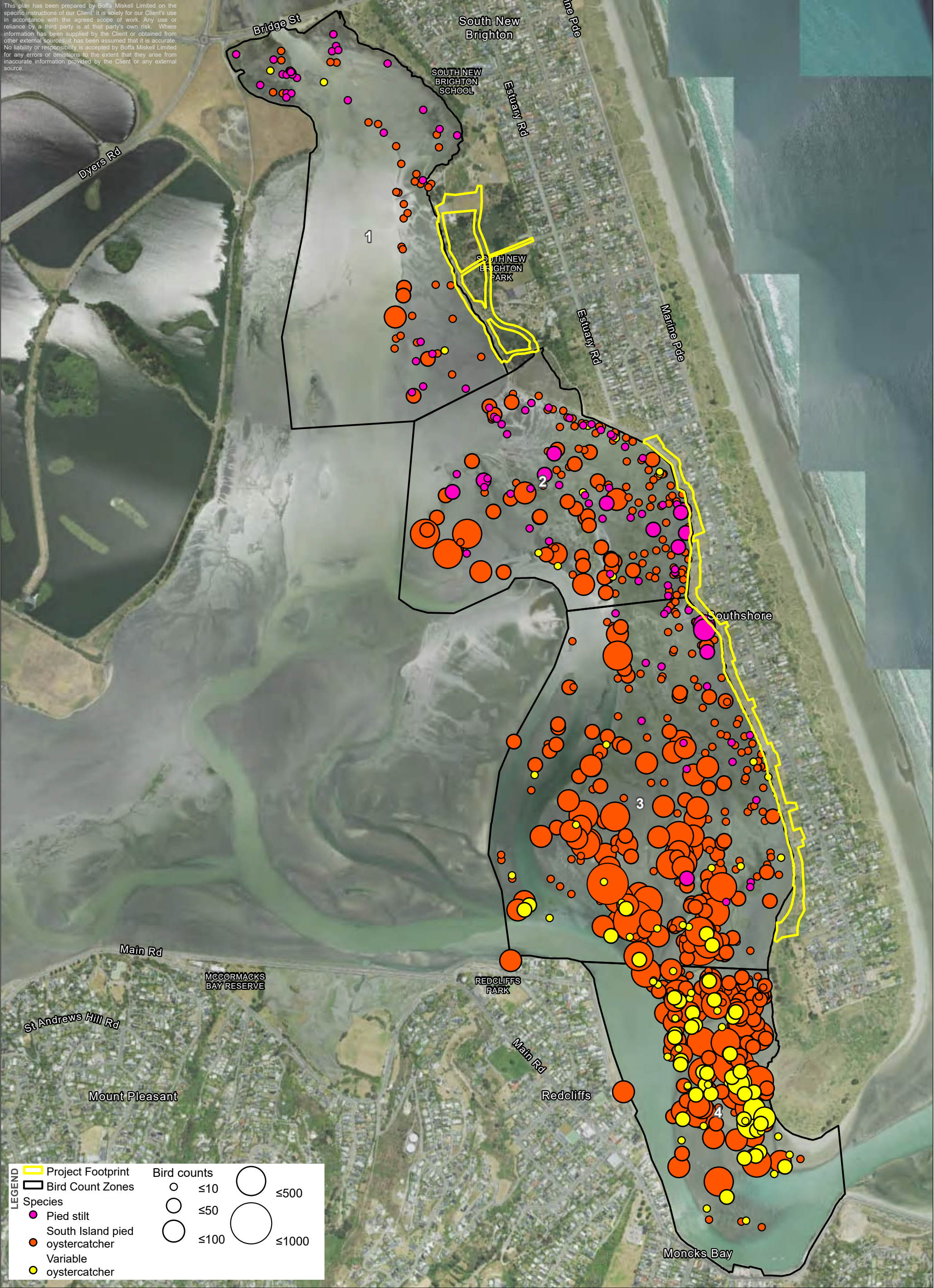


LEGEND

- Project Footprint
- Bird Count Zones
- Kingfisher (Bird Counts)
- ≤10

Figure 36

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3.4.1 Eastern shoreline avifauna assemblage

Based on the data collected for the purpose of this project, as well as species identified by Crossland (2022), the avifauna species recorded along the eastern shoreline of the Avon-Heathcote Estuary are listed in Table 12, along with an estimated estuary population⁵ for each.

Crossland (2022) identified pied shag and marsh crake as breeding along the shoreline, while noting Australasian bittern may possibly breeding and grey duck probably breeding. Pied shag nest in large trees close to the water's edge, however no shag species were recorded roosting or nesting in the remaining such trees within the SNBP part of the project. Marsh crake, grey duck and Australasian bittern breed in saltmarsh rushlands; while there are scattered areas of saltmarsh along the shoreline of the project footprint, these are unlikely to provide breeding habitat for these species due to their size. However, the extensive area of saltmarsh rushland located between the SNBP and Southshore sites (i.e., Jellicoe Marsh) provides potential breeding habitat for these species.

Table 12: Threatened and At Risk avifauna species utilising the eastern shoreline of the Avon-Heathcote Estuary (Source: Crossland (2022)).

SPECIES	NZ THREAT CLASSIFICATION	ESTIMATED ESTUARY POPULATION ⁵
Australasian bittern	Threatened - Nationally Critical	<10
Black-fronted tern	Threatened - Nationally Endangered	>50
Grey duck	Threatened - Nationally Vulnerable	10-50
Caspian tern	Threatened - Nationally Vulnerable	>50
Spotted shag	Threatened - Nationally Vulnerable	>500
Wrybill	Threatened - Nationally Increasing	<10
Banded dotterel	At Risk - Declining	>50
NZ pipit	At Risk - Declining	10-50
SIPO	At Risk - Declining	>2000
Bar-tailed godwit	At Risk - Declining	>2000
Lesser knot	At Risk - Declining	<10
Marsh crake	At Risk - Declining	10-50
Black-billed gull	At Risk - Declining	>200
Red-billed gull	At Risk - Declining	>2000
White-fronted tern	At Risk - Declining	>500
Variable oystercatcher	At Risk - Recovering	>50
Pied shag	At Risk - Recovering	>200
Black shag	At Risk - Relict	>50
Little shag	At Risk - Relict	>50
Little black shag	At Risk - Naturally Uncommon	10-50
Royal spoonbill	At Risk - Naturally Uncommon	>50
Bellbird	Not Threatened	10-50
Black swan	Not Threatened	>500
Black-backed gull	Not Threatened	>2000

SPECIES	NZ THREAT CLASSIFICATION	ESTIMATED ESTUARY POPULATION ⁵
Fantail	Not Threatened	10-50
Grey teal	Not Threatened	>2000
Grey warbler	Not Threatened	>50
Harrier	Not Threatened	10-50
Kereru	Not Threatened	<10
Kingfisher	Not Threatened	>50
NZ scaup	Not Threatened	>2000
NZ shoveler	Not Threatened	>2000
Paradise shelduck	Not Threatened	>500
Pied stilt	Not Threatened	>200
Pukeko	Not Threatened	>2000
Silveryeye	Not Threatened	>500
Spur-wing plover	Not Threatened	>50
Welcome swallow	Not Threatened	>500
White-faced heron	Not Threatened	>50
Blackbird	Introduced & Naturalised	
Chaffinch	Introduced & Naturalised	
Dunnock	Introduced & Naturalised	
Feral goose	Introduced & Naturalised	10-50
Goldfinch	Introduced & Naturalised	
Greenfinch	Introduced & Naturalised	
House sparrow	Introduced & Naturalised	
Magpie	Introduced & Naturalised	>50
Mallard	Introduced & Naturalised	>500
Starling	Introduced & Naturalised	

3.4.2 Ecological value

Table 13 lists the avifauna species that were recorded occurring, or are expected¹⁹ to occur, within and adjacent to the project site.

Table 13. Ecological value attributed avifauna assemblage associated with the Avon-Heathcote Estuary eastern shoreline, including the project site.

SPECIES	NZ THREAT CLASSIFICATION	ECOLOGICAL VALUE ²⁰
Australasian bittern	Threatened - Nationally Critical	Very High
Black-fronted tern	Threatened - Nationally Endangered	Very High
Grey duck	Threatened - Nationally Vulnerable	Very High
Caspian tern	Threatened - Nationally Vulnerable	Very High
Spotted shag	Threatened - Nationally Vulnerable	Very High
Wrybill	Threatened - Nationally Increasing	Very High
Banded dotterel	At Risk - Declining	High
NZ pipit	At Risk - Declining	High
SIPO	At Risk - Declining	High
Bar-tailed godwit	At Risk - Declining	High
Lesser knot	At Risk - Declining	High
Marsh crake	At Risk - Declining	High
Black-billed gull	At Risk - Declining	High
Red-billed gull	At Risk - Declining	High
White-fronted tern	At Risk - Declining	High
Variable oystercatcher	At Risk - Recovering	Moderate
Pied shag	At Risk - Recovering	Moderate
Black shag	At Risk - Relict	Moderate
Little shag	At Risk - Relict	Moderate
Little black shag	At Risk - Naturally Uncommon	Moderate
Royal spoonbill	At Risk - Naturally Uncommon	Moderate
Bellbird	Not Threatened	Low
Black swan	Not Threatened	Low
Black-backed gull	Not Threatened	Low
Fantail	Not Threatened	Low
Grey teal	Not Threatened	Low
Grey warbler	Not Threatened	Low
Harrier	Not Threatened	Low
Kereru	Not Threatened	Low
Kingfisher	Not Threatened	Low
NZ scaup	Not Threatened	Low

¹⁹ Based on species lists from other data sources or habitat present

²⁰ Based on the criteria provided in Table 6

SPECIES	NZ THREAT CLASSIFICATION	ECOLOGICAL VALUE ²⁰
NZ shoveler	Not Threatened	Low
Paradise shelduck	Not Threatened	Low
Pied stilt	Not Threatened	Low
Pukeko	Not Threatened	Low
Silvereye	Not Threatened	Low
Spur-wing plover	Not Threatened	Low
Welcome swallow	Not Threatened	Low
White-faced heron	Not Threatened	Low
Blackbird	Introduced & Naturalised	Negligible
Chaffinch	Introduced & Naturalised	Negligible
Dunnoek	Introduced & Naturalised	Negligible
Feral goose	Introduced & Naturalised	Negligible
Goldfinch	Introduced & Naturalised	Negligible
Greenfinch	Introduced & Naturalised	Negligible
House sparrow	Introduced & Naturalised	Negligible
Magpie	Introduced & Naturalised	Negligible
Mallard	Introduced & Naturalised	Negligible
Starling	Introduced & Naturalised	Negligible

3.5 Summary of ecological values

Table 14 summarises our assessment of ecological value following the EIANZ EcIA methodology and in accordance with Section 2.7.

Table 14. Summary of ecological values assigned to terrestrial vegetation and habitats, estuarine species and habitats, and avifauna and herpetofauna assemblages at the project site.

Ecosystem Component	Representativeness	Rarity / Distinctiveness	Diversity and Pattern	Ecological Context	Overall Ecological Value
Terrestrial Vegetation and Habitats					
Exotic Grassland / Herbfield	Very Low	Very Low	Very Low	Very Low	Negligible
Exotic Forest / Treeland	Very Low	Low-Moderate	Very Low	High	Moderate
Exotic Herb Cobblefield	Very Low	Very Low	Very Low	Very Low	Negligible
Saltmarsh Ribbonwood / Marram Grass Grassland	Moderate	Moderate	Low	Moderate	Moderate
Saltmeadow	Moderate	Moderate-High	Low-Moderate	Low	Moderate
Saltmarsh	Moderate-High	High	Moderate	Low-Moderate	High
Estuarine Species and Habitats					
Hard-bottom habitat at SNBP and Southshore	High degree of habitat modification. Common hard shore estuarine species. Low species richness, diversity and abundance. No invasive species. No Threatened / At Risk species. Macroalgae include opportunistic / disturbance tolerant species and provide minimal habitat. Low diversity and abundance of benthic invertebrates.				Low
Soft-sediment habitat: mudflat at SNBP and Southshore	Less than 30% silt and clay. Low level of contaminants. Limited habitat modification. Moderate species richness, diversity and abundance. Vegetation provides minimal habitat. Both tolerant and sensitive taxa present. No invasive species. No Threatened / At Risk species present.				Moderate
Soft-sediment habitat: seagrass at Southshore	Less than 30% silt and clay. Low level of contaminants. Limited habitat modification. Moderate species richness, diversity and abundance. Vegetation provides significant habitat. Both tolerant and sensitive taxa present. No invasive species. Threatened / At Risk species present. Indigenous coastal habitat vulnerable to modification present.				High
Soft-sediment habitat: saltmarsh below MHWS at Southshore	Less than 30% silt and clay. Low level of contaminants. Limited habitat modification. Moderate species richness, diversity and abundance. Vegetation provides significant habitat. Both tolerant and sensitive taxa present. No invasive species. No Threatened / At Risk species present. Indigenous coastal habitat vulnerable to modification present.				High
Herpetofauna (species confirmed to be present)					
Southern grass skink	At Risk - Declining				High
Avifauna (species confirmed or expected to be present)					
Australasian bittern	Threatened - Nationally Critical				Very High
Black-fronted tern	Threatened - Nationally Endangered				Very High
Grey duck	Threatened - Nationally Vulnerable				Very High
Caspian tern	Threatened - Nationally Vulnerable				Very High

Ecosystem Component	Representativeness	Rarity / Distinctiveness	Diversity and Pattern	Ecological Context	Overall Ecological Value
Spotted shag	Threatened - Nationally Vulnerable				Very High
Wrybill	Threatened - Nationally Increasing				Very High
Banded dotterel	At Risk - Declining				High
NZ pipit	At Risk - Declining				High
SIPO	At Risk - Declining				High
Bar-tailed godwit	At Risk - Declining				High
Lesser knot	At Risk - Declining				High
Marsh crake	At Risk - Declining				High
Black-billed gull	At Risk - Declining				High
Red-billed gull	At Risk - Declining				High
White-fronted tern	At Risk - Declining				High
Variable oystercatcher	At Risk - Recovering				Moderate
Pied shag	At Risk - Recovering				Moderate
Black shag	At Risk - Relict				Moderate
Little shag	At Risk - Relict				Moderate
Little black shag	At Risk - Naturally Uncommon				Moderate
Royal spoonbill	At Risk - Naturally Uncommon				Moderate
Bellbird	Not Threatened				Low
Black swan	Not Threatened				Low
Black-backed gull	Not Threatened				Low
Fantail	Not Threatened				Low
Grey teal	Not Threatened				Low
Grey warbler	Not Threatened				Low
Harrier	Not Threatened				Low
Kereru	Not Threatened				Low
Kingfisher	Not Threatened				Low
NZ scaup	Not Threatened				Low
NZ shoveler	Not Threatened				Low
Paradise shelduck	Not Threatened				Low
Pied stilt	Not Threatened				Low
Pukeko	Not Threatened				Low
Silvereye	Not Threatened				Low
Spur-wing plover	Not Threatened				Low
Welcome swallow	Not Threatened				Low
White-faced heron	Not Threatened				Low
Blackbird	Introduced & Naturalised				Negligible
Chaffinch	Introduced & Naturalised				Negligible

Ecosystem Component	Representativeness	Rarity / Distinctiveness	Diversity and Pattern	Ecological Context	Overall Ecological Value
Dunnock	Introduced & Naturalised				Negligible
Feral goose	Introduced & Naturalised				Negligible
Goldfinch	Introduced & Naturalised				Negligible
Greenfinch	Introduced & Naturalised				Negligible
House sparrow	Introduced & Naturalised				Negligible
Magpie	Introduced & Naturalised				Negligible
Mallard	Introduced & Naturalised				Negligible
Starling	Introduced & Naturalised				Negligible

3.6 Site significance

3.6.1 Existing significant sites

The operative Christchurch District Plan identifies the “tidal extent” of the Avon Heathcote Estuary / Ihutai (i.e., all intertidal areas below MHWS) as a Site of Ecological Significance (SES) under Section 6(c) of the RMA, which is called ‘Avon-Heathcote Estuary / Ihutai & Environs’ (SES/LP/14, Shadbolt 2015). The SES also includes some areas above MHWS in the project Site. The SES boundary is indicated in Figure 6 and Figure 7.

In addition, most of the estuary mudflat is listed as an Area of Significant Natural Value in the Regional Coastal Environment Plan (Estuary of the Heathcote and Avon Rivers/Ihutai site).

The Avon-Heathcote Estuary / Ihutai & Environs SES meets most criteria for determining significant indigenous vegetation and significant habitat of indigenous fauna listed in Appendix 3 of the Canterbury Regional Policy Statement (CRPS, Environment Canterbury, 2013). The criteria met and discussed in Shadbolt (2015) relate largely to the diversity and numbers of birds at the site (CRPS criteria 1, 4, 5, and 10). However, the area is also noted in Shadbolt (2015) as having ecological significance as:

- A habitat that supports a representative community of fish;
- A large example of an originally uncommon ecosystem (an estuary);
- Containing areas of indigenous vegetation that have been depleted regionally and nationally (indigenous coastal vegetation types such as saltmarsh, located along the banks of the Avon / Ōtākaro and Heathcote / Ōpāwaho River mouths); and
- A large intertidal mudflat habitat that provides habitat for fish as well as both resident and migratory waterfowl.

The following areas of the project Site are within the SES and are, therefore, significant:

- All areas below MHWS including Jellicoe Marsh.
- All ‘Saltmarsh Rushland’ and ‘Saltmarsh Ribbonwood / Marram Grass Grassland’ vegetation above MHWS (located at the southern end of the proposed works at Southshore).

- Part of the 'Exotic Forest / Exotic Treeland' (large conifers adjoining Jellicoe Marsh and the Estuary margin near Pleasant Point Yacht Club).

3.6.2 Other significant sites

Other areas above MHWS within the project Site at SNBP and Southshore are not included in the Avon-Heathcote Estuary / Ihutai & Environs SES. Moreover, the Christchurch District Plan does not include a complete list of all the sites in the District that are ecologically significant under Section 6(c) of the RMA. For this reason, the vegetation and habitats that are above MHWS and are outside the Avon Heathcote Estuary / Ihutai SES that could potentially be impacted by the proposal were assessed against the ecological significance criteria in Appendix 3 of the CRPS and the NPS-IB.

The project site above MHWS and outside the SES was assessed in two sections: **SNBP**, and **Southshore**. The Southshore area includes two broad sub-areas:

- Estuary fringing habitat above MHWS that includes relatively more natural / representative habitat areas (vegetation types comprising Exotic Herb Cobblefield, Saltmeadow, and Saltmarsh areas); and
- Exotic habitats in the RRZ that are generally former private properties that have been subject to extensive historic and ongoing modification (Exotic Grassland / Herbfield, Exotic Forest / Treeland vegetation types).

The assessment is split because of the clear difference in character of habitat and the physical separation of these parts of the Estuary edge (and proposed project works) by a c.600 m gap that includes Jellicoe Marsh (where no works would occur) and the northernmost inundation bund in Ebbside St. Results of the assessment for significance against the CRPS ecological significance criteria and the NPS-IB are provided in Table 15 below.

Table 15. Summary of assessment of areas against statutory significance criteria (italicised).

CRPS Criteria	Equivalent NPS-IB Criteria	Assessment
Representativeness <i>1. Indigenous vegetation or habitat of indigenous fauna that is representative, typical or characteristic of the natural diversity of the relevant ecological district. This can include degraded examples where they are some of the best remaining examples of their type, or represent all that remains of indigenous biodiversity in some areas.</i>	Representativeness: <i>An area that qualifies as an SNA under this criterion has at least one of the following attributes:</i> <i>(a) indigenous vegetation that has ecological integrity that is typical of the character of the ecological district:</i> <i>(b) habitat that supports a typical suite of indigenous fauna that is characteristic of the habitat type in the ecological district and retains at least a moderate range of species expected for that habitat type in the ecological district.</i>	<u>SNBP:</u> <u>Does not meet CRPS or NPS-IB criteria.</u> Planted coastal forest / treeland areas and grassland / herbfield areas at SNBP that are outside the existing SES are not indigenous vegetation. Ecological integrity is low, with substantial areas of weedy / exotic vegetation and generally low populations of indigenous species that are vulnerable to loss. Indigenous species are generally artificial (planted / managed / weedy) and not representative of indigenous coastal vegetation. The occasional presence of self-established coastal species (e.g., knobby clubrush) on the fringe of this area does not meet the threshold for representativeness. The prevailing vegetation cover and habitat character is exotic, modified, and weedy. <u>Southshore:</u> <u>Meets CRPS and NPS-IB criteria.</u> Saltmeadow and saltmarsh areas are representative vegetation types that contains typical assemblages of coastal edge species. In places, these form a representative ecotone driven by a gradient of estuarine influence. Cobblefield areas are not representative, as they contain only short-lived adventive species that have been able to establish on essentially artificial land surfaces on / below coastal armour structures. RRZ areas are not indigenous vegetation or habitat of indigenous fauna (other than for a small number of common and Not Threatened bird species, and possibly southern grass skink, see below). RRZ vegetation is entirely artificial (planted / managed / weedy) and is not representative of indigenous coastal vegetation. The occasional presence of planted coastal tree species (e.g., ngaio) in the wider RRZ treeland does not meet the threshold for representativeness. Ecological integrity is low, with substantial areas of weedy / exotic vegetation and generally low populations of indigenous species that are vulnerable to loss. As noted in Section 3.6.1, along the RRZ area, saltmarsh above MHWS adjoins saltmarsh below MHWS that is already part of an existing significant area (SES/LP/14). At the south end of the project site, saltmarsh above MHWS is already part of an existing significant area (SES/LP/14).
<i>2. Indigenous vegetation or habitat of indigenous fauna that is a relatively large example of its type within the relevant ecological district.</i>	n/a (see above)	<u>SNBP</u> <u>Does not meet CRPS criterion.</u> Terrestrial areas outside the SES and above MHWS are not considered indigenous vegetation nor a large example of indigenous fauna habitat at the level of the Low Plains ED. <u>Southshore:</u> <u>Does not meet CRPS criterion.</u>

CRPS Criteria	Equivalent NPS-IB Criteria	Assessment
		Even when considered alongside adjoining similar habitats below MHWS, the project area is narrow and effectively squeezed between estuary mudflat and built urban areas. Much larger examples of estuarine vegetation sequences (including created / restored areas) exist elsewhere in the Estuary (e.g., Charlesworth Reserve, Bridge Reserve, Jellicoe Marsh, and Cockayne Reserve and at the level of the ED.
Rarity / Distinctiveness 3. Indigenous vegetation or habitat of indigenous fauna that has been reduced to less than 20% of its former extent in the region, or relevant land environment, ecological district, or freshwater environment.	Rarity and Distinctiveness An area that qualifies as an SNA under this criterion has at least one of the following attributes: (d) indigenous vegetation that has been reduced to less than 20 per cent of its prehuman extent in the ecological district, region, or land environment:	<u>SNBP:</u> <u>Does not meet CRPS or NPS-IB criteria.</u> Terrestrial areas outside the SES and above MHWS are not considered indigenous vegetation and therefore the criteria does not apply. <u>Southshore:</u> <u>Meets CRPS and NPS-IB criteria.</u> In saltmarsh and saltmeadow areas, indigenous species are naturally present and occur on a land environment with less than 10% indigenous vegetation remaining. Wetland habitat types (saltmeadow and saltmarsh) have been reduced to less than 20% of their former extent nationally and regionally (Ausseil et al., 2008). RRZ areas lack naturally occurring indigenous species and do not meet the criterion.
4. Indigenous vegetation or habitat of indigenous fauna that supports an indigenous species that is threatened, at risk, or uncommon, nationally or within the relevant ecological district.	(a) provides habitat for an indigenous species that is listed as Threatened or At Risk (declining) in the New Zealand Threat Classification System lists: (b) an indigenous vegetation type or an indigenous species that is uncommon within the region or ecological district:	<u>SNBP:</u> <u>Meets CRPS and NPS-IB criteria.</u> Little shag (At Risk – Relict) are known to roost on trees overhanging the estuary at SNBP; many of these trees are outside the SES but meet this criterion and are therefore also significant. Kereru could be considered locally uncommon in the Low Plains ED and, conservatively, taller forest areas where kereru have been known to attempt to breed are considered significant for this reason. The area contains suitable habitat for and likely supports southern grass skink (At Risk – Declining). On this basis, these areas meet this criterion. <u>Southshore:</u> <u>Meets CRPS and NPS-IB criteria.</u> No nationally Threatened, At Risk, or locally uncommon plant species are present. Threatened and At Risk coastal bird species may use saltmarsh and saltmeadow areas sporadically, especially for resting at higher tides, but the area does not meet the threshold for significance on this basis. No At Risk bird species are known or considered likely to use RRZ habitat, but this area contains suitable habitat for and likely supports southern grass skink (At Risk – Declining). On this basis, RRZ areas meet this criterion.
5. The site contains indigenous vegetation or an indigenous species at its distribution limit within Canterbury Region or nationally.	(c) an indigenous species or plant community at or near its natural distributional limit:	<u>SNBP and Southshore:</u> <u>Does not meet CRPS or NPS-IB criteria.</u> No naturally occurring species or vegetation types are at or near their distribution limits.

CRPS Criteria	Equivalent NPS-IB Criteria	Assessment
6. Indigenous vegetation or an association of indigenous species that is distinctive, of restricted occurrence, occurs within an originally rare ecosystem, or has developed as a result of an unusual environmental factor or combinations of factors.	(e) indigenous vegetation or habitat of indigenous fauna occurring on naturally uncommon ecosystems: (g) the presence of a distinctive assemblage or community of indigenous species:	<u>SNBP:</u> <u>Does not meet CRPS or NPS-IB criteria.</u> Terrestrial areas outside the SES and above MHWS are not considered indigenous vegetation and in any case are not distinctive, of restricted occurrence, or originally rare. Indigenous species in this area have been almost entirely deliberately planted, and the prevailing vegetation cover and habitat character is exotic, modified, and weedy, rather than the result of environmental factors. Species assemblages / communities are not distinct. <u>Southshore:</u> <u>Meets CRPS and NPS-IB criteria.</u> Estuaries are a naturally uncommon ecosystem type (Williams et al., 2007). Saltmeadow areas are distinctive and have developed since the earthquake sequence as a result of this unusual environmental factor. Other species assemblages / communities are not distinct.
n/a	(f) the type locality of an indigenous species: (h) the presence of a special ecological or scientific feature.	<u>SNBP and Southshore:</u> <u>Does not meet CRPS or NPS-IB criteria.</u> The project site is not known to be a type locality or considered to be a special ecological or scientific feature.
Diversity and Pattern 7. Indigenous vegetation or habitat of indigenous fauna that contains a high diversity of indigenous ecosystem or habitat types, indigenous taxa, or has changes in species composition reflecting the existence of diverse natural features or ecological gradients.	An area that qualifies as a significant natural area under this criterion has at least one of the following attributes: (a) at least a moderate diversity of indigenous species, vegetation, habitats of indigenous fauna or communities in the context of the ecological district: (b) presence of indigenous ecotones, complete or partial gradients or sequences.	<u>SNBP:</u> <u>Does not meet CRPS criteria, meets NPS-IB criteria.</u> Forest / Treeland areas at SNBP have very low indigenous species diversity. Terrestrial habitats at SNBP are not considered indigenous habitats and therefore the presence of ecotones and gradients / sequences is not considered to meet the criteria. <u>Southshore:</u> <u>Does not meet CRPS criteria, meets NPS-IB criteria.</u> Indigenous diversity in saltmarsh and saltmeadow at Southshore is generally low-moderate, but is not moderate or high. Cobblefield and RRZ areas at Southshore have very low indigenous species diversity. The Site contributes to an ecotone of estuarine to terrestrial indigenous habitats, although terrestrial habitats that could be considered 'indigenous' are limited in extent (e.g., saltmeadows).
Ecological Context 8. Vegetation or habitat of indigenous fauna that provides or contributes to an important ecological linkage or network, or provides an important buffering function.	An area that qualifies as an SNA under this criterion has at least one of the following attributes: (a) at least moderate size and a compact shape, in the context of the relevant ecological district:	<u>SNBP:</u> <u>Does not meet CRPS or NPS-IB criteria.</u> While forest / treeland areas provide some buffering function between built residential areas and estuary habitat, the presence of tracks and walkways through the area means that the value of this buffering function is limited (and not <i>important</i>) in terms of reducing fauna disturbance. Because the forest / treeland does not comprise indigenous habitat as part of a sequence of estuarine to terrestrial habitats, it is not considered to have an <i>important</i> buffering function in terms of vegetation.

CRPS Criteria	Equivalent NPS-IB Criteria	Assessment
	<i>(b) well-buffered relative to remaining habitats in the relevant ecological district:</i> <i>(c) provides an important full or partial buffer to, or link between, one or more important habitats of indigenous fauna or significant natural areas:</i>	<u>Southshore:</u> <u>Does not meet CRPS or NPS-IB criteria.</u> The areas assessed are at an abrupt edge of natural habitats and constructed coastal armour and / or exotic RRZ habitats. They are therefore generally unable to provide an important ecological linkage or network. Their buffering function is unlikely to be important.
9. A wetland which plays an important hydrological, biological or ecological role in the natural functioning of a river or coastal system.	n/a	<u>SNBP:</u> <u>Does not meet CRPS or NPS-IB criteria.</u> No wetlands are present in terrestrial areas in SNBP outside the SES. <u>Southshore:</u> <u>Possibly meets CRPS and NPS-IB criteria.</u> Inclusively, and as above, the area assessed includes wetlands, and these represent part of a wider coastal estuarine system. Their ecological importance in this system relates to their contribution to coastal erosion protection, sediment attenuation, and habitat connectivity / gene flow. The wider context is important; if assessed in isolation these areas are considered generally too small to have any important functional role in the coastal system.
10. Indigenous vegetation or habitat of indigenous fauna that provides important habitat (including refuges from predation, or key habitat for feeding, breeding, or resting) for indigenous species, either seasonally or permanently.	<i>(d) important for the natural functioning of an ecosystem relative to remaining habitats in the ecological district.</i>	<u>SNBP and Southshore:</u> <u>Does not meet CRPS or NPS-IB criteria.</u> While the area may provide resting or feeding habitat for various avifauna species at times, this narrow area is not considered <i>important</i> for those species whether individually or collectively. Whilst the presence of kereru and southern grass skink are notable in terms of separate rarity criteria, their populations are small and occupy low-quality habitat; the SNBP and Southshore areas are not <i>important</i> for those species at the local Estuary, ED, or national scale.

3.6.3 Summary of ecological significance

In summary, in terms of locations:

- All areas of the project site below MHWS, part of the Estuary edge at SNBP above MHWS, an area of tall conifer trees above MHWS near Jellicoe Marsh, and all 'Saltmarsh Rushland' and 'Saltmarsh Ribbonwood / Marram Grass Grassland' at Southshore above MHWS are within the 'Avon-Heathcote Estuary / Ihutai & Environs' site (SES/LP/14, Shadbolt 2015) and, therefore, significant.
- Except for the above, the extent of the 'Avon-Heathcote Estuary / Ihutai & Environs' SES does not include any other areas above MHWS within the project site. However, based on our assessment against the CRPS ecological significance criteria both the SNBP and Southshore areas of the project site contain significant values.
 - o At SNBP, grassland / herbfields at the margins of forest / treeland habitat is significant for the presence of southern grass skink; forest / treeland habitat is significant for the occasional presence of breeding kereru.
 - o At Southshore, saltmeadow and saltmarsh areas above MHWS are significant based on multiple criteria, whereas RRZ habitat is significant only for the presence of southern grass skink.

In summary, in terms of species / habitat types within the project area (within both the existing SES LP/14 and in areas newly assessed as significant in this report):

- The significant values relate to southern grass skink habitat, forest / treeland that provides kereru breeding habitat, sand dunes (with indigenous shrubs and marram grass), and all saltmarsh, saltmeadow, and estuary mudflat areas.

4.0 Original project design

The original project design, which informed the site surveys described in Section 2.0 of this report, is based on the following information provided by Jacobs:

- Technical Experts Scoping Document provided in December 2021.
- Draft Basis of Design Report provided in January 2021.
- Georeferenced layout of the envelopes of target habitat for the ecological assessment provided in January 2022. The envelopes encompass the terrestrial and intertidal estuarine habitat expected to be affected by the works.
- Construction Methodology Memo provided in March 2022.

4.1 Erosion protection works

At SNBP, the erosion protection works originally proposed involved the establishment of a combination of:

- Rock revetment (encapsulating where possible the damaged reno mattresses)
- Cobble beach (combined in some areas with offshore breakwaters to encourage the establishment of saltmarsh vegetation)

At Southshore, the erosion protection works originally proposed involved the establishment of a combination of:

- Rock revetment (encapsulating where possible the existing rubble revetment material)
- Cobble beach + offshore breakwater (to enhance the existing saltmarsh habitat)

The habitat envelopes delineating the terrestrial and intertidal estuarine habitat expected to be either permanently or temporarily impacted by the construction of the erosion protection structures according to the original project design are displayed in Figure 41 and Figure 42 for SNBP and Southshore, respectively.

4.2 Inundation protection works

At SNBP, the inundation protection works originally proposed involved the construction of approximately 530 m of inundation bund located within a 30-40 m wide corridor and tying into existing high ground on both ends. The original project design provided three different options for the alignment of the bund, with the preferred option to be selected based on the outcome of subsequent investigations.

At Southshore, the inundation protection works originally proposed involved the construction of approximately 1,960 m of inundation bund located approximately 5 m behind the estuary edge and tying into an existing bund along Caspian Street and into high ground south of Tern Street.

The habitat envelope delineating the terrestrial habitat expected to be either permanently or temporarily impacted by the construction of the inundation bund according to the original project design are displayed in Figure 41 and Figure 42 for SNBP and Southshore, respectively.

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LEGEND

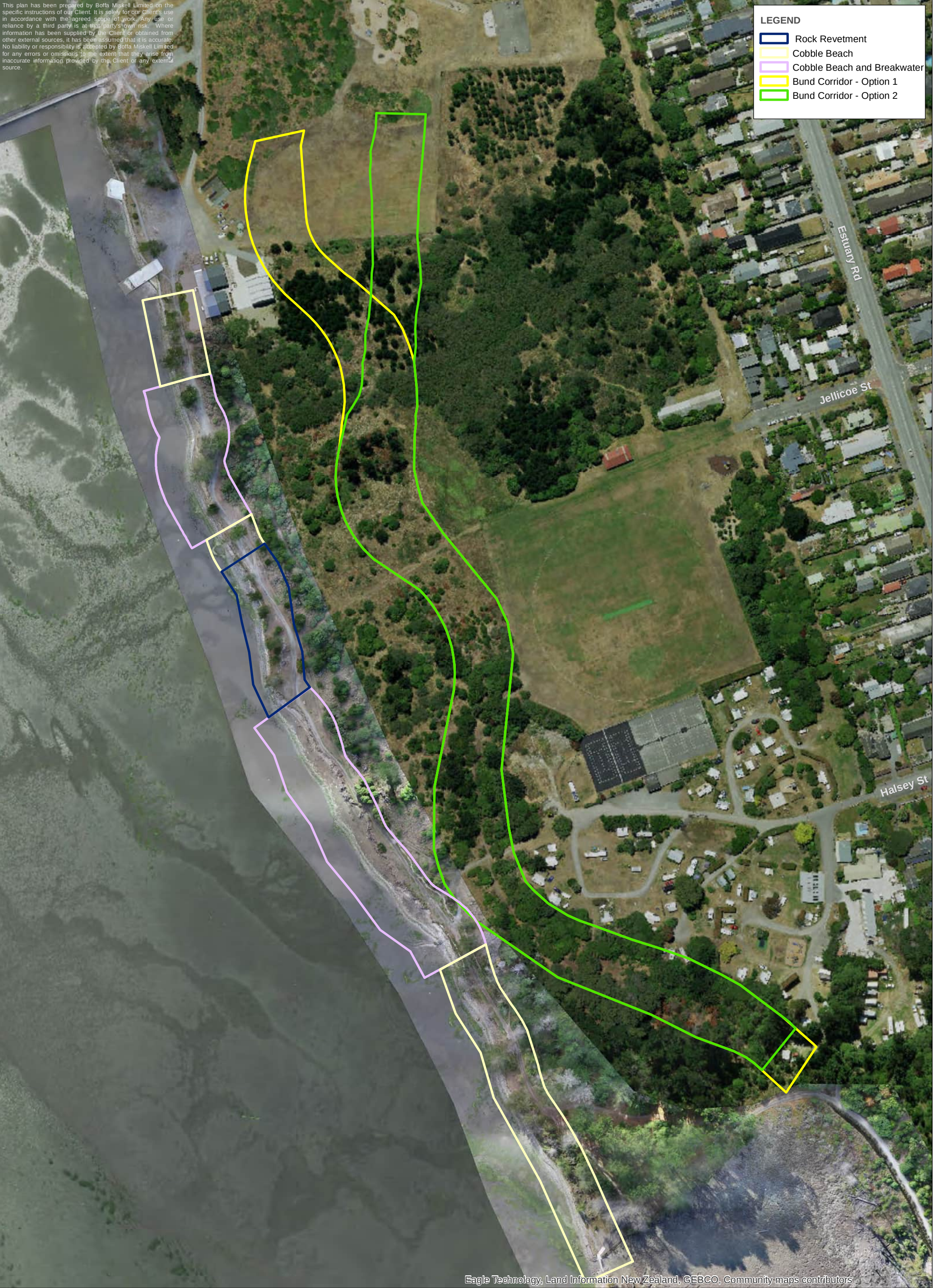
Rock Revetment

Cobble Beach

Cobble Beach and Breakwater

Bund Corridor - Option 1

Bund Corridor - Option 2



Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors

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LEGEND

Design Corridors

Inundation Bund

Rock Revetment

Cobble Beach and Breakwater

Road Boundaries



Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors

5.0 Design shaping

A design shaping process was carried out in collaboration with other technical specialists and CCC to identify opportunities for reducing the impact of the proposed work on habitats and species identified within the project site. This process was based on the effects management hierarchy (see Section 8.0).

The design shaping process initially explored the feasibility of an alternative approach based on the reinstatement of a naturalised estuary edge (i.e., with no engineered structures) at least in some areas of the project site. However, this was incompatible with the scope of the project, which aimed to reinstate pre-earthquake conditions without changes in the position of the land / coastal marine area (CMA) interface (see Sections 1 and 10.3.4 of the AEE). Therefore, the focus of the design shaping process shifted on revising the original design to avoid, where possible, or minimise the footprint of the new erosion protection structures onto the estuary bed and onto the habitats located immediately above MHWS. The revised design also includes the creation of new estuary habitat through the removal of the existing earthquake-damaged structures (see Sections 4.3, 4.4 and 10.3.4 of the AEE).

The key outcomes of the design shaping process were:

- **Avoidance of effects on the saltmeadow habitat above MHWS at SNBP:** design changes were implemented to retain an area of existing coastal erosion protection (reno mattress), rather than its replacement and associated potential impacts to a small area of saltmeadow near Jellicoe Marsh.
- **Minimisation of effects on the mudflat habitat at SNBP:** design changes with the use of gabion baskets, the removal of offshore breakwaters and with a landward shift in the position of the erosion protection structures to minimise the loss of mudflat habitat, as required by Policy 11(b) of the New Zealand Coastal Policy Statement. However, there is some overlap between mudflat and the footprint of the erosion protection structures (i.e., reclamation) due to constraints to the landward shift in the position of the erosion protection structures (see Sections 4.3, and 10.3.4 of the AEE).
- **Remediation of the effects on the mudflat habitat at SNBP:** declamation through the removal of damaged reno mattresses and other rock material allowing the creation of new mudflat habitat. However, the overall amount of reclamation at SNBP exceeds by 780 m² the amount of declamation (see Section 7.3.1.1).
- **Avoidance of effects on the seagrass habitat at Southshore:** design changes with a landward shift in the position of the erosion protection structures to avoid, as far as practicable, overlap between seagrass and the footprint of the erosion protection structures, as required by Policy 11(a) of the New Zealand Coastal Policy Statement. A small overlap (0.2 m²) between seagrass and the project footprint is present in the area adjacent to 44a Rocking Horse Road, where the design options are severely constrained by lack of space (see Section 4.4.2 of the AEE). From preliminary conversations with the technical design team, we understand that it will be possible to avoid impacts on this area of seagrass as there is some flexibility in the extent of the excavation required to accommodate the toe of the new revetment (see Section 8.1.1).
- **Avoidance of effects on the saltmarsh habitat below MHWS at Southshore:** design changes with a landward shift in the position of the erosion protection structures to

avoid any overlap between saltmarsh and the footprint of the erosion protection structures, as required by Policy 11(b) of the New Zealand Coastal Policy Statement.

- **Minimisation of effects on the saltmarsh habitat above MHWS at Southshore:** design changes with a landward shift in the position of the erosion protection structures to minimise the overlap between saltmarsh and the footprint of the erosion protection structures, with loss of saltmarsh limited to an area of a few square metres (see Section 7.2.1.5).
- **Minimisation of effects on the mudflat habitat at Southshore:** design changes with the removal of a proposed offshore breakwater and a landward shift in the position of the erosion protection structures to minimise the loss of mudflat habitat, as required by Policy 11(b) of the New Zealand Coastal Policy Statement. Some overlap between mudflat and the footprint of the erosion protection structures (i.e., reclamation) is still present in areas where a landward shift in the position of the erosion protection structures was not feasible (see Sections 4.4 and 10.3.4 of the AEE).
- **Remediation of the effects on the mudflat habitat at Southshore:** design changes with a landward shift in the position of the erosion protection structures and declamation through the removal of the existing structures allowing the creation of new mudflat habitat, with the overall amount of declamation exceeding by 1,660 m² the amount of reclamation (see Section 7.3.1.1).

The design shaping process also sought options to avoid / minimise impacts on saltmeadow habitat at Southshore, although this had lower priority²¹ than avoidance / minimisation of adverse effects on estuarine habitats.

Despite being outside the footprint of the new erosion protection structures (based on the original project design), the saltmeadow at Southshore would have been at least partly subject to direct loss through construction impacts. In addition, it was precautionarily assumed that any remaining areas would be permanently lost due to a loss of hydrological connection with the adjacent estuary environment because of the estuary edge repairs. As a result, the indigenous saltmeadow species would be replaced by exotic species.

The design shaping process explored the feasibility of allowing some saline intrusion through the new erosion protection structures, to maintain hydrological conditions suitable for saltmeadow. However, this idea was abandoned once the design changes needed to avoid and minimise impacts on estuarine habitats meant that the footprint of the erosion protection structures entirely overlapped the saltmeadow habitats. In addition, creation of permeable erosion protection was not considered feasible as it would have created a risk of back-scour that would have undermined the purpose of the erosion protection structures and ultimately the project objectives.

The level of ecological effect of the loss of saltmeadow at Southshore and recommendations to offset / compensate such loss are discussed in Section 7.2.1.6 and Section 8.1.4, respectively.

²¹ This lower priority was based on two factors: firstly, ecological advice was to prioritise avoidance of remnant / natural coastal saltmarsh habitat fringing the estuary mudflat rather than saltmeadow that has opportunistically established on former gardens more recently post-earthquake; secondly, Policy 11(b) of the NZCPS (which applies to the saltmarsh) was deemed somewhat more stringent than policy direction under the NPS-FM 2020 (which applies to the saltmeadow).

6.0 Confirmed project design

Following the design shaping process described in Section 5.0, the project design was amended and the construction methodology developed. Further detail about the project design and construction methodology is available in Section 4 of the AEE.

6.1 Erosion protection works

6.1.1 South New Brighton Park

The SNBP erosion protection works will involve the establishment of approx. 390 m of cobble beach and 180 m of gabion baskets (Figure 43).

Gabion baskets will be used to protect shell midden sites identified at the northern end of the project site at SNBP. Gabion baskets were selected as the preferred option for the midden sites because they allow the encapsulation of the middens without excavation and with a smaller footprint on the estuary bed compared to other erosion protection structures (see Section 4.3 of the AEE).

Together, gabion baskets and cobble beach will occupy approx. 1,346 m² of mudflat habitat (reclamation) due to the impossibility to shift their position further back (see Section 4.3 of the AEE). The areas of reclamation are scattered across the project site (Figure 44).

In addition, approx. 2,640 m² of estuary bed will be disturbed (this may include excavation to accommodate the new structures and subsequent reinstatement). The areas of seabed disturbance are scattered across the project site and extend between 2 m and 8 m in front of the new erosion protection structures (Figure 44). This 2-8 m band is also considered the greatest extent of the construction footprint. There will be no disturbance of the seabed beyond this 2-8 m point.

Approx. 566 m² of new mudflat habitat will be created through the removal of damaged reno mattresses and other existing rock material (declamation; Section 4.3 of the AEE). The areas of declamation are scattered across the project site (Figure 44).

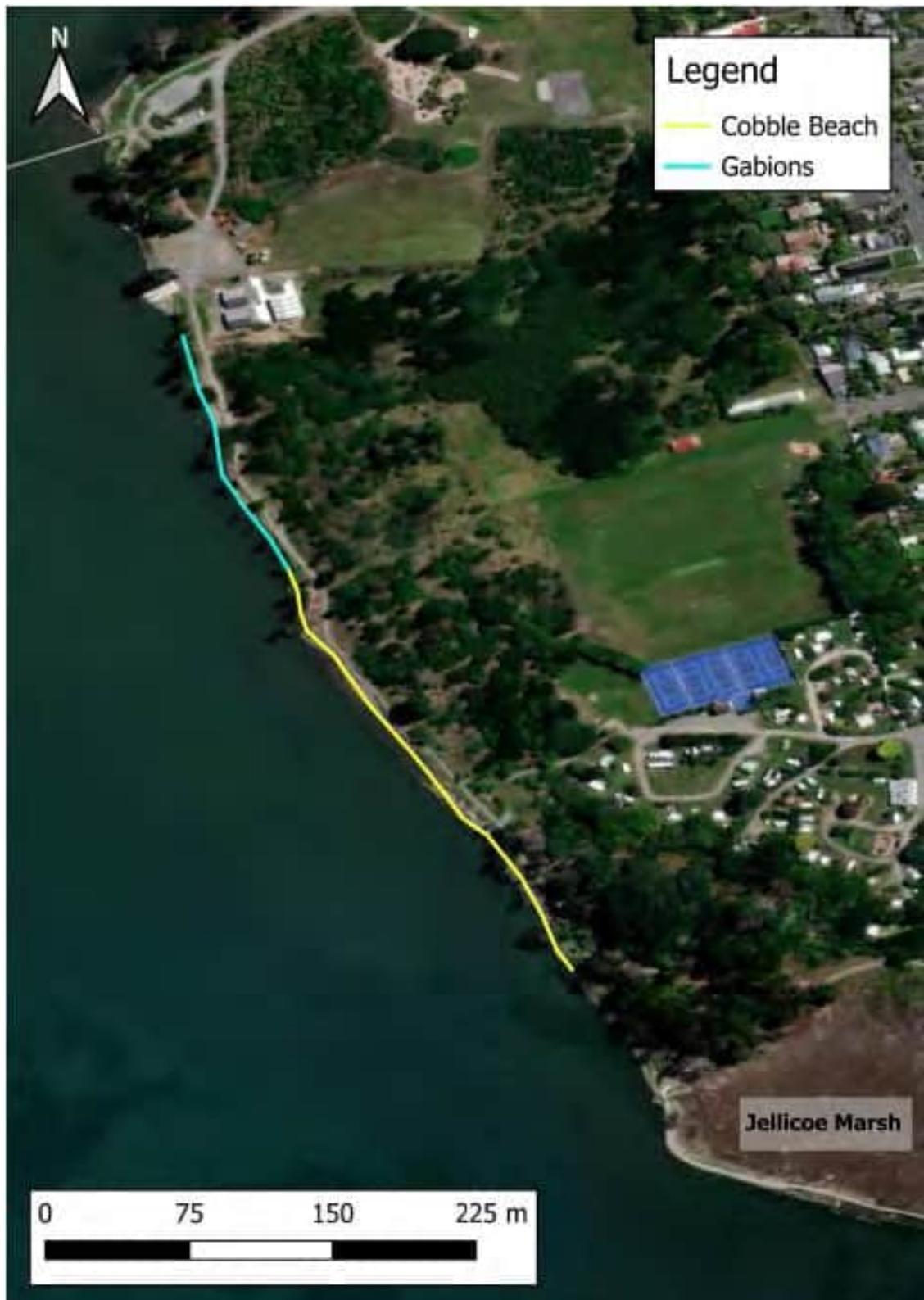


Figure 43: Layout of the erosion protection structures at South New Brighton Park.

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LEGEND

Project Footprint

Project Footprint

Mudflat Declamation

Mudflat Reclamation

Mudflat Excavation\Disturbance

Bund and Revetment Design



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6.1.2 Southshore

The Southshore erosion protection works involve the establishment of approx. 1,230 m of rock revetment and 330 m of cobble beach (Figure 45).

The cobble beach, located between Penguin Street and Kingfisher Lane, will be almost entirely above MHWS, with minimal overlap with the estuarine habitats (Figure 45 and Figure 46).

The rock revetment will encapsulate the existing structures in some areas along the project site, while in other areas the existing structures will be removed and replaced altogether by the new revetment (see Section 4.4 of the AEE).

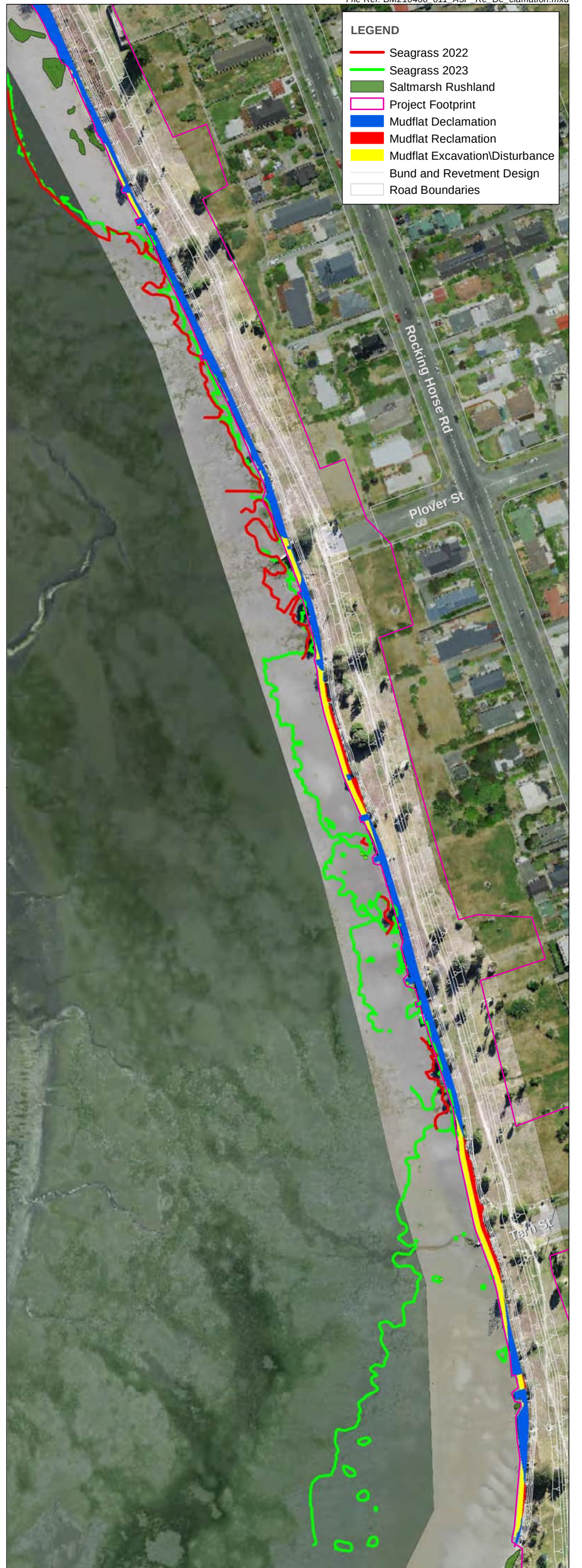
The rock revetment will occupy approx. 480 m² of mudflat habitat (reclamation), where the new structures cannot be placed within the footprint of the existing ones (see Section 4.4 of the AEE). The areas of reclamation are scattered across the project site (Figure 46). Based on the April 2023 seagrass mapping, a single seagrass plant is present within the reclamation footprint by 44a Rocking Horse Road (Figure 46).

Approx. 1,570 m² of estuary bed will be excavated to a depth of approx. 1 m to accommodate the toe of the new revetment and subsequently reinstated. The areas of excavation are scattered across the project site and extend up to 3 m in front of the new revetment structures. This 3 m band is also considered the greatest extent of the construction footprint. There will be no disturbance of the seabed beyond this point.

At the same time, approx. 2,140 m² of new mudflat habitat will be created with a landward shift in the position of the new revetment relative to the footprint of the existing structures, which will be removed (declamation; Section 4.4 of the AEE). The areas of declamation are scattered across the project site (Figure 46).



Figure 45. Layout of the erosion protection structures at Southshore.



6.1.3 Construction methodology

The following construction methodology has been summarised from Section 4.5 of the AEE.

The erosion protection works will be undertaken using earthmoving machinery working from the shore. There will be no use of machinery on the estuary bed.

Any excavated and / or disturbed areas of seabed (up to 4,210 m² across SNBP and Southshore) will be suitably reinstated, ensuring it is appropriately compacted and the area disturbed is level with the surrounding seabed. Any seabed disturbance (excavation, declamation, temporary stockpiling) will be reinstated within the same low-tide window.

Stockpiling of construction and excavated material will be outside of the estuary bed. There will be multiple small stockpiles within the project site. Stockpiles will be on land and adjacent to the areas of construction. The location of the stockpiles will change as construction progresses.

6.1.3.1 Rock revetment

The construction of the rock revetment will involve the following steps:

- Clear vegetation, debris and existing structures to be removed and dispose off-site.
- Strip topsoil and stockpile along the work corridor for future respreading.
- Excavate estuary bed to design levels and temporarily stockpile material adjacent to the active work area for replacement once rock revetment completed.
- Excavate existing estuary edge to formation levels, temporarily stockpile material adjacent the active work area, periodically removing the balance of material not to be re-used to the primary stockpile site or direct to disposal. If the material is contaminated it will be managed as per the Contaminated Material Management Plan.
- Deliver rock from local primary stockpile, place in temporary secondary stockpile adjacent the active work area.
- Take rock from temporary secondary stockpile, place on geotextiles and shape to design profile.
- Take estuary bed material from temporary stockpile, place and shape to existing estuary bed levels.

6.1.3.2 Cobble beach

The construction of the cobble beach will involve the following steps:

- Clear vegetation, debris and existing structures to be removed and dispose off-site.
- Strip topsoil and stockpile along the work corridor for future respreading.
- Excavate existing estuary edge to formation levels, temporarily stockpile material adjacent to the active work area, periodically removing the balance of material not to be re-used to the primary stockpile site or direct to disposal.
- Deliver cobbles from local primary stockpile, place in temporary secondary stockpile adjacent the active work area.
- Take cobbles from temporary secondary stockpile, place on geotextiles and shape to design profile.

6.1.3.3 Gabion baskets

The construction of the gabion baskets will involve the following steps:

- Clear vegetation, debris and existing reno mattresses to be removed and dispose off-site.
- Strip topsoil and stockpile along the work corridor for future respreading.
- Excavate existing estuary edge to formation levels, place at toe of completed gabion sections, otherwise temporarily stockpile material adjacent to the active work area for reuse as backfill behind, below, and at the toe of gabion baskets.
- Deliver gabion baskets to a site adjacent the work area.
- Place geotextile and lower gabion baskets on the estuary bed, and fill and secure the baskets.
- Place estuary bed material from the temporary stockpile as backfill behind the gabion baskets.

6.2 Tern Street jetty

At Southshore, the project's landscape plan includes a new jetty with a ramp providing access to the estuary bed at the Tern Street road end (Figure 47). The jetty will cover an area of approx. 85 m² and will be supported by piles of untreated hardwood. Approx. 61 m² of the surface of the jetty will be located above the estuary bed, while the rest of the structure will overlay the new revetment structure along the estuary edge (Figure 47). Altogether, the jetty structures, which will be installed within the seabed (i.e., the piles and the toe of the ramp), will occupy approx. 1 m² of estuary bed.

The jetty will be located above an unvegetated area of estuary bed according to aerial imagery and observations made during the field surveys. Two small patches of seagrass are located just north of the proposed structure (Figure 47).

The construction of the Tern Street jetty will involve the use of piling machinery working from the land or positioned on the structures itself. The installation of the piles within the estuary bed will take place during low tide windows (see Section 4.5.7 of the AEE).



Figure 47. Layout of the Tern Street jetty.

6.3 Inundation protection works

At SNBP, a preferred bund alignment has been selected, setting the bund between 40 to 180 metres behind the estuary edge. The proposed bund is 640 m long.

At Southshore, the alignment of the inundation bund is generally as per the original project design, with a 5 m set back from the estuary edge. The proposed bund is 2,050 m long.

The construction of the inundation bunds will follow behind the gabion basket, rock revetment, or cobble beach formation, as this provides greater opportunity for direct placement of material to be re-used.

6.3.1 Construction methodology

The following construction methodology has been summarised from Section 4.5 of the AEE.

The construction of the inundation bund will involve the following steps:

- Clear vegetation and dispose off-site.
- Strip topsoil and stockpile along the work corridor for future respreading.

- Excavate existing bund and new bund to formation levels, temporarily stockpile material adjacent the active work area, periodically removing the balance of material not to be re-used to the primary stockpile site or direct to disposal.
- Import aggregate from local primary stockpile, place in temporary secondary stockpile adjacent the active work area, take, place, compact and shape to design profile.
- Take general fill from temporarily stockpiles adjacent the active work area, place, shape and compact to form final inundation bund shape and fill where required between the erosion protection and the inundation bund.
- Take topsoil from temporarily stockpiles adjacent the active work area, place, shape and compact to form final inundation bund shape.

There will be multiple small stockpiles of construction and excavated material within the project site. Stockpiles will be on land and adjacent to the areas of construction. The location of the stockpiles will change as construction progresses.

6.4 Construction duration

Construction duration is likely to be between 12 and 15 months for Southshore and around 5 months for SNBP.

7.0 Assessment of ecological effects

The following assessment of effects on the ecological values of the terrestrial vegetation and habitats, estuarine species and habitats, and the avifauna and herpetological fauna assemblages is based on the:

- confirmed project design;
- proposed construction methodology;
- proposed landscape design;
- Coastal Processes Assessment; and
- the project's impact management measures provided in Section 7.1.

In accordance with the EIANZ EcIA guidelines, we have used ecological values and magnitude of effect to determine the likely level of effect without mitigation (but with 'project impact management measures' included as base assumptions, outlined in Section 7.1).

The assessments in Section 7.0 also reflect general design principles established as part of the design shaping process (Section 5.0), such as avoiding overlaps between the erosion protection structures and seagrass, but do not incorporate the specific mitigation measures described in Section 8.0 required by the effects management hierarchy.

7.1 Project impact management measures

The following 'project impact management measures' are assumed as included in the project design and proposed construction methodology and form part of the base assumptions for our ecological impact assessment:

- Avoiding runoff of sediment and contaminants from land to the Estuary through strict adherence to good practice erosion and sediment control and for the management of contaminated material.
- Erosion protection structures will be put in place immediately following any required excavation works, to avoid prolonged exposure of the estuary edge without erosion protection.
- A geotextile fabric layer will be placed under the erosion protection structures to prevent ongoing discharge of fine sediment material through the structures and into the Estuary.
- Minimising the resuspension and spread of benthic sediments and contaminants by:
 - o Working from the land with no use of machinery on the estuary bed;
 - o Only carrying out construction activities on the Estuary bed within low-tide windows, to ensure working in dry conditions;
 - o Avoiding temporary stockpiling of excavated seabed material on the Estuary bed;
 - o Reinstating the Estuary bed in areas of excavation and declaration so that the reinstated material is compacted and level with the surrounding estuary bed, and
 - o Reinstating the Estuary bed disturbed in areas of excavation and declamation within the same low-tide window.
- The majority of existing structures (e.g., jetties and stormwater outlet structures) within the Estuary will be retained.
- Implementation of the project's landscape plan.

7.2 Terrestrial vegetation and habitats

7.2.1 Vegetation clearance

Based on the project construction footprint, the quantum of vegetation clearance / effective loss has been calculated in Table 16 based on the vegetation types described in Section 3.1.2.

At Southshore, removal of existing coastal armour and installation of the erosion protection (revetment / cobble beach) and inundation bunds is likely to lead to direct removal of most habitat in the project footprint via earthworks. Even if not all areas landward of MHWS are directly impacted (due to being worked over), it has been precautionarily (and for simplicity) assumed that loss / change will be total and permanent within the construction footprint, except where specifically noted. This includes permanent loss of saltmeadow areas in the RRZ (for the reasons described in Section 5.0).

As described in Section 5.0 above, all saltmarsh (aside from a 0.01 ha area described in Section 7.2.1.5 below) is outside the project footprint, and saltmarsh would otherwise be avoided by the proposed works.

Table 16. Vegetation clearance / loss, based on project construction footprint and presumed loss of saltmeadow regardless of actual clearance via works.

Vegetation Type	Ecological Value/ (Roper-Lindsay et al. 2018)	Meets CRPS Significance Criteria	Area Removed (m ² / ha)	Location / Explanation
Exotic Grassland / Herbfield	Negligible	Yes	73,730 m ² / 7.3 ha	SNBP and Southshore RRZ area / removed via construction; note that it would largely be replanted
Exotic Forest / Treeland	Moderate	Yes	17,282 m ² / 1.7 ha	SNBP, primarily in inundation bund area
Exotic Herb Cobblefield	Low	Yes	4,551 m ² / 0.45 ha	Backshore and existing edge structures / replaced by new structures; some natural reestablishment on revetment / cobble beach possible
Saltmarsh Ribbonwood / Marram Grass Grassland	Moderate	Yes	3,416 m ² / 0.34 ha*	South end of project site at Southshore / lost due to replacement by inundation bund*
Saltmarsh (above MHWS)	High	Yes	6 m ² / 0.001 ha	Below revetment and cobble beach at Southshore. Margin of error of mapping and / or loss of isolated sea rush plants at upper edge of saltmarsh
Saltmeadow	Moderate	Yes	1,716 m ² / 0.17 ha	Between revetment or cobble beach at Southshore and inundation bund / loss either due to replacement with estuary edge protection or due to loss of essential hydraulic connection with estuary

* The actual footprint of the inundation bund represents only a fraction (c.10%) of the 0.34 ha area where the indicative (broad) construction footprint overlaps with this habitat type. Nevertheless, temporary impacts beyond this bund footprint are inevitable due to construction effects and in the absence of a more precise construction footprint and applying the precautionary principle, the higher loss amount has been applied to this assessment.

7.2.1.1 Loss of exotic grassland / herbfield at SNBP and in RRZ

At both SNBP and Southshore, provided that impacts to indigenous skink species are appropriately managed (see Sections 7.4 and 8.0), the loss of up to 7.3 ha of this habitat is not of ecological importance. The significant values of this area are only southern grass skinks, and so any net loss of significant values would therefore be avoided.

Vegetation lost is exotic trees and lawn similar to extensive private gardens and RRZ areas beyond the project. Following the project's landscape plan (see appended in the AEE), essentially all of the area lost (excluding areas that would become the inundation bund, pathways, etc.) would be replaced by plantings of appropriately eco-sourced indigenous plants species suitable for the habitat. In time, this would likely be better skink habitat than what currently exists. This **Positive** magnitude effect for this negligible ecological value habitat type represents a **Net Gain** for this area.

7.2.1.2 Loss of exotic forest / treeland at SNBP

During works to install an inundation bund at SNBP and to install coastal erosion control structures at the estuary edge near Pleasant Point Yacht Club, a corridor of existing vegetation will be cleared; with the bund to be resown largely in grass. The proposed inundation bund largely follows an existing track, minimising vegetation clearance. Species that would be cleared comprise various planted indigenous trees (e.g., ngaio), non-local natives (karo, taupata) and exotics (radiata pine and tagasaste), with none comprising Threatened, At Risk, or locally uncommon indigenous species. Various problematic weeds are present in this area, including boneseed, scotch broom, lily of the valley vine, and boxthorn. Based on the footprint of the inundation bund, it is understood that large radiata pine and macrocarpa trees would be retained in this area. The loss of vegetation, in terms of the types of species present, is not of ecological concern (planted natives, non-local natives, and exotic species are not considered of intrinsic ecological value). However, the likelihood is that the works will serve to somewhat fragment a currently continuous area of tall-stature vegetation providing bird habitat. Effects to indigenous bird species within this habitat type are discussed further in Section 7.5. In terms of vegetation impacts, adverse effects from clearance of up to 1.7 ha of this area (noting that much of this area includes an existing track) are Low. Adverse effects would be remedied / mitigated by infill planting (amounting to approx. 2.1 ha) in uncleared adjoining areas, and additional coastal edge planting (based on the project's landscape plan) to achieve a **Positive** overall magnitude of effect from a vegetation perspective; i.e., a **Net Gain**.

7.2.1.3 Loss of exotic herb cobblefield on backshore

During works to replace existing erosion control structures it is likely that much of this sparsely vegetated backshore area will be worked over, with a loss of the existing generally adventive plants present (i.e., weedy species, whether indigenous or exotic). The vegetation in this area represents opportunistic individual colonists representing species common and widespread in the surrounding habitat (i.e., none are particular to this area). Similar vegetation is likely to re-establish in suitable parts of the new revetment and cobble beach structures. Losses over approx. 0.45 ha are likely to be temporary; even in the worst case they would be of **Negligible** magnitude (on a low ecological value habitat) and represent a **Very Low** level of ecological effect. The significant values of this habitat at Southshore (described in Section 3.6.2) are marginal and relate only to the inclusion of this area in the wider estuary / terrestrial ecotone; given that similar vegetation will likely re-establish, the project would not diminish (would not lead to any net loss of) that value and function.

7.2.1.4 Loss of saltmarsh ribbonwood / marram grass grassland at south end of project site at Southshore

The loss of up to 0.34 ha of this vegetation type (of Moderate value, and part of a significant area²²) would occur in an area containing largely marram grass, Siberian lyme grass, several ngaio trees, several exotic trees (various species), and knobby clubrush. The overall project footprint (0.34 ha) includes a small number (likely >10) saltmarsh ribbonwood shrubs, although the more specific inundation bund footprint itself (c.0.03 ha) appears to fully avoid these shrubs (i.e., depending on whether construction impacts affect the entire project footprint, or only some of it; all, none or only some of these shrubs may be lost). Following construction, it is likely that similar vegetation would establish generally in any unmanaged areas (i.e., not on tracks or the bund itself). The project's draft landscape plan does not include providing new indigenous plantings in this area.

²² As described in Section 3.6.1, this grassland area forms part of the significant site SES/LP/14.

Provided that impacts to indigenous skink species in this area are appropriately managed (see Sections 7.4 and 8.0), the permanent loss of some of this vegetation (up to, but possibly less than 0.3 ha), would be of a **Low** magnitude (on a moderate ecological value habitat), being a **Low** level effect overall. This low magnitude of effect assumes loss of some indigenous plants but also that some reestablishment naturally occurs. Any loss of indigenous plants should be avoided or otherwise remedied (see Section 8.0) to ensure that the proposal leads to no net loss (and preferably a net gain) in significant coastal vegetation.

7.2.1.5 Loss of saltmarsh below revetment / cobble beach at Southshore

An apparent 0.01 ha area of saltmarsh loss essentially represents margin of error between the mapping of saltmarsh (based largely on the extent of sea rush) and the proposed construction footprint. This level of impact, while a *de minimis* (**Very Low**) level effect (based on negligible magnitude impact to high ecological value habitat), would most likely affect sea rush, the core vegetation component of this significant habitat type²³. While this species is abundant in suitable habitats in the surrounding area, coastal wetland vegetation in the estuary is generally declining (Orchard, 2020). Any loss should be avoided or otherwise remedied (see Section 8.0) to ensure that the proposal leads to no net loss (and preferably a net gain) in significant coastal wetland habitat.

7.2.1.6 Loss of saltmeadow above existing estuary edge at Southshore

Loss of 0.17 ha of saltmeadow due either to construction impacts (damage or permanent replacement with structures) or loss of hydraulic connection to the estuary would remove the only existing representative areas of indigenous vegetation landward of the estuary edge along the project extent at Southshore. While other similar / more intact and frequently much larger areas are present (and would remain) nearby at Jellicoe Marsh and Southshore Spit Reserve, this nevertheless represents a complete loss of a distinctive post-earthquake area of significant values.

In considering the extent of similar habitat at the level of the estuary and the ED, but also widespread historic and ongoing losses of estuarine wetland types (and wetland types in general), these adverse effects are considered of **Moderate** magnitude of effect²⁴. Based on the moderate ecological value of this habitat, and its ecological significance, this magnitude of effect represents a **Moderate** level of effect (i.e., a net loss of significant values) that requires offsetting or mitigation.²⁵

With the impact management measures described in Section 8.0, the magnitude of effect is considered to be **Positive**, which equates to a **Net Gain** level of effect.

²³ Losses, if any, would be in areas adjoining the RRZ. No loss of saltmarsh would occur within the area of saltmarsh near 172a Rocking Horse Road that is already part of the significant site SES/LP/14.

²⁴ Meaning a 'loss or alteration to one or more key elements/features of the existing baseline conditions, such that the post-development character, composition and/or attributes will be partially changed' (Roper-Lindsay et al. 2018).

²⁵ As outlined in Section 5.0, saltmeadow was not able to be avoided via project shaping. It also cannot be recreated (remedied / mitigated) following construction, due to an assumption of a complete loss of hydraulic connection to the estuary, e.g., via inundation / wave splash inputs.

7.2.2 Indirect effects

7.2.2.1 Saltmarsh

As a consequence of installation of a new coastal edge, it is possible that tidal / wave motion against this new edge may possibly alter existing patterns of scour and deposition of sediment in saltmarsh areas around MHWS at Southshore. This may lead to some adjustment (slight loss or gain, or slight shifts in elevation / location) in saltmarsh location and extent, but (based on the negligible expected degree of mudflat elevation and sediment transport change as determined in the Coastal Processes and Natural Hazards Assessment (Appendix I of the AEE)) saltmarsh habitat is unlikely to appreciably diminish in extent.

The installation of the cobble beach area would create a gentler landform gradient, potentially allowing for sediment to deposit, and plant species to establish in appropriate upper tidal zones, where water motion is attenuated by existing saltmarsh. This could conceivably include establishment of saltmeadow species within more sparsely vegetated areas of existing saltmarsh, and / or an upward expansion in saltmarsh, whereas the existing environment includes partial areas of abrupt transition from saltmarsh to coastal edge structures.

These effects are uncertain and likely range from Negligible to Positive magnitudes of effect (on a High ecological value), which equates to a **Very Low** or a **Positive (Net Gain)** level of effect. No effects management is required.

7.2.2.2 Other effects

No other indirect effects on terrestrial vegetation and habitats (e.g., weed establishment and spread, cumulative effects, loss of habitat connectivity) are considered to be of ecological concern in the context of the site and proposed activity. It is notable that the main locations of project works inland from the estuary edge (the inundation bund area) are substantially modified already; they contain either unmanaged weed issues (SNBP) or are subject to ongoing management (i.e., mown areas, largely at Southshore).

7.3 Estuarine species and habitats

The following construction and post-construction effects on the ecological values of estuarine species and habitats were considered for this assessment:

- Loss and creation of mudflat habitat
- Loss and creation of hard-bottom habitat
- Modification (shading) of mudflat and hard-bottom habitat
- Mudflat habitat disturbance
- Mortality of estuarine organisms
- Resuspension of benthic sediment and contaminants
- Runoff of terrestrial sediment and contaminants
- Noise and vibration
- Estuary bed lowering
- Movement of cobble beach material

- Increased access to the estuary bed
- Coastal squeeze
- Cumulative effects

7.3.1 Construction effects

7.3.1.1 Loss and creation of mudflat habitat

Across the project site, approx. 1,827 m² of mudflat habitat will be occupied by the new erosion protection structures (i.e., reclamation) in areas where the new structures cannot be placed within the footprint of the existing ones (Table 17; see also Sections 5.0 and 8.0, and Sections 4.3, 4.4 and 10.3.4 of the AEE). This figure also accounts for the footprint of the Tern Street jetty (see Section 6.2).

At the same time, approx. 2,706 m² of new mudflat habitat will be created with a landward shift in the alignment of the of the new erosion protection structures and through the removal of the existing ones (Table 17; see also Sections 5.0 and 8.0, and Sections 4.3, 4.4 and 10.3.4 of the AEE).

Table 17. Amount of mudflat habitat loss and creation*.

Mudflat habitat			
	SNBP	Southshore	Total across the project site
Mudflat habitat lost	1,346 m ²	481 m ²	1,827 m²
Mudflat habitat created	566 m ²	2,140 m ²	2,706 m²
Permanent change	- 780 m ²	+ 1,659 m ²	+ 879 m²

*For these calculations, the current extent of the mudflat habitat (i.e., the position of the mudflat boundary along the estuary edge) was assessed based on high resolution aerial imagery collected in May 2021 by Christchurch City Council surveyors (and provided to us by Jacobs) and on the position of the MHWS line calculated by Jacobs as part of this project (Jacobs New Zealand Ltd, 2023). On-site ground-truthing was carried out at specific locations where the mudflat extent could not be assessed based on the aerial imagery or the MHWS line.

Once the newly-created mudflat habitat is appropriately reinstated (so that it is compacted and level with the surrounding seabed), it is expected to be analogous to the existing mudflat and to be colonised by the same suite of benthic organisms that is currently present.

As a result, an increase of approx. 879 m² in the extent of mudflat habitat across the project site is a **Positive** magnitude effect. A positive magnitude of effect on the moderate ecological value of the mudflat habitat equates to a **Net Gain** level of effect.

This level of effect will make a positive contribution to the ecological values that contribute to the ecological significance of the Estuary.

7.3.1.2 Loss and creation of hard-bottom habitat

Across the project site, all the existing hard-bottom habitat below MWS (approx. 1,731 m²) will be lost, as the existing structures will be either removed or encapsulated within the new ones. The new erosion protection structures will provide a greater amount of hard-bottom habitat below MWS (approx. 2,436 m² across the project site; Table 18).

Table 18. Amount of hard-bottom habitat loss and creation.

Hard-bottom habitat			
	SNBP	Southshore	Total across the project site
Hard-bottom habitat lost	1,023 m ²	708 m ²	1,731 m²
Hard-bottom habitat created	1,530 m ²	906 m ²	2,436 m²
Permanent change	+ 507 m ²	+ 198 m ²	+ 705 m²

Despite the increase in the availability of hard-bottom habitat, the new erosion protection structures will maintain the unnatural hardening of the estuary edge and are unlikely to support communities of higher ecological value than those found on the existing structures. Therefore, an increase of approx. 705 m² in the extent of hard-bottom habitat across the project site is assessed as having a **Negligible** magnitude of effect, with no change or only a very slight change from the existing baseline conditions. A negligible magnitude of effect on the low ecological value of the hard-bottom habitat equates to a **Very Low** level of effect.

This level of effect will not affect the ecological values that contribute to the ecological significance of the Estuary.

7.3.1.3 Permanent modification (shading) of mudflat and hard-bottom habitat

The Tern Street jetty will cause permanent shading of approx. 55 m² of mudflat habitat (about 6 m² of the mudflat habitat that would be overlaid by the jetty are already occupied by a stormwater outlet) and 8 m² of hard-bottom revetment habitat. The shaded habitat will be unsuitable for the growth of estuarine vegetation, while shading is unlikely to affect benthic invertebrates.

Shading from the jetty will affect a small area of unvegetated mudflat and artificial hard-bottom habitat and it will not impact two small patches of seagrass which are present in close proximity (see Section 6.2). As a result, the permanent habitat modification created by the shading is assessed as having a **Low** magnitude of effect, resulting in a minor shift away from existing baseline conditions. A low magnitude of effect on the low ecological value of the hard-bottom habitat and on the moderate ecological value of the mudflat habitat equates to a **Very Low-Low** level of effect.

This level of effect will not affect the ecological values that contribute to the ecological significance of the Estuary.

7.3.1.4 Mudflat habitat disturbance

Across the project site, up to 4,210 m² of mudflat habitat will be disturbed by the construction activities. Disturbance will include excavation and subsequent reinstatement to accommodate the new structures (see Section 6.1 and Section 4.5 of the AEE).

Once the excavated/disturbed mudflat material is appropriately reinstated (so that it is compacted and level with the surrounding seabed), the mudflat habitat post excavation/disturbance is expected to be analogous to the existing mudflat and to be colonised by the same suite of benthic organisms which is currently present.

As a result, the disturbance of mudflat habitat is assessed as having a **Negligible** magnitude of effect, with no change or only a very slight change from the existing baseline conditions. A

negligible magnitude of effect on the moderate ecological value of the mudflat habitat equates to a **Very Low** level of effect.

This level of effect will not affect the ecological values that contribute to the ecological significance of the Estuary.

7.3.1.5 Seagrass habitat disturbance

Although the revised design avoids overlap between the project footprint and the seagrass habitat as far as feasible, at Southshore seagrass habitat disturbance may occur:

- In the area adjacent to 44a Rocking Horse Road, where a 0.2 m² patch of seagrass is present on the outer edge of the excavation zone, and one isolated plant is located within the revetment footprint (see Figure 45 in Section 6.1.3).
- Where seagrass grows in close proximity to existing erosion protection structures, which may require seabed excavation to be removed.

Seagrass habitat disturbance will require careful management before and during construction. This may include small design changes as well as temporarily removing and reinstating very small patches of seagrass as outlined in the recommendations provided in Section 8.0.

Without any management of seagrass during construction, the temporary disturbance of the seagrass habitat is assessed as having a **Negligible** magnitude of effect, because, based on the most recent mapping, it will affect only very small patches or isolated seagrass plants and will result in a minor shift away from existing baseline conditions. A negligible magnitude of effect on the high ecological value of the seagrass habitat equates to a **Very Low** level of effect.

However, it is important to note that adverse effects of activities on Threatened and At Risk indigenous taxa must be avoided (Policy 11(a)(i) of the NZCPS). Therefore, any loss of seagrass should be avoided or otherwise remedied (see Section 8.0) to ensure that the proposal leads to no net loss of seagrass habitat.

7.3.1.6 Mortality of estuarine organisms

Sessile or slow-moving organisms within the areas of mudflat and hard-bottom habitat impacted by the construction works are likely to suffer mortality, whereas mobile organisms (such as fish) will be able to leave or avoid the construction area. Macroalgae and benthic invertebrates are the taxa that will be primarily impacted by the replacement of the existing erosion protection structures and by the reclamation and disturbance of mudflat habitat. Loss of very small patches of seagrass may also occur without appropriate management measures during construction, as outlined in Section 7.3.1.5. Aside from seagrass, the surveys did not reveal any Threatened or At Risk marine organisms within the area of mudflat and hard-bottom habitat that will be lost or disturbed, with all organisms being common across New Zealand estuarine systems.

The new erosion protection structures and the reinstated mudflat and seagrass habitats are expected to be colonised by the same suite of benthic organisms that is currently present. The mortality of the organisms living within the excavated seabed will be minimised by reinstating the excavated material within a few hours (i.e., within the same low-tide window). In addition, the net gain in the extent of mudflat habitat across the project area will provide additional benthic habitat to infauna and epibenthic organisms.

As a result, the mortality of estuarine organisms within the mudflat habitat and very small patches of the seagrass habitat is assessed as having a **Negligible** magnitude of effect, resulting in a minor shift away from existing baseline conditions for a limited period of time. A

low magnitude of effect on the low ecological value of the hard-bottom habitat and on the moderate-high ecological values of the different soft-bottom habitats that would be affected equates to a **Very Low** level of effect.

This level of effect will not affect the ecological values that contribute to the ecological significance of the Estuary.

However, it is important to note that adverse effects of activities on Threatened and At Risk indigenous taxa must be avoided (Policy 11(a)(i) of the NZCPS). Therefore, any loss of seagrass should be avoided or otherwise remedied (see Section 8.0) to ensure that the proposal leads to no net loss of seagrass habitat.

7.3.1.7 Resuspension of benthic sediments and contaminants

The excavation of the seabed during construction can cause the resuspension of benthic sediment and of the associated contaminants. This can make the contaminants that are bound to sediments bioavailable (e.g., through ingestion) and increased suspended sediments can affect water quality and clarity. Suspended sediment can reduce the photosynthetic efficiency of plants and interfere with the breathing and feeding apparatuses of fish and filter feeders (Hewitt et al., 2001). When falling out of suspension, deposited sediment at a thickness of greater than approximately 3 mm can have adverse effects on the most sensitive benthic organisms (Lohrer et al., 2006).

The estuarine organisms that may be affected by the resuspension of benthic sediments and increased availability of contaminants include animals and plants inhabiting the seabed of the estuary. The effects of resuspension of benthic sediments and contaminants are not relevant for hard-bottom organisms, which will either be about to be removed from the existing structures or not yet present on the new ones.

According to the project's construction methodology, the resuspension of benthic sediments and contaminants will be minimised by working in the estuary only during low tide windows, so that work can be carried out in dry conditions. In addition, any area of disturbed seabed (through excavation or declamation) will be reinstated within the same low tide window, to minimise sediment resuspension with the tidal inundation. Appropriate reinstatement of the disturbed material will ensure that the seabed in the disturbed areas is compacted and level with the surrounding seabed (see Section 4.5 of the AEE).

With these measures in place, if small sediment resuspension events were to occur, these will be small and short-lived, and therefore any effect on marine organisms will be temporary. In addition, the seabed in the project area comprises mostly medium and fine sands (see Section 3.2.3), which are likely to quickly fall out of suspension without the formation of large plumes, and sediment contaminant concentrations at the project site are below effect thresholds (see Section 3.2.4).

As a result, the resuspension of benthic sediment and contaminants is assessed as having a **Negligible** magnitude of effect, resulting in a minor shift away from existing baseline conditions for a limited period of time. A low magnitude of effect on the moderate-high ecological values of the different estuarine habitats that would be affected equates to a **Very Low** level of effect.

This level of effect will not affect the ecological values that contribute to the ecological significance of the Estuary.

7.3.1.8 Runoff of terrestrial sediment and contaminants

Adverse effects on water quality and benthic organisms could also result from runoff of fine sediments and associated contaminants from the surrounding land / terrestrial environment, during the removal of the existing structures. As above, the estuarine organisms that may be affected by the runoff of land-derived sediments and contaminants include animals and plants inhabiting the seabed of the estuary. These effects are not relevant for hard-bottom organisms, which will either be about to be removed from the existing structures or not yet present on the new ones.

The construction methodology includes measures for erosion and sediment control and for the management of contaminated material (see Section 4.5 of the AEE). In addition, the placement of the erosion protection structures will progressively follow the excavation works to avoid prolonged exposure of the estuary edge without erosion protection. A geotextile fabric layer is included in the design of the new structures to prevent fine sediment material from migrating through the new erosion protection structures (see Section 4.5 of the AEE).

With stringent adherence to erosion and sediment control measures, the runoff of terrestrial sediment and contaminants is assessed as having a **Negligible** magnitude of effect, with no change or only a very slight change from the existing baseline conditions. A negligible magnitude of effect on the moderate-high ecological values of the different estuarine habitats that would be affected equates to a **Very Low** level of effect.

This level of effect will not affect the ecological values that contribute to the ecological significance of the Estuary.

7.3.1.9 Noise and vibration

Noise and vibration associated with offloading of material, excavation and piling operations will represent a further source of disturbance during construction. Noise and vibration can have adverse effects on estuarine organisms, with the level of effect depending on the degree and duration of the disturbance. The estuarine organisms that may be affected by noise and vibration include benthic invertebrates inhabiting the seabed of the estuary. These organisms may temporarily cease normal behaviour and stop feeding, retract into their shell, stop moving or hide. The effects of noise and vibration are not relevant for hard-bottom organisms, which will either be about to be removed from the existing structures or not yet present on the new ones.

Noise and vibration effects will be intermittent as they will occur only at low tide, so that noise propagation through the water column will be unlikely and highly mobile organisms (such as fish) will not be present within and in proximity of the project site. As a result, noise and vibration are assessed as having a **Negligible** magnitude of effect, with no change or only a very slight change from the existing baseline conditions. A negligible magnitude of effect on the moderate-high ecological values of the different estuarine habitats that would be affected equates to a **Very Low** level of effect.

This level of effect will not affect the ecological values that contribute to the ecological significance of the Estuary.

7.3.2 Post-construction effects

7.3.2.1 Estuary bed lowering

Localised estuary bed lowering could be experienced around the new revetments and gabion baskets because of wave reflection scouring the seabed at the toe of these structures. On the other hand, bed lowering will be minimal in the areas of cobble beach because the gentle slope of the cobble beach structures will result in lower wave reflection (see Section 5 of the Coastal Processes and Natural Hazards Assessment at Appendix I of the AEE).

Scouring of the seabed could affect the ability of epibenthic and infaunal animals to occupy the area at the toe of the new revetments and gabion baskets. According to the Coastal Processes and Natural Hazards Assessment, any bed lowering around the toe of the new revetments and gabion baskets will be small and highly localised. Bed scouring will be similar to what is currently experienced at the base of the existing revetment / sloping structures, and less than currently experienced in the areas at the southern end of the project site at Southshore, which are characterised by the presence of vertical seawalls.

In light of this, estuary bed lowering is assessed as having a **Negligible** magnitude of effect, resulting in a very slight change from the existing baseline conditions. A negligible magnitude of effect on the moderate-high ecological values of the different estuarine habitats that would be affected equates to a **Very Low** level of effect.

This level of effect will not affect the ecological values that contribute to the ecological significance of the Estuary.

7.3.2.2 Movement of cobble beach material

The cobble beach structures are intended to be dynamic in nature, with the cobbles being free to move. Hence some renourishment of the cobble beach may be required over the 20-year design life of these structures, particularly after large storm events (see Design Report at Appendix D of the AEE).

Cobbles moving because of the dynamic nature of the structures or displaced in large storm events may be washed onto the estuary bed and impact the receiving habitats, i.e., mudflat (both at SNBP and Southshore) and saltmarsh (at Southshore).

The mudflat habitat is largely unvegetated. Based on this, on the infrequent nature of large storm events, and on the low energy environment of the estuary (see Coastal Processes and Natural Hazards Assessment at Appendix I of the AEE) we consider that the impact of the cobbles would have a **Negligible** magnitude of effect on the animals living on the surface and within the mudflat habitat, resulting in a very slight change from the existing baseline conditions. A negligible magnitude of effect on the moderate ecological value of the mudflat habitat equates to a **Very Low** level of effect.

This level of effect will not affect the ecological values that contribute to the ecological significance of the Estuary. Nonetheless, we recommend that any cobble material washed onto the mudflat habitat is promptly removed (see Section 8.1.2.2).

In the saltmarsh habitat below MHWS at Penguin Street (Southshore), the saltmarsh vegetation could be damaged if smothered by cobbles. Based on the infrequent nature of large storm events, on the low energy environment of the estuary (see Coastal Processes and Natural Hazards Assessment at Appendix I of the AEE) and on the fact that the cobble beach will be almost entirely above MHWS under current sea level, we consider that this would have a **Low** magnitude of effect, resulting in a minor shift away from existing baseline conditions. A low

magnitude of effect on the high ecological values of the saltmarsh habitat equates to a **Low** level of effect.

This level of effect will not affect the ecological values that contribute to the ecological significance of the Estuary. However, it is important to note that adverse effects of activities on areas of predominantly indigenous vegetation in the coastal environment must be avoided, remedied or mitigated (Policy 11(b)(i) of the NZCPS). Impact management measures to remedy post-construction effects on the saltmarsh habitat below MHWS at Penguin Street (Southshore) are outlined in Section 8.1.2.2.

7.3.2.3 Increased access to the estuary bed

The new erosion protection structures will include ramp and stairs facilities to facilitate access to the estuary. These facilities, along with the landscaping plans for the land behind the estuary edge²⁶, may result in a higher number of people accessing the estuary bed across the project site. As a result, there could be increased trampling and harvesting of estuarine organisms and littering.

Overall, we consider that the increase in the number of visitors and users of the project site and surrounding areas will not be of a magnitude likely to affect estuarine habitats and organisms. As a result, the effects associated with increased access to the estuary bed are assessed as having a **Low** magnitude of effect, resulting in a minor shift away from existing baseline conditions. A low magnitude of effect on the moderate-high ecological values of the different estuarine habitats equates that would be affected equates to a **Low** level of effect.

This level of effect will not affect the ecological values that contribute to the ecological significance of the Estuary.

With the impact management measures described in Section 8.0, the magnitude of effect is considered to be **Negligible**, which equates to a **Very Low** level of effect (see Table 27).

7.3.2.4 Coastal squeeze

As discussed in Section 7.2.2.1, plant dominated habitats (e.g., seagrass, saltmarsh and algal beds) are expected to move landwards in response to sea level rise and to reduce in spatial extent where their ability to migrate is constrained by artificial barriers (i.e., coastal squeeze). Coastal squeeze can also occur in the event of a natural expansion in the distribution of a species / habitat (i.e., not driven by rising sea levels).

While the vast majority of the estuary edge along the project site is currently occupied by a variety of erosion protection structures, there are areas where a “soft” edge (i.e., not armoured with engineered structures) is present. In these areas, the establishment of erosion protection structures may reduce the capacity of estuarine habitats and organisms to migrate landwards relative to present conditions, thereby introducing additional coastal squeeze.

Based on field observations and on the information provided by Jacobs (2019) the largest areas of unarmoured estuary edge present within the project site are:

- approx. 170 m of soft estuary edge bordering mudflat habitat at SNBP (in the area where new areas of seabed have developed behind damaged reno mattresses; see Section 3.2.1 and Figure 9).

²⁶ <https://newsline.ccc.govt.nz/news/story/landscaping-plans-revealed-for-christchurchs-estuary-edge>

- Approx. 90 m of soft estuary edge bordering saltmarsh habitat below MHWS at Penguin Street (Southshore; see Section 3.2.2 and Figure 7).

In both areas, the project design involves the establishment of cobble beach structures.

At SNBP, the main impact of the establishment of the cobble beach will be represented by the reclamation of mudflat habitat (see Section 7.3.1.1). The additional coastal squeeze imposed by the cobble beach on the mudflat habitat will affect animal-dominated communities characterized by species capable of adapting to increases in water depths expected as a result of sea level rise. Furthermore, the additional habitat squeeze on the mudflat habitat introduced by the project will be minimal both at the scale of the project sites and in the context of the estuary, where 81.5% of the shoreline is armoured with erosion protection structures (Hunt, 2015).

Overall, the coastal squeeze of the mudflat habitat at SNBP is assessed as having a Negligible magnitude of effect, resulting in a very slight change from the existing baseline conditions. A negligible magnitude of effect on the moderate ecological value of the mudflat habitat equates to a Very Low level of effect. This level of effect will not affect the ecological values that contribute to the ecological significance of the Estuary.

At Southshore, the establishment of the cobble beach behind the Penguin Street saltmarsh will introduce additional habitat squeeze along the approx. 90 m of shoreline where there currently is a soft edge. However, along the rest of the shoreline flanking the saltmarsh (approx. 180 m) the presence of the cobble beach will represent an improvement compared to the structures that are currently present (i.e., a mix of rubbles, walls and revetments; Jacobs 2019) because the cobble beach will create a gentler landform gradient compared to the existing structures.

The proposed cobble beach will be located almost entirely above MHWS under current sea level and therefore responses to sea level rise are unlikely to occur within the design life of the structure (20 years). Over a longer timeframe, it is possible that sediment could deposit in between the cobbles as sea level rises and the cobble beach is increasingly submerged (Derek Todd, Jacobs – personal communication). The accumulation of sediment in between the cobbles may create conditions suitable for the establishment of saltmarsh (saltmarsh has recently been successfully restored in areas of cobble and gravel in the Waikawa Estuary; Stevens, 2021). However, it is difficult to predict if and when saltmarsh may be able to naturally colonize the cobble beach at the project site and there is also uncertainty around the fate of the structure beyond the timeframe of the project (20 years).

Overall, based on the current conditions, with stretches of both armoured and unarmoured estuary edge, the establishment of the cobble beach behind the Penguin Street saltmarsh is likely to have both positive and negative effects in terms of coastal squeeze. On balance, any additional squeeze on the saltmarsh habitat introduced by the project is likely to be small, both at the scale of the project site and at the scale of the estuary, where 81.5% of the shoreline is armoured with erosion protection structures, including many of the areas colonized by saltmarsh vegetation (Hunt, 2015).

However, given the many areas of uncertainties involved in this assessment, we are not able to establish the magnitude/level of effect of the coastal squeeze on the saltmarsh habitat introduced by the project. Impact management measures to monitor and address this effect are outlined in Section 8.1.2.2.

7.3.3 Cumulative effects

We have considered that this project will add to a long history of developments and habitat modification along the shorelines of the Estuary. However, the project will affect a stretch of estuary edge already modified, it will increase the extent of mudflat habitat across the project site and will not affect key elements and features of the existing baseline conditions which contribute to the ecological value of the estuary.

Overall, considering the creation of new mudflat habitat and the low level of effect on estuarine habitats and organisms of all other construction and post-construction effects, the cumulative effects of the project in the context of the Avon-Heathcote Estuary / Ihutai are assessed as having **Positive** magnitude. A positive magnitude of effect on the low-high ecological values of the different estuarine habitats that would be affected equates to **Net Gain** level of effect.

7.4 Herpetofauna

The following is a summary of the lizard survey conducted by Dr Tocher. Refer to the full report in Appendix 1.

Southern grass skink populations were found at South New Brighton and Southshore, primarily in rank exotic grassland and marram / lyme grasslands. Over the southernmost part of the survey area, south of Heron Street, skinks were only detected in two places. Here they occurred in low-moderate numbers over two isolated areas of rank grass near the estuary edge. As Caspian Street and south to Godwit Street, southern grass skinks were present in low-moderate numbers in rank grassland, including in an area with saltmarsh ribbonwood, marram and lyme grass at the estuary edge, and at one location in an abandoned garden (26 Ebbside Street). Skinks could occur at other locations along the estuary edge, where these habitat types exist, despite not being detected during this survey.

Construction of the erosion protection structures and inundation bund will result in the permanent loss of habitat for southern grass skink. This includes some of the vegetation types described in Section 7.2.1.

The potential effects on the skink populations present could include loss of habitat, mortality or injury of animals, or displacement into unsuitable habitat.

The habitats present within the project site and project footprint are expected to support low to moderate numbers of lizards. The southern grass skink is an At Risk – Declining species, so is considered of High ecological value and is protected under the Wildlife Act 1953. Mitigation will be required, including development of a Lizard Management Plan, which will outline any lizard management requirements.

7.5 Avifauna

7.5.1 Direct habitat loss

For terrestrial and estuarine vegetation habitat (above MHWS), the project will result in the clearance of approximately 8.3 ha of vegetation, comprising approximately:

- 7.3 ha of exotic grassland / herffield;
- 1.7 ha of exotic forest / treeland;

- 0.45 ha of exotic herb cobblefield;
- 0.34 ha of saltmarsh ribbonwood / marram grass grassland;
- 0.001 ha of saltmarsh; and
- 0.17 ha of saltmeadow (see Table 16).

We note that the areas of estuarine vegetation located under the project footprint do not provide habitat for cryptic marshbird species (e.g., marsh crake and Australasian bittern).

The species that were recorded within the project footprint during the terrestrial surveys (5MBC), or likely to be present, are listed in Table 19. Note that while there is accurate location data for the birds recorded during the coastal surveys (refer to Figure 33 to Figure 40), this not the case with respect to the 5MBC data. As such, we have assumed that all birds recorded during the 5MBC surveys could be within the project footprint. With the exception of red-billed gull (At Risk – Declining) and little shag (threat classification At Risk – Relict), all other species recorded during the 5MBC are classified native Not Threatened or Introduced species (Table 19). Three of the five red-billed gull birds were recorded traversing, indicating that they were not utilising the habitat within the project footprint. Furthermore, the roost trees that the little shag were recorded in during the April 2022 survey are no longer present, as is the case for white-faced heron.

While Crossland (2022) reported pied shag breeding on the eastern shoreline, no breeding shag species (or white-faced heron) were observed within the SNBP footprint during the November 2023 survey. Similarly, there are reports of kereru nesting within the trees of SNBP (refer to Section 3.4.1 above), potentially within the project footprint adjacent to Jellicoe Marsh, however none were observed during the November 2023 survey.

Table 19. Avifauna species recorded, or likely to occur, within the project footprint.

SPECIES	CLASSIFICATION	MAX. COUNTS	ESTIMATED ESTUARY POPULATION ⁶
NZ pipit	At Risk - Declining	-	10-50
Red-billed gull	At Risk – Declining	3	>2000
Pied shag	At Risk - Recovering		>200
Little shag	At Risk – Relict		>50
Bellbird	Not Threatened	2	10-50
Fantail	Not Threatened	3	10-50
Grey warbler	Not Threatened	1	>50
Kereru	Not Threatened	3	<10
Kingfisher	Not Threatened	5	>50
Silvereye	Not Threatened	7	>500
Welcome swallow	Not Threatened	4	>500
White-faced heron	Not Threatened	1	>50
Blackbird	Introduced & Naturalised	4	
Chaffinch	Introduced & Naturalised	1	
Dunnock	Introduced & Naturalised	1	

SPECIES	CLASSIFICATION	MAX. COUNTS	ESTIMATED ESTUARY POPULATION ⁶
Goldfinch	Introduced & Naturalised	10	
Greenfinch	Introduced & Naturalised	2	
House sparrow	Introduced & Naturalised	11	
Magpie	Introduced & Naturalised	1	>50
Starling	Introduced & Naturalised	48	

The exotic grasslands within the project footprint offers limited habitat for common, widespread terrestrial native and introduced bird species typically found in urban / residential and open habitats. While reported to occur along the eastern shoreline, Crossland (2022) did not report NZ pipit breeding there, and no such observations were made during the November 2023 survey. Kingfisher nest hole crevices were observed in several Phoenix palms with the earthwork zones in Southshore, and as such efforts should be made to avoid their removal.

As such, we consider the magnitude of effect associated with the loss exotic grasslands will be **Negligible** (refer Table 21). However, the direct removal of the exotic treeland habitat at SNBP will result in the potential loss of breeding habitat for a number of native species including bellbird, fantail, grey warbler, kereru and silvereye. As such, we consider the magnitude of effect associated with the loss exotic treeland will be **Negligible to High** (based on the proportion of the population recorded or likely to occur within the project footprint, and the presence of similar unimpacted habitat nearby) (refer Table 21).

In terms of estuary habitat (below MHWS), the project will result in:

- An area of 1,826 m² of mudflat will be lost;
- An area of 2,706 m² of mudflat will be created;
- An overall net gain of 879 m² of mudflat area.

The species that were recorded within the project footprint below MHWS during the coastal bird surveys are listed in Table 20.

Table 20. Avifauna species recorded during the coastal bird counts within the project footprint.

SPECIES	CLASSIFICATION	WITHIN FOOTPRINT	TOTAL SURVEY COUNTS	MAXIMUM COUNT
Little shag	At Risk - Relict	1	109	6
Kingfisher	Not Threatened	10	54	4
Paradise shelduck	Not Threatened	2	46	3
Spur-wing plover	Not Threatened	1	13	7
White-faced heron	Not Threatened	5	126	12

Very few birds were recorded foraging within the project footprint, however the existing coastal structures (e.g., jetties and stormwater outlet structures) within the project footprint provide the

potential for little shag, as well as other shag species, terns, gulls and kingfisher, to roost / perch. Our assessment assumes that the majority of these existing structures will be retained.

Given no other coastal species were recorded within the project footprint during the 2022 surveys, and the fact that there will be an increase of 879 m² of mudflat area following the construction of the project, we consider there will be a **Net Gain** (Table 21). As noted above in the assessment of effects on estuarine species and habitats (Section 7.3.1.1), the new mudflat habitat created through declamation is expected to be analogous to the existing mudflat and to be colonised by the same suite of benthic organisms.

Table 21. Ecological value, magnitude of effect and overall level of effect of direct habitat loss on avifauna species found, or expected to occur, within and adjacent to the project footprint.

SPECIES	ECOLOGICAL VALUE ²⁷	MAGNITUDE OF EFFECT	OVERALL EFFECT
Australasian bittern	Very High	Positive	Net gain
Black-fronted tern	Very High	Positive	Net gain
Grey duck	Very High	Positive	Net gain
Caspian tern	Very High	Positive	Net gain
Spotted shag	Very High	Positive	Net gain
Wrybill	Very High	Positive	Net gain
Banded dotterel	High	Positive	Net gain
NZ pipit	High	Negligible	Very Low
SIPO	High	Positive	Net gain
Bar-tailed godwit	High	Positive	Net gain
Lesser knot	High	Positive	Net gain
Marsh crake	High	Positive	Net gain
Black-billed gull	High	Positive	Net gain
Red-billed gull	High	Negligible	Very Low
White-fronted tern	High	Positive	Net gain
Variable oystercatcher	Moderate	Positive	Net gain
Pied shag	Moderate	Positive	Net gain
Black shag	Moderate	Positive	Net gain
Little shag	Moderate	Positive	Net gain
Little black shag	Moderate	Positive	Net gain
Royal spoonbill	Moderate	Positive	Net gain
Bellbird	Low	Moderate	Low
Black swan	Low	Positive	Net gain
Black-backed gull	Low	Positive	Net gain
Fantail	Low	Moderate	Low
Grey teal	Low	Positive	Net gain
Grey warbler	Low	Low	Very Low

²⁷ Based on the criteria provided in Table 6

SPECIES	ECOLOGICAL VALUE ²⁷	MAGNITUDE OF EFFECT	OVERALL EFFECT
Harrier	Low	Negligible	Very Low
Kereru	Low	High	Low
Kingfisher	Low	Moderate	Low
NZ scaup	Low	Positive	Net gain
NZ shoveler	Low	Positive	Net gain
Paradise shelduck	Low	Positive	Net gain
Pied stilt	Low	Positive	Net gain
Pukeko	Low	Positive	Net gain
Silvereye	Low	Low	Very Low
Spur-wing plover	Low	Positive	Net gain
Welcome swallow	Low	Negligible	Very Low
White-faced heron	Low	Positive	Net gain
Blackbird	Negligible	Negligible	Very Low
Chaffinch	Negligible	Negligible	Very Low
Dunnock	Negligible	Negligible	Very Low
Feral goose	Negligible	Negligible	Very Low
Goldfinch	Negligible	Negligible	Very Low
Greenfinch	Negligible	Negligible	Very Low
House sparrow	Negligible	Negligible	Very Low
Magpie	Negligible	Negligible	Very Low
Mallard	Negligible	Positive	Net gain
Starling	Negligible	Negligible	Very Low

7.5.2 Disturbance and displacement

Disturbance activities can occur during both the construction and operational phases of the project. The disturbance of birds is taken to mean an activity that results in changes to bird behaviour (Weston et al., 2012). Disturbance includes short term displacement (flight or running away from a perceived threat) and reduced time feeding (due to vigilant behaviour to monitor perceived threats, or time spent escaping perceived threats as above). Disturbance in this context can, in worst-case scenarios, lead to reduced fitness, reduced feeding rates, reduced breeding success, and potentially long-term displacement from an area; and can result in an effective loss of habitat (Hockin et al., 1992). These adverse effects are of concern for many bird species present in the Estuary, an area that has suffered from a range of anthropogenic modifications and an increased range and level of human use in recent decades (Kaldor, 2019).

Numerous studies have reported various distances at which various bird species are disturbed by human activities (including walking, running and dogs) (e.g., Glover et al. 2011, Weston et al. 2012). The distance at which a bird flees from perceived danger is referred to as the flight initiation distance (FID). FIDs differ between species and are also significantly influenced by a number of factors including the starting distance of the human approach, flock size, previous exposure to humans and stimulus type (walker, jogger, walker with dog) (Glover et al., 2011).

Weston et al.'s (2012) review of FIDs included 14 species expected to use the habitats in the vicinity of the project (Table 22). For some species a range of FIDs have been recorded by different studies (i.e., black swan and spur-winged plover). The greatest FIDs recorded were for spur-winged plover and the lowest were for Australasian bittern. While there is considerable variability between species, the mean FID for those species for which it is known, and who have a Threatened or At Risk classification, ranges from approximately 10-45 m (Table 22). In order to take a conservative approach to assessing the potential effect of construction and operational disturbance, we have used a distance of 45 m as the FID for all species.

Table 22. Mean flight initiation distances (FID; as reported in Weston et al. (2012)) for those indigenous coastal / estuarine bird species expected to use the habitats in the vicinity of the proposed SNBP and Southshore flood protection works for, which FIDs are available in Weston et al (2012).

SPECIES	NZ THREAT CLASSIFICATION	MEAN FID (m) ²⁸
Australasian bittern	Threatened – Nationally Critical	10.0
Caspian tern	Threatened - Nationally Vulnerable	35.0
Red-billed gull	At Risk - Declining	16.8
Pied shag	At Risk - Recovering	31.3
Black shag	At Risk - Relict	32.3
Little shag	At Risk - Relict	19.8
Royal spoonbill	At Risk – Naturally Uncommon	44.4
Black-backed gull	Not Threatened	24.4
Black swan	Not Threatened	3.6 – 50.4
Grey teal	Not Threatened	41.6
Pied stilt	Not Threatened	38.3
Spur-winged plover	Not Threatened	46.8 – 62.6
Welcome swallow	Not Threatened	11.0
White-faced heron	Not Threatened	31.2

Given all birds recorded by the 5MBCs were considered to be impacted directly by habitat loss (refer to Section 7.5.1), we have not assessed the potential impact of disturbance on these species. Rather, we have considered the species that were recorded within or are likely to occur immediately adjacent to the project footprint. A total of 14 species (refer to Table 23) were recorded within 45 m of the project footprint; it is these species that we consider will be subject to the potential effect of construction and operational disturbance. In terms of those species, the highest number of records were obtained for SIPO (n=167), but this represented only 0.8% of all SIPO recorded. Whereas 45.9% of pied stilt records were within 45 m of the project footprint.

²⁸ Excludes FIDs where data were not collected using the direct continuous method or the stimulus was a boat, canoe or dog.

Table 23. Species and number of birds recorded within 45 m of the project footprint during the 2022 coastal / estuarine surveys. Species for which more than 10% of their records were within 45 m of the project footprint are in bold.

SPECIES	NZ THREAT CLASSIFICATION	WITHIN 45 m OF PROJECT FOOTPRINT	SURVEY TOTAL	% OF BIRDS RECORDED
Caspian tern	Threatened - Nationally Vulnerable	1	80	1.3%
Bar-tailed godwit	At Risk - Declining	39	4,073	1.0%
SIPO	At Risk - Declining	171	22,071	0.8%
Red-billed gull	At Risk - Declining	627	13,247	4.7%
Pied shag	At Risk - Recovering	1	332	0.3%
Variable oystercatcher	At Risk - Recovering	9	1,697	0.5%
Little shag	At Risk - Relict	10	109	9.2%
Black-backed gull	Not Threatened	3	2,918	0.1%
Black swan	Not Threatened	22	5,718	0.4%
Grey teal	Not Threatened	31	959	3.2%
Kingfisher	Not Threatened	46	54	85.2%
Paradise shelduck	Not Threatened	4	46	8.7%
Pied stilt	Not Threatened	343	748	45.9%
Spur-winged plover	Not Threatened	15	89	16.9%
White-faced heron	Not Threatened	32	126	25.4%

Disturbance to birds as a result of construction activities is a potential adverse effect that may lead to effective loss of habitat due to noise, vibration and machinery movement altering bird behaviour. Construction duration is likely to be between 12 and 15 months for Southshore and around 5 months for SNBP. Timing of coastal works being restricted by tide; construction works will occur 2-hours either side of high tide, meaning an average available working time of 8-hours in a 12-hour tide cycle. There will be a progressive advancement of work area, with the placement of erosion protection progressively following excavation works to avoid prolonged exposure without erosion protection.

During low tide, when intertidal areas are exposed, bird species occupying the Estuary will have extensive areas of habitat undisturbed by construction activities available for feeding and roosting. Because of the mobility of these bird species, and the considerable extent of other such habitat available in the estuary during construction works, effects are likely to be of a **Negligible** and temporary magnitude of effect. However, for those species for which a greater proportion of birds were recorded within 45 m of the project, we consider the magnitude of effects associated with construction disturbance will be **Moderate** (10-20%) or **High** (20-50%), but still of a temporary nature. Bird species expected to use the habitats in the vicinity of the project likely to be exposed to construction disturbance have ecological values ranging from **Low** to **Very High**, and the resulting overall level of effect is **Very Low** to **Low** (Table 24).

Construction works at the southern end of SNBP are occurring immediately adjacent to the saltmarsh rushland (Jellicoe Marsh) that may provide habitat for breeding Australasian bittern, marsh crake and grey duck. As noted in the cryptic marshbirds limitation section above (Section 2.7.1.2), surveys were not conducted for these species at that location. As such, we have taken a conservative approach and assumed that a pair of each species are breeding there, and that works will occur during their breeding season. On that basis, we consider that the magnitude of

effects associated with construction disturbance will be **Moderate** to **Low** based on the proportion of the estimated estuary population that each pair represents, but will be temporary for the duration of the construction works in that area.

As noted in the coastal avifauna limitation section (Section 2.7.1.4) above, the surveys undertaken to inform this assessment were only carried out in a single season. As such, there may be other species (not listed in Table 24) that may occur within 45 m of the project footprint that we have not captured. As such, we have assumed that the effects of construction disturbance on any such species would be **Negligible** (noting that we have already accounted for all potential breeding species).

In terms of the operational phase, given the project site is already a popular walking area (including dog walkers), we do not consider there will be any additional or new disturbance effects than the birds are currently exposed to in the existing environment.

Table 24. Ecological value, magnitude and overall level of effect (without impact management measures) of disturbance and displacement on bird species recorded or likely to occur within 45 m of the project footprint.

SPECIES	ECOLOGICAL VALUE ²⁹	MAGNITUDE OF EFFECT	OVERALL EFFECT ³⁰
Australasian bittern	Very High	Moderate	High
Black-fronted tern	Very High	Negligible	Low
Grey duck	Very High	Low	Moderate
Caspian tern	Very High	Negligible	Low
Spotted shag	Very High	Negligible	Low
Wrybill	Very High	Negligible	Low
Banded dotterel	High	Negligible	Very Low
NZ pipit	High	n/a	-
SIPO	High	Negligible	Very Low
Bar-tailed godwit	High	Negligible	Very Low
Lesser knot	High	Negligible	Very Low
Marsh crake	High	Low	Low
Black-billed gull	High	Negligible	Very Low
Red-billed gull	High	Negligible	Very Low
White-fronted tern	High	Negligible	Very Low
Variable oystercatcher	Moderate	Negligible	Very Low
Pied shag	Moderate	Negligible	Very Low
Black shag	Moderate	Negligible	Very Low
Little shag	Moderate	Negligible	Very Low
Little black shag	Moderate	Negligible	Very Low
Royal spoonbill	Moderate	Negligible	Very Low
Bellbird	Low	n/a	-
Black-backed gull	Low	Negligible	Very Low
Black swan	Low	Negligible	Very Low

²⁹ Based on the criteria provided in Table 6

³⁰ Without impact management measures

SPECIES	ECOLOGICAL VALUE ²⁹	MAGNITUDE OF EFFECT	OVERALL EFFECT ³⁰
Fantail	Low	n/a	-
Grey teal	Low	Negligible	Very Low
Grey warbler	Low	n/a	-
Harrier	Low	n/a	-
Kereru	Low	n/a	-
Kingfisher	Low	High	Low
NZ scaup	Low	Negligible	Very Low
NZ shoveler	Low	Negligible	Very Low
Paradise shelduck	Low	Negligible	Very Low
Pied stilt	Low	High	Low
Pukeko	Low	Negligible	Very Low
Silvereye	Low	n/a	-
Spur-wing plover	Low	Moderate	Low
Welcome swallow	Low	n/a	-
White-faced heron	Low	Moderate	Low
Blackbird	Negligible	n/a	-
Chaffinch	Negligible	n/a	-
Dunnock	Negligible	n/a	-
Feral goose	Negligible	n/a	-
Goldfinch	Negligible	n/a	-
Greenfinch	Negligible	n/a	-
House sparrow	Negligible	n/a	-
Magpie	Negligible	n/a	-
Mallard	Negligible	n/a	-
Starling	Negligible	n/a	-

7.5.3 Mortality or injury

The mobile nature of most avifauna species means that the potential for direct mortalities associated with construction activities are likely to be confined to birds that may be breeding. As noted previously, while the exotic grassland habitat is unlikely to provide breeding habitat, the Phoenix palms along the coastal edge of Southshore provide breeding habitat for kingfisher. In addition, the exotic trees in SNBP provide potential breeding habitat for a number of native forest birds such as grey warbler, bellbird, fantail, kereru and silvereye. As such, we have assumed that all the birds recorded during the 5MBC which breed in exotic trees could be impacted if this habitat is removed during the breeding season. The magnitude of effect on these species has been determined based on the proportion of the estimated estuary population that were recorded during the 5MBCs, ranging from **High** to **Negligible** (Table 25).

Given there will be no works in the saltmarsh rushland (Jellicoe Marsh) to the immediate south of the SNBP footprint, we have assumed that there will be no risk or mortality and / or injury to Australasian bittern, marsh crake and grey duck if they are breeding there.

In terms of the potential for mortalities or injuries during the operational phase of the project, we consider that there will be no change from that in the existing environment.

Table 25. Ecological value, magnitude and overall level of effect (Without impact management measures) of potential mortalities and / or injuries associated with the construction and operation of the project.

SPECIES	ECOLOGICAL VALUE ³¹	MAGNITUDE OF EFFECT	OVERALL EFFECT ³²
Australasian bittern	Very High	n/a	-
Black-fronted tern	Very High	n/a	-
Grey duck	Very High	n/a	-
Caspian tern	Very High	n/a	-
Spotted shag	Very High	n/a	-
Wrybill	Very High	n/a	-
Banded dotterel	High	n/a	-
NZ pipit	High	n/a	-
SIPO	High	n/a	-
Bar-tailed godwit	High	n/a	-
Lesser knot	High	n/a	-
Marsh crake	High	n/a	-
Black-billed gull	High	n/a	-
Red-billed gull	High	n/a	-
White-fronted tern	High	n/a	-
Variable oystercatcher	Moderate	n/a	-
Pied shag	Moderate	n/a	-
Black shag	Moderate	n/a	-
Little shag	Moderate	n/a	-
Little black shag	Moderate	n/a	-
Royal spoonbill	Moderate	n/a	-
Bellbird	Low	Moderate	Low
Black-backed gull	Low	n/a	-
Black swan	Low	n/a	-
Fantail	Low	Moderate	Low
Grey teal	Low	n/a	-
Grey warbler	Low	Low	Very Low
Harrier	Low	n/a	-
Kereru	Low	High	Low
Kingfisher	Low	Low	Very Low
NZ scaup	Low	n/a	-

³¹ Based on the criteria provided in Table 6

³² Without impact management measures

SPECIES	ECOLOGICAL VALUE ³¹	MAGNITUDE OF EFFECT	OVERALL EFFECT ³²
NZ shoveler	Low	n/a	-
Paradise shelduck	Low	n/a	-
Pied stilt	Low	n/a	-
Pukeko	Low	n/a	-
Silvereye	Low	Low	Very Low
Spur-wing plover	Low	n/a	-
Welcome swallow	Low	n/a	-
White-faced heron	Low	Moderate	Low
Blackbird	Negligible	Negligible	Very Low
Chaffinch	Negligible	Negligible	Very Low
Dunnoek	Negligible	Negligible	Very Low
Feral goose	Negligible	n/a	-
Goldfinch	Negligible	Negligible	Very Low
Greenfinch	Negligible	Negligible	Very Low
House sparrow	Negligible	Negligible	Very Low
Magpie	Negligible	Negligible	Very Low
Mallard	Negligible	n/a	-
Starling	Negligible	Negligible	Very Low

7.5.4 Food supply and foraging

Impacts on food supply or the ability of birds that forage visually to detect and capture prey items can have flow-on effects to avifauna through reduced foraging success.

If, during construction, runoff from the site is untreated or not adequately managed prior to discharge to the receiving environment, or if construction material deposited in the estuarine environment is not free of fine sediment, there is the potential for adverse effects on water quality and estuarine organisms through increased suspended and deposited sediment. Impacts on benthic and fish communities can affect food supply for coastal and estuarine birds. In addition, increased water turbidity associated with construction activities can impact on the foraging ability of visual foragers to locate prey items.

The assessment of effects on estuarine species and habitats determined there will be:

- A **Very Low** level of effect associated with resuspension of benthic sediment and contaminants (refer to Section 7.3.1.7); and
- A **Very Low** level of effect associated with runoff of terrestrial sediment and contaminants (refer to Section 7.3.1.8).

Thus, based on the **Very Low** level of effect of construction activities on estuarine species and habitats, and the ability for avifauna species to forage over the wider area, we have determined the magnitude of potential effects on food supply and foraging ability on local populations of coastal and estuarine avifauna species to be **Negligible** (Table 26).

Based on this level of effect, and assuming that best practice construction methods are employed, specific impact management measures are not required to manage potential effects on bird's food supply or foraging success.

Table 26. Ecological value, magnitude of effect and overall level of effect of changes to food supply and foraging on coastal and estuarine avifauna species found within and adjacent to the project footprint.

SPECIES	ECOLOGICAL VALUE ³³	MAGNITUDE OF EFFECT	OVERALL EFFECT
Australasian bittern	Very High	Negligible	Low
Black-fronted tern	Very High	Negligible	Low
Grey duck	Very High	Negligible	Low
Caspian tern	Very High	Negligible	Low
Spotted shag	Very High	Negligible	Low
Wrybill	Very High	Negligible	Low
Banded dotterel	High	Negligible	Very Low
NZ pipit	High	n/a	-
SIPO	High	Negligible	Very Low
Bar-tailed godwit	High	Negligible	Very Low
Lesser knot	High	Negligible	Very Low
Marsh crake	High	Negligible	Very Low
Black-billed gull	High	Negligible	Very Low
Red-billed gull	High	Negligible	Very Low
White-fronted tern	High	Negligible	Very Low
Variable oystercatcher	Moderate	Negligible	Very Low
Pied shag	Moderate	Negligible	Very Low
Black shag	Moderate	Negligible	Very Low
Little shag	Moderate	Negligible	Very Low
Little black shag	Moderate	Negligible	Very Low
Royal spoonbill	Moderate	Negligible	Very Low
Bellbird	Low	n/a	-
Black swan	Low	Negligible	Very Low
Black-backed gull	Low	Negligible	Very Low
Fantail	Low	n/a	-
Grey teal	Low	n/a	-
Grey warbler	Low	n/a	-
Harrier	Low	n/a	-
Kereru	Low	n/a	-
Kingfisher	Low	n/a	-
NZ scaup	Low	Negligible	Very Low

³³ Based on the criteria provided in Table 6

SPECIES	ECOLOGICAL VALUE ³³	MAGNITUDE OF EFFECT	OVERALL EFFECT
NZ shoveler	Low	Negligible	Very Low
Paradise shelduck	Low	Negligible	Very Low
Pied stilt	Low	Negligible	Very Low
Pukeko	Low	Negligible	Very Low
Silvereye	Low	n/a	-
Spur-wing plover	Low	Negligible	Very Low
Welcome swallow	Low	n/a	-
White-faced heron	Low	Negligible	Very Low
Blackbird	Negligible	n/a	-
Chaffinch	Negligible	n/a	-
Dunnock	Negligible	n/a	-
Feral goose	Negligible	n/a	-
Goldfinch	Negligible	n/a	-
Greenfinch	Negligible	n/a	-
House sparrow	Negligible	n/a	-
Magpie	Negligible	n/a	-
Mallard	Negligible	Negligible	Very Low
Starling	Negligible	n/a	-

7.5.5 Lighting

There will be no new lighting associated with the project, and as such there will be no such effect on avifauna.

7.5.6 Cumulative effects

We have determined the following with respect to potential cumulative effects associated with the construction and operation of this project:

- The project will result in the loss of large exotic trees adjacent to the estuary, which provide potential nesting habitat for several native Not Threatened forest bird species. However, as there are other trees within SNBP that likely also provide this habitat, there will be no cumulative effect due to direct habitat loss on these birds due to the loss of estuary edge trees.
- The project will result in the overall net gain of 879 m² of extra mudflat area. Therefore, there will be no cumulative effect due to direct habitat loss on foraging birds.
- The project site is currently used by pedestrians and dog walkers. Therefore, there will be no cumulative effect due to operational disturbance on avifauna, including those foraging in the Estuary.

There is no lighting associated with the project. Therefore, there will be no cumulative effect due to increased artificial lighting on avifauna.

7.6 Summary of assessment

A summary of the levels of ecological effects (without mitigation, but with 'project impact management measures') identified in Section 7.0 is provided in Table 27.

Table 27 also includes a summary of the magnitude of effect and level of effect on ecological values when the impact management measures in Section 8.0 are considered.

Table 27. Assessment of magnitude and level of effect inclusive of impact management measures included as part of the project description (Section 7.1) and before and after taking into account the impact management measures recommended in Section 8.0 this report.

Ecosystem Component	Ecological Value	Magnitude of Effect <u>Without</u> Impact Management	Level of Effect <u>Without</u> Impact Management	Magnitude of Effect With Impact Management (see Section 8.0)	Level of Effect With Impact Management (see Section 8.0)
Terrestrial Vegetation and Habitats					
Vegetation clearance - saltmeadow	Moderate	Moderate	Moderate	Positive	Net Gain
Vegetation clearance - saltmarsh	High	Negligible	Very Low	None	None
Vegetation clearance & implementation of planting plan – SNBP forest / treeland area and RRZ	Negligible-Moderate	Positive	Net Gain	Positive	Net Gain
Vegetation clearance – all other areas	Low-High	Negligible	Very Low	Negligible	Very Low
Indirect effects of vegetation clearance – saltmarsh	High	Negligible	Very Low	None or Positive	None or Net Gain
Indirect effects of vegetation clearance – all other areas	Negligible-High	None	None	None	None
Estuarine Species and Habitats					
<i>Mudflat habitat</i>					
Loss and creation of mudflat habitat	Moderate	Positive	Net Gain		

Ecosystem Component	Ecological Value	Magnitude of Effect <u>Without</u> Impact Management	Level of Effect <u>Without</u> Impact Management	Magnitude of Effect With Impact Management (see Section 8.0)	Level of Effect With Impact Management (see Section 8.0)
Permanent mudflat habitat modification (shading)	Moderate	Low	Low		
Mudflat habitat disturbance	Moderate	Negligible	Very Low		
Mortality of estuarine organisms	Moderate	Negligible	Very Low		
Resuspension of benthic sediment and contaminants	Moderate	Negligible	Very Low		
Runoff of terrestrial sediment and contaminants	Moderate	Negligible	Very Low		
Noise and vibration	Moderate	Negligible	Very Low		
Estuary bed lowering	Moderate	Negligible	Very Low	Negligible	Very Low
Movement of cobble beach material	Moderate	Negligible	Very Low		
Increased access to the estuary bed	Moderate	Low	Low	Negligible	Very Low
Coastal squeeze	Moderate	Negligible	Very Low		
Cumulative effects	Moderate	Positive	Net Gain		
<i>Seagrass and saltmarsh habitat</i>					
Seagrass habitat disturbance	High	Negligible	Very Low	Negligible	Very Low
Mortality of estuarine organisms (including seagrass)	High	Negligible	Very Low	Negligible	Very Low
Resuspension of benthic sediment and contaminants	High	Negligible	Very Low		
Runoff of terrestrial sediment and contaminants	High	Negligible	Very Low		
Noise and vibration	High	Negligible	Very Low		
Estuary bed lowering	High	Negligible	Very Low		

Ecosystem Component	Ecological Value	Magnitude of Effect <u>Without</u> Impact Management	Level of Effect <u>Without</u> Impact Management	Magnitude of Effect With Impact Management (see Section 8.0)	Level of Effect With Impact Management (see Section 8.0)
Movement of cobble beach material (saltmarsh only)	High	Low	Low	Negligible	Very Low
Increased access to the estuary bed	High	Low	Low	Negligible	Very Low
Coastal squeeze (saltmarsh only)	High	No score assigned	No score assigned		
Cumulative effects	High	Positive	Net Gain		
Hard-bottom habitat					
Loss and creation of hard-bottom habitat	Low	Negligible	Very Low		
Permanent hard-bottom habitat modification (shading)	Low	Low	Very Low		
Mortality of estuarine organisms	Low	Negligible	Very Low		
Increased access to the estuary bed	Low	Low	Very Low	Negligible	Very Low
Herpetofauna					
Loss of habitat, mortality/ injury of southern grass skink, displacement into unsuitable habitat	High h	The southern grass skink is an At Risk – Declining species, so considered of High ecological value and is protected under the Wildlife Act 1953. Mitigation will be required, including development of a Lizard Management Plan, which will outline any lizard management requirements.			
Avifauna					
Direct habitat loss	Negligible to Very High	Positive to High	Net Gain to Low		
Disturbance and displacement	Negligible to Very High	Negligible to Moderate	Very Low to High ³⁴	Negligible	Very Low to Low
Mortality or injury	Negligible to Very High	Negligible to High	Very Low to Low	Negligible	Very Low to Low

³⁴ High and Moderate levels of effect for Australasian bittern and grey duck, respectively.

Ecosystem Component	Ecological Value	Magnitude of Effect <u>Without</u> Impact Management	Level of Effect <u>Without</u> Impact Management	Magnitude of Effect With Impact Management (see Section 8.0)	Level of Effect With Impact Management (see Section 8.0)
Food supply and foraging	Negligible to Very High	Negligible	Very Low to Low		
Lighting	Negligible to Very High	None	None		
Cumulative effects	Negligible to Very High	None	None		

8.0 Impact management measures

The following impact management measures are required to avoid, remedy, mitigate, offset or compensate for any adverse effects of the project. These are in addition to, and should be read in conjunction with, the project impact management measures described in Section 7.1. It is assumed that the impact management measures in Sections 7.1 and 8.0 will inform conditions of consent.

Should either the Project, construction methodology or project impact management measures change from what is described in those sections, then the level of effect on terrestrial vegetation and habitats, estuarine habitats and species, avifauna and herpetofauna would need to be reassessed accordingly.

The following impact management measures are provided for in order of priority for ecological impact management, following the effects management hierarchy described in Maseyk et al. (2018) (Figure 48) and Roper-Lindsay et al. (2018), and in the National Policy Statement for Indigenous Biodiversity 2023 (NPSIB 2023) where:

- **Avoid:** means to modify a project proposal to prevent any environmental damage or loss of an ecological or environmental feature or function.
- **Remedy:** means to rehabilitate, restore or reinstate an ecological or environmental feature or function to reverse any environmental damage at the impact point.
- **Mitigate:** means to alleviate, minimise, abate, alleviate or moderate the severity of environmental damage.
- **Offset:** means a measurable conservation outcome resulting from actions designed to compensate for residual, adverse biodiversity effects arising from activities after appropriate avoidance, remediation, and mitigation measures have been applied. The goal of a biodiversity offset is to achieve no net loss, and preferably a net gain, of indigenous biodiversity values. Best practice for biodiversity offset methodology is described in Maseyk et al. (2018), Roper-Lindsay et al. (2018) and New Zealand Government (2014). Note that the NPS-IB 2023 states that biodiversity offsets are intended to achieve a net gain in type, amount, and condition of indigenous biodiversity compared to that lost. In summary, adverse effects must be offset by the restoration, enhancement, or averted loss of biodiversity values of 'ecological equivalence'³⁵. In this case, biodiversity offset means restoration and enhancement of similar vegetation types, of similar ecological functioning, as close to the site of impact as possible.
- **Compensate:** means a non-quantified biodiversity benefit offered to compensate for biodiversity losses. The compensation actions may benefit different biodiversity to that lost (out-of-kind compensation), including biodiversity of a lesser conservation concern than that lost. Compensation is not quantified or balanced with losses and may involve subjective decision-making subject to socio-political influences.

³⁵ See New Zealand Government (2014). *Guidance on good practice biodiversity offsetting in New Zealand*. New Zealand Government.

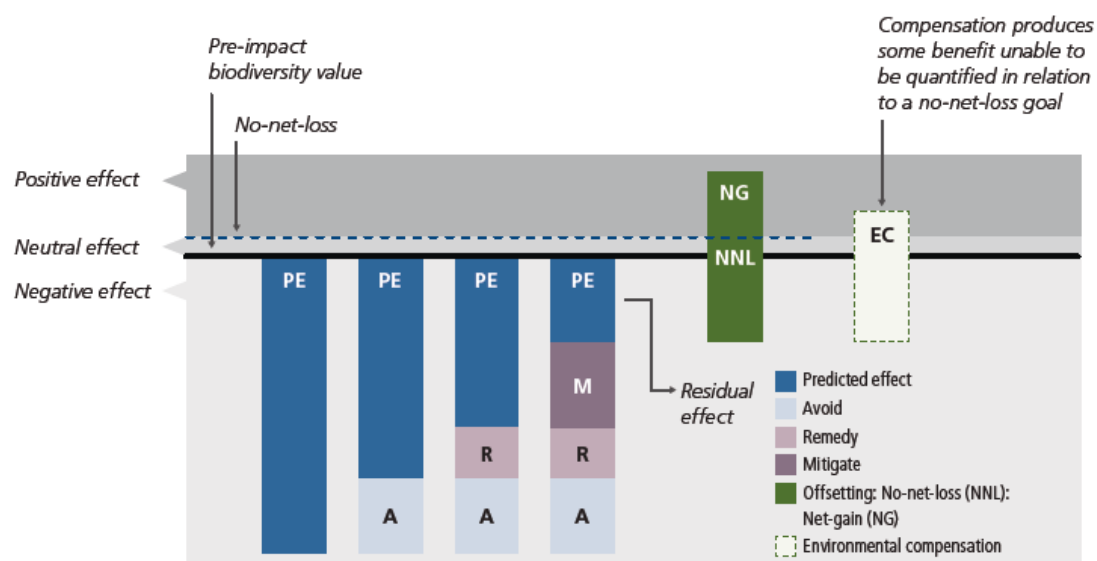


Figure 48. Conceptual illustration of the effects management hierarchy from Maseyk et al. (2018).

Further, Policy 11(a)(i) of the NZCPS requires the avoidance of adverse effects of activities on indigenous taxa that are listed as Threatened or At Risk in the New Zealand Threat Classification System lists³⁶. As identified above, Australasian bittern and grey duck (both Threatened), and marsh crane (At Risk) may be impacted by disturbance and displacement (Section 7.5.2). These adverse effects must be avoided.

8.1.1 Avoid

- Avoid impacts on the seagrass and saltmarsh habitat. In addition to the design changes outlined in Section 5.0, we recommend that:
 - o At Southshore, the eastern boundary (closest to the estuary edge) of the seagrass and saltmarsh habitat is re-mapped before construction begins to:
 - Confirm the extent of the overlap between seagrass and the project footprint at 44a Rocking Horse Road;
 - Confirm that there is no further overlap between seagrass or saltmarsh and the project footprint.
 - o The project design is revised if the updated mapping identifies new areas of seagrass / saltmarsh overlapping with the footprint of the new structures.
 - o Within 1 month of construction works commencing in the proximity of seagrass, a suitably qualified marine ecologist marks the boundary of the main seagrass meadow, as well as the location of small, isolated seagrass patches (with flags / stakes or similar) to ensure that the areas to be avoided are clearly visible.
 - o Seabed excavation is not carried out in the 0.2 m² patch of seagrass on the outer edge of the excavation zone by 44a Rocking Horse Road. From

³⁶ The threat classifications that are captured under the EIANZ Very High, High or Moderate ecological value criteria, are the same as those identified in the New Zealand Coastal Policy Statement (Department of Conservation, 2010) Policy 11a(i), that is, *Threatened* or *At Risk* species in the New Zealand Threat Classifications System lists.

preliminary conversations with the technical design team, we understand that this is feasible as there is some flexibility in the extent of the excavation required to accommodate the toe of the new revetment.

- Avoid impacts on southern grass skinks. We recommend that a suitably qualified herpetologist develops a Lizard Management Plan, to be submitted to DOC as part of the Wildlife Act Authority, outlining the methodology to be used for:
 - o Capturing and relocating skinks (generally only between the months of October and March/April) from the project site before the works begin.
 - o Facilitating their establishment at selected release site(s). This may include creating suitable rocky habitat and undertaking rodent control using new generation rodenticides.
- Avoid impacts of loss of nesting habitat for kingfisher by avoiding the removal of Phoenix palms within the Southshore footprint.
- Avoid impacts of construction disturbance on Australasian bittern, grey duck and marsh crake that may be breeding in the saltmarsh rushland to the immediate south of SNBP (i.e., Jellicoe Marsh) by undertaking works in that area:
 - o During the non-breeding season (March to August), or
 - o When it has been confirmed that no birds are breeding with the Jellicoe Marsh.
- If works are to occur within 45 m of the northern edge of Jellicoe Marsh within the breeding season (i.e., September to February), a suitably qualified ornithologist should carry out a breeding survey to determine the presence of breeding cryptic marsh birds. If cryptic marsh bird species are breeding in Jellicoe Marsh, no works are to occur within 45 m of the nests.
- Avoid potential mortalities or injuries to tree-nesting birds (e.g., shags, kereru, bellbird, grey warbler, fantail, white-faced heron) by only undertaking tree removal:
 - o During the non-breeding season (March to August), or
 - o When it has been confirmed that no birds are breeding with the area to be disturbed.

8.1.2 Remedy

8.1.2.1 Construction effects

- Remedy impacts on the seagrass and saltmarsh habitat. At Southshore, it may not always be possible to remove the existing structures from the estuary edge without impacting small patches of seagrass or sea rush plants (upper edge of saltmarsh) growing in close proximity to the construction footprint. Design constraints may also prevent the avoidance of small patches of seagrass that may have developed within the project footprint between the consenting and the construction phase (in addition to the plant already present within the revetment footprint at 44a Rocking Horse Road).
 - o For seagrass, we recommend that:
 - A suitably qualified marine ecologist develops a Seagrass Management Plan to remedy adverse effects on small patches of seagrass based on the available information of seagrass restoration in New Zealand and

consultation with local seagrass experts. The Seagrass Management Plan may involve excavating seagrass and reinstating it at the same location or transplanting to a suitable receiving site in adjacent areas of the estuary.

- The Seagrass Management Plan is applied only for remedying impacts on very small seagrass patches (indicatively less than 400 cm²) on an occasional basis, with avoidance always being the first principle.
- The Seagrass Management Plan is implemented by a suitably qualified marine ecologist who should be present on site when work is undertaken in areas where impacts on seagrass may occur.

With these measures in place, along with the avoidance measures outlined in Sections 5.0 and 8.1.1:

- The magnitude of effect of seagrass habitat disturbance (see Section 7.3.1.5) is assessed as Negligible, because remediation measures would involve some degree of small-scale disturbance, with very slight change from the existing baseline conditions. The resulting level of effect is Very Low (see Table 27).
- The magnitude of effect of the mortality of seagrass and of the associated estuarine organisms (see Section 7.3.1.6) is assessed as having a **Negligible** magnitude of effect, with no change or only a very slight change from the existing baseline conditions, and the resulting level of effect is **Very Low** (see Table 27).
 - For saltmarsh at Southshore, we recommend that losses are remedied by planting of greater numbers of sea rush plants into sparsely vegetated areas of (or at the upper edge of) existing saltmarsh, to achieve no net loss or preferably net gain in saltmarsh extent.
- Remedy impacts on the saltmarsh ribbonwood / marram grass grassland habitat at Southshore. Any losses of saltmarsh ribbonwood, knobby clubrush, or native celery due to construction of the flood protection bund in the significant saltmarsh ribbonwood / marram grass grassland area³⁷ should be remedied by transplantation of any native celery and knobby clubrush, and new plantings of saltmarsh ribbonwood, into grassland areas adjacent to the inundation bund, following construction.

With these measures in place, levels of effect for all terrestrial vegetation types would either be Very Low, neutral (no residual effect), or Net Gain.

8.1.2.2 Post-construction effects

- Remedy the impacts of inundation by cobble beach material on the mudflat habitat (both at SNBP and Southshore) and on the saltmarsh habitat below MHWS at Penguin Street (Southshore):
 - Monitor and map the position of the toe of the cobble beach structures yearly to assesses whether the structures are encroaching or moving closer to the mudflat and saltmarsh habitats.
 - Promptly inspect the cobble beach structures following large storm events.

³⁷ This area is part of significant site SES/LP/14.

- o Assess damage to the saltmarsh vegetation in case of cobble encroachment/inundation in the saltmarsh habitat.
- o If needed, based on the results of the yearly mapping and of any post-storm inspection:
 - Reinstall the original position of the toe of the cobble beach structures.
 - Remove any material washed onto the mudflat and saltmarsh habitats.
 - Re-establish sea rush plants in areas where cobbles have caused damage to the saltmarsh vegetation.

With these measures in place, the magnitude of effect of mudflat/saltmarsh inundation by cobble material (see Section 7.3.2.2) is assessed as having a **Negligible** magnitude of effect, with no or only a very slight change from the existing baseline conditions. The resulting level of effects is **Very Low** for both habitats (see Table 27).

- Remedy the impacts of coastal squeeze on the saltmarsh habitat below MHWS at Penguin Street (Southshore):
 - o Monitor and map the extent of the saltmarsh habitat yearly to assess whether the cobble beach is constraining the upward movement of the saltmarsh vegetation.
 - o If needed, based on the results of the yearly mapping, undertake actions to facilitate the establishment of sea rush plant onto the cobble beach (see Stevens, 2021 for a recent case study).

8.1.3 Mitigate

Minimise disturbance to estuarine habitats and organisms resulting from increased public access to the estuary bed through measures including:

- Signage about water quality (likely to discourage the harvesting of estuarine organisms) and about the ecological values of the estuarine habitats/organisms.
- Avoiding placement of access points (e.g., stairs or ramps) in proximity to the most sensitive habitats (i.e., seagrass and saltmarsh).

With these measures in place, the magnitude of effect of increased access to the estuary bed (see Section 7.3.2.3) is assessed as having a **Negligible** magnitude of effect, with no change or only a very slight change from the existing baseline conditions, and the resulting level of effects is **Very Low** (see Table 27).

8.1.4 Offsetting

- The loss of 0.2 ha of saltmeadow habitat cannot be avoided, remedied or mitigated, and hence this represents a net loss of significant habitat. Wider habitat benefits (ecological enhancements) associated with implementation of the planting plan are considered insufficiently relevant to the loss of saltmeadow to constitute a remedy, mitigation. On this basis, an offset is required.
- The proposed offset involves creation of at least 0.25 ha of saltmeadow habitat at nearby Southshore Spit Reserve.

- The offset is described in a Saltmeadow Offset Plan included as Appendix 8 of this report.
- The scale of the offset has been determined with reference to existing value of habitats lost, reference habitat traits, target restoration state, timeframes for implementation and likelihood of success. This method has employed guidance and offset accounting methodology (Maseyk et al., 2015; New Zealand Government, 2014).
- Implementation of the proposed offset would achieve a Positive magnitude of effect, equating to a **Net Gain** level of effect.

8.1.5 Environmental compensation

Environmental compensation is not required, if the above measures are implemented.

9.0 Conclusions

In relation to terrestrial vegetation and habitats this assessment has identified that:

- Impacts to Exotic Grassland / Herbfield, which (aside from the presence of southern grass skink) is not ecologically significant, are of a **Very Low** level of effect. On the other hand, a substantial planting plan in this area, when implemented, would constitute an overall Positive magnitude of effect and hence a **Net Gain**.
- Construction of the inundation bund at SNBP will involve clearance of a corridor of planted and / or exotic vegetation, somewhat fragmenting a currently continuous area of forest / treeland habitat. The corridor follows an existing track, minimising this impact. Infill and supplemental planting proposed via the project's landscape plan (over a larger area) remedies or mitigates vegetation losses to achieve an overall Positive magnitude of effect and hence a **Net Gain**.
- Impacts to sea rush plants (that cannot be avoided), although Negligible (**Very Low** level), at the edge of an ecologically significant area of saltmarsh vegetation must be remedied via replanting, because the statutory context dictates that the project achieves *no net loss and preferably a net gain* in saltmarsh vegetation extent.
- Any loss of indigenous herbs, rushes and shrubs within a significant coastal grassland area (Saltmarsh Ribbonwood / Marram Grass Grassland) at the south end of the project site, while of Negligible magnitude (**Very Low** level), must be remedied via replanting. This is to ensure *no net loss and preferably a net gain* in the significant indigenous vegetation component of this habitat.
- Low-Moderate magnitude impacts to significant saltmeadow vegetation (of Moderate ecological value) cannot be avoided despite design changes and all the factors that influence the design. **Low-Moderate** level effects, i.e., net loss of the values of this area cannot be remedied or mitigated and an offset of at least 0.25 ha of saltmeadow is required to achieve *no net loss or preferably a net gain*. The offset is proposed and detailed in a separate Saltmeadow Restoration Plan, and following implementation would achieve an overall **Net Gain**.

In relation to estuarine species and habitats, this assessment has identified that:

- Both at SNBP and Southshore, the hard-bottom habitat provided by the existing erosion protection structures along the estuary edge is artificial and the result of significant habitat modification. It is occupied by common estuarine species which are present in low abundance. This habitat is of low ecological value.
- Both at SNBP and Southshore, the soft-bottom habitat on the estuary bed is characterised by mostly medium and fine sand, low levels of contaminants and some habitat modification in proximity of the estuary edge due to the release of rock material from the armouring structures. Infaunal communities have moderate species richness, diversity and abundance, with both tolerant and sensitive taxa present. The surface of the seabed is colonised by epibenthic communities typical of estuarine habitats. While at SNBP the seabed is mostly unvegetated, at Southshore there are areas dominated by different types of intertidal vegetation, including macroalgae, seagrass and saltmarsh. There is no seagrass or saltmarsh at SNBP.
- The ecological value of the soft-bottom habitat is assessed as moderate for the areas of mudflat habitat (i.e., the soft-bottom habitat which is either unvegetated or presents limited cover of macroalgae, both at SNBP and Southshore) and as high for the areas of seagrass and saltmarsh (at Southshore).
- The project will involve both reclamation and declamation of soft-bottom mudflat habitat. Areas of mudflat reclamation and declamation will be scattered across the project site. Overall, through the removal of the existing erosion protection structures and a landward shift in the position of the new structures where this is achievable, there will be an 879 m² increase in the availability of mudflat habitat along the estuary edge across the project site. The level of effect associated with the increase in the extent of mudflat habitat is assessed as a **Net Gain**.
- The project will also result in a 705 m² increase in the availability of artificial hard bottom habitat across the project site. The level of effect associated with the increase in the extent of hard-bottom habitat is assessed as **Very Low**.
- Permanent habitat modification through shading of both mudflat and hard-bottom habitat by a new jetty at Southshore will be limited to a small area of the project site and is assessed as having a **Very Low-Low** level of effect.
- While there is only minimal overlap between the project footprint and the seagrass habitat at Southshore, it may not always be possible to remove the existing structures without impacting small patches of seagrass growing in close proximity. With the recommended avoidance and remediation measures in place, along with the impact management measures already included in the project design and construction methodology, small-scale seagrass habitat disturbance and seagrass mortality are assessed as having a **Very Low** level of effect.
- Disturbance of the mudflat habitat to accommodate the new structures throughout the project site is assessed as having a **Very Low** level of effect because, with the impact management measures included in the project design and construction methodology, the reinstated mudflat habitat is expected to be analogous to the existing one and to be colonised by the same suite of benthic organisms which is currently present.
- Common species of macroalgae and benthic invertebrates will suffer mortality during the removal of the existing erosion protection structures and as part of the reclamation and disturbance of the mudflat habitat throughout the project site. With the impact management measures included in the project design and construction methodology,

the mortality of estuarine organisms is assessed as having a **Very Low** level of effect as the new erosion protection structures and the reinstated mudflat habitat are expected to be colonised by the same suite of benthic organisms which is currently present. In addition, the net gain in the extent of mudflat habitat across the project site will provide additional benthic habitat to infauna and epibenthic organisms.

- Other construction effects including resuspension of benthic sediments and contaminants, runoffs of terrestrial sediment and contaminants, as well as noise and vibration are assessed as having a **Very Low** level of effect, provided that such effects are avoided/minimised with stringent adherence to the impact management measures included in the construction methodology.
- Following construction, erosion at the base of the new erosion protection structures could affect the ability of epibenthic and infaunal animals to occupy the area at the toe of the new structures. This is assessed as having a **Very Low** level of effect based on the findings of the Coastal Processes and Natural Hazards Assessment.
- Following construction, the mobilization of cobble beach material (particularly in the event of large storms) may impact the adjacent mudflat (both at SNBP and Southshore) and saltmarsh habitat (at Southshore). Based on the infrequent nature of large storm events and on the low energy environment of the estuary, this is assessed as having a **Very Low** level of effect on both habitat types with the mitigation measures recommended in this report in place.
- Increased public access to the estuary bed is a further post-construction effect which could result in increased trampling and harvesting of estuarine organisms and littering. This is also assessed as having a **Very Low** level of effect with the mitigation measures recommended in this report in place.
- Coastal squeeze in response to sea level rise is a longer-term post-construction effect. The project will introduce additional coastal squeeze in one area of mudflat habitat at SNBP and one area of saltmarsh habitat at Southshore. In the two areas, cobble beach structures will replace the “soft”, unarmoured edge that is currently present. Considering the spatial extent of the area affected, the composition of the estuarine communities that would be affected and the widespread hardening of the estuary edge, both at the scale of the project site and of the Estuary, coastal squeeze is assessed as having a **Very Low** level of effect on the mudflat habitat at SNBP. The impact of coastal squeeze introduced by the project is also likely to be small for the saltmarsh habitat at Southshore. However, given the many areas of uncertainties involved in this assessment, we were not able to establish the magnitude / level of effect of coastal squeeze on the saltmarsh habitat. The report provides impact management measures to monitor and address this effect on the saltmarsh habitat.
- Although the project will add to a long history of developments and habitat modification along the shorelines of the Avon-Heathcote Estuary / Ihutai, it will increase the extent of mudflat habitat along the estuary edge and will not affect key elements and features of the existing baseline conditions which contribute to the ecological value of the estuary. Therefore, the level of cumulative effects of the project on the ecological values of estuarine species and habitats is assessed as a **Net Gain**.

In relation to herpetofauna this assessment has identified that:

- Southern grass skink are present within the project site, including utilising habitats within the project footprint. This is an At Risk – Declining species, which is protected under the Wildlife Act 1953.

- A Lizard Management Plan (LMP) and Wildlife Act Authority will need to be prepared by a suitably qualified and experienced herpetologist and submitted to the Department of Conservation prior to any vegetation clearance and earthworks commencing for this project.
- The LMP will describe the management approach required to ensure any effects on the southern grass skink are appropriately avoided or mitigated, resulting in a no net loss and preferably a net gain for this species.

In relation to avifauna this assessment has identified that:

- The terrestrial species avifauna assemblage recorded within and adjacent to the project site is comprised of species assigned Low or Negligible ecological value (Table 13, page 71 **Error! Bookmark not defined.**) as per the criteria of the EIANZ guidelines (refer to Table 6 on page 22 **Error! Bookmark not defined.**).
- The intertidal mudflats of the Estuary are considered to be of Very High value based on the presence of a number of Threatened and At Risk species utilising that habitat. However, the avifauna species utilising the area are assigned Very High to Low ecological value (Table 13, page 71) as per the criteria of the EIANZ guidelines (refer to Table 6 on page 22).
- In terms of habitat loss, the direct loss of terrestrial habitat will result in an overall Very Low to Low effect on avifauna species (Table 21, page 113).
- The project will in result in the overall net gain of 879 m² of extra mudflat area, and therefore a Net Gain in habitat for coastal species (Table 21, page 113).
- The overall level of effects associated with disturbance during both the construction and operational phases is considered to be Very Low to High (Table 24, page 117). However, impact management measures have been identified (Section 8.1.1) to avoid the Moderate and High levels of effects.
- While birds are generally mobile, the potential for mortalities and injuries of breeding birds is possible, with the overall level of such effects ranging from Very Low to Low (Table 25, page 119). However, impact management measures have been identified (Section 8.1.1) to avoid these effects.
- The overall level of effects associated with potential impacts on coastal avifauna food supply and foraging ability during the construction of the project are considered to be Very Low to Low (Table 26, page 121).
- There is no lighting associated with the project and therefore no potential effects on avifauna.
- No cumulative effects on avifauna were identified as a result of this project.

Overall, if the impact management measures recommended in this report are carried out to a suitable standard, the overall level of effect of the erosion and inundation protection works at Southshore on the of ecological values of terrestrial and estuarine habitats, avifauna and herpetofauna is expected to be **Very Low to Low**, or a **Net Gain**.

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Appendix 1: Lizard survey by Lizard Expert NZ

Southshore Flood Protection Works, Avon-Heathcote Estuary

Lizard survey to Inform AEE & Wildlife Act permit



September 2023



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1. Introduction

Christchurch City Council (CCC) plan to undertake four erosion and inundation protection projects over red-zoned land situated along the of Ihutai / Avon Heathcote Estuary (Figure 1). Red-zoned land was once residential-zoned land, and much has been abandoned for c. 10 years in the aftermath of the Christchurch earthquakes. Although much of the red-zoned land is kept tidy and regularly mown by CCC, some areas have remained unmown and provide habitat for southern grass skinks, an indigenous lizard known to occur over the wider area^{1,2,3}. Other areas, especially over the northern areas near the yacht club have retained a wild character and also have southern grass skinks present.

In order to ascertain actual and potential effects of the proposed erosion and inundation protection works on any resident southern grass skinks, a lizard survey of the project area was undertaken between February 17-21st 2022. The following report details the lizard values of the four project areas (Figure 1). This report will ultimately inform a wider assessment of effects, that will accompany the application for consent; and a Lizard Management Plan for the project, that will accompany a Wildlife Act (1953) permit application to DOC to allow works over habitat of absolutely protected wildlife.

2. Proposed Works

Works across project sites will involve a combination of vegetation clearance, rock armouring, cobble beach and salt marsh restoration/regeneration, above and below MHWS. The proposed works include the following sub-projects:

- The South New Brighton Park estuary edge erosion protection works, situated on the estuary edge from Pleasant Point yacht club and the start of Jellicoe Marsh (yellow line in Figure 1).

¹K. MacDonald & M. Lettink 2019. Lizard Management Plan for the Bexley Landfill Remediation Project, Christchurch.

²M. Tocher & C. McClure November 2019. Bridge Reserve Lizard Management Plan.

³ M. Tocher, March 2020. Lizard Survey Estuary Green Edge Pathway. Report prepared by Ryder Environmental for Boffa Miskell.

- The South New Brighton Park inundation protection works situated directly inland from the South New Brighton Park estuary edge erosion protection works (red line in Figure 1).
- The Southshore estuary edge erosion protection works situated on the estuary edge between Godwit Street and Tern Street (green line in Figure 1), and
- The Southshore inundation protection works which is situated inland and setback 5 m from the Southshore estuary edge erosion protection works and extended further south (blue line in Figure 1).



Figure 1: Overview of the project area showing the indicative locations of the project footprints. Red line=South New Brighton Park inundation protection works; yellow= South New Brighton Park estuary edge erosion protection works; green= Southshore estuary edge erosion protection works; blue=Southshore inundation protection works.

3. Survey Methods

A 5-day lizard survey was carried out over the c. 22.7 ha survey area from February 17-21st 2022 (Figure 2). Weather conditions during survey were suitable for lizard activity (Table 1) and active lizards were observed on most days at sites where

vegetation was conducive to sighting lizards e.g., in rank grass near Jellicoe Park.

A range of methods were employed to detect and capture lizards over the survey area, including:

- The entire survey area was scoped and then 56 gee's minnow traps were deployed across 13 sites baited with tinned pear. Traps were deployed in groups of up to 11 over areas that were either deemed likely southern grass skink habitat and where handsearching would have been ineffective (e.g., Figure 3); or were placed in representative habitats of the survey area. Some traps were moved to new locations as the survey progressed. Gee's minnow traps were primarily used as a detection tool, but some quantitative data were collected (Table 2).
- Slowly walking through areas of vegetation and over rock/cobble and the remains of domestic gardens whilst conducting a visual search and listening for the distinctive rustle of a disturbed lizards.
- Searching for skink faecal pellets on top of any litter present, the remains of garden fences and walls, fence stays/posts and rocks, and under rocks.
- Turning over rocks, and logs/fence posts and any litter wherever they are encountered, in search of lizards and/or their sign.
- Re-searching areas thought to have lizard habitat and lizards present at different times of day, to detect/capture lizards thought to be present, but not sighted.
- All lizards captured were measured and georeferenced and all lizard survey was carried out in accordance with Wildlife Act permit 96063-FAU issued to the author.

Table 1: Weather conditions for survey & gee's minnow trapping of the Southshore survey area (see Figure 1). VES=visual encounter survey.

Date	Daily Minimum Air Temperature °C	Daily Maximum Air Temperature °C	Method
17/2/22	11	20	Gee's minnow traps and VES
18/2/22	11	25	Gee's minnow traps and VES
19/2/22	10	25	Gee's minnow traps and VES
20/2/22	11	19	Gee's minnow traps and VES
21/2/22	11	19	Gee's minnow traps and VES



Figure 2. Upper: Northern part of the survey area taking in c. 7.1 ha of estuary edge, rank grassland and tree land habitats. Lower: Southern part of the survey area taking in c. 15.6 ha of estuary edge, rank and mown grassland and abandoned garden plantings habitats. Both areas were simultaneously surveyed over February 17-21st 2022, using mix of walkthrough survey and gee's minnow trapping (total lizard survey area = c. 22.7 ha).



Figure 3. Gee's minnow trap in situ near the estuary edge near Penguin Street (red arrow) that caught a southern grass skink. Traps were covered in vegetation to provide shade for any skinks captured and marked with blue flagging tape. Some traps were labelled to explain to the public why shade was important.

4. Survey Results

Lizard Habitats

Overview

Five major lizard habitats were identified over the c. 22.7 ha survey area, and each are described below, with photographs. Other areas within the 22.7 ha search area were not considered lizard habitat because they were shaded and had been shaded

for some time and were therefore not expected to support sun-loving skinks, except perhaps at the edges where sunny habitat with suitable cover remained e.g., trees around the South Brighton Holiday Park (see Figure 2). Some of the now shaded areas, will have almost certainly been suitable southern grass skink habitat in the past before trees created shade beneath (e.g., Figure 4).



Figure 4. View north towards the Pleasant Point yacht club showing open habitat becoming progressively shaded by yellow lupin after being clear felled of all large trees in 2014.

1. Rank exotic grassland

Exotic grassland contained a mix of exotic grass species including browntop (*Agrostis capillaris*) over less disturbed areas, and cocksfoot (*Dactylis glomerata*) where some disturbance had taken place in the recent past. Occasional indigenous shrub species were also present, including both naturally occurring and planted shrubs.

Rank exotic grassland was extensive over some areas (e.g., adjacent to the sports field at the end of Jellicoe Road (Jellicoe Park; Figure 5), and pockets were present over the southern part of the survey area where CCC mowers were not able to

access (e.g., Figure 5). Along the estuary edge, thin bands of rank grass (<2 m wide), at times, provided habitat for grass skink (e.g., see Figure 7) and at 78 Rocking Horse Road, an empty section was fully covered in rank grass (Figure 8 & 9).

Near the Pleasant Point yacht club, a mix of exotic woody weeds and plantings (*Pinus* spp.) were systematically shading the exotic grassland habitat present (Figure 10) and are probably displacing southern grass skinks to the periphery of such areas. Other parts of the survey area had rank exotic grassland that was shaded, or experienced heavy foot traffic (Figure 11). Over these areas, southern grass skinks were not detected.



Figure 5. View north over the dense, undisturbed rank exotic grassland adjacent to Jellicoe Park (Site 2 in Figure 19); nowhere else over the survey area were skinks so abundant as in the rank grass and adjacent indigenous plantings of this area.



Figure 6. Rank grassland habitat south of Tern Street (Site 12) where southern grass skinks were captured; the presence of the low wire fence had protected the habitat from mowing both before and after the Christchurch earthquakes. Grassland habitat here had characteristics of a well-established grassland, that had not been disturbed for decades.



Figure 7. Left: Thin strip of rank grassland habitat along the estuary edge that provided habitat for southern grass skink. This area was north of Penguin Street. Right: View south across a thin strip of grassland habitat adjacent to a small area of saltmarsh near Penguin Street that did not have resident southern grass skinks.



Figure 8. Rank exotic grassland habitat, fenced, at 78 Rocking Horse Road that was trapped and searched for southern grass skinks; none were detected.



Figure 9. View east showing rank exotic grassland habitat of 78 Rocking Horse Road.



Figure 10. Upper: Rank exotic grassland habitat at the back of the Pleasant Point yacht club being slowly invaded by yellow lupin and overtopped by planted pine trees. A single skink was captured here on the last day of trapping. **Lower:** View south along rank grass suitable as southern grass skink habitat, south of the yacht club. A skink was sighted here during the walkthrough survey, February 21st, 2022.



Figure 11. Rank exotic grassland habitat, fenced, at 78 Rocking Horse Road that was trapped and searched for southern grass skinks; none were detected Yacht club where I got skink on last day – 10 GMs here all survey got nothing. Habitat at 471. & Habitat at waypoint 462

2. Exotic grassland with saltmarsh ribbonwood (*Plagianthus divaricatus*)

A small area (c. 80 m²) of exotic grassland with saltmarsh ribbonwood was present near the main track adjacent to the large saltmarsh, south of the South Brighton Holiday Park (Figure 12). The area, although small in relation to the survey area, had very high densities of grass skinks present, with 12 captured over the 4 days trapping (Table 2; see next Section).



Figure 12. Upper: Location of the 80 m² area of open and sunny grassland with saltmarsh ribbonwood. Lower: View east across the 80 m² area of grassland that was home to a very high density of southern grass skinks (Site 5 in Figure 19).

3. Marram grassland

Marram grassland (*Ammophila arenaria*) (Figure 13) was most prevalent over a small part of the survey area c. 220 m south of Tern Street, where the spit widens and eventually becomes the Spit Reserve. Here, marram exists with other vegetation

communities towards to estuary, and woody weeds are common here. No southern grass skinks were detected here.



Figure 13. Marram grassland adjacent to Petrel Lane over the southern part of the survey area where 10 gee's minnows were deployed but no southern grass skinks detected.

4. *Estuary edge lyme grass (Leymus arenarius) grassland*

Lyme grass, a sand-loving exotic grass species, was common along the estuary edge either as a single species (Figure 14) or growing with other lower-growing exotic grasses (Figure 15). Lyme grass was more common over the northern part of the survey area, and almost all area trapped had southern grass skinks present.

5. *Abandoned gardens with greywacke river cobble mulch and occasional rocks*

Abandoned gardens were a feature of the survey area, and where suitable cover was present, were searched for lizards (e.g., Figure 16). No lizards were found in gardens despite appropriate habitat being present. On completion of survey, a local resident reported a skink at 26 Ebbtide Street (between Caspian and Godwit Streets, in a garden where I noted greywacke river cobble suitable for southern grass skink habitat was present. This sighting, in my opinion is very

credible and close to where I detected skinks during my survey (see next Section).



Figure 14. View south showing lyme grass growing near Godwit Street. The red arrow shows where Southern grass skinks were found.



Figure 15. Lyme grass growing with other exotic grasses and succulents near the Pleasant Point yacht club. No southern grass skinks detected here but habitat is suitable.



Figure 16. An example of a red-zone garden near Mermaid Place showing weedy plantings with a small area of greywacke cobble used as mulch.

Lizard Captures & Sightings

Southern grass skinks (*Oligosoma* aff *polychroma* clade 5) was the only lizard species detected over the survey area, and a mix of striped and speckled patterned skinks were captured (e.g.,

Figure 17 and Figure 20). Southern grass skinks are currently classified as At Risk – Declining by DOC⁴. Skinks were sighted very rarely during the survey (n=6; Figure 18), despite suitable weather for skink activity occurring during the survey period (Table 1).



Figure 17. An example of a strongly striped southern grass skink captured over the survey area.



Figure 18. Locations (n=6; red dots) where southern grass skinks were observed actively foraging over the survey area. The additional sighting of local Lee Osborn, at 26 Ebbtide Street soon after my survey was completed, is also shown (red arrow).

⁴ Hitchmough et al. 2021. Conservation status of New Zealand reptiles, 2021. New Zealand Threat Classification Series 35. Department of Conservation, Wellington. 15 p.

The majority of skinks detected during the survey (82 %) were captured in gee's minnow traps (Figure 19 and Table 2). A total of 29 skinks were captured (versus six sightings) that ranged in size from adult to sub adult (Table 3). No new-born skinks were captured and 65.5 % of captured skinks had regenerating tails indicating levels tail loss that were not notable (Table 3). Trapping rates were highest at Sites 5 and 6 (Table 2), but these data are too few to determine actual densities. Skinks were, however, very obviously abundant at Site 5 near the saltmarsh/small estuary (see Figures 12 & 19); and within the exotic grassland adjacent to Jellicoe Park (Site 2 in Figure 19 and Table 2). At these sites 2 & 5, between 0.2-1 southern grass skinks were captured per trap day, and on more than one occasion, multiple skinks were captured in each trap (Table 2 and Figure 21). Site 6 was two very small, isolated marram grass/exotic grass islands surrounded by paths and roads (Figure 22); here 1 trap caught 2 skinks over 2 nights, but the limited habitat meant the skink population was small despite the trapping rate. This site was also a little outside the development footprint being on the corner of Ebbside Street and Caspian Street but was nonetheless included in Table 2 and Figure 21 for context.

Table 2: Summary of location (site as per Figure 18), dates, number of gee's minnow's traps deployed and captures over the survey area.

Dates	No. days trapping	Site	Number of Traps deployed	Skink captures	Skink captures per trap day
17-21 st	4	Site 1	10	1	0.024
17-21 st	4	Site 2	10	8	0.2
17-21 st	4	Site 3	6	0	0
20-21 st	1	Site 4	4	0	0
17-20 th	3	Site 5	4	12	1.0
19-21 st	2	Site 6	1	2	1.0
17-19 th	2	Site 7	3	2	0.33
17-19 th	2	Site 8	4	0	0
17-21 st	4	Site 9	3	2	0.16
17-21 st	4	Site 10	1	0	0
17-21 st	4	Site 11	6	0	0
17-21 st	4	Site 12	5	2	0.1
17-21 st	4	Site 13	6	0	0
Totals	42			29	



Figure 19. Locations ($n=13$ sites; numbered white dots) where between 1-10 gee's minnow traps were deployed between February 17-21st 2022.



Figure 20. Example of a speckled patterned southern grass skink captured at Site 1 (Figure 18), 21st February 2022.



Figure 21. Overview of skink captures & sightings and perceived relative abundances (based on captures, sightings, and quality/extent of habitat present) across sites February 17-21st 2022.

Table 3: Summary of sex & size measurements taken from captured skinks, 17-21st February 2022.

Skink #	Site	Date	SVL (mm)	VTL (mm)	Tail regeneration (mm)	Sex/age
1	Site 2	18/02/2022	70	93		male
2	Site 2	18/02/2022	65	83	15	male
3	Site 2	18/02/2022	66	76		female
4	Site 2	18/02/2022	70	87	40	male
5	Site 2	18/02/2022	55	60	22	male
6	Site 2	18/02/2022	56	63	42	female
7	Site 5	18/02/2022	55	68	9	male
8	Site 5	18/02/2022	60	73		female
9	Site 5	18/02/2022	65	67	29	male
10	Site 5	18/02/2022	48	41	28	female
11	Site 5	18/02/2022	65	68	26	male
12	Site 5	18/02/2022	52	65	7	male
13	Site 5	18/02/2022	70	44	37	female
14	Site 7	18/02/2022	33	47		sub adult
15	Site 7	18/02/2022	35	48		sub adult
16	Site 9	18/02/2022	58	58	39	male
17	Site 12	18/02/2022	67	75	28	female
18	Site 2	19/02/2022	65	83	15	male
19	Site 2	19/02/2022	70	93		male
20	Site 5	19/02/2022	60	77		male
21	Site 5	19/02/2022	38	53		sub adult
22	Site 5	19/02/2022	57	72	Tip gone	male
23	Site 5	19/02/2022	72	72		male
24	Site 12	19/02/2022	66	63	35	male
25	Site 5	20/02/2022	70	43	39	female
26	Site 6	20/02/2022	55	61	21	male
27	Site 1	21/02/2022	71	70	53	male
28	Site 6	21/02/2022	65	35	27	male
29	Site 9	21/02/2022	54	53		sub adult



Figure 22. Two small exotic grass/marram grass islands on the corner of Caspian Street and Ebbside Street where two grass skinks were captured (red arrows).

5. Summary & Mitigation Suggestions

- Southern grass skink populations were found over both the northern and southern parts of the c. 22.7 ha survey area, primarily in rank exotic grassland and marram/lyme grasslands. This species is classified as 'at risk declining' by DOC. No other lizard species were detected over the site.
- Over the southernmost part of the survey area, south of Heron Street, skinks were only detected in two places. Here they occurred in low-moderate numbers over two isolated areas of rank grass near the estuary edge. Apart from these two areas, no skinks or their habitat was detected, including over abandoned gardens and marram grassland.
- At Caspian Street and south to Godwit Street, southern grass skinks were present in low-moderate numbers in rank grassland, including marram & lyme grass, at the estuary edge and at one location in an abandoned garden (26 Ebbitide Street). Skinks could occur at other locations along the estuary edge here, where these habitat types exist, despite not being detected during this survey.
- Southern grass skinks were more common north of Caspian Street, with highest perceived densities occurring at two quite different sites; one adjacent to Jellicoe Park where extensive areas of rank grass were present, and the second at a small site adjacent to the small saltmarsh (Site 5). The high density at the saltmarsh site could be explained by skinks becoming concentrated there as the surrounding habitat has become progressively shaded by *Pinus* spp. and other woody weeds; google earth imagery from 2005 and then 2014 (Figure 23) shows the area has remained unshaded for many years despite surrounding areas being shaded at times.



Figure 23. *Extent of closed-canopy forest over the northern part of the survey area in 2005 (left) and the extent of grassed area once they were felled in 2014 (right).*

- Figure 23 shows the extent of closed canopy in 2005 versus the area cleared of trees in 2014. The area of grassland adjacent to Jellicoe Park was unshaded in 2005 and has remained so, explaining the high southern grass skink populations there.
- The images in Figure 23, together with the observation of a skink foraging at the edge of a closed canopy area, and another trapped at a similar edge behind the yacht club during the survey, indicates skinks are present at low densities throughout the now wooded areas of South New Brighton Park, where some canopy gaps still occur.
- Southern grass skinks are protected under the Wildlife Act (1953), administered by DOC. A Wildlife Act permit from DOC will be required to carry out the proposed works.
- Mitigation will be required should CCC works proceed. I recommend creating rocky habitat ahead of works, in collaboration with the local community, that could then be used as a release site for southern grass skinks rescued from works areas. Rodent control using new generation rodenticides (e.g., Double Tap) would be a useful method to support skink establishment at the newly created release site. The location of the rocky habitat could help link currently isolated populations of skinks.

Appendix 1: ARDS Cards

ARDS CARD		NEW ZEALAND AMPHIBIAN/REPTILE DISTRIBUTION SCHEME Herpetofauna Administrator, RD&I, Department of Conservation, P.O. Box 10420, Wellington.				Card No:	
Observer: <u>MD</u> <u>Tocher</u> Initials Surname			Date: 17-21st February 2022		Locality Name: Southshore, Christchurch		
Address: 1 Cleghorn Street, Dunedin 9085			Alt (m):sealevel		44° 6'54.29"S 169°50'1.04"E		
Affiliation: LizardExpertNZ			GPS Series Map No. Easting Northing Area Office: Conservancy: Ecol. District: Canterbury				
Species name	No.	Time	Habitat	Weather	Weather	Major Habitat Types	
<i>Oligosoma</i> aff. <i>polychroma</i> clade 5 - sighted	6		13, 17,H	1,2,1	<u>Light</u> 1 Fine/Sunny 2 Part Cloudy 3 Overcast 4 Showers 5 Rain 6 Night 7 0-½ Moonlit 8 ½-1 Moonlit	1 Beech Forest 2 Podocarp forest 3 Broadleaf forest 4 Exotic forest 5 Scrub 6 Sub-alpine 7 Alpine 8 Undeveloped tussock land 9 Developed farmland 10 River terrace 11 Fresh water	
<i>Oligosoma</i> aff. <i>polychroma</i> clade 5- trapped in gee's minnow traps.	29		13, 17,H	1,2,1	<u>Temperature</u> 1 Hot 2 Warm 3 Moderate 4 Cool 5 Cold	12 Wet land 13 Coastal 14 Scree 15 Bare rocks 16 Beach 17 Urban	
Voucher specimen(s)	No	Specify:			<u>Wind</u> 1 Calm 2 Light breeze 3 Mod breeze 4 Gusty 5 Strong winds	18 19 20	
Photograph(s)	Yes					Micro habitats A Foliage B Trunk C Branches D Under stones E Under wood F Open ground G Crevices H Rank grass	
Extra notes on reverse side	No						
Notes: Survey for Boffa Miskell (for CCC) from pleasant point yacht club to south of Tern Street ahead of flood protection works. Survey report produced and issued to Tanya Blakely, Boffa Miskell. Map of sightings attached.							
Identified by: Mandy Tocher Authority used:							



Figure 20. Overview of skink captures & sightings and perceived relative abundances (based on captures, sightings, and quality/extent of habitat present) across sites February 17-21st 2022.

Appendix 2: Terrestrial plant species list

Species name	Common name	Growth Form	Species Status	Threat Status
<i>Acacia mearnsii</i>	Black Wattle	Tree	Exotic	
<i>Acer pseudoplatanus</i>	Sycamore	Tree	Exotic	
<i>Achillea millefolium</i>	Yarrow	Dicot Herb	Exotic	
<i>Agapanthus species</i>		Grass	Exotic	
<i>Ammophila arenaria</i>	Marram Grass	Grass	Exotic	
<i>Apium prostratum subsp. prostratum var. filiforme</i>	New Zealand Celery	Dicot Herb	Indigenous Non-Endemic	Not Threatened
<i>Apodasmia similis</i>	Jointed Wire Rush	Grass	Indigenous Endemic	Not Threatened
<i>Araucaria heterophylla</i>	Norfolk Island Pine	Tree	Exotic	
<i>Argyranthemum species</i>		Low Shrub	Exotic	
<i>Atriplex prostrata</i>	Orache	Dicot Herb	Exotic	
<i>Beta vulgaris</i>	Beet	Dicot Herb	Exotic	
<i>Capsella bursa-pastoris</i>	Shepherd's Purse	Dicot Herb	Exotic	
<i>Carpobrotus edulis</i>	Ice Plant	Dicot Herb	Exotic	
<i>Chenopodium album</i>	Fathen	Dicot Herb	Exotic	
<i>Cirsium arvense</i>	Californian Thistle	Dicot Herb	Exotic	
<i>Coprosma repens</i>	Taupata	Tree	Indigenous Non-Endemic	Not Threatened
<i>Cordyline australis</i>	Ti Kōuka / Cabbage Tree		Indigenous Endemic	Not Threatened
<i>Cortaderia selloana</i>	Pampas Grass	Grass	Exotic	
<i>Corynocarpus laevigatus</i>	Karaka	Tree	Indigenous Endemic	Not Threatened
<i>Cotula coronopifolia</i>	Batchelors Button	Dicot Herb	Indigenous Non-Endemic	Not Threatened
<i>Crepis capillaris</i>	Hawksbeard	Dicot Herb	Exotic	
<i>Cupressus macrocarpa</i>	Macrocarpa	Tree	Exotic	
<i>Dimorphotheca fruticosa</i>	Trailing African Daisy	Low Shrub	Exotic	
<i>Dodonaea viscosa</i>	Akeake	Tree	Indigenous Non-Endemic	Not Threatened
<i>Ehrharta erecta</i>	Veldt Grass	Grass	Exotic	

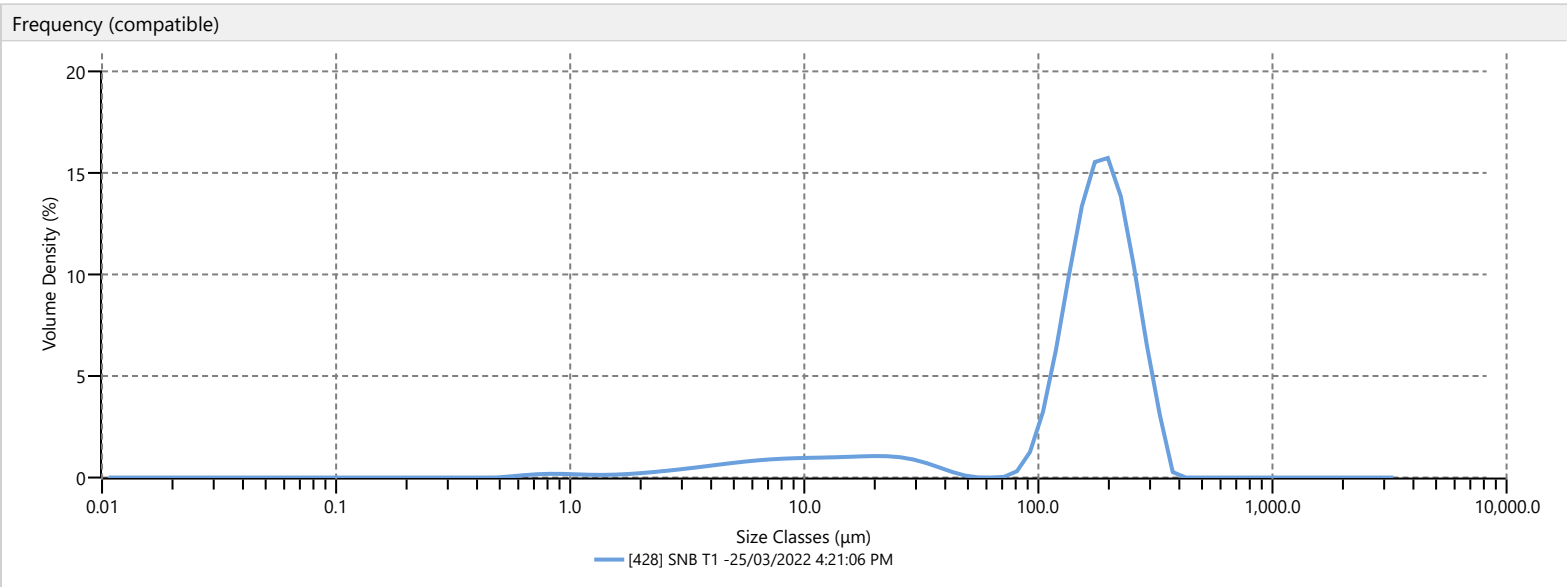
Species name	Common name	Growth Form	Species Status	Threat Status
<i>Elytrigia repens</i>	Couch	Grass	Exotic	
<i>Erigeron sumatrensis</i>	Broad-leaved Flea-Bane	Dicot Herb	Exotic	
<i>Erodium cicutarium</i>	Storksbill	Dicot Herb	Exotic	
<i>Eucalyptus species</i>		Tree	Exotic	
<i>Ficinia nodosa</i>	Knobbly Club Rush	Grass	Indigenous Non-Endemic	Not Threatened
<i>Fumaria species</i>		Dicot Herb	Exotic	
<i>Genista monspessulana</i>	Montpellier Broom	Shrub	Exotic	
<i>Grass species</i>	Unidentified Exotic Grass	Grass	Unknown	
<i>Holcus lanatus</i>	Yorkshire Fog	Grass	Exotic	
<i>Hordeum species</i>		Grass	Exotic	
<i>Hypochaeris radicata</i>	Catsear	Dicot Herb	Exotic	
<i>Isolepis cernua</i>		Grass	Indigenous Non-Endemic	
<i>Juncus kraussii</i> subsp. <i>australiensis</i>	Sea Rush	Grass	Indigenous Non-Endemic	Not Threatened
<i>Lepidium africanum</i>	Peppergrass	Dicot Herb	Exotic	
<i>Leymus racemosus</i>	Siberian Lyme Grass	Grass	Exotic	
<i>Lobularia maritima</i>	Alyssum	Dicot Herb	Exotic	
<i>Lolium arundinaceum</i>	Tall Fescue	Grass	Exotic	
<i>Lolium perenne</i>	Perennial Rye Grass	Grass	Exotic	
<i>Lupinus arboreus</i>	Tree Lupin	Shrub	Exotic	
<i>Lysimachia arvensis</i>	Pimpernel	Dicot Herb	Exotic	
<i>Malva arborea</i>	Tree Mallow	Low Shrub	Exotic	
<i>Metrosideros excelsa</i>	Pohutukawa	Tree	Indigenous Endemic	Threatened - Nationally Vulnerable
<i>Myoporum aff. insulare</i>	Tasmanian Ngaio	Tree	Exotic	
<i>Myoporum laetum</i>	Ngaio	Tree	Indigenous Endemic	Not Threatened
<i>Olearia chathamica</i>	Keketeruhe	Shrub	Indigenous Endemic	Threatened - Nationally Vulnerable
<i>Phoenix canariensis</i>	Phoenix Palm		Exotic	
<i>Phormium tenax</i>	Harakeke	Grass	Indigenous Endemic	Not Threatened
<i>Pittosporum crassifolium</i>	Karo	Tree	Indigenous Endemic	Not Threatened

Species name	Common name	Growth Form	Species Status	Threat Status
<i>Plagianthus divaricatus</i>	Salt Marsh Ribbonwood	Shrub	Indigenous Endemic	Not Threatened
<i>Plantago coronopus</i>	Buck's Horn Plantain	Dicot Herb	Exotic	
<i>Plantago lanceolata</i>	Narrow-leaved Plantain	Dicot Herb	Exotic	
<i>Polygonum aviculare</i>	Wireweed	Dicot Herb	Exotic	
<i>Puccinellia stricta</i>	Saltgrass	Grass	Indigenous Non-Endemic	Not Threatened
<i>Salicornia quinqueflora</i>	Glasswort	Dicot Herb	Indigenous Non-Endemic	
<i>Salicornia quinqueflora subsp. quinqueflora</i>	Glasswort	Dicot Herb	Indigenous Non-Endemic	Not Threatened
<i>Sambucus nigra</i>	Elderberry	Shrub	Exotic	
<i>Selliera radicans</i>	Remuremu	Dicot Herb	Indigenous Non-Endemic	Not Threatened
<i>Solanum chenopodioides</i>	Velvety Nightshade	Low Shrub	Exotic	
<i>Solanum nigrum</i>	Black Nightshade	Low Shrub	Exotic	
<i>Soliva sessilis</i>	Onehunga Weed	Dicot Herb	Exotic	
<i>Sonchus oleraceus</i>	Sow Thistle	Dicot Herb	Exotic	
<i>Spergularia media</i>	New Zealand Sea Spurrey	Dicot Herb	Exotic	
<i>Suaeda novae-zelandiae</i>	Sea Blite	Low Shrub	Indigenous Endemic	Not Threatened
<i>Tanacetum parthenium</i>	Feverfew	Dicot Herb	Exotic	
<i>Tetragonia implexicoma</i>	Native Spinach	Dicot Herb	Indigenous Non-Endemic	Not Threatened
<i>Trifolium dubium</i>	Suckling Clover	Dicot Herb	Exotic	
<i>Trifolium repens</i>	White Clover	Dicot Herb	Exotic	
<i>Trifolium species</i>		Dicot Herb	Exotic	
<i>Veronica species</i>			Indigenous Non-Endemic	
<i>Vicia faba</i>	Broad Bean		Exotic	
<i>Vicia sativa</i>	Vetch	Dicot Herb	Exotic	

Appendix 3: Analyses of sediment grain size

Measurement Details	Measurement Details
Sample Name SNB T1	Analysis Date Time 25/03/2022 4:21:06 PM
SOP File Name Marine Sediment.msop	Measurement Date Time 25/03/2022 4:21:06 PM
Lab Number 2022056/1	Result Source Measurement
Operator Name instrument	

Analysis	Result
Particle Name Marine Sediment	Concentration 0.0494 %
Particle Refractive Index 1.500	Span 1.465
Particle Absorption Index 0.200	Uniformity 0.379
Dispersant Name Water	Specific Surface Area 216.5 m²/kg
Dispersant Refractive Index 1.330	D [3,2] 27.7 µm
Scattering Model Mie	D [4,3] 163 µm
Analysis Model General Purpose	Dv (10) 13.7 µm
Weighted Residual 0.55 %	Dv (50) 171 µm
Laser Obscuration 12.53 %	Dv (90) 265 µm
	Volume Below (31) µm 15.38 %



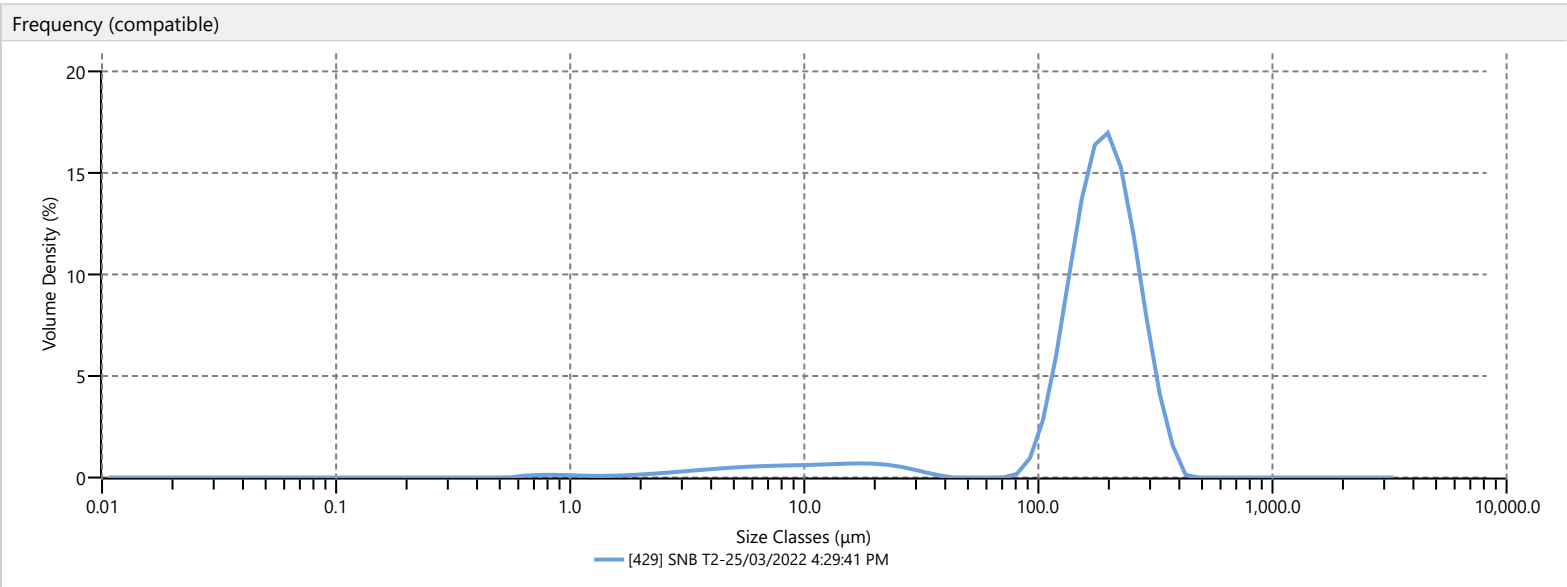
Result									
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	6.43	88.0	17.09	350	99.89	1410	100.00
0.0600	0.00	15.6	10.84	105	19.31	420	100.00	1680	100.00
0.120	0.00	31.0	15.38	125	25.19	500	100.00	2000	100.00
0.240	0.00	37.0	16.15	149	37.10	590	100.00	2380	100.00
0.490	0.00	44.0	16.58	177	53.41	710	100.00	2830	100.00
0.980	0.57	53.0	16.72	210	71.11	840	100.00	3360	100.00
2.00	1.29	63.0	16.72	250	86.13	1000	100.00		
3.90	2.95	74.0	16.73	300	96.10	1190	100.00		

Measurement Details
Sample Name SNB T2
SOP File Name Marine Sediment.msop
Lab Number 2022056/2
Operator Name instrument

Analysis
Particle Name Marine Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.35 %
Laser Obscuration 14.34 %

Measurement Details
Analysis Date Time 25/03/2022 4:29:41 PM
Measurement Date Time 25/03/2022 4:29:41 PM
Result Source Measurement

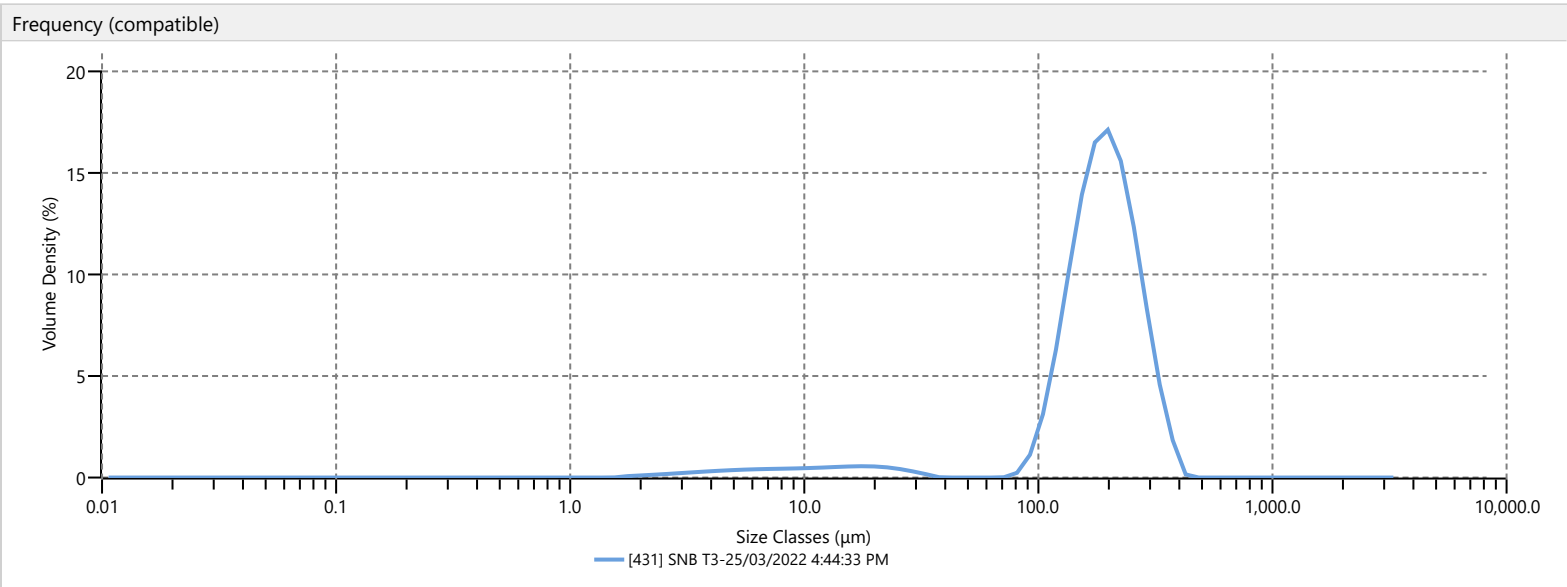
Result
Concentration 0.0799 %
Span 1.344
Uniformity 0.333
Specific Surface Area 154.2 m²/kg
D [3,2] 38.9 µm
D [4,3] 180 µm
Dv (10) 32.5 µm
Dv (50) 183 µm
Dv (90) 278 µm
Volume Below (31) µm 9.92 %



Result									
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	4.36	88.0	10.44	350	98.64	1410	100.00
0.0600	0.00	15.6	7.23	105	12.26	420	100.00	1680	100.00
0.120	0.00	31.0	9.92	125	17.72	500	100.00	2000	100.00
0.240	0.00	37.0	10.17	149	29.62	590	100.00	2380	100.00
0.490	0.00	44.0	10.23	177	46.59	710	100.00	2830	100.00
0.980	0.40	53.0	10.23	210	65.57	840	100.00	3360	100.00
2.00	0.86	63.0	10.23	250	82.25	1000	100.00		
3.90	2.04	74.0	10.23	300	93.83	1190	100.00		

Measurement Details	Measurement Details
Sample Name SNB T3	Analysis Date Time 25/03/2022 4:44:33 PM
SOP File Name Marine Sediment.msop	Measurement Date Time 25/03/2022 4:44:33 PM
Lab Number 2022056/3	Result Source Measurement
Operator Name instrument	

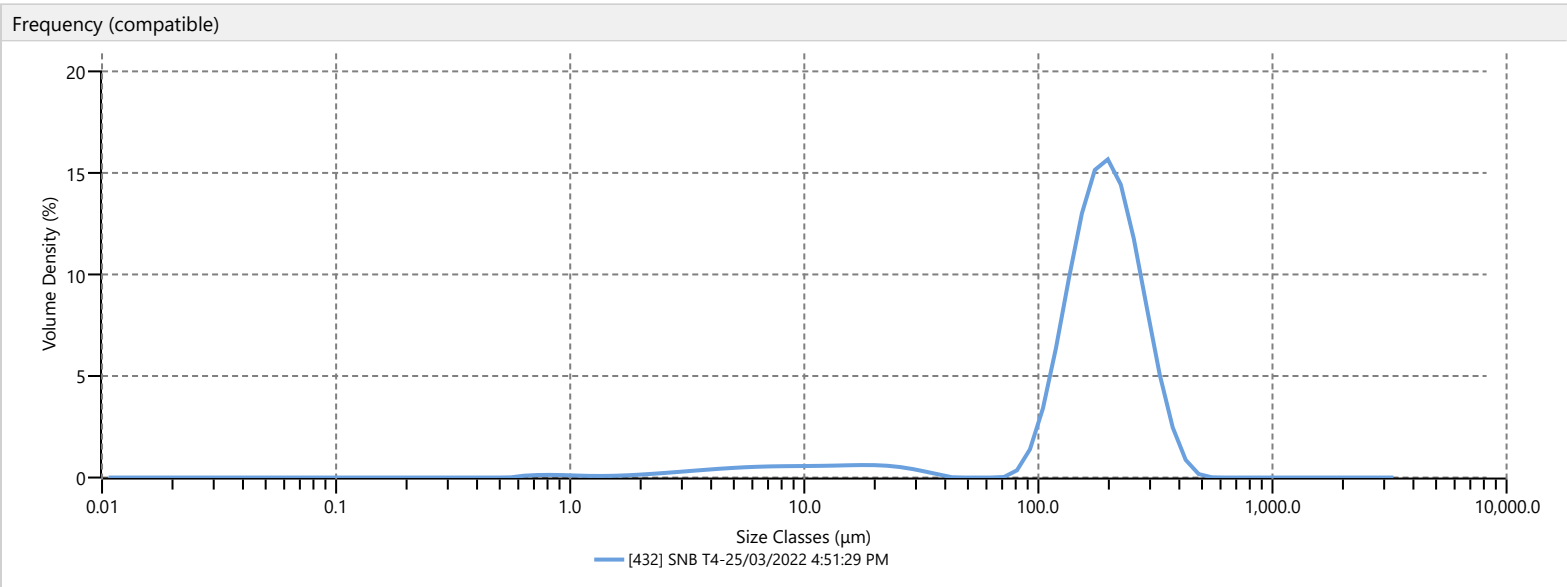
Analysis	Result
Particle Name Marine Sediment	Concentration 0.1432 %
Particle Refractive Index 1.500	Span 0.946
Particle Absorption Index 0.200	Uniformity 0.313
Dispersant Name Water	Specific Surface Area 89.19 m²/kg
Dispersant Refractive Index 1.330	D [3,2] 67.3 µm
Scattering Model Mie	D [4,3] 187 µm
Analysis Model General Purpose	Dv (10) 108 µm
Weighted Residual 0.40 %	Dv (50) 186 µm
Laser Obscuration 15.54 %	Dv (90) 283 µm
	Volume Below (31) µm 7.02 %



Result									
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	2.71	88.0	7.44	350	98.39	1410	100.00
0.0600	0.00	15.6	4.89	105	9.51	420	100.00	1680	100.00
0.120	0.00	31.0	7.02	125	15.34	500	100.00	2000	100.00
0.240	0.00	37.0	7.16	149	27.57	590	100.00	2380	100.00
0.490	0.00	44.0	7.16	177	44.72	710	100.00	2830	100.00
0.980	0.00	53.0	7.16	210	63.84	840	100.00	3360	100.00
2.00	0.11	63.0	7.16	250	80.90	1000	100.00		
3.90	0.98	74.0	7.17	300	93.09	1190	100.00		

Measurement Details	Measurement Details
Sample Name SNB T4	Analysis Date Time 25/03/2022 4:51:29 PM
SOP File Name Marine Sediment.msop	Measurement Date Time 25/03/2022 4:51:29 PM
Lab Number 2022056/4	Result Source Measurement
Operator Name instrument	

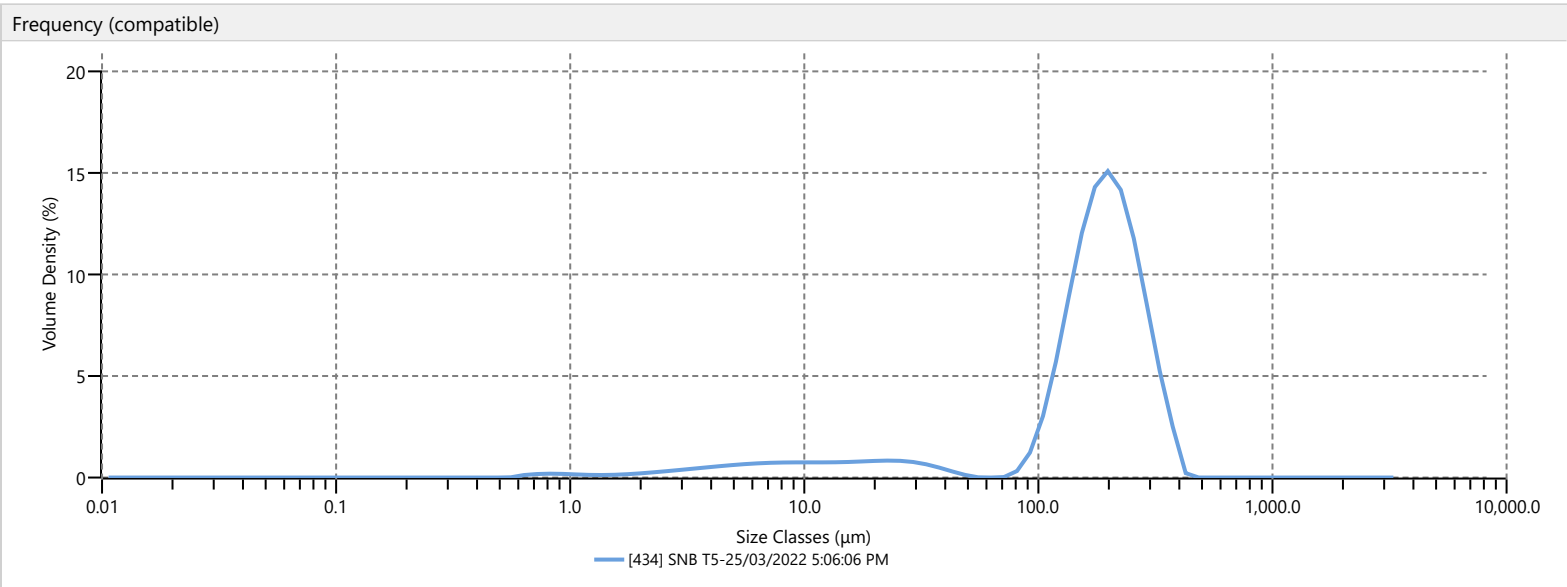
Analysis	Result
Particle Name Marine Sediment	Concentration 0.0812 %
Particle Refractive Index 1.500	Span 1.117
Particle Absorption Index 0.200	Uniformity 0.355
Dispersant Name Water	Specific Surface Area 149.5 m²/kg
Dispersant Refractive Index 1.330	D [3,2] 40.1 µm
Scattering Model Mie	D [4,3] 185 µm
Analysis Model General Purpose	Dv (10) 86.9 µm
Weighted Residual 0.34 %	Dv (50) 184 µm
Laser Obscuration 14.14 %	Dv (90) 293 µm
	Volume Below (31) µm 9.32 %



Result									
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	4.22	88.0	10.10	350	97.09	1410	100.00
0.0600	0.00	15.6	6.83	105	12.51	420	99.49	1680	100.00
0.120	0.00	31.0	9.32	125	18.53	500	99.97	2000	100.00
0.240	0.00	37.0	9.61	149	30.25	590	100.00	2380	100.00
0.490	0.00	44.0	9.69	177	46.11	710	100.00	2830	100.00
0.980	0.39	53.0	9.69	210	63.60	840	100.00	3360	100.00
2.00	0.83	63.0	9.69	250	79.47	1000	100.00		
3.90	1.99	74.0	9.69	300	91.37	1190	100.00		

Measurement Details	Measurement Details
Sample Name SNB T5	Analysis Date Time 25/03/2022 5:06:06 PM
SOP File Name Marine Sediment.msop	Measurement Date Time 25/03/2022 5:06:06 PM
Lab Number 2022056/5	Result Source Measurement
Operator Name instrument	

Analysis	Result
Particle Name Marine Sediment	Concentration 0.0604 %
Particle Refractive Index 1.500	Span 1.493
Particle Absorption Index 0.200	Uniformity 0.382
Dispersant Name Water	Specific Surface Area 195.4 m²/kg
Dispersant Refractive Index 1.330	D [3,2] 30.7 µm
Scattering Model Mie	D [4,3] 178 µm
Analysis Model General Purpose	Dv (10) 18.6 µm
Weighted Residual 0.34 %	Dv (50) 182 µm
Laser Obscuration 13.72 %	Dv (90) 290 µm
	Volume Below (31) µm 12.70 %



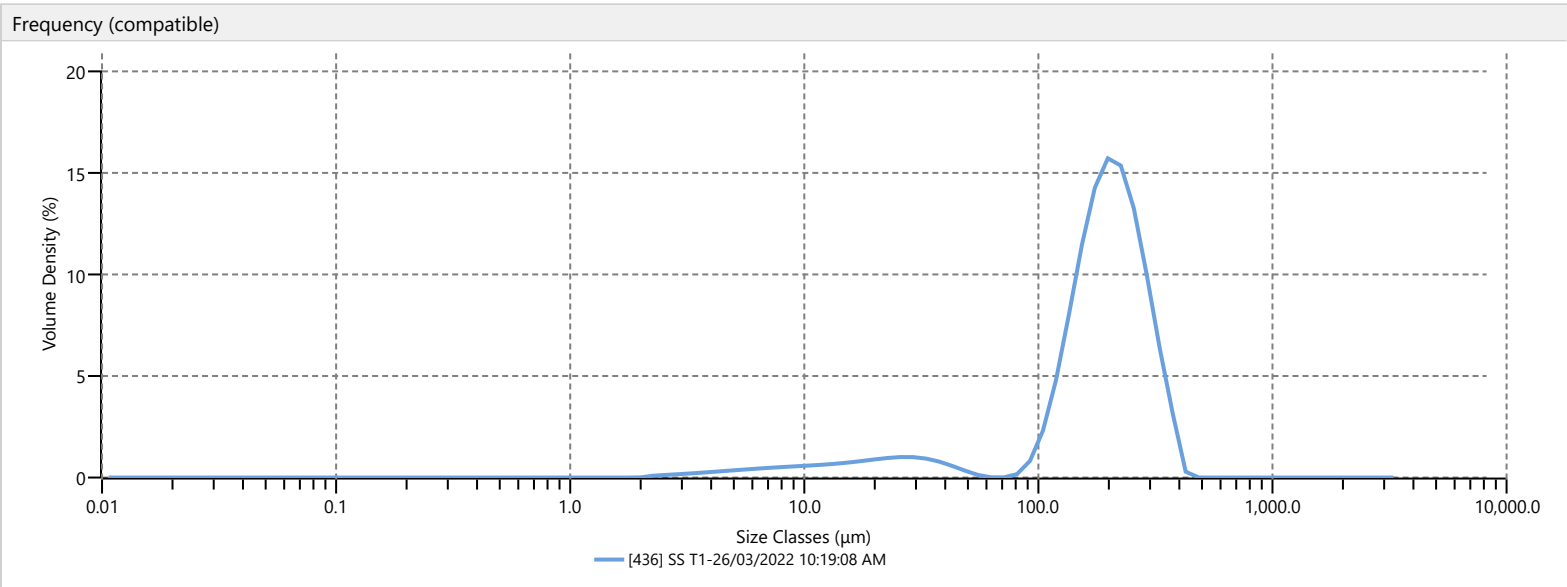
Result									
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	5.70	88.0	14.40	350	97.76	1410	100.00
0.0600	0.00	15.6	9.09	105	16.53	420	99.99	1680	100.00
0.120	0.00	31.0	12.70	125	21.91	500	100.00	2000	100.00
0.240	0.00	37.0	13.41	149	32.60	590	100.00	2380	100.00
0.490	0.00	44.0	13.86	177	47.43	710	100.00	2830	100.00
0.980	0.55	53.0	14.03	210	64.18	840	100.00	3360	100.00
2.00	1.24	63.0	14.03	250	79.82	1000	100.00		
3.90	2.78	74.0	14.03	300	91.84	1190	100.00		

Measurement Details
Sample Name SS T1
SOP File Name Marine Sediment.msop
Lab Number 2022056/6
Operator Name instrument

Analysis
Particle Name Marine Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.42 %
Laser Obscuration 13.98 %

Measurement Details
Analysis Date Time 26/03/2022 10:19:08 AM
Measurement Date Time 26/03/2022 10:19:08 AM
Result Source Measurement

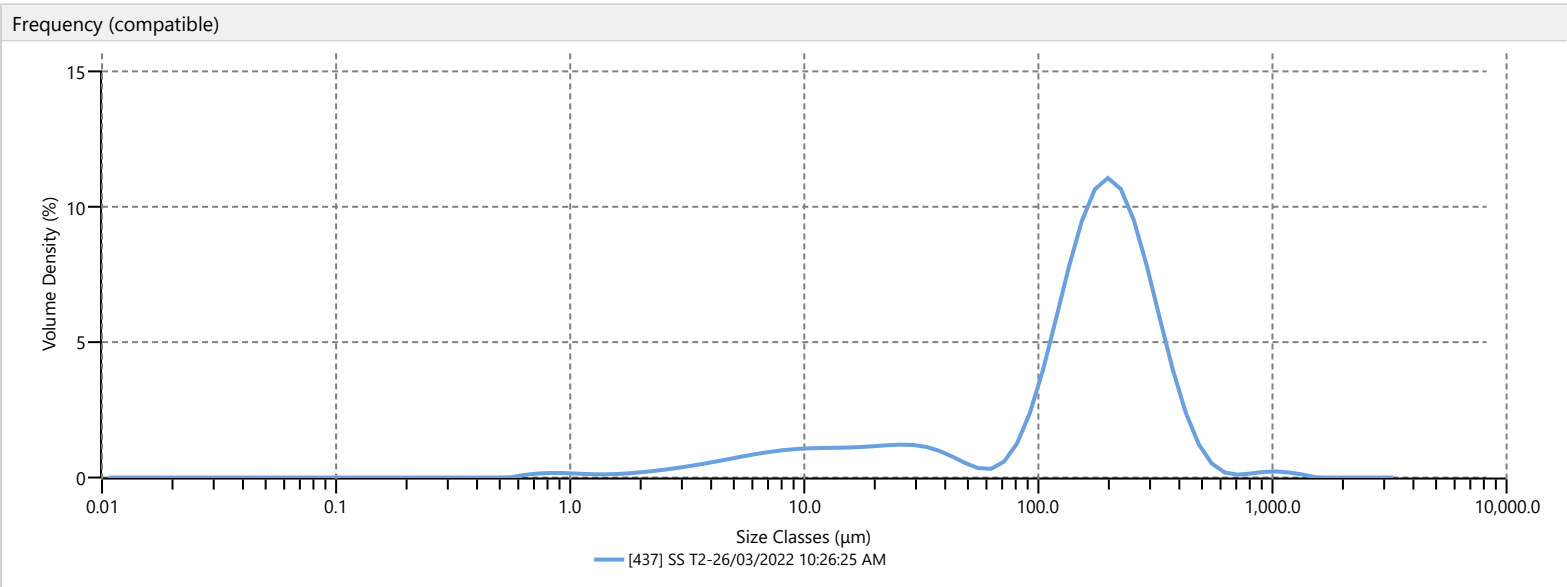
Result
Concentration 0.1272 %
Span 1.380
Uniformity 0.351
Specific Surface Area 89.54 m ² /kg
D [3,2] 67.0 μm
D [4,3] 190 μm
Dv (10) 34.6 μm
Dv (50) 192 μm
Dv (90) 300 μm
Volume Below (31) μm 9.33 %



Result									
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	2.42	88.0	11.86	350	97.15	1410	100.00
0.0600	0.00	15.6	5.20	105	13.37	420	99.98	1680	100.00
0.120	0.00	31.0	9.33	125	17.77	500	100.00	2000	100.00
0.240	0.00	37.0	10.38	149	27.46	590	100.00	2380	100.00
0.490	0.00	44.0	11.14	177	41.90	710	100.00	2830	100.00
0.980	0.00	53.0	11.57	210	59.15	840	100.00	3360	100.00
2.00	0.00	63.0	11.66	250	76.24	1000	100.00		
3.90	0.66	74.0	11.66	300	90.03	1190	100.00		

Measurement Details	Measurement Details
Sample Name SS T2	Analysis Date Time 26/03/2022 10:26:25 AM
SOP File Name Marine Sediment.msop	Measurement Date Time 26/03/2022 10:26:25 AM
Lab Number 2022056/6	Result Source Measurement
Operator Name instrument	

Analysis	Result
Particle Name Marine Sediment	Concentration 0.0522 %
Particle Refractive Index 1.500	Span 1.828
Particle Absorption Index 0.200	Uniformity 0.550
Dispersant Name Water	Specific Surface Area 207.0 m²/kg
Dispersant Refractive Index 1.330	D [3,2] 29.0 µm
Scattering Model Mie	D [4,3] 183 µm
Analysis Model General Purpose	Dv (10) 13.5 µm
Weighted Residual 0.38 %	Dv (50) 174 µm
Laser Obscuration 12.79 %	Dv (90) 331 µm
	Volume Below (31) µm 16.32 %



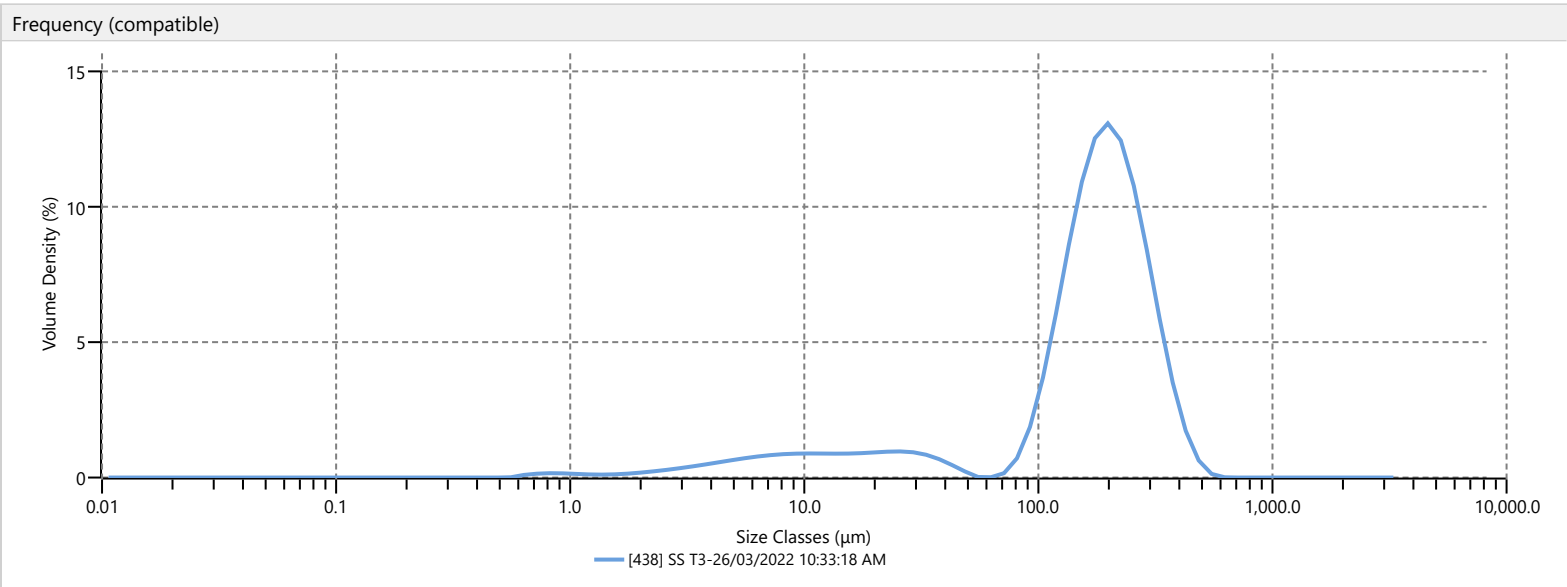
Result									
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	6.19	88.0	21.51	350	92.16	1410	99.99
0.0600	0.00	15.6	11.05	105	24.94	420	96.43	1680	100.00
0.120	0.00	31.0	16.32	125	30.85	500	98.39	2000	100.00
0.240	0.00	37.0	17.59	149	40.02	590	99.04	2380	100.00
0.490	0.00	44.0	18.59	177	51.35	710	99.22	2830	100.00
0.980	0.48	53.0	19.27	210	63.64	840	99.36	3360	100.00
2.00	1.12	63.0	19.63	250	75.54	1000	99.59		
3.90	2.65	74.0	20.11	300	85.84	1190	99.83		

Measurement Details
Sample Name SS T3
SOP File Name Marine Sediment.msop
Lab Number 2022056/8
Operator Name instrument

Analysis
Particle Name Marine Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.43 %
Laser Obscuration 13.50 %

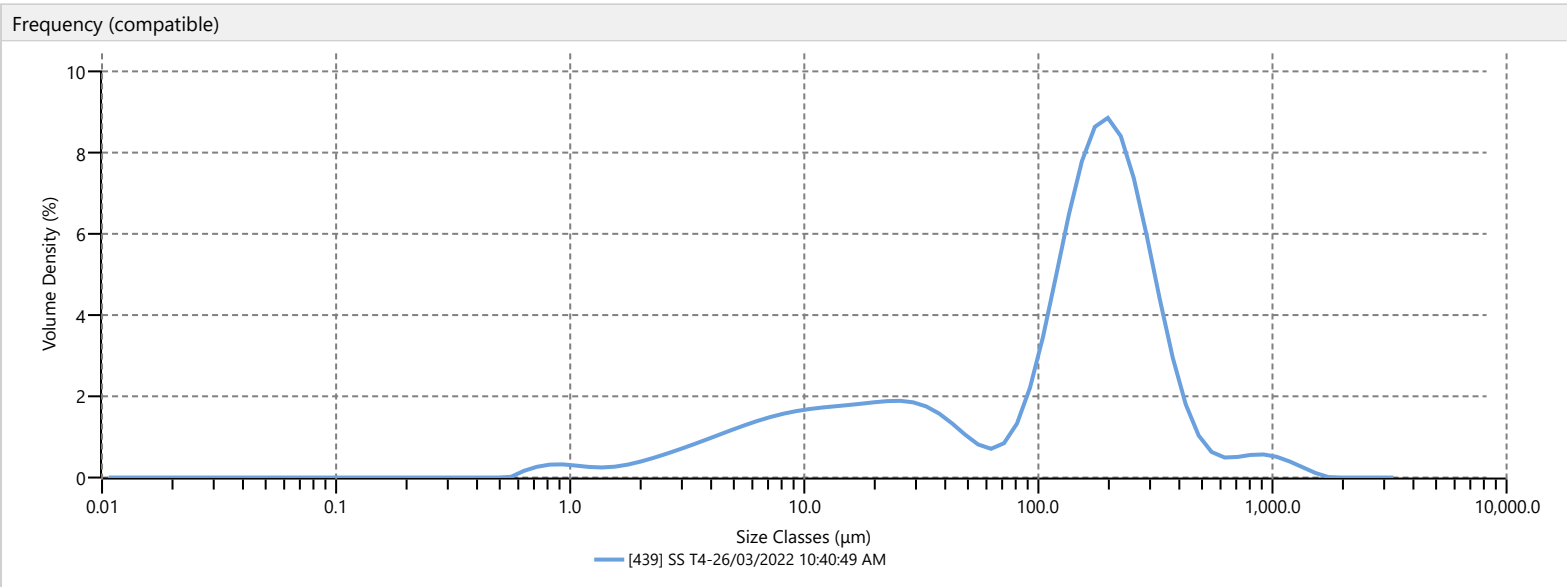
Measurement Details
Analysis Date Time 26/03/2022 10:33:18 AM
Measurement Date Time 26/03/2022 10:33:18 AM
Result Source Measurement

Result
Concentration 0.0607 %
Span 1.622
Uniformity 0.439
Specific Surface Area 189.4 m ² /kg
D [3,2] 31.7 µm
D [4,3] 180 µm
Dv (10) 16.6 µm
Dv (50) 180 µm
Dv (90) 308 µm
Volume Below (31) µm 13.83 %



Result									
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	5.65	88.0	16.58	350	94.97	1410	100.00
0.0600	0.00	15.6	9.64	105	19.48	420	98.58	1680	100.00
0.120	0.00	31.0	13.83	125	25.41	500	99.80	2000	100.00
0.240	0.00	37.0	14.76	149	35.62	590	100.00	2380	100.00
0.490	0.00	44.0	15.40	177	48.82	710	100.00	2830	100.00
0.980	0.46	53.0	15.70	210	63.35	840	100.00	3360	100.00
2.00	1.06	63.0	15.70	250	77.19	1000	100.00		
3.90	2.49	74.0	15.78	300	88.58	1190	100.00		

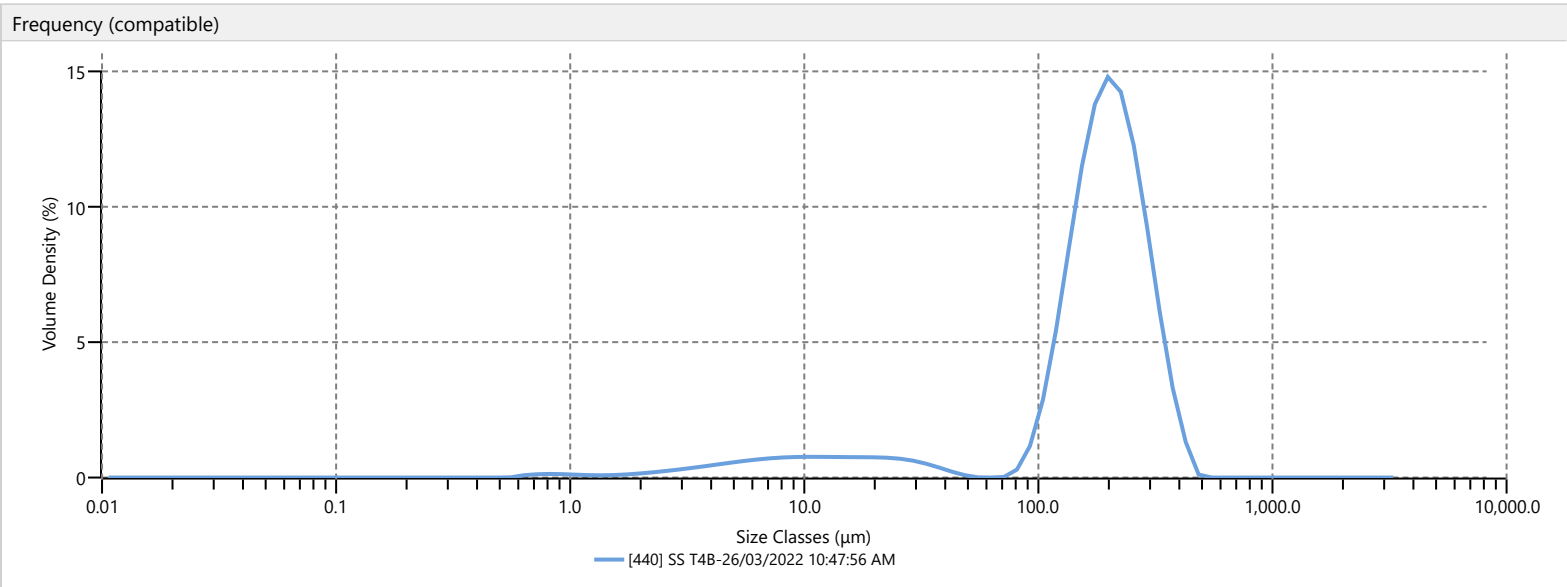
Measurement Details	Measurement Details
Sample Name SS T4	Analysis Date Time 26/03/2022 10:40:49 AM
SOP File Name Marine Sediment.msop	Measurement Date Time 26/03/2022 10:40:49 AM
Lab Number 2022056/9	Result Source Measurement
Operator Name instrument	
Analysis	Result
Particle Name Marine Sediment	Concentration 0.0356 %
Particle Refractive Index 1.500	Span 2.188
Particle Absorption Index 0.200	Uniformity 0.793
Dispersant Name Water	Specific Surface Area 343.6 m²/kg
Dispersant Refractive Index 1.330	D [3,2] 17.5 µm
Scattering Model Mie	D [4,3] 168 µm
Analysis Model General Purpose	Dv (10) 7.16 µm
Weighted Residual 0.39 %	Dv (50) 147 µm
Laser Obscuration 14.33 %	Dv (90) 329 µm
	Volume Below (31) µm 26.82 %



Result									
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	10.84	88.0	34.90	350	91.77	1410	99.88
0.0600	0.00	15.6	18.50	105	37.97	420	94.92	1680	100.00
0.120	0.00	31.0	26.82	125	43.02	500	96.46	2000	100.00
0.240	0.00	37.0	28.80	149	50.64	590	97.19	2380	100.00
0.490	0.00	44.0	30.44	177	59.89	710	97.78	2830	100.00
0.980	0.88	53.0	31.75	210	69.77	840	98.37	3360	100.00
2.00	2.22	63.0	32.61	250	79.12	1000	99.01		
3.90	5.10	74.0	33.41	300	87.03	1190	99.54		

Measurement Details	Measurement Details
Sample Name SS T4B	Analysis Date Time 26/03/2022 10:47:56 AM
SOP File Name Marine Sediment.msop	Measurement Date Time 26/03/2022 10:47:56 AM
Lab Number 2022056/10	Result Source Measurement
Operator Name instrument	

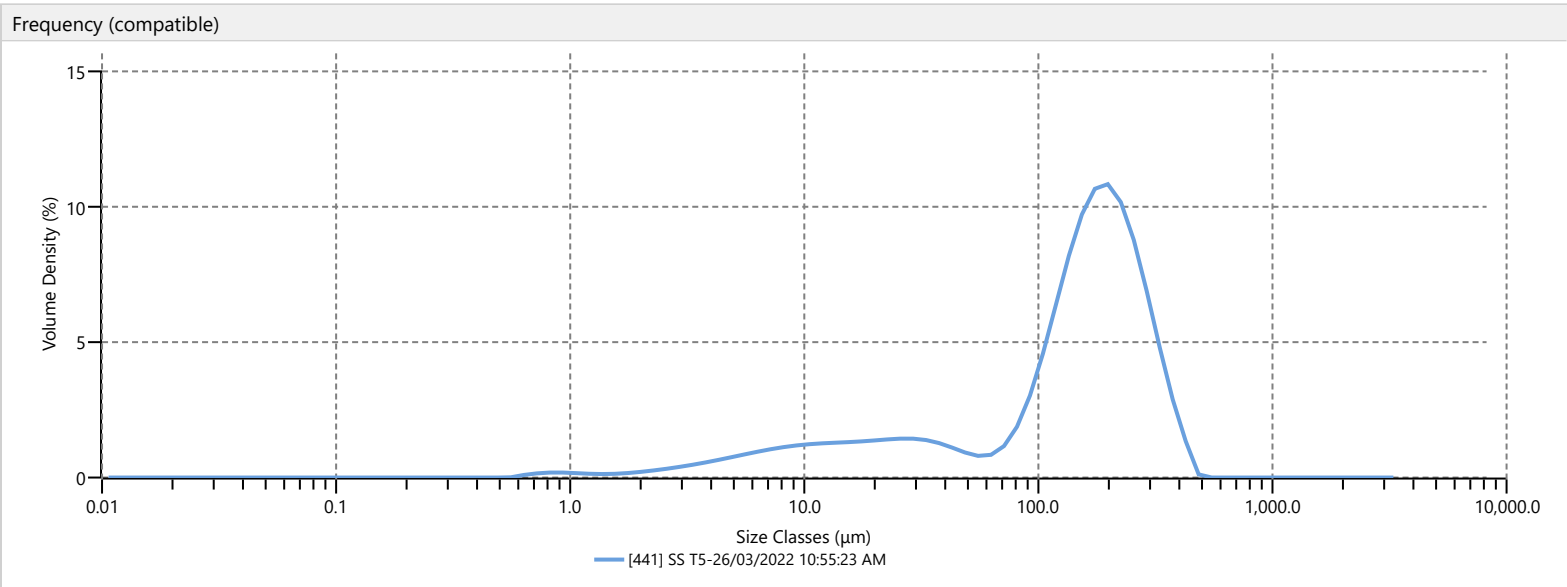
Analysis	Result
Particle Name Marine Sediment	Concentration 0.0755 %
Particle Refractive Index 1.500	Span 1.494
Particle Absorption Index 0.200	Uniformity 0.382
Dispersant Name Water	Specific Surface Area 162.9 m²/kg
Dispersant Refractive Index 1.330	D [3,2] 36.8 µm
Scattering Model Mie	D [4,3] 187 µm
Analysis Model General Purpose	Dv (10) 22.3 µm
Weighted Residual 0.30 %	Dv (50) 188 µm
Laser Obscuration 14.40 %	Dv (90) 304 µm
	Volume Below (31) µm 11.46 %



Result									
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	4.83	88.0	12.80	350	96.07	1410	100.00
0.0600	0.00	15.6	8.26	105	14.82	420	99.36	1680	100.00
0.120	0.00	31.0	11.46	125	19.93	500	100.00	2000	100.00
0.240	0.00	37.0	12.02	149	30.09	590	100.00	2380	100.00
0.490	0.00	44.0	12.34	177	44.30	710	100.00	2830	100.00
0.980	0.39	53.0	12.46	210	60.64	840	100.00	3360	100.00
2.00	0.86	63.0	12.46	250	76.47	1000	100.00		
3.90	2.10	74.0	12.46	300	89.28	1190	100.00		

Measurement Details	Measurement Details
Sample Name SS T5	Analysis Date Time 26/03/2022 10:55:23 AM
SOP File Name Marine Sediment.msop	Measurement Date Time 26/03/2022 10:55:23 AM
Lab Number 2022056/11	Result Source Measurement
Operator Name instrument	

Analysis	Result
Particle Name Marine Sediment	Concentration 0.0527 %
Particle Refractive Index 1.500	Span 1.796
Particle Absorption Index 0.200	Uniformity 0.531
Dispersant Name Water	Specific Surface Area 227.0 m²/kg
Dispersant Refractive Index 1.330	D [3,2] 26.4 µm
Scattering Model Mie	D [4,3] 156 µm
Analysis Model General Purpose	Dv (10) 11.9 µm
Weighted Residual 0.34 %	Dv (50) 156 µm
Laser Obscuration 14.08 %	Dv (90) 293 µm
	Volume Below (31) µm 18.49 %



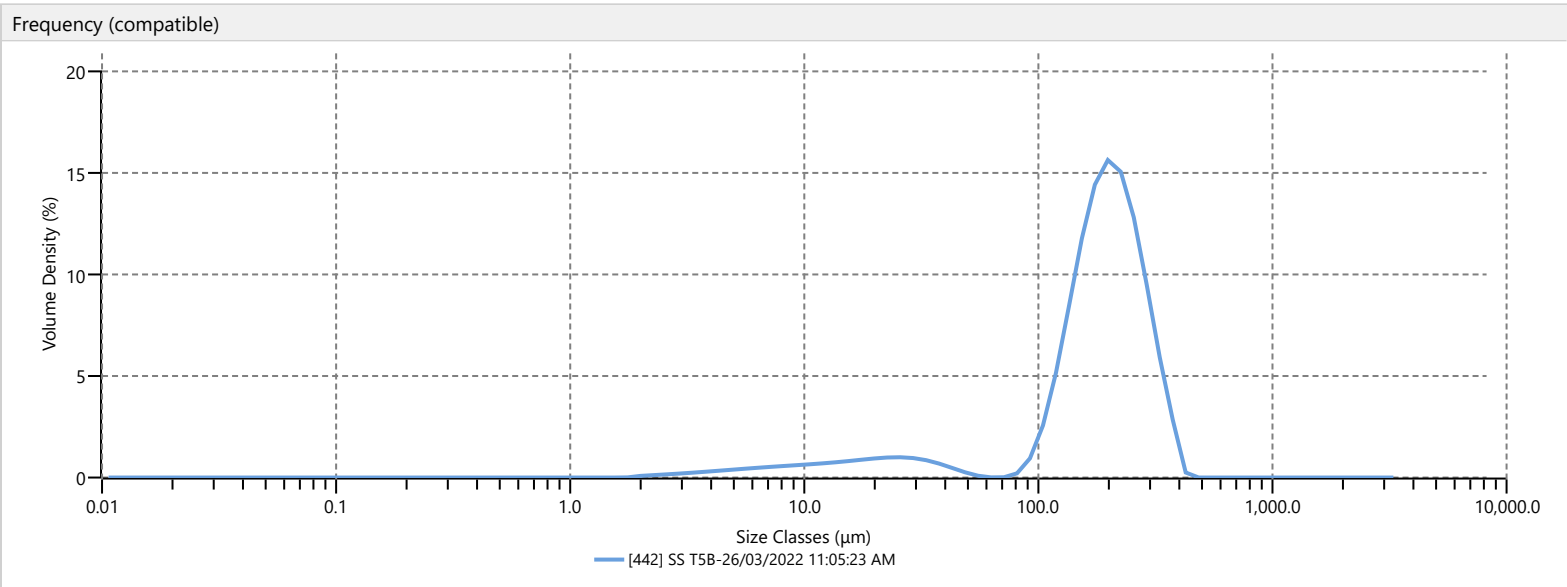
Result									
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	6.68	88.0	26.62	350	96.36	1410	100.00
0.0600	0.00	15.6	12.25	105	30.76	420	99.32	1680	100.00
0.120	0.00	31.0	18.49	125	37.32	500	100.00	2000	100.00
0.240	0.00	37.0	20.07	149	46.94	590	100.00	2380	100.00
0.490	0.00	44.0	21.41	177	58.42	710	100.00	2830	100.00
0.980	0.51	53.0	22.55	210	70.54	840	100.00	3360	100.00
2.00	1.22	63.0	23.45	250	81.83	1000	100.00		
3.90	2.85	74.0	24.52	300	91.11	1190	100.00		

Measurement Details
Sample Name SS T5B
SOP File Name Marine Sediment.msop
Lab Number 2022056/12
Operator Name instrument

Analysis
Particle Name Marine Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.42 %
Laser Obscuration 15.18 %

Measurement Details
Analysis Date Time 26/03/2022 11:05:23 AM
Measurement Date Time 26/03/2022 11:05:23 AM
Result Source Measurement

Result
Concentration 0.1275 %
Span 1.405
Uniformity 0.357
Specific Surface Area 97.55 m²/kg
D [3,2] 61.5 µm
D [4,3] 186 µm
Dv (10) 30.7 µm
Dv (50) 189 µm
Dv (90) 296 µm
Volume Below (31) µm 10.06 %



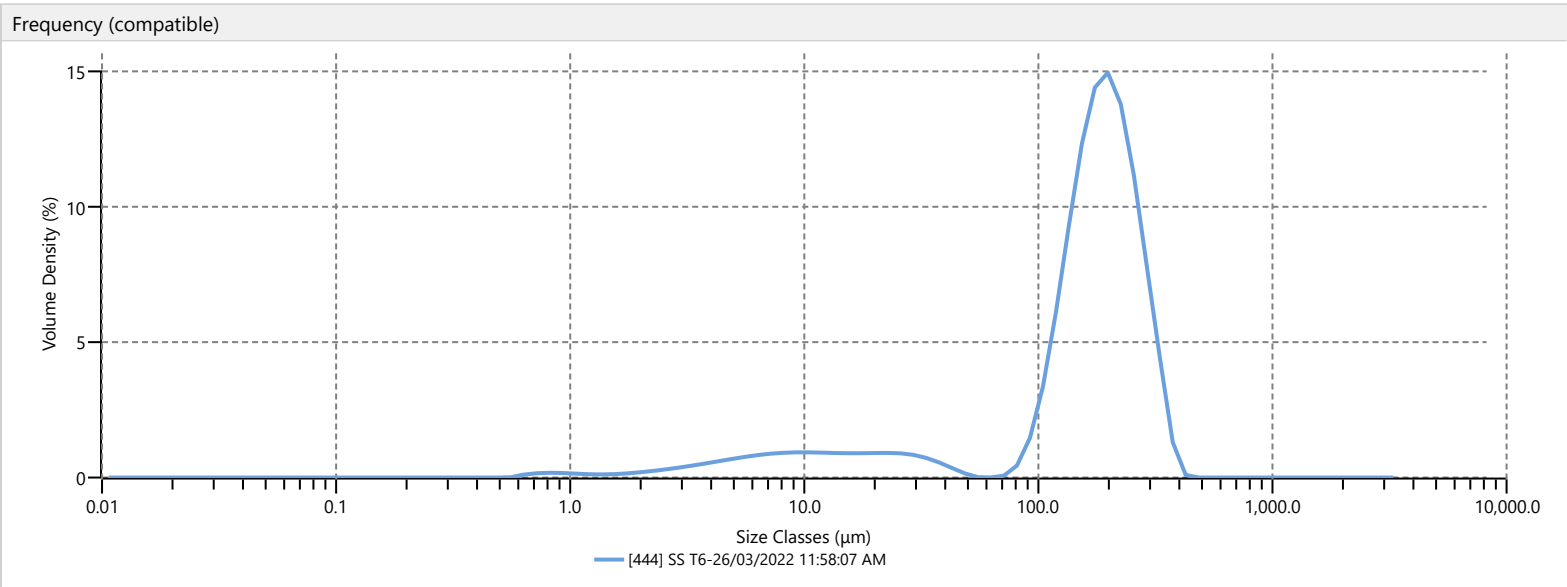
Result									
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	2.78	88.0	12.30	350	97.44	1410	100.00
0.0600	0.00	15.6	5.83	105	14.01	420	99.99	1680	100.00
0.120	0.00	31.0	10.06	125	18.78	500	100.00	2000	100.00
0.240	0.00	37.0	11.01	149	28.93	590	100.00	2380	100.00
0.490	0.00	44.0	11.66	177	43.64	710	100.00	2830	100.00
0.980	0.00	53.0	12.00	210	60.88	840	100.00	3360	100.00
2.00	0.04	63.0	12.05	250	77.57	1000	100.00		
3.90	0.84	74.0	12.05	300	90.79	1190	100.00		

Measurement Details
Sample Name SS T6
SOP File Name Marine Sediment.msop
Lab Number 2022056/13
Operator Name instrument

Analysis
Particle Name Marine Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.34 %
Laser Obscuration 15.97 %

Measurement Details
Analysis Date Time 26/03/2022 11:58:07 AM
Measurement Date Time 26/03/2022 11:58:07 AM
Result Source Measurement

Result
Concentration 0.0690 %
Span 1.501
Uniformity 0.389
Specific Surface Area 200.1 m ² /kg
D [3,2] 30.0 μm
D [4,3] 170 μm
Dv (10) 15.0 μm
Dv (50) 176 μm
Dv (90) 279 μm
Volume Below (31) μm 14.22 %



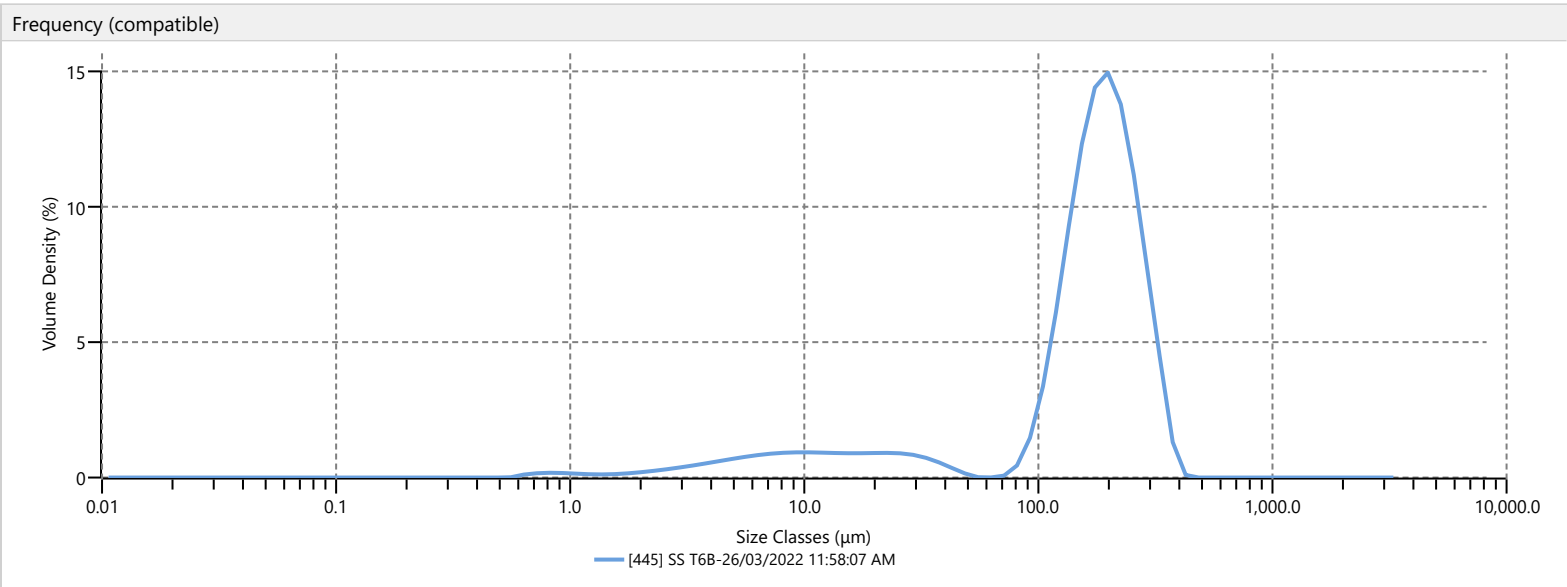
Result									
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	6.06	88.0	16.26	350	98.92	1410	100.00
0.0600	0.00	15.6	10.22	105	18.71	420	100.00	1680	100.00
0.120	0.00	31.0	14.22	125	24.53	500	100.00	2000	100.00
0.240	0.00	37.0	15.01	149	35.64	590	100.00	2380	100.00
0.490	0.00	44.0	15.52	177	50.69	710	100.00	2830	100.00
0.980	0.51	53.0	15.73	210	67.38	840	100.00	3360	100.00
2.00	1.15	63.0	15.73	250	82.52	1000	100.00		
3.90	2.68	74.0	15.76	300	93.75	1190	100.00		

Measurement Details
Sample Name SS T6B
SOP File Name Marine Sediment.msop
Lab Number 2022056/14
Operator Name instrument

Analysis
Particle Name Marine Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.34 %
Laser Obscuration 15.97 %

Measurement Details
Analysis Date Time 26/03/2022 11:58:07 AM
Measurement Date Time 26/03/2022 11:58:07 AM
Result Source Edited

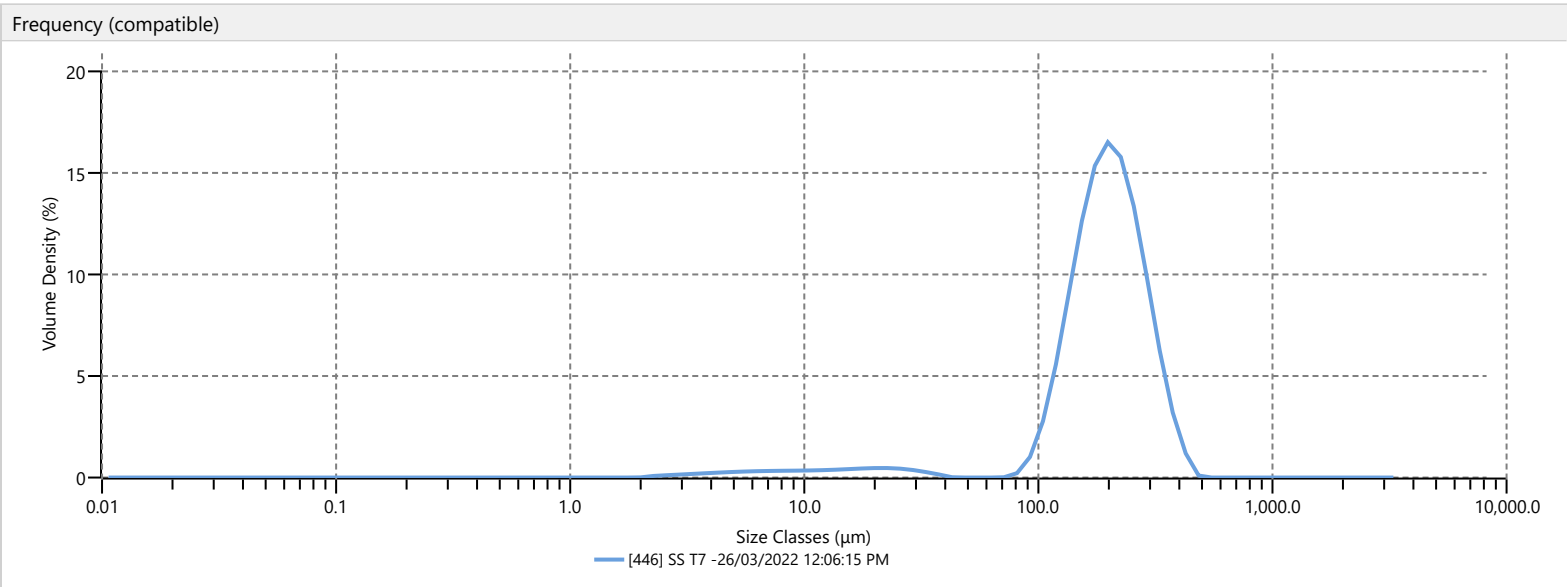
Result
Concentration 0.0690 %
Span 1.501
Uniformity 0.389
Specific Surface Area 200.1 m ² /kg
D [3,2] 30.0 μm
D [4,3] 170 μm
Dv (10) 15.0 μm
Dv (50) 176 μm
Dv (90) 279 μm
Volume Below (31) μm 14.22 %



Result									
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	6.06	88.0	16.26	350	98.92	1410	100.00
0.0600	0.00	15.6	10.22	105	18.71	420	100.00	1680	100.00
0.120	0.00	31.0	14.22	125	24.53	500	100.00	2000	100.00
0.240	0.00	37.0	15.01	149	35.64	590	100.00	2380	100.00
0.490	0.00	44.0	15.52	177	50.69	710	100.00	2830	100.00
0.980	0.51	53.0	15.73	210	67.38	840	100.00	3360	100.00
2.00	1.15	63.0	15.73	250	82.52	1000	100.00		
3.90	2.68	74.0	15.76	300	93.75	1190	100.00		

Measurement Details	Measurement Details
Sample Name SS T7	Analysis Date Time 26/03/2022 12:06:15 PM
SOP File Name Marine Sediment.msop	Measurement Date Time 26/03/2022 12:06:15 PM
Lab Number 2022056/15	Result Source Measurement
Operator Name instrument	

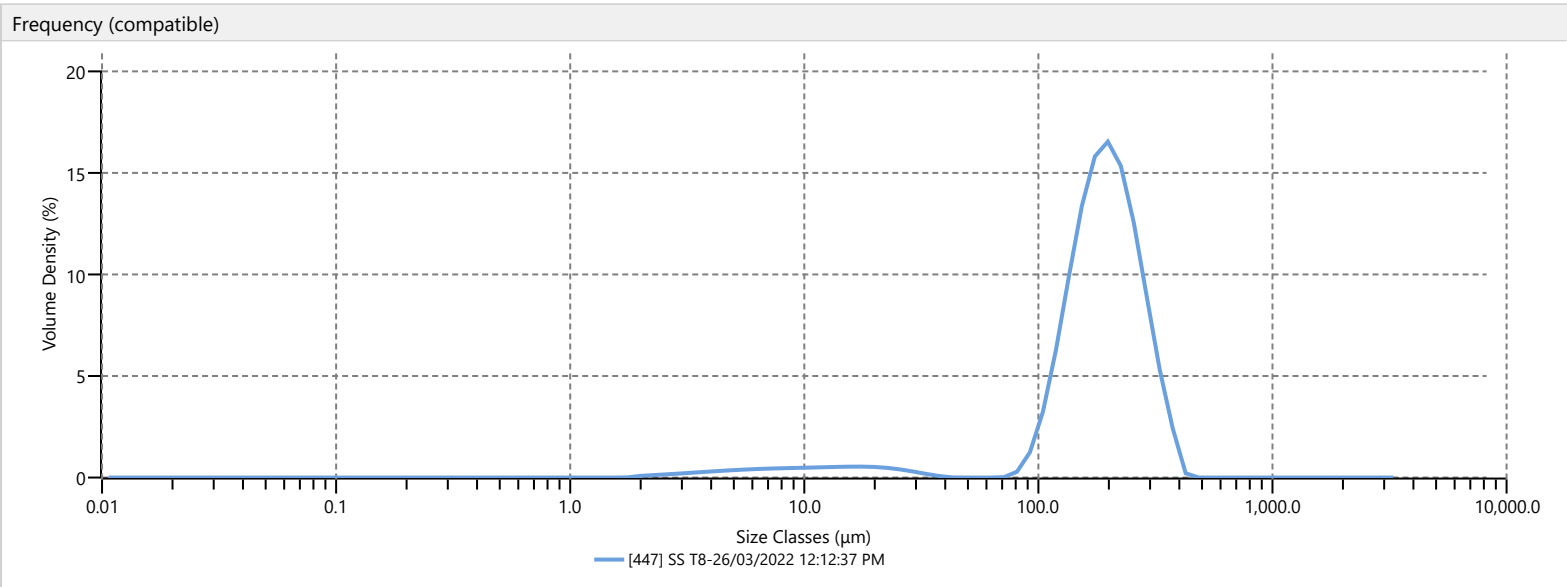
Analysis	Result
Particle Name Marine Sediment	Concentration 0.1601 %
Particle Refractive Index 1.500	Span 0.967
Particle Absorption Index 0.200	Uniformity 0.315
Dispersant Name Water	Specific Surface Area 70.30 m²/kg
Dispersant Refractive Index 1.330	D [3,2] 85.3 µm
Scattering Model Mie	D [4,3] 199 µm
Analysis Model General Purpose	Dv (10) 115 µm
Weighted Residual 0.40 %	Dv (50) 195 µm
Laser Obscuration 13.78 %	Dv (90) 303 µm
	Volume Below (31) µm 5.47 %



Result									
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	1.87	88.0	6.08	350	96.28	1410	100.00
0.0600	0.00	15.6	3.51	105	7.93	420	99.43	1680	100.00
0.120	0.00	31.0	5.47	125	13.10	500	100.00	2000	100.00
0.240	0.00	37.0	5.75	149	24.05	590	100.00	2380	100.00
0.490	0.00	44.0	5.83	177	39.78	710	100.00	2830	100.00
0.980	0.00	53.0	5.83	210	58.02	840	100.00	3360	100.00
2.00	0.00	63.0	5.83	250	75.50	1000	100.00		
3.90	0.57	74.0	5.83	300	89.28	1190	100.00		

Measurement Details	Measurement Details
Sample Name SS T8	Analysis Date Time 26/03/2022 12:12:37 PM
SOP File Name Marine Sediment.msop	Measurement Date Time 26/03/2022 12:12:37 PM
Lab Number 2022056/15	Result Source Measurement
Operator Name instrument	

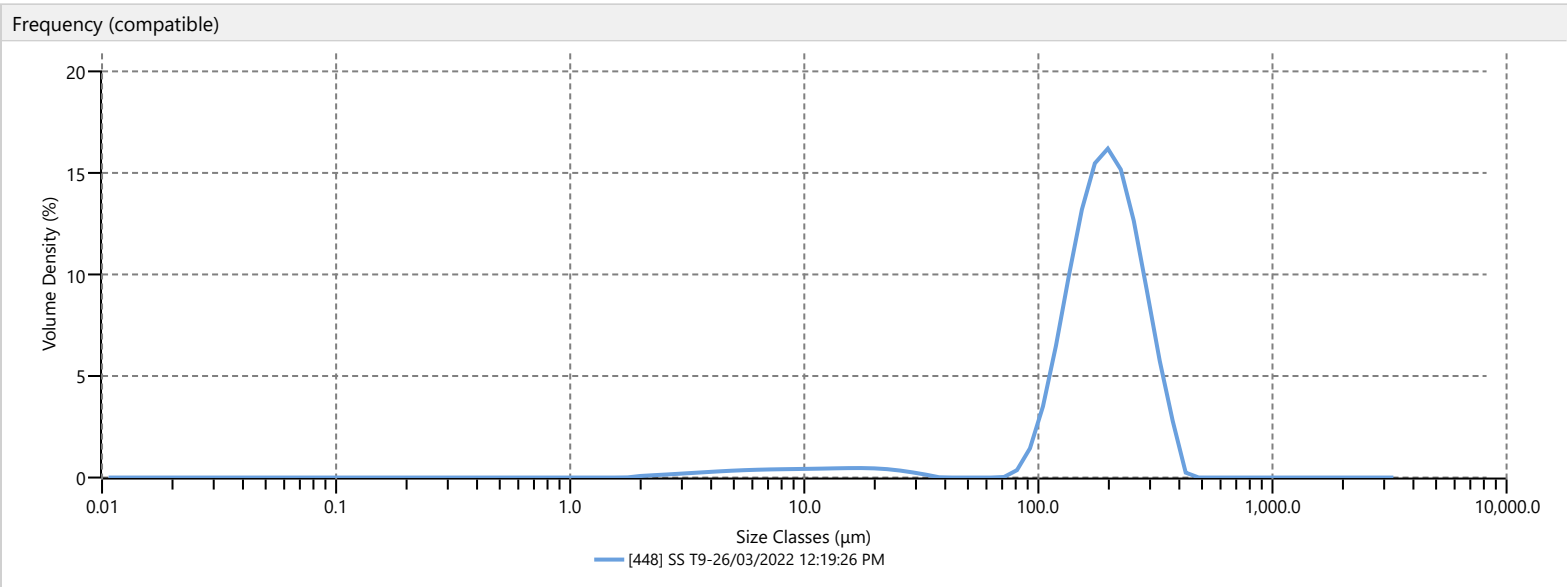
Analysis	Result
Particle Name Marine Sediment	Concentration 0.1254 %
Particle Refractive Index 1.500	Span 0.980
Particle Absorption Index 0.200	Uniformity 0.321
Dispersant Name Water	Specific Surface Area 85.34 m²/kg
Dispersant Refractive Index 1.330	D [3,2] 70.3 µm
Scattering Model Mie	D [4,3] 189 µm
Analysis Model General Purpose	Dv (10) 107 µm
Weighted Residual 0.39 %	Dv (50) 188 µm
Laser Obscuration 13.19 %	Dv (90) 291 µm
	Volume Below (31) µm 6.87 %



Result									
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	2.58	88.0	7.42	350	97.84	1410	100.00
0.0600	0.00	15.6	4.83	105	9.64	420	99.99	1680	100.00
0.120	0.00	31.0	6.87	125	15.53	500	100.00	2000	100.00
0.240	0.00	37.0	7.05	149	27.39	590	100.00	2380	100.00
0.490	0.00	44.0	7.09	177	43.83	710	100.00	2830	100.00
0.980	0.00	53.0	7.09	210	62.24	840	100.00	3360	100.00
2.00	0.04	63.0	7.09	250	79.13	1000	100.00		
3.90	0.84	74.0	7.09	300	91.82	1190	100.00		

Measurement Details	Measurement Details
Sample Name SS T9	Analysis Date Time 26/03/2022 12:19:26 PM
SOP File Name Marine Sediment.msop	Measurement Date Time 26/03/2022 12:19:26 PM
Lab Number 2022056/16	Result Source Measurement
Operator Name instrument	

Analysis	Result
Particle Name Marine Sediment	Concentration 0.1301 %
Particle Refractive Index 1.500	Span 0.984
Particle Absorption Index 0.200	Uniformity 0.321
Dispersant Name Water	Specific Surface Area 80.94 m²/kg
Dispersant Refractive Index 1.330	D [3,2] 74.1 µm
Scattering Model Mie	D [4,3] 192 µm
Analysis Model General Purpose	Dv (10) 109 µm
Weighted Residual 0.36 %	Dv (50) 189 µm
Laser Obscuration 12.98 %	Dv (90) 295 µm
	Volume Below (31) µm 6.14 %



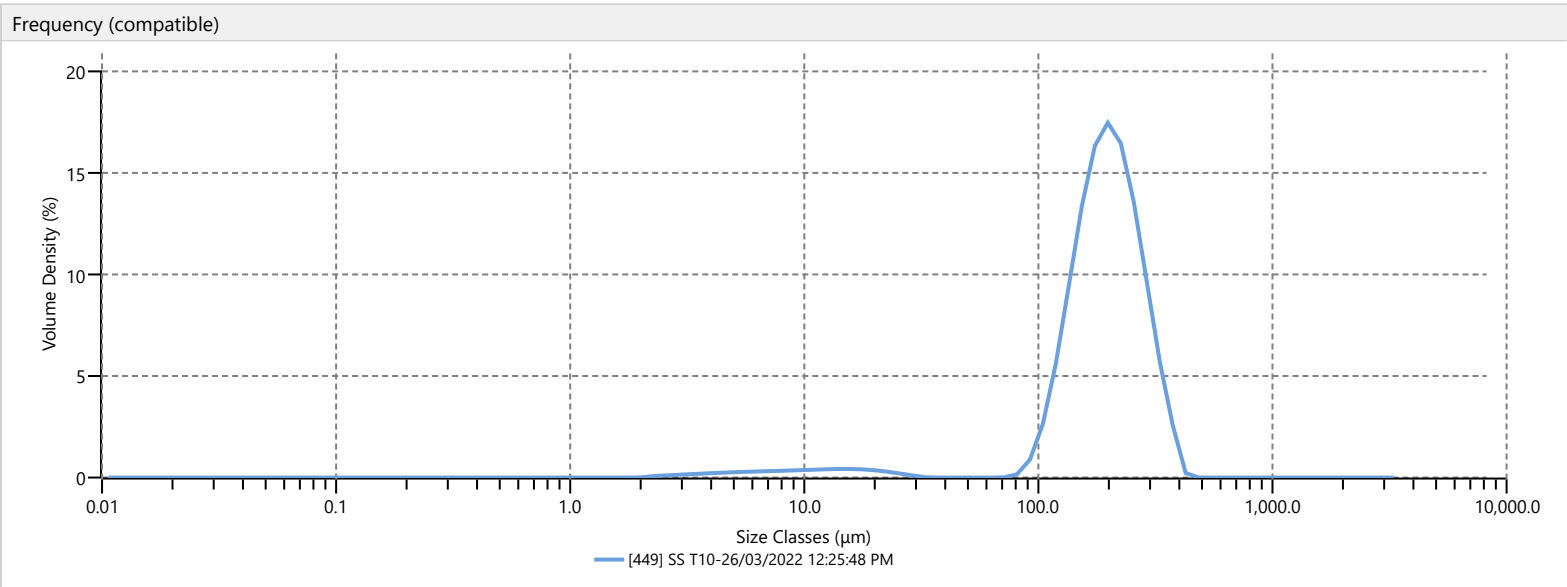
Result									
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	2.40	88.0	6.69	350	97.50	1410	100.00
0.0600	0.00	15.6	4.37	105	9.16	420	99.99	1680	100.00
0.120	0.00	31.0	6.14	125	15.32	500	100.00	2000	100.00
0.240	0.00	37.0	6.26	149	27.19	590	100.00	2380	100.00
0.490	0.00	44.0	6.26	177	43.33	710	100.00	2830	100.00
0.980	0.00	53.0	6.26	210	61.35	840	100.00	3360	100.00
2.00	0.04	63.0	6.26	250	78.09	1000	100.00		
3.90	0.80	74.0	6.27	300	91.05	1190	100.00		

Measurement Details
Sample Name SS T10
SOP File Name Marine Sediment.msop
Lab Number 2022056/18
Operator Name instrument

Analysis
Particle Name Marine Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.30 %
Laser Obscuration 13.52 %

Measurement Details
Analysis Date Time 26/03/2022 12:25:48 PM
Measurement Date Time 26/03/2022 12:25:48 PM
Result Source Measurement

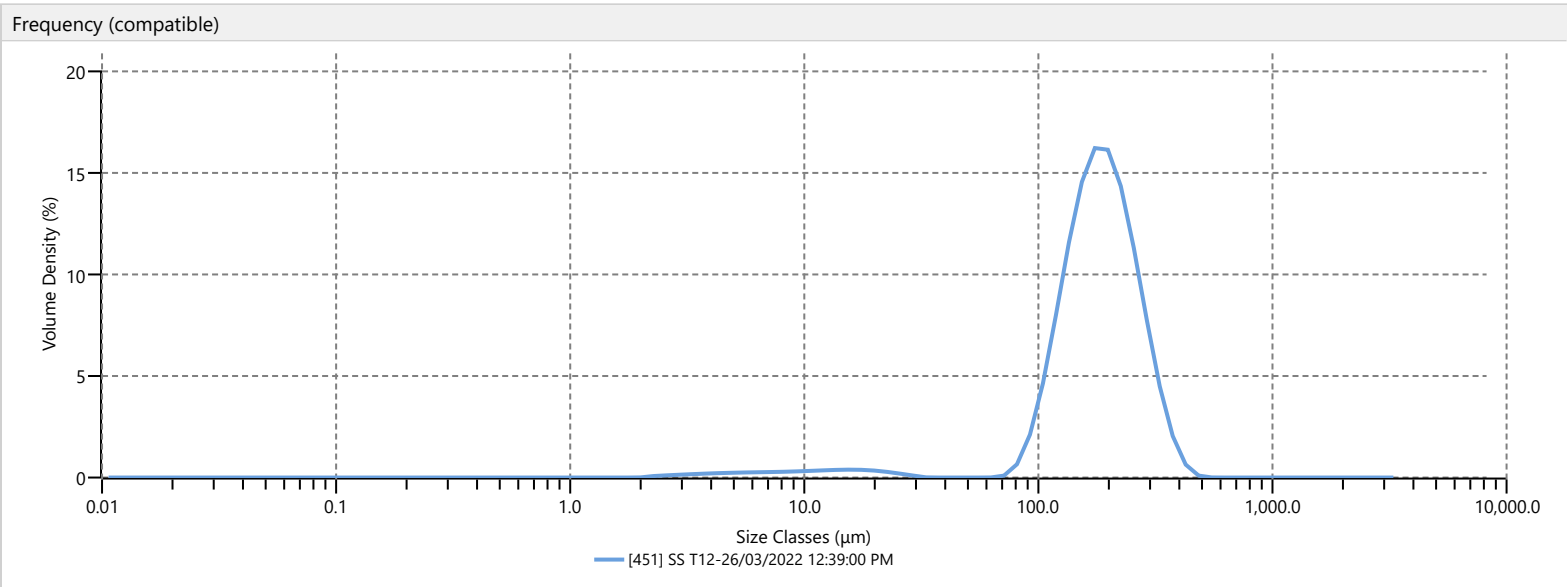
Result
Concentration 0.1626 %
Span 0.906
Uniformity 0.293
Specific Surface Area 67.89 m ² /kg
D [3,2] 88.4 μm
D [4,3] 197 μm
Dv (10) 119 μm
Dv (50) 194 μm
Dv (90) 294 μm
Volume Below (31) μm 4.80 %



Result									
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	1.78	88.0	4.99	350	97.70	1410	100.00
0.0600	0.00	15.6	3.52	105	6.69	420	99.99	1680	100.00
0.120	0.00	31.0	4.80	125	11.84	500	100.00	2000	100.00
0.240	0.00	37.0	4.80	149	23.26	590	100.00	2380	100.00
0.490	0.00	44.0	4.80	177	39.97	710	100.00	2830	100.00
0.980	0.00	53.0	4.80	210	59.31	840	100.00	3360	100.00
2.00	0.00	63.0	4.80	250	77.46	1000	100.00		
3.90	0.54	74.0	4.80	300	91.20	1190	100.00		

Measurement Details	Measurement Details
Sample Name SS T12	Analysis Date Time 26/03/2022 12:39:00 PM
SOP File Name Marine Sediment.msop	Measurement Date Time 26/03/2022 12:39:00 PM
Lab Number 2022056/20	Result Source Measurement
Operator Name instrument	

Analysis	Result
Particle Name Marine Sediment	Concentration 0.1761 %
Particle Refractive Index 1.500	Span 0.966
Particle Absorption Index 0.200	Uniformity 0.314
Dispersant Name Water	Specific Surface Area 67.34 m²/kg
Dispersant Refractive Index 1.330	D [3,2] 89.1 µm
Scattering Model Mie	D [4,3] 187 µm
Analysis Model General Purpose	Dv (10) 110 µm
Weighted Residual 0.42 %	Dv (50) 181 µm
Laser Obscuration 14.43 %	Dv (90) 285 µm
	Volume Below (31) µm 4.37 %



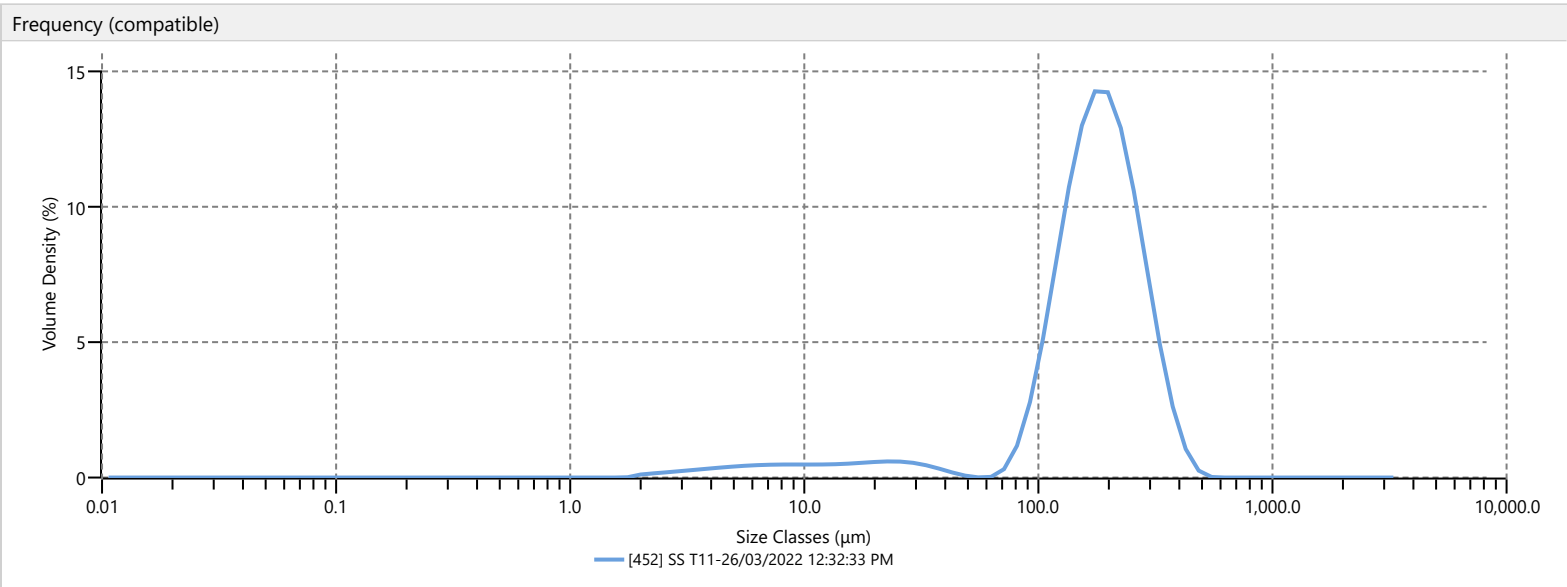
Result									
Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	1.64	88.0	5.16	350	97.71	1410	100.00
0.0600	0.00	15.6	3.16	105	8.62	420	99.67	1680	100.00
0.120	0.00	31.0	4.37	125	16.37	500	99.99	2000	100.00
0.240	0.00	37.0	4.38	149	30.07	590	100.00	2380	100.00
0.490	0.00	44.0	4.38	177	47.45	710	100.00	2830	100.00
0.980	0.00	53.0	4.38	210	65.66	840	100.00	3360	100.00
2.00	0.00	63.0	4.38	250	81.34	1000	100.00		
3.90	0.53	74.0	4.41	300	92.58	1190	100.00		

Measurement Details
Sample Name SS T11
SOP File Name Marine Sediment.msop
Lab Number 2022056/19
Operator Name instrument

Analysis
Particle Name Marine Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.47 %
Laser Obscuration 14.49 %

Measurement Details
Analysis Date Time 26/03/2022 12:32:33 PM
Measurement Date Time 26/03/2022 12:32:33 PM
Result Source Edited

Result
Concentration 0.1251 %
Span 1.161
Uniformity 0.371
Specific Surface Area 94.58 m ² /kg
D [3,2] 63.4 μm
D [4,3] 182 μm
Dv (10) 87.8 μm
Dv (50) 177 μm
Dv (90) 293 μm
Volume Below (31) μm 7.67 %



Result									
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	2.93	88.0	10.03	350	96.72	1410	100.00
0.0600	0.00	15.6	5.13	105	14.22	420	99.32	1680	100.00
0.120	0.00	31.0	7.67	125	22.12	500	99.95	2000	100.00
0.240	0.00	37.0	8.16	149	34.76	590	100.00	2380	100.00
0.490	0.00	44.0	8.45	177	50.15	710	100.00	2830	100.00
0.980	0.00	53.0	8.55	210	66.17	840	100.00	3360	100.00
2.00	0.05	63.0	8.55	250	80.36	1000	100.00		
3.90	1.01	74.0	8.73	300	91.20	1190	100.00		

Appendix 4: Analyses of sediment contaminants



Certificate of Analysis

Page 1 of 3

Client:	Boffa Miskell Limited	Lab No:	2921358	SPv1
Contact:	Tommaso Alestra	Date Received:	18-Mar-2022	
	C/- Boffa Miskell Limited	Date Reported:	11-Apr-2022	
	PO Box 110	Quote No:	111621	
	Christchurch 8140	Order No:		
		Client Reference:	Avon Heathcote Estuary	
		Submitted By:	Tommaso Alestra	

Sample Type: Sediment

Sample Name:		SNB T1 14-Mar-2022	SNB T3 14-Mar-2022	SNB T5 14-Mar-2022	SS T1 14-Mar-2022	SS T3 15-Mar-2022
Lab Number:		2921358.1	2921358.2	2921358.3	2921358.4	2921358.5
Individual Tests						
Dry Matter	g/100g as rcvd	79	79	75	80	72
Total Recoverable Copper	mg/kg dry wt	2.5	2.2	2.5	3.2	3.0
Total Recoverable Lead	mg/kg dry wt	7.6	8.9	6.9	7.8	6.7
Total Recoverable Zinc	mg/kg dry wt	35	34	33	57	37
Total Organic Carbon*	g/100g dry wt	0.16	0.19	0.21	0.27	0.26
Polycyclic Aromatic Hydrocarbons Trace in Soil*						
Total of Reported PAHs in Soil	mg/kg dry wt	0.16	0.11	0.07	0.10	0.15
1-Methylnaphthalene	mg/kg dry wt	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
2-Methylnaphthalene	mg/kg dry wt	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Acenaphthene	mg/kg dry wt	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Acenaphthylene	mg/kg dry wt	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Anthracene	mg/kg dry wt	< 0.002	< 0.002	< 0.002	0.002	0.002
Benzo[a]anthracene	mg/kg dry wt	0.011	0.006	0.004	0.006	0.009
Benzo[a]pyrene (BAP)	mg/kg dry wt	0.015	0.009	0.006	0.008	0.013
Benzo[b]fluoranthene + Benzo[j]fluoranthene	mg/kg dry wt	0.017	0.011	0.008	0.009	0.014
Benzo[e]pyrene	mg/kg dry wt	0.010	0.006	0.007	0.005	0.010
Benzo[g,h,i]perylene	mg/kg dry wt	0.012	0.007	0.006	0.005	0.009
Benzo[k]fluoranthene	mg/kg dry wt	0.007	0.004	0.003	0.003	0.006
Chrysene	mg/kg dry wt	0.010	0.007	0.004	0.006	0.010
Dibenzo[a,h]anthracene	mg/kg dry wt	0.002	< 0.002	< 0.002	< 0.002	< 0.002
Fluoranthene	mg/kg dry wt	0.024	0.017	0.010	0.013	0.025
Fluorene	mg/kg dry wt	< 0.002	< 0.002	< 0.002	0.002	< 0.002
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	0.010	0.006	0.005	0.005	0.008
Naphthalene	mg/kg dry wt	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Perylene	mg/kg dry wt	0.003	< 0.002	< 0.002	< 0.002	0.002
Phenanthrene	mg/kg dry wt	0.010	0.008	0.004	0.011	0.012
Pyrene	mg/kg dry wt	0.023	0.016	0.009	0.011	0.023
Benzo[a]pyrene Potency Equivalency Factor (PEF) NES*	mg/kg dry wt	0.022	0.013	0.009	0.012	0.019
Benzo[a]pyrene Toxic Equivalence (TEF)*	mg/kg dry wt	0.022	0.013	0.009	0.012	0.018



This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised. The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked * or any comments and interpretations, which are not accredited.

Sample Type: Sediment						
Sample Name:		SS T4B 15-Mar-2022	SS T5 16-Mar-2022	SS T6B 15-Mar-2022	SS T8 16-Mar-2022	SS T10 16-Mar-2022
Lab Number:		2921358.6	2921358.7	2921358.8	2921358.9	2921358.10
Individual Tests						
Dry Matter	g/100g as rcvd	80	77	73	78	78
Total Recoverable Copper	mg/kg dry wt	2.0	3.6	2.2	2.0	4.3
Total Recoverable Lead	mg/kg dry wt	5.6	12.4	6.2	5.7	6.0
Total Recoverable Zinc	mg/kg dry wt	30	40	32	31	31
Total Organic Carbon*	g/100g dry wt	0.19	0.41	0.19	0.14	0.27
Polycyclic Aromatic Hydrocarbons Trace in Soil*						
Total of Reported PAHs in Soil	mg/kg dry wt	< 0.05	1.30	0.10	0.24	< 0.05
1-Methylnaphthalene	mg/kg dry wt	< 0.002	0.003	< 0.002	< 0.002	< 0.002
2-Methylnaphthalene	mg/kg dry wt	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Acenaphthene	mg/kg dry wt	< 0.002	0.005	< 0.002	< 0.002	< 0.002
Acenaphthylene	mg/kg dry wt	< 0.002	0.016	0.002	< 0.002	< 0.002
Anthracene	mg/kg dry wt	< 0.002	0.033	0.002	0.004	< 0.002
Benzo[a]anthracene	mg/kg dry wt	0.003	0.087	0.006	0.017	< 0.002
Benzo[a]pyrene (BAP)	mg/kg dry wt	0.004	0.106	0.008	0.020	0.002
Benzo[b]fluoranthene + Benzo[j]fluoranthene	mg/kg dry wt	0.004	0.107	0.009	0.020	0.002
Benzo[e]pyrene	mg/kg dry wt	0.003	0.053	0.008	0.011	0.002
Benzo[g,h,i]perylene	mg/kg dry wt	0.003	0.058	0.006	0.013	0.002
Benzo[k]fluoranthene	mg/kg dry wt	< 0.002	0.045	0.004	0.009	< 0.002
Chrysene	mg/kg dry wt	0.003	0.088	0.006	0.016	< 0.002
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.002	0.014	< 0.002	0.002	< 0.002
Fluoranthene	mg/kg dry wt	0.007	0.22	0.014	0.049	0.002
Fluorene	mg/kg dry wt	< 0.002	0.017	0.002	< 0.002	< 0.002
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	0.002	0.058	0.006	0.012	< 0.002
Naphthalene	mg/kg dry wt	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Perylene	mg/kg dry wt	< 0.002	0.020	< 0.002	0.004	< 0.002
Phenanthrene	mg/kg dry wt	0.003	0.172	0.012	0.012	< 0.002
Pyrene	mg/kg dry wt	0.006	0.197	0.012	0.044	< 0.002
Benzo[a]pyrene Potency Equivalency Factor (PEF) NES*	mg/kg dry wt	0.005	0.152	0.012	0.029	< 0.005
Benzo[a]pyrene Toxic Equivalence (TEF)*	mg/kg dry wt	0.005	0.150	0.012	0.028	< 0.005
Sample Name:		SS T12 16-Mar-2022				
Lab Number:		2921358.11				
Individual Tests						
Dry Matter	g/100g as rcvd	76	-	-	-	-
Total Recoverable Copper	mg/kg dry wt	2.2	-	-	-	-
Total Recoverable Lead	mg/kg dry wt	6.8	-	-	-	-
Total Recoverable Zinc	mg/kg dry wt	33	-	-	-	-
Total Organic Carbon*	g/100g dry wt	0.18	-	-	-	-
Polycyclic Aromatic Hydrocarbons Trace in Soil*						
Total of Reported PAHs in Soil	mg/kg dry wt	0.07	-	-	-	-
1-Methylnaphthalene	mg/kg dry wt	< 0.002	-	-	-	-
2-Methylnaphthalene	mg/kg dry wt	< 0.002	-	-	-	-
Acenaphthene	mg/kg dry wt	< 0.002	-	-	-	-
Acenaphthylene	mg/kg dry wt	< 0.002	-	-	-	-
Anthracene	mg/kg dry wt	< 0.002	-	-	-	-
Benzo[a]anthracene	mg/kg dry wt	0.005	-	-	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	0.006	-	-	-	-
Benzo[b]fluoranthene + Benzo[j]fluoranthene	mg/kg dry wt	0.007	-	-	-	-
Benzo[e]pyrene	mg/kg dry wt	0.005	-	-	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	0.005	-	-	-	-
Benzo[k]fluoranthene	mg/kg dry wt	0.003	-	-	-	-
Chrysene	mg/kg dry wt	0.005	-	-	-	-

Sample Type: Sediment						
Sample Name:		SS T12				
		16-Mar-2022				
Lab Number:		2921358.11				
Polycyclic Aromatic Hydrocarbons Trace in Soil*						
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.002	-	-	-	-
Fluoranthene	mg/kg dry wt	0.011	-	-	-	-
Fluorene	mg/kg dry wt	< 0.002	-	-	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	0.004	-	-	-	-
Naphthalene	mg/kg dry wt	< 0.010	-	-	-	-
Perylene	mg/kg dry wt	< 0.002	-	-	-	-
Phenanthrene	mg/kg dry wt	0.004	-	-	-	-
Pyrene	mg/kg dry wt	0.010	-	-	-	-
Benzo[a]pyrene Potency Equivalency Factor (PEF) NES*	mg/kg dry wt	0.008	-	-	-	-
Benzo[a]pyrene Toxic Equivalence (TEF)*	mg/kg dry wt	0.008	-	-	-	-

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Laboratories, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Sediment			
Test	Method Description	Default Detection Limit	Sample No
Environmental Solids Sample Drying*	Air dried at 35°C Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-11
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation May contain a residual moisture content of 2-5%.	-	1-11
Polycyclic Aromatic Hydrocarbons Trace in Soil*	Sonication extraction, GC-MS analysis. Tested on as received sample. In-house based on US EPA 8270.	0.002 - 0.03 mg/kg dry wt	1-11
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. (Free water removed before analysis, non-soil objects such as sticks, leaves, grass and stones also removed). US EPA 3550.	0.10 g/100g as rcvd	1-11
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-11
Total Recoverable Copper	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, trace level. US EPA 200.2.	0.2 mg/kg dry wt	1-11
Total Recoverable Lead	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, trace level. US EPA 200.2.	0.08 mg/kg dry wt	1-11
Total Recoverable Zinc	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, trace level. US EPA 200.2.	0.8 mg/kg dry wt	1-11
Total Organic Carbon*	Acid pretreatment to remove carbonates present followed by Catalytic Combustion (900°C, O ₂), separation, Thermal Conductivity Detector [Elementar Analyser].	0.05 g/100g dry wt	1-11

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 23-Mar-2022 and 11-Apr-2022. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

This certificate of analysis must not be reproduced, except in full, without the written consent of the signatory.

Ara Heron BSc (Tech)
Client Services Manager - Environmental

Appendix 5: Epibenthic organisms

South New Brighton Park																									
			Macroalgae (% cover)				Plants (% cover)		Amphipods (number)	Barnacles (% cover)	Bivalves (number)		Bryozoans (% cover)	Crabs (number)		Isopods (number)	Limpets (number)		Mussels (% cover)	Polychaete (number)	Snails (number)				
Location	Transect	Replicate	<i>Agarophyton chilense</i>	Encrusting algae	<i>Ulva</i> sp. (filamentous)	<i>Ulva</i> sp. (foliose)	<i>Juncus kraussii</i>	<i>Zostera muelleri</i>	Sandhopper amphipods	<i>Austrominius modestus</i>	<i>Paphies australis</i>	<i>Austrovenus stutchburyi</i>	Unidentified bryozoan	<i>Austrohelice crassa</i>	<i>Cyclograpsus lavauxi</i>	Unidentified isopod	<i>Notoacmea</i> sp.	<i>Onchidella nigricans</i>	<i>Limnoperna pulex</i>	Nerade worm	<i>Amphibola crenata</i>	<i>Cominella glandiformis</i>	<i>Diloma subrostratum</i>	<i>Littorina amphipodum</i>	<i>Micrelencus huttonii</i>
SNBP	T1	Hard edge							120																
SNBP	T1	Estuary bed 1				1.1							0.1												
SNBP	T1	Gabion basket		0.5																					1
SNBP	T1	Estuary bed 2	30			3						2		5			2					4			2
SNBP	T1	Estuary bed 3	2								1	1					1				4				
SNBP	T1	Estuary bed 4	0.1																		3	1			
SNBP	T2	Hard edge			0.1									1											1
SNBP	T2	Estuary bed 1	3			0.6								2			4								
SNBP	T2	Estuary bed 2	0.1									4									3				
SNBP	T2	Estuary bed 3										2									8				
SNBP	T2	Estuary bed 4				0.1						2									3		1		
SNBP	T3	Hard edge												NO HARD EDGE											
SNBP	T3	Estuary bed 1				5																			
SNBP	T3	Estuary bed 2				4								2											
SNBP	T3	Gabion basket								0.1							1								1
SNBP	T3	Estuary bed 3										2									4				
SNBP	T3	Estuary bed 4				0.1															5				
SNBP	T4	Hard edge												NO HARD EDGE											
SNBP	T4	Estuary bed 1				31			200																
SNBP	T4	Gabion basket							20																
SNBP	T4	Estuary bed 2			0.1									4			20								
SNBP	T4	Estuary bed 3															10				2				
SNBP	T4	Estuary bed 4										2									6				
SNBP	T5	Hard edge												2			8		0.1	1					1
SNBP	T5	Estuary bed 1	0.1			0.5								1											
SNBP	T5	Estuary bed 2				4															8				2
SNBP	T5	Estuary bed 3				18						2									7	4			4
SNBP	T5	Estuary bed 4				28						3									8				1

Southshore																										
			Macroalgae (% cover)				Plants (% cover)		Amphipods (number)	Barnacles (% cover)	Bivalves (number)		Bryozoans (% cover)	Crabs (number)		Isopods (number)	Limpets (number)		Mussels (% cover)	Polychaete (number)	Snails (number)					
Location	Transect	Replicate	Agarophyton chilense	Encrusting algae	Ulva sp. (filamentous)	Ulva sp. (foliose)	Juncus kraussii	Zostera muelleri	Sandhopper amphipods	Austrominius modestus	Paphies australis	Austrovenus stutchburyi	Unidentified bryozoan	Austrohelice crassa	Cyclograpsus lavauxi	Unidentified isopod	Notoacmea sp.	Onchidella nigricans	Limnoperna pulex	Nerade worm	Amphibola crenata	Cominella glandiformis	Diloma subrostratum	Littorina amphipodum	Microelencus huttonii	
Southshore	T1	Hard edge			0.1																					
Southshore	T1	Estuary bed 1				0.1			200								2					1			1	
Southshore	T1	Estuary bed 2				1																				
Southshore	T1	Estuary bed 3				1.1																				
Southshore	T2	Hard edge			6										1				0.1							
Southshore	T2	Estuary bed 1				8								2	2		28									
Southshore	T2	Estuary bed 2				1						1														
Southshore	T2	Estuary bed 3			1	7		65																	2	
Southshore	T3	Hard edge							10	1					2			5	1						2	
Southshore	T3	Estuary bed 1				4											3								1	
Southshore	T3	Estuary bed 2				4															1					
Southshore	T3	Estuary bed 3				30						1					1					1				
Southshore	T4	Hard edge	NO HARD EDGE																							
Southshore	T4	Estuary bed 1					70																			
Southshore	T4	Estuary bed 2				20	65																			
Southshore	T4	Estuary bed 3	1																							
Southshore	T5	Hard edge	NO HARD EDGE																							
Southshore	T5	Estuary bed 1				3																				
Southshore	T5	Estuary bed 2	1			3	40					1			1						1					
Southshore	T5	Estuary bed 3	0.5			10			3					1							1					
Southshore	T6	Hard edge							5							2										
Southshore	T6	Estuary bed 1				0.1																				
Southshore	T6	Estuary bed 2				1																				
Southshore	T6	Estuary bed 3			18	0.1				0.1				3			2		8			2				
Southshore	T7	Hard edge																								
Southshore	T7	Estuary bed 1			0.1	5											1		0.1							
Southshore	T7	Estuary bed 2				10											5									
Southshore	T7	Estuary bed 3	1			80		5									9				1	30			9	
Southshore	T8	Hard edge							40																	
Southshore	T8	Estuary bed 1															4								6	
Southshore	T8	Estuary bed 2				0.5		65									5						1		1	
Southshore	T8	Estuary bed 3						4													9					
Southshore	T9	Hard edge																								
Southshore	T9	Estuary bed 1			3	0.1				0.1							2		0.1							
Southshore	T9	Estuary bed 2			0.1																7					
Southshore	T9	Estuary bed 3			0.1	0.1											1				4					
Southshore	T10	Hard edge			7					7							6		3							
Southshore	T10	Estuary bed 1			0.1	1															9					
Southshore	T10	Estuary bed 2			0.1	0.1																23				
Southshore	T10	Estuary bed 3			0.1																	12				
Southshore	T11	Hard edge							30	0.1									0.1							
Southshore	T11	Estuary bed 1				4															4					
Southshore	T11	Estuary bed 2			0.1	0.1																30				
Southshore	T11	Estuary bed 3			0.1	0.1																20				
Southshore	T12	Hard edge							20																	
Southshore	T12	Estuary bed 1	6			200			10										3						1	
Southshore	T12	Estuary bed 2				3						1									5					
Southshore	T12	Estuary bed 3			0.1	1																28				

Appendix 6: Infaunal organisms

			South New Brighton Park																			
General Group	Common name	Lowest practical taxon	T1.1	T1.2	T1.3	T1.4	T2.1	T2.2	T2.3	T2.4	T3.1	T3.2	T3.3	T3.4	T4.1	T4.2	T4.3	T4.4	T5.1	T5.2	T5.3	T5.4
Nemertean and Nematods																						
Nemertea	Ribbon worm	Nemertea (grey with white stripe)	1			1	1	1	2			1	1	1			1					
Nemertea	Ribbon worm	Nemertea (white)		1	1							1					1					
Nematoda	Round worm	Nematoda																				
Gastropoda																						
Gastropoda: Amphibo	Pulmonate snail	<i>Amphibola crenata</i>							2	1	1	1	1	1			2	1		2	1	
Gastropoda: Cominell	Mudflat whelk	<i>Cominella glandiformis</i>		1	1	1		1					1			1	1	2	1	1	1	4
Gastropoda: Lottiidae	Estuarine limpet	<i>Notoacmaea</i> spp.		3												9	15		5	4		
Gastropoda: Lottiidae	Seagrass limpet	<i>Notoacmaea scapha</i>															1					
Gastropoda: Trochida	Mudflat top shell	<i>Diloma subrostrata</i>		1					1											1		
Gastropoda: Trochida	Hutton's top shell	<i>Micrelenchus huttonii</i>																	1			
Bivalvia																						
Bivalvia: Lasaeidae	Micro-bivalve	<i>Arthritica</i> sp.		44	49	6	1			1		1	1	2		2		4	1	1		3
Bivalvia: Macridae	Trough shell	<i>Cyclomactra ovata</i>			1																	
Bivalvia: Mesodesmat	Pipi	<i>Paphies australis</i>		1								8										
Bivalvia: Tellinidae	Wedge shell	<i>Macomona liliana</i>				1			1	1				1				1			1	1
Bivalvia: Veneridae	Common cockle	<i>Austrovenus stutchburyi</i>		4	2		2	1	1			1	1	1		8	6		1	1	1	2
Annelida																						
Oligochaeta	Oligochaete worm	Oligochaeta					1	1				4	1		1		1	3	4			
Polychaeta: Capitellid	Bristle worm	<i>Capitella</i> sp.						4	3		2	6					1	4	2	10		1
Polychaeta: Capitellid	Bristle worm	<i>Heteromastus filiformis</i>																				
Polychaeta: Nereidae	Rag worm (juvenile)	<i>Nereidae</i> (juvenile)		6	7	9	8	15	14	6		22	3	2		13	8	12	1		11	6
Polychaeta: Nereidae	Rag worm	<i>Nicon aestuariensis</i>		5	7	1																
Polychaeta: Nereidae	Rag worm	<i>Perinereis vallata</i>					1												1			
Polychaeta: Orbinidae	Bristle worm	<i>Ledomas cylindrifera</i>		1	1	1				2			1			4			8		1	1
Polychaeta: Spionidae	Bristle worm	<i>Aonides</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0
Polychaeta: Spionidae	Bristle worm	<i>Boccardia</i> sp.														1						
Polychaeta: Spionidae	Bristle worm	<i>Scolecoides benhami</i>	2	36	26	17	5	35	19	7	0	2	10	9	1	2	26	9	1	3	15	17
Polychaeta: Spionidae	Bristle worm	<i>Scolecopsis</i> sp.							2	4				1								
Small Crustacea																						
Amphipoda: Melitidae	Amphipod (family)	Melitidae														1	6					1
Amphipoda: Paracalli	Amphipod	<i>Paracalliope novaezealandiae</i>		4		2			1													2
Amphipoda: Talitridae	Amphipod (family)	Talitridae									1				29				2			
Isopoda: Cirolanidae	Isopod	<i>Eurylana arcuata</i>									1											
Isopoda undet.	Stater	Isopoda																				
Ostracoda undet.	Seed shrimp	Ostracoda																				
Mysida: Mysidae	Mysid shrimp	<i>Tenagomysis</i> sp.																				
Decapoda																						
Decapoda: Hymenoso	Pillbox crab	<i>Haliscarcinus whitei</i>						1	2			1							8	2	2	2
Decapoda: Macrophth	Sentinel crab	<i>Hemiplax hirtipes</i>		1															1	2		2
Decapoda: Varunidae	Mud crab	<i>Austrohelice crassa</i>	1			1						1				3	1		1			
Decapoda: Varunidae	Hairy handed crab	<i>Hemigrapsus crenulatus</i>														1						
Other taxa																						
Anthozoa: Actiniidae	Mudflat anemone	<i>Anthopleura hemaphysodictica</i>																				
Coleoptera: Staphyli	Beetle larvae	Staphylinidae	1												5							
Diptera: Dolichopodid	Long-legged fly larva	Dolichopodidae	1																		1	
Diptera: Muscidae	Fly larvae	Muscidae	1												2							
Collembola	Springtail	Collembola																				
Chilopoda	Centipede	Chilopoda																				
Acarina	Mite	Acarina													8							

			Southshore																																					
General Group	Common name	Lowest practical taxon	T1.1	T1.2	T1.3	T2.1	T2.2	T2.3	T3.1	T3.2	T3.3	T4.1	T4.2	T4.3	T5.1	T5.2	T5.3	T6.1	T6.2	T6.3	T7.1	T7.2	T7.3	T8.1	T8.2	T8.3	T9.1	T9.2	T9.3	T10.1	T10.2	T10.3	T11.1	T11.2	T11.3	T12.1	T12.2	T12.3		
Nemerteans and Nematods																																								
Nemertea	Ribbon worm	Nemertea (grey with white stripe)			3	1	1				4			1		1					2	1	1	1	3	6	1		1	1	1	1	1		1		1			
Nemertea	Ribbon worm	Nemertea (white)		1					3	3	2						1													1	1	1	1	1	2				1	
Nematoda	Round worm	Nematoda											1				1															1								
Gastropoda																																								
Gastropoda: Amphibid	Pulmonate snail	<i>Amphibola crenata</i>			2	1		1								1							1				5	2	4	2	1	1	2	2	3	1		4	1	
Gastropoda: Cominel	Mudflat whelk	<i>Cominella glandiformis</i>					2	2	1		1											1		1			1									1				
Gastropoda: Lottiidae	Estuarine limpet	<i>Notosmarea</i> spp.	2						1	4	1								1			5					1				2									
Gastropoda: Lottiidae	Seagrass limpet	<i>Notosmarea scapha</i>						5	1								1						3	1	6	2	1												1	
Gastropoda: Trochida	Mudflat top shell	<i>Diloma subrostrata</i>					1														2																			
Gastropoda: Trochida	Hutton's top shell	<i>Microtenchus huttonii</i>																																						
Bivalvia																																								
Bivalvia: Lasseidae	Micro-bivalve	<i>Arthritica</i> sp.				21	8	2	1	2	2				1	1	2																			1				
Bivalvia: Macridae	Trough shell	<i>Cyclomactra ovata</i>																											2											
Bivalvia: Mesodesma	Pipi	<i>Paphies australis</i>				1				1												1	2																	
Bivalvia: Tellinidae	Wedge shell	<i>Macomona liliana</i>									1											3	1			1														
Bivalvia: Veneridae	Common cockle	<i>Austrovenus stutchburyi</i>			1	3	5		5	5	1			1		1		1		1	1	2				1	2	1					1	5		1			1	
Annelida																																								
Oligochaeta	Oligochaete worm	Oligochaeta	7	4	5	15		19	12	2	41		3		1	1	22	2			45	16	20	1	8	4	5		2	12	11	5	7	1	29	5	7	1		
Polychaeta: Capitellid	Bristle worm	<i>Capitella</i> sp.		15	18	5		7	15	4	22				5	3	18	1	1	2	2	2	4			1		2	2	2	8	3	5		19	2	4			
Polychaeta: Capitellid	Bristle worm	<i>Heteromastus filiformis</i>																								1														
Polychaeta: Nereididae	Rag worm (juvenile)	<i>Nereididae</i> (juvenile)	1	1	5	6	7	8	2	12				1	1		7	2	4	4	4	1	1		3	12	2	6	4	3	5	2	2	1	2					
Polychaeta: Nereididae	Rag worm	<i>Nicon aestuariensis</i>				2	4							1			1																							
Polychaeta: Nereididae	Rag worm	<i>Parinereis vallata</i>				2																																		
Polychaeta: Orbiniid	Bristle worm	<i>Ledomas cylindricus</i>	1			10	1	5	1	1	4					1					1	16	24		8	8	2	3	2							2				
Polychaeta: Spionidae	Bristle worm	<i>Aonides</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	0	0	0	0	0	0	0	1	1	5	0	0	0	0	0	0	
Polychaeta: Spionidae	Bristle worm	<i>Boccardia</i> sp.																						1	1									1				1		
Polychaeta: Spionidae	Bristle worm	<i>Scolecoplepis benhami</i>	0	5	5	84	36	53	4	47	67	0	0	0	14	7	5	2	1	1	4	5	4	1	2	3	1	3	3	0	5	1	3	0	1	1	1	0	4	
Polychaeta: Spionidae	Bristle worm	<i>Scolecopsis</i> sp.																																		1	1			
Small Crustacea																																								
Amphipoda: Melitidae	Amphipod (family)	Melitidae				2								1	1				1																					
Amphipoda: Paracalli	Amphipod	<i>Paracalliope novizealandiae</i>										9	24	9		5			13	29	5	13	8	14		2	1		1							1				
Amphipoda: Talitridae	Amphipod (family)	Talitridae	4																																			1		1
Isopoda: Cirolanidae	Isopod	<i>Eurylana arcuata</i>																																						
Isopoda: undet.	Slater	Isopoda											3																											
Ostracoda: undet.	Seed shrimp	Ostracoda																																						
Mysida: Mysidae	Mysid shrimp	<i>Tenagomysis</i> sp.													1																					1				
Decapoda																																								
Decapoda: Hymenod	Pillbox crab	<i>Haliscarcinus whitei</i>							1					1												1														
Decapoda: Macrophth	Sentinel crab	<i>Hemiplax hirtipes</i>				1													1					1						2									1	
Decapoda: Varunidae	Mud crab	<i>Austrohelice crassa</i>		1	1	1	2		2				1		2					1	1			3	1		1										2			
Decapoda: Varunidae	Hairy handed crab	<i>Hemigrapsus crenulatus</i>																																						
Other taxa																																								
Anthozoa: Actinidae	Mudflat anemone	<i>Anthopleura hemaphysodictica</i>				1																																		
Coleoptera: Staphyl	Beetle larvae	Staphylinidae											1																											
Diptera: Dolichopodid	Long-legged fly lar	Dolichopodidae		2									1		1	1				1						1					3	3		1			1			
Diptera: Muscidae	Fly larvae	Muscidae											1																											
Collembola	Springtail	Collembola										2	3																								4	1		
Chilopoda	Centipede	Chilopoda										1																												
Acarina	Mite	Acarina	2										34		1																									

Appendix 7: Avifauna species list

SPECIES		CONSERVATION STATUS		HABITAT								DATA SOURCES				
				Native forest	Exotic Forest	Scrub / shrubland	Farmland / open country	Freshwater / wetlands	Coastal / Estuary	Oceanic	Urban/Residential	BML 5MBC 2022	BML 2022 surveys	Crossland 2013 - Estuary & Bromley Oxidation Ponds	NZBirds Online Avon-Heathcote	Crossland 2022 – Estuary eastern shoreline
Bellbird	<i>Anthornis m. melanura</i>	Not Threatened	Not Threatened									✓				
Kereru	<i>Hemiphaga novaeseelandiae</i>	Not Threatened	Not Threatened ^{CD Inc}									✓				
Kingfisher	<i>Todiramphus sanctus vagans</i>	Not Threatened	Not Threatened									✓	✓		✓	
Shining cuckoo	<i>Chrysococcyx l. lucidus</i>	Not Threatened	Not Threatened												✓	
South Island fantail	<i>Rhipidura f. fuliginosa</i>	Not Threatened	Not Threatened ^{EF}									✓			✓	
Blackbird	<i>Turdus merula</i>	Introduced	Introduced & Naturalised ^{SO}									✓			✓	
Grey warbler	<i>Gerygone igata</i>	Not Threatened	Not Threatened									✓			✓	
Pheasant	<i>Phasianus colchicus</i>	Introduced	Introduced & Naturalised ^{SO}												✓	
Silvereye	<i>Zosterops lateralis lateralis</i>	Not Threatened	Not Threatened ^{SO}									✓			✓	
Canada goose	<i>Branta canadensis</i>	Introduced	Introduced & Naturalised ^{SO}											✓	✓	
Cape Barren goose	<i>Cereopsis novaehollandiae</i>	Introduced	Introduced & Naturalised ^{SO Sp}												✓	
Cattle egret	<i>Ardea ibis coromanda</i>	Migrant	Migrant ^{SO}												✓	
Chaffinch	<i>Fringilla coelebs</i>	Introduced	Introduced & Naturalised ^{SO}									✓			✓	
Cirl bunting	<i>Emberiza cirlus</i>	Introduced	Introduced & Naturalised ^{SO Sp}												✓	
Dunnoek	<i>Prunella modularis</i>	Introduced	Introduced & Naturalised ^{SO}									✓			✓	
Goldfinch	<i>Carduelis carduelis</i>	Introduced	Introduced & Naturalised ^{SO}									✓			✓	
Greenfinch	<i>Carduelis chloris</i>	Introduced	Introduced & Naturalised ^{SO}									✓			✓	
House sparrow	<i>Passer domesticus</i>	Introduced	Introduced & Naturalised ^{SO}									✓			✓	
Little owl	<i>Athene noctua</i>	Introduced	Introduced & Naturalised ^{SO}												✓	

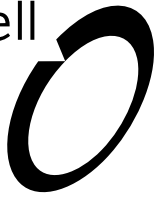
SPECIES		CONSERVATION STATUS		HABITAT								DATA SOURCES				
				Native forest	Exotic Forest	Scrub / shrubland	Farmland / open country	Freshwater / wetlands	Coastal / Estuary	Oceanic	Urban/Residential	BML 5MBC 2022	BML 2022 surveys	Crossland 2013 - Estuary & Bromley Oxidation Ponds	NZBirds Online Avon-Heathcote	Crossland 2022 – Estuary eastern shoreline
Magpie	<i>Gymnorhina tibicen</i>	Introduced	Introduced & Naturalised ^{SO}									✓			✓	
Nankeen kestrel	<i>Falco cenchroides</i>	Vagrant	Vagrant ^{SO}												✓	
NZ falcon	<i>Falco novaeseelandiae</i>	At Risk	Recovering												✓	
NZ pipit	<i>Anthus n. novaeseelandiae</i>	At Risk	Declining ^{CI CR}												✓	✓
Redpoll	<i>Carduelis flammea</i>	Introduced	Introduced & Naturalised ^{SO}												✓	
Skylark	<i>Alauda arvensis</i>	Introduced	Introduced & Naturalised ^{SO}												✓	
Song thrush	<i>Turdus philomelos</i>	Introduced	Introduced & Naturalised ^{SO}												✓	
Spur-winged plover	<i>Vanellus miles novaehollandiae</i>	Not Threatened	Not Threatened ^{SO}										✓	✓	✓	
Starling	<i>Sturnus vulgaris</i>	Introduced	Introduced & Naturalised ^{SO}									✓			✓	
Swamp harrier	<i>Circus approximans</i>	Not Threatened	Not Threatened ^{SO}										✓	✓	✓	
Welcome swallow	<i>Hirundo n. neoxena</i>	Not Threatened	Not Threatened ^{SO ST}									✓		✓	✓	
Yellowhammer	<i>Emberiza citrinella</i>	Introduced	Introduced & Naturalised ^{SO}												✓	
Australian white-eyed duck	<i>Aythya australis</i>	Vagrant	Vagrant ^{SO}												✓	
Australian wood duck	<i>Chenonetta jubata</i>	Coloniser	Coloniser ^{SO}												✓	
Australasian bittern	<i>Botaurus poiciloptilus</i>	Threatened	Nationally Critical ^{CR DPT RF Sp TO}												✓	✓
Australasian crested grebe	<i>Podiceps cristatus</i>	Threatened	Nationally Vulnerable ^{DPS inc SO}												✓	
Australian coot	<i>Fulica atra australis</i>	At Risk	Naturally Uncommon ^{Inc SO}											✓	✓	
Black shag	<i>Phalacrocorax carbo novaehollandiae</i>	At Risk	Relict ^{CR DPS DPT SO Sp}											✓	✓	✓
Black stilt	<i>Himantopus novaeseelandiae</i>	Threatened	Nationally Critical ^{CD CR RR}												✓	

SPECIES		CONSERVATION STATUS		HABITAT								DATA SOURCES				
				Native forest	Exotic Forest	Scrub / shrubland	Farmland / open country	Freshwater / wetlands	Coastal / Estuary	Oceanic	Urban/Residential	BML 5MBC 2022	BML 2022 surveys	Crossland 2013 - Estuary & Bromley Oxidation Ponds	NZBirds Online Avon-Heathcote	Crossland 2022 – Estuary eastern shoreline
Black swan	<i>Cygnus atratus</i>	Not Threatened	Not Threatened ^{SO}										✓	✓	✓	
Black-billed gull	<i>Larus bulleri</i>	At Risk	Declining ^{CI CR RF}											✓	✓	✓
Black-fronted tern	<i>Chlidonias albastratus</i>	Threatened	Nationally Endangered ^{CI CD, PD, RF, Sp}										✓	✓	✓	✓
Chestnut teal	<i>Anas castanea</i>	Vagrant	Vagrant ^{SO}											✓	✓	
Chestnut-breasted shelduck	<i>Tadorna tadornoides</i>	Vagrant	Vagrant ^{SO}												✓	
Feral goose	<i>Anser anser</i>	Introduced	Introduced & Naturalised ^{SO}										✓	✓		
Glossy ibis	<i>Plegadis falcinellus</i>	Coloniser	Coloniser ^{OL SO}											✓		
Grey duck	<i>Anas superciliosa superciliosa</i>	Threatened	Nationally Vulnerable													✓
Grey duck x mallard hybrid	<i>Anas superciliosa x platyrhynchos</i>	Not Threatened	Not Threatened											✓	✓	
Grey teal	<i>Anas gracilis</i>	Not Threatened	Not Threatened ^{Inc SO}										✓	✓	✓	
Hoary-headed grebe	<i>Poliiocephalus poliocephalus</i>	Coloniser	Coloniser ^{SO}												✓	
Little black shag	<i>Phalacrocorax sulcirostris</i>	At Risk	Naturally Uncommon ^{RR SO}										✓	✓	✓	✓
Little shag	<i>Phalacrocorax melanoleucos brevirostris</i>	At Risk	Relict ^{CR DPT}										✓	✓	✓	✓
Marsh crake	<i>Porzana pusilla affinis</i>	At Risk	Declining ^{CI CR DPS DPT PF RR}												✓	✓
Mute swan	<i>Cygnus olor</i>	Introduced	Introduced & Naturalised ^{SO Sp}												✓	
NZ pied oystercatcher	<i>Haematopus finschi</i>	At Risk	Declining ^{CI}										✓	✓	✓	✓
NZ scaup	<i>Aythya novaeseelandiae</i>	Not Threatened	Not Threatened ^{Inc}										✓	✓	✓	
NZ shoveler	<i>Anas rhynchotis</i>	Not Threatened	Not Threatened ^{SO}										✓	✓	✓	
Paradise shelduck	<i>Tadorna variegata</i>	Not Threatened	Not Threatened										✓	✓	✓	

SPECIES		CONSERVATION STATUS		HABITAT								DATA SOURCES				
				Native forest	Exotic Forest	Scrub / shrubland	Farmland / open country	Freshwater / wetlands	Coastal / Estuary	Oceanic	Urban/Residential	BML 5MBC 2022	BML 2022 surveys	Crossland 2013 - Estuary & Bromley Oxidation Ponds	NZBirds Online Avon-Heathcote	Crossland 2022 – Estuary eastern shoreline
Pied shag	<i>Phalacrocorax varius varius</i>	At Risk	Recovering ^{CD}										✓	✓	✓	✓
Pied stilt	<i>Himantopus h. leucocephalus</i>	Not Threatened	Not Threatened ^{SO}										✓	✓	✓	
Plumed egret	<i>Ardea intermedia</i>	Vagrant	Vagrant ^{SO}												✓	
Pukeko	<i>Porphyrio m. melanotus</i>	Not Threatened	Not Threatened ^{Inc SO}										✓	✓	✓	
Spotless crane	<i>Porzana t. tabuensis</i>	At Risk	Declining ^{DPS DPT PF SO}												✓	
White heron	<i>Ardea modesta</i>	Threatened	Nationally Critical ^{CR OL SO St}												✓	
Asiatic dowitcher	<i>Limnodromus semipalmatus</i>	Vagrant	Vagrant ^{SO}												✓	
Asiatic whimbrel	<i>Numenius phaeopus variegatus</i>	Migrant	Migrant ^{SO}											✓	✓	
Banded dotterel	<i>Charadrius bicinctus bicinctus</i>	At Risk	Declining ^{CD CI CR DPS PD}										✓	✓	✓	✓
Black-backed gull	<i>Larus d. dominicanus</i>	Not Threatened	Not Threatened ^{SO}										✓	✓	✓	
Caspian tern	<i>Hydroprogne caspia</i>	Threatened	Nationally Vulnerable ^{CI SO Sp}										✓	✓	✓	✓
Eastern bar-tailed godwit	<i>Limosa lapponica baueri</i>	At Risk	Declining ^{CI TO}										✓	✓	✓	✓
Eastern curlew	<i>Numenius madagascariensis</i>	Vagrant	Vagrant ^{TO}												✓	
Grey plover	<i>Pluvialis squatarola</i>	Vagrant	Vagrant ^{SO}												✓	
Gull-billed tern	<i>Gelochelidon nilotica</i>	Coloniser	Coloniser ^{SO}												✓	
Lesser knot	<i>Calidris canutus rogersi</i>	At Risk	Declining ^{CI TO}											✓	✓	✓
Red-billed gull	<i>Larus novaehollandiae scopulinus</i>	At Risk	Declining ^{CI}							✓			✓	✓		✓
Reef heron	<i>Egretta sacra sacra</i>	Threatened	Nationally Endangered ^{CI CR DPT SO Sp}												✓	
Royal spoonbill	<i>Platalea regia</i>	At Risk	Naturally Uncommon ^{Inc RR SO Sp}										✓	✓	✓	✓

SPECIES		CONSERVATION STATUS		HABITAT								DATA SOURCES				
				Native forest	Exotic Forest	Scrub / shrubland	Farmland / open country	Freshwater / wetlands	Coastal / Estuary	Oceanic	Urban/Residential	BML 5MBC 2022	BML 2022 surveys	Crossland 2013 - Estuary & Bromley Oxidation Ponds	NZBirds Online Avon-Heathcote	Crossland 2022 – Estuary eastern shoreline
Spotted shag	<i>Stictocarro punctatus</i>	Threatened	Nationally Vulnerable ^{CI CR}										✓	✓	✓	✓
Turnstone	<i>Arenaria interpres</i>	Migrant	Migrant ^{SO}											✓	✓	
Variable oystercatcher	<i>Haematopus unicolor</i>	At Risk	Recovering ^{CI Inc}										✓	✓	✓	✓
Whiskered tern	<i>Chlidonias hybridus</i>	Vagrant	Vagrant ^{SO}												✓	
White-faced heron	<i>Egretta novaehollandiae</i>	Not Threatened	Not Threatened ^{SO}									✓	✓	✓	✓	
White-fronted tern	<i>Sterna s. striata</i>	At Risk	Declining ^{CI CR DPT}										✓	✓	✓	✓
Wrybill	<i>Anarhynchus frontalis</i>	Threatened	Nationally Increasing ^{RR CD CR}												✓	✓
Arctic skua	<i>Stercorarius parasiticus</i>	Migrant	Migrant ^{SO}											✓	✓	
Australasian gannet	<i>Morus serrator</i>	Not Threatened	Not Threatened ^{CI De* Inc SO}												✓	
Pomarine skua	<i>Coprotheres pomarinus</i>	Migrant	Migrant ^{SO}												✓	
Rock pigeon	<i>Columba livia</i>	Introduced	Introduced & Naturalised ^{SO}												✓	

Appendix 8: Saltmeadow Offset Plan



Southshore and South New Brighton Park Flood Protection Works

Saltmeadow Offset Plan
Prepared for Christchurch City Council

1 December 2023





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Toitū net carbonzero certified consultancy

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Cover photograph: Saltmeadow at 172c Rocking Horse Rd, Southshore. © Boffa Miskell 2022.

Executive summary

Christchurch City Council is planning to undertake works along the eastern edge of the Avon-Heathcote Estuary / Ihutai to address erosion and flood risk at South New Brighton Park and Southshore. Boffa Miskell was engaged to prepare an ecological impact assessment (EcIA; Boffa Miskell 2023) considering the potential effects of the proposed works on the ecological values of the project site. This EcIA, to which this Offset Plan is attached as an appendix, concluded that the loss of up to 0.2 ha of ecologically significant saltmeadow (saltmarsh herbfield) habitat requires ecological offsetting. This Offset Plan should be read alongside the full EcIA report.

The offset proposed is the creation of 0.36 ha of saltmeadow habitat in an area of exotic grassland at the fringe of an existing saltmeadow at South Spit Reserve. Simply, the offset proposes to expand this existing similar habitat.

This Offset Plan provides a summary of the offset proposal, outlining the methods used to derive the quantum of offset, the proposed offset location, and high-level implementation measures. It demonstrates that the proposed offset has been successfully implemented widely within the Estuary and is a straightforward and achievable offset measure.

The purpose of the saltmeadow offset is to ensure an overall Net Gain outcome for saltmeadow habitats arising from the erosion and flood protection works.

This Offset Plan also includes assessment against the principles for biodiversity offsetting in the National Policy Statement for Indigenous Biodiversity (2023). It concludes that the proposed offset generally accords with these principles and is therefore an appropriate and ecologically acceptable outcome.

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Appendices

Appendix 1: Southshore RRZ saltmeadow plant species list and
vegetation plots, and plot location map

Appendix 2: Offset Calculations

1.0 Introduction

1.1 Background / scope

Boffa Miskell was engaged by the Christchurch City Council (CCC) as a subcontractor to Jacobs New Zealand Ltd to prepare an ecological impact assessment (the EclA; Boffa Miskell Ltd, 2023) considering the potential effects of the proposed erosion and flood protection works on the ecological values of the project site (Figure 1).



Figure 1. Extent of the proposed structures along the South New Brighton Park and Southshore estuary edge.

As described in the EclA (Boffa Miskell, 2023), the proposal would result in the permanent loss of up to 0.2 ha of saltmeadow habitat that has established in the residential red zone (RRZ) following the Christchurch Earthquake Sequence in former residential areas at Southshore (Figure 2). This loss of saltmeadow habitat represents an adverse ecological effect of the proposal that cannot be avoided or remedied¹. In accordance with the 'effects management hierarchy' and statutory direction to achieve no net loss, and preferably a net gain in ecologically significant habitats from land use activities in Canterbury Region, an offset is required.

¹ As described in the EclA, overall impacts to saltmeadow have been avoided and minimised where possible, such as via project design to avoid impacts to a similar saltmeadow area at South New Brighton Park. The project footprint also avoids a saltmeadow area at 172c Rocking Horse Road.



Figure 2. Saltmeadow near Penguin St. This habitat has established following the Christchurch Earthquake Sequence on former residential areas in low points subject to occasional inundation, typically behind existing ad-hoc coastal armour. Sea rush plants have been deliberately planted into these areas. This area would be lost due to proposed works.

The offset proposed is the creation of 0.36 ha of saltmeadow habitat in an area of exotic grassland at the fringe of an existing saltmeadow at Southshore Spit Reserve. Simply put, the offset proposes to use light earthworks to enable natural expansion of pre-existing similar habitat. The indicative 0.36 ha area for offset is shown in Figure 3.

The scope of this Offset Plan is to summarise the values of and impacts to saltmeadow (based on the EclA; Boffa Miskell 2023) arising from the proposal, and to provide a summary of the offset proposal, outlining the methods used to derive the quantum of offset, the proposed offset location, and high-level implementation measures.

This Offset Plan should be read alongside the EclA, which describes in detail the habitat context, the proposed erosion and flood protection works, and measures taken to sequentially avoid, remedy, or mitigate impacts to other ecological values.



Figure 3. Offset area map (prepared by CCC).

1.2 Effects management hierarchy / biodiversity offsetting

Ecological impact management measures follow the effects management hierarchy described in Maseyk et al. (2018) (Figure 4) and Roper-Lindsay et al. (2018), and in the National Policy Statement for Indigenous Biodiversity 2023 (NPS-IB; Ministry for the Environment, 2023). A definition² of this is where:

- **Avoid:** means to modify a project proposal to prevent any environmental damage or loss of an ecological or environmental feature or function.
- **Remedy:** means to rehabilitate, restore or reinstate an ecological or environmental feature or function to reverse any environmental damage at the impact point.
- **Mitigate:** means to alleviate, minimise, abate, alleviate or moderate the severity of environmental damage.
- **Offset:** means a measurable conservation outcome resulting from actions designed to compensate for residual, adverse biodiversity effects arising from activities after appropriate avoidance, remediation, and mitigation measures have been applied. The goal of a biodiversity offset is to achieve no net loss, and preferably a net gain, of indigenous biodiversity values. Best practice for biodiversity offset methodology is described in Maseyk et al. (2018), Roper-Lindsay et al. (2018) and New Zealand Government (2014). In summary, adverse effects must be offset by the restoration, enhancement, or averted loss of biodiversity values of 'ecological equivalence'. In this case, biodiversity offset means restoration and enhancement of similar vegetation types, of similar ecological functioning, as close to the site of impact as possible.
- **Compensate:** means a non-quantified biodiversity benefit offered to compensate for biodiversity losses. The compensation actions may benefit different biodiversity to that lost (out-of-kind compensation).

The Canterbury Regional Policy Statement (Environment Canterbury, 2021) does not include 'biodiversity compensation' as an option for effects management, though it does provide for 'out of kind' biodiversity trades (Section 9.3.6). The Canterbury RPS requires '*no net loss and preferably a net gain*' for offsets, while the NPS-IB states that biodiversity offsets are intended to achieve a '*net gain*' in type, amount, and condition of indigenous biodiversity compared to that lost. The NPS-IB also requires an assessment of offsets against the Principles for Biodiversity Offsets in Appendix 3 of the NPS-IB (see Section 5.0).

² We note that the above definitions are not statutory, but the 'avoid, minimise, remedy, offset, and compensate' steps of the effects management hierarchy in the NPS-IB are statutory, meaning that each step in the hierarchy must be sequentially exhausted before moving to the next.

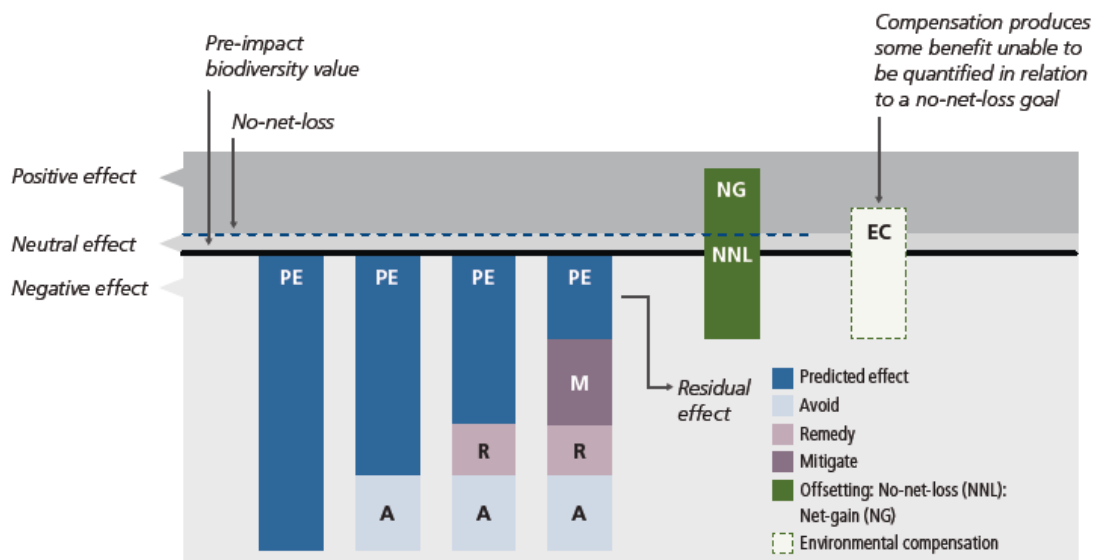


Figure 4. Conceptual illustration of the effects management hierarchy from Maseyk et al. (2018)

2.0 Description of Existing Southshore Saltmeadow Habitats

2.1 Survey methods

Dr Jaz Morris conducted a walk-through survey of saltmeadow habitats at the project site on 23 March 2022.

During the vegetation surveys:

- The plant communities at the project site were classified using the classification system and naming conventions developed by Atkinson (1985). A handheld Garmin Global Positioning System (GPS) was also used to mark plant community boundaries where necessary.
- Plant species, and their cover (using the 'DAFOR' scale) were recorded in each of the plant communities.
- General notes were made on the condition of the plant communities and habitats present.

Subsequently, once the need for an ecological offset was identified, Dr Morris undertook two further site investigations, to:

- Undertake four 2x2 m vegetation plot measurements within a representative saltmeadow area at Southshore and to visit potential offsetting sites at Jellicoe Marsh and Southshore Spit Reserve, where saltmeadow could be established or expanded to offset adverse effects. This visit took place on 6 October 2023, with Mike Pentecost and Tim Reed (Landscape Architects, CCC) also in attendance.

- Re-visit Southshore Spit Reserve (the preferred offset site), and to visit other sites around the Avon-Heathcote Estuary / Ihutai where CCC saltmeadow creation projects have occurred. This visit took place on 27 October 2023, with Mike Pentecost and Andrew Crossland (Ecologist, CCC) also in attendance.

2.2 Saltmeadow habitats in the Southshore RRZ (summarised from EcIA)

The following section summarises saltmeadow descriptions from the EcIA (Boffa Miskell, 2023).

Several small (c.5 m x 20 m areas) saltmarsh herbfield patches are present at Southshore in the RRZ behind (landward of) the hard edge of existing ad hoc coastal armour structures (Figure 5). These are estuarine marsh wetlands entirely above mean high water springs (MHWS).

Plant species and plot measurement results for the saltmeadow are provided in Appendix 1, as well as a map showing the plot locations. Plots were undertaken in the largest of several saltmeadow areas that would be lost due to the proposal. This location is considered suitably representative of the other saltmeadow areas in the Southshore RRZ.

Saltmarsh herbfields (or 'saltmeadows') are a distinct and highly salt-tolerant vegetation type characterised by low-growing and often succulent herbs. Coastal saltmarsh herbfields are typically dry or intermittently wet, receiving infrequent saline inundation such as during spring or perigean tides. In estuaries, saltmarsh herbfields typically occur as part of an overall saltmarsh ecotone (gradient) of vegetation that includes taller rushes in areas lower down the shore, below MHWS.

Previous surveys in the Estuary have classified different saltmarsh vegetation types. For example, Jupp et al. (2007) describe twelve estuarine saltmarsh vegetation types, of which the saltmeadow at Southshore best fits a so-called "Type 3 'Salt marsh herbfield'". Saltmeadow at Southshore fits a "Type 1.01 'Mixed saltmarsh herbfield, glasswort present'" vegetation type as described by Grove et al. (2012). Orchard (2020) recognises this vegetation type as a 'mixed saltmarsh herbfield' typically found in the mid-marsh zone at the Estuary.

Saltmeadow patches in the RRZ are generally dominated by salt-tolerant herbs and grasses, with glasswort, sea blite, bachelor's button, buckshorn plantain and exotic couch grass forming variable cover (frequent to abundant overall); saltgrass (*Puccinellia stricta*) is patchy (occasional to frequent). Many areas have been deliberately planted into with sea rush, but the underlying herbfield has very likely arisen naturally. Many areas have an almost entirely indigenous cover, typically in lower areas that are more frequently inundated. This saltmeadow vegetation appears to have naturally established since the Christchurch Earthquake Sequence in former residential areas, where slumping of (or breaks in) the existing ad hoc coastal armour permits inundation, and / or where episodic wave conditions allow for splash inputs above MHWS. Strand lines with obviously estuarine debris (e.g., seagrass leaves, crab shells) were observed at the upper edge of saltmeadow areas during site investigations.

As described in the EcIA, these areas of saltmeadow are of **Moderate** ecological value, and **ecologically significant in terms of Canterbury Regional Policy Statement and NPS-IB criteria**.



Figure 5. Southshore vegetation types.

2.3 Vegetation clearance (summarised from EcIA)

The following section summarises the impact assessment in the EcIA (Boffa Miskell, 2023), which is the basis for this offset proposal.

At Southshore, removal of existing coastal armour and installation of the erosion protection (revetment / cobble beach) and inundation bunds is likely to lead to direct removal of most habitat in the project footprint via earthworks. Even if not all areas landward of MHWS are directly impacted (due to being worked over), we have assumed that loss / change will be total and permanent within the construction footprint, except where specifically noted. This includes permanent loss of saltmeadow areas with a total existing extent of 1,715 m² / 0.2 ha.

Loss of saltmeadow due either to construction impacts (damage or permanent replacement with structures) or loss of hydraulic connection to the estuary would remove the only existing representative areas of indigenous vegetation landward of the estuary edge along the project extent at Southshore. While other similar / more intact and frequently much larger areas are present (and would remain) nearby at 172c Rocking Horse Road, Jellicoe Marsh and Southshore Spit Reserve, this nevertheless represents a complete loss of 0.2 ha of a distinctive post-earthquake area of significant values.

In considering the extent of similar habitat at the level of the estuary and the ED, but also widespread historic and ongoing losses of estuarine wetland types (and wetland types in general), these adverse effects are considered of **Moderate** magnitude of effect³. Based on the moderate ecological value of this habitat, and its ecological significance, this represents a **Moderate** level of effect (i.e., a net loss of significant values) that requires offsetting.⁴

³ Meaning a 'loss or alteration to one or more key elements/features of the existing baseline conditions, such that the post-development character, composition and/or attributes will be partially changed' (Roper-Lindsay et al. 2018).

⁴ As outlined in the EcIA, saltmeadow was not able to be fully avoided via project shaping. Saltmeadow also cannot be recreated (remedied) following construction, due to an assumption of a complete loss of hydraulic connection to the estuary, e.g., via inundation / wave splash inputs.

3.0 Offsetting approach / metrics

3.1 Offset type / accounting

Offset accounting to demonstrate an ecological net gain is reliant on the determination of habitat characteristics at the impact site and the offset site, in order to derive an appropriate quantum of offsetting. The approach taken and assumptions applied are detailed below. The accounting model is provided in Appendix 2.

The **offset accounting methods** recommended by the Department of Conservation (Maseyk et al., 2015; New Zealand Government, 2014) have been used to derive quantum of effect and quantum of offset, based on habitat metrics obtained from both direct site measurements and authors' specialist knowledge of saltmeadow communities and their dynamics. **'Like for like'** saltmeadow herbfield habitat creation was preferred (in contrast to e.g., 'averted loss' or 'trading up' offset), as this approach directly addresses the impacts of the proposed activity.

3.2 Offset location, levels, and mapping

Following principle 7 (landscape context) for offsetting in Appendix 3 of the NPS-IB, an offset location as close as possible to the point of impact was preferred. Two prospective locations were considered: Southshore Spit Reserve, and an area of RRZ adjacent to Jellicoe Marsh. Both Southshore Spit Reserve and Jellicoe Marsh are located within 1-2 km of the project site and contain existing saltmeadow fringed by exotic habitats; the logical opportunity is to expand these existing habitats. CCC has advised that offsetting at the Jellicoe Marsh RRZ is not preferred; Southshore Spit is the preferred offset location (Figure 6). The indicative 0.36 ha area for offset is shown in Figure 3.

The precise areas to be offset were mapped by Mike Pentecost and Tim Reed (CCC), based on survey and with input from CCC's herpetologist (Chris McClure) to ensure that the grassland areas selected for offset did not encroach on adjacent sand dune habitats that provide habitat for indigenous skink species.



Figure 6. Sequence of images (from top to bottom: looking roughly south to west) showing a representative exotic grass area at the fringe of the existing saltmeadow at Southshore Spit Reserve. Exotic grassland areas would be scraped to the level of the existing saltmeadow. Taller dunes / marram grass areas providing lizard habitat at left in the upper image would be avoided by earthworks, to avoid risk of lizard injury / mortality.

3.3 Restoration actions

To create new saltmeadow herbfield, the proposal is to mechanically 'scrape' (via light earthworks with a digger) areas of existing exotic grassland (with no saltmeadow values) in a low-lying area to achieve the same levels (elevation) as an immediately adjoining area of saltmeadow herbfield. This would allow natural expansion of existing saltmeadow into the scraped areas. This approach has been successfully undertaken in several places around the Estuary, including in areas directly adjacent to the proposed offset site itself (Figure 7).

A surveyor accompanied by Mike Pentecost (CCC) precisely measured RL (elevation) to confirm ground levels in the offset areas in relation to the adjacent saltmeadows. On the basis of these measurements, and publicly available LIDAR imagery, the areas to be offset and required 'scrape' depth was determined by CCC. Existing levels are mapped in Figure 8. Achieving the same ground levels within the offset area as the ground levels in the adjacent saltmeadow habitat is fundamental to the offset proposal.

The offset proposal is extremely simple and reliant on establishing suitable ground levels that will enable occasional estuarine inundation during high water levels. A suitable frequency / duration of estuarine (saline / tidal) inputs will reliably exclude exotic species but be suitable for indigenous saltmeadow herbfield species.

No deliberate plantings are required or proposed. Species will naturally expand / establish within only a few years. Occasional estuarine inundation during high water levels will allow seeds to enter the scraped / lowered area, or else creeping / mat forming species may establish vegetatively. The species / species assemblage that colonises a given scrape area will depend on its precise 'niche' in relation to the salinity / inundation regime.

This approach has also been successfully implemented by CCC at McCormacks Bay, lower Avoca Valley / lower Heathcote, and Charlesworth Reserve. In these areas, good quality and diverse saltmeadow herbfields now occupy areas of former exotic grassland (etc.). Based on these examples, functioning saltmarsh habitat may take as little as two years to establish following the scrape.



Figure 7. Existing saltmeadow at Southshore Spit Reserve. It is understood that this saltmeadow area was originally created (largely or entirely) via the same process proposed in this Offset Plan. This area is proposed to be expanded by a greater amount than the area of loss at the Southshore RRZ.

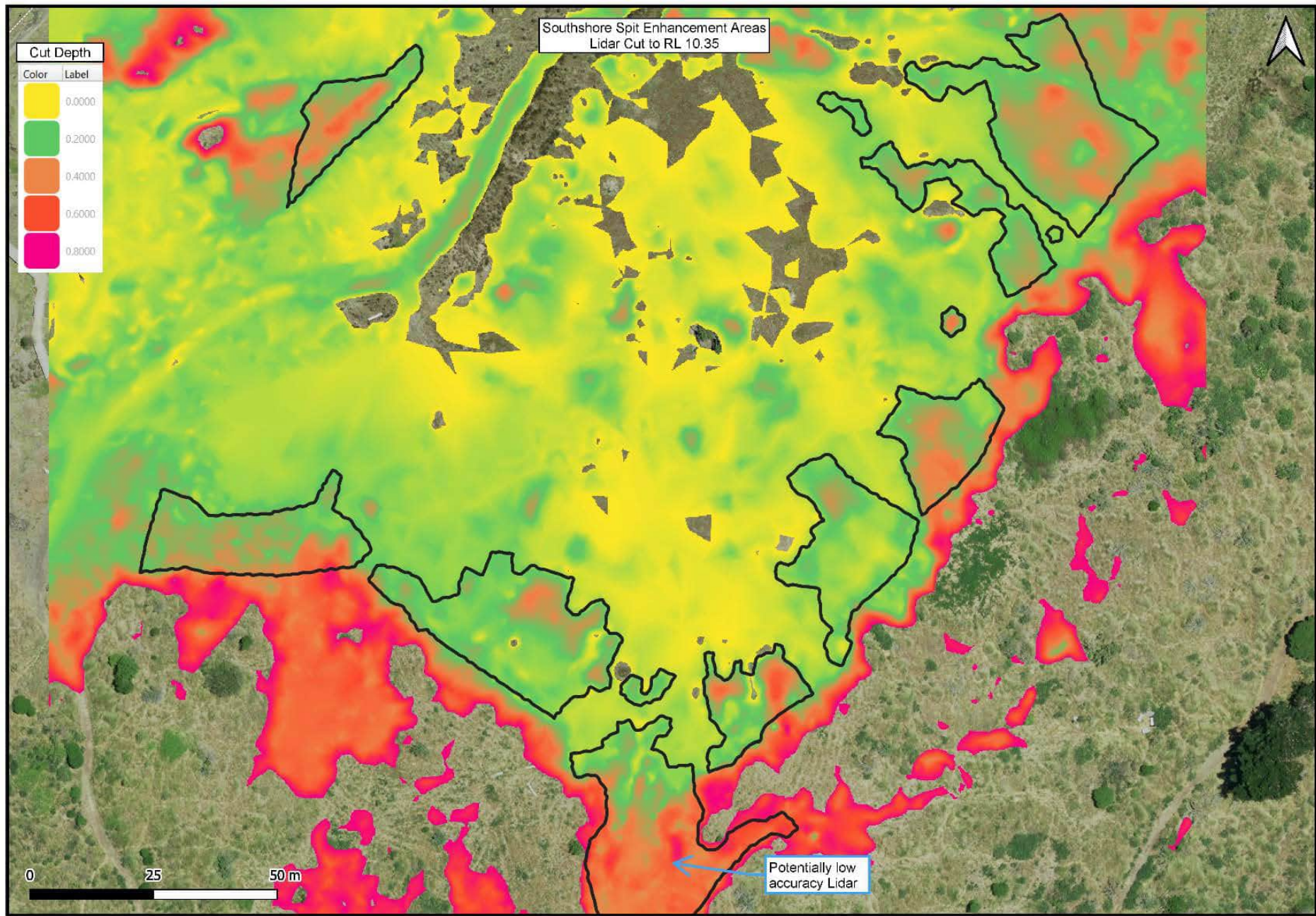


Figure 8. Existing ground levels in offset area (prepared by CCC).

3.4 Biodiversity attribute / benchmark metrics

Offset accounting models rely on subjectively determined biodiversity attributes. Disaggregated attributes are preferred, to avoid 'concealed' losses.

Attributes

The attributes chosen are **cover of indigenous species (%)** and **number of indigenous species (count)** applicable to a given area of the impact or offset site. It is acknowledged that these are simple metrics (with inherent similarity), but it is highlighted that they closely follow worked examples provided in offset methodology (Maseyk et al., 2015).

Natural and intact saltmeadow habitats often have a high to total cover of indigenous plant species, due to the factors of salinity and inundation excluding exotic species. Typical natural saltmeadows have a fairly small species assemblage (compared to a forest or grassland), with a handful (roughly 3-10) species present and usually only one or two species (often glasswort, sveda, or remuremu) dominating the vegetation cover. Whereas saltmeadow habitats in the RRZ have moderate cover of indigenous species, with buckshorn plantain, couch grass, and creeping bent often dominant or co-dominant with indigenous species.

Benchmark

Offset accounting relies on appropriate selection of a 'benchmark' site, i.e., an ideal 'best possible' state for that indigenous habitat type, which both the impact site and the offset site can be compared against. The benchmark for the accounting model in this case is a hypothetical indigenous / remnant saltmeadow area with attributes based on observations in nearby saltmeadow habitats and the experience of the author in remnant / high quality examples of similar habitats in coastal areas of Canterbury. The assumptions and inputs in this benchmark model are provided below.

Results

The modelling approach and results are described qualitatively in Section 3.6-3.7. Appendix 2 shows the offset calculations used as well as results, using the spreadsheets provided by Maseyk et al. (2015).

3.5 Impact model inputs

3.5.1 Impact area biodiversity input metrics

3.5.1.1 Cover of indigenous species (%)

The input value for the **impact site** (saltmeadow at Southshore) was **45% cover** of indigenous saltmeadow herbfield species, based on the average cover in four representative 2x2 m vegetation plots. See also Figure 9 below.

The input value for the hypothetical **benchmark site** chosen was **95% cover** of indigenous saltmeadow herbfield species. Based on the experience of the author, is not unusual for high quality / remnant saltmeadow herbfield areas to have total (100%) cover of indigenous species, although more commonly small areas of bare mud or occasional exotic species are present. The figure of 95% therefore provides a conservative benchmark even though similar habitats in

coastal areas of Canterbury may on occasion slightly exceed this value. See also Figure 10 below.

The input value for exotic grassland areas in the **offset site** at Southshore Spit Reserve is **0% cover**, because indigenous saltmeadow herbfield species are fully absent from the areas proposed for offset actions.



Figure 9. Top: Saltmeadow at Southshore RRZ, with planted sea rush, glasswort, and exotic buckshorn plantain. Bottom: A separate saltmeadow area at Southshore RRZ also with glasswort, buckshorn plantain, exotic iceplant (at rear), bachelors buttons, and miscellaneous hard debris.



Figure 10. Top and Bottom: Remnant and high quality saltmeadow at 172c Rocking Horse Road, with a natural 'soft' estuary edge, and effectively total cover of indigenous species (remuremu, glasswort, sea rush, and sveda). This location close to the impact site was influential in determining a benchmark for the offset model.

3.5.1.2 Number of indigenous species (count)

The input value for the **impact site** (saltmeadow at Southshore) was **five indigenous saltmeadow herbfield species being present**, based on the **maximum result** from four representative 2x2 m vegetation plots (noting that 3.75 was the average per plot, and that all plots included one deliberately planted species, sea rush). This approach is considered conservative. See also Figure 9 above.

The input value for the hypothetical **benchmark** site chosen was **eight indigenous saltmeadow herbfield species being present**. Based on the experience of the author, this number of indigenous species in a given (small) saltmeadow herbfield area would be expected in a highly diverse / intact site. See also Figure 10 above.

The input value for exotic grassland areas in the **offset site** at Southshore Spit Reserve is **zero indigenous saltmeadow herbfield species being present**, because indigenous saltmeadow herbfield species are fully absent from the areas proposed for offset actions.

3.5.2 Impact area size

The input value for the impact area was **0.2 ha**. It is noted that this has conservatively been rounded upwards from an actual calculated loss of 1700 m² (0.17 ha).

3.6 Offset model inputs

To inform the offset model, several areas where similar saltmeadow herbfields have been established in the Estuary were visited, and notes were recorded on species composition and cover. In many cases, conversion to near total indigenous species cover (comprising 4-6 indigenous saltmeadow herbfield species) was observed to have occurred.

3.6.1 Offset confidence / endpoint

Inputs for model offset confidence were '**very confident >90%**' out of possible choices of 'low confidence >50% <75%', 'confident >75% <90%' and 'very confident >90%.' Based on repeated successful outcomes nearby, there is very high confidence of achieving the desired outcome (see also Figure 11-Figure 13 below. These figures sum up the proposed offset neatly).

A finite endpoint of 10 years was chosen. This means that the offset targets are expected to be achievable in ten years. This approach is considered highly conservative; saltmeadow establishment via the same process took less than two years at Charlesworth Reserve (see also Figure 11-Figure 13 below).



Figure 11. Charlesworth Reserve, June 2007, showing recent earthworks 'scrape'. Photo provided to Boffa Miskell by A. Crossland / CCC.



Figure 12. Charlesworth Reserve, April 2009, showing excellent saltmeadow establishment. Photo provided to Boffa Miskell by A. Crossland / CCC.



Figure 13. Charlesworth Reserve, August 2023, showing developed saltmeadow. Photo provided to Boffa Miskell by A. Crossland / CCC.

3.6.2 Offset area biodiversity input metrics

No indigenous saltmeadow herbfield species were observed in the offset areas visited. Therefore, for **% indigenous cover and number of indigenous species present prior to the offset occurring, input metrics were zero.**

3.6.3 Offset site size

The input value for the offset site size was **0.25 ha** (based on the approximate bare minimum offset area advised to CCC early in the offset planning process).

Note that the actual offset area proposed is 0.36 ha.

3.6.4 Outcome for cover of indigenous species (%)

Conservatively, the model assumes the same end result as existing saltmeadow at the Southshore RRZ (**45% cover of indigenous saltmeadow herbfield species**), even though created saltmeadow areas observed exceed this value substantially. This assumption allows for a hypothetical scenario where the habitat created ultimately and for whatever reason does not achieve the same habitat quality as has been achieved in previous saltmeadow creation projects⁵.

⁵ It should be noted that even this conservative approach assumes a result that is at least the same quality as the areas lost, in a greater amount and in an ecologically more cohesive area, translating to a net gain in overall habitat type, amount, and condition.

3.6.5 Outcome for number of indigenous species (count)

Conservatively, the model assumes the same end result as existing saltmeadow at the Southshore RRZ (**five indigenous saltmeadow herbfield species**), even though created saltmeadow areas observed exceed this value substantially. This assumption allows for a hypothetical scenario where the habitat created ultimately and for whatever reason does not achieve the same habitat quality as has been achieved in previous saltmeadow creation projects⁵.

3.7 Impact model outputs

The model (Appendix 2) uses the metrics provided above to determine 'Biodiversity Values' based on the input attributes⁶.

- For cover of indigenous species, the modelled value at the impact site is -0.09.
- For diversity of indigenous species, the modelled value at the impact site is -0.13.

Based on implementation of the offset over 0.25 ha (an approximate bare minimum):

- For cover of indigenous species, the modelled end-result value at the offset site is 0.11.
- For diversity of indigenous species, the modelled end-result value at the offset site is 0.15.

This equates to a 'Component Net Present Biodiversity Value' of 0.02. Because this modelled number is positive, it indicates the **offset will achieve a net gain**. Note that the actual offset area proposed is 0.36 ha. This means that the actual offset outcome is in fact a 'greater' net gain than what the model has determined.

The model demonstrates that following implementation, the proposed offset will achieve an overall net gain for ecologically significant saltmeadow habitat.

⁶ Numbers are arbitrary but relative (e.g., if '2000 m²' was used as an input instead of '0.2 ha' the 'Biodiversity Value' would be 10,000x higher).

4.0 Implementation and monitoring

This Offset Plan generally describes the target outcomes and quantum of measures to be taken. In general, the offset should be implemented as follows:

- Careful scraping by an experienced digger operator, potentially with the use of laser guidance (etc.) to achieve accurate design levels. It is anticipated that scrape depths in the offset area will be approx. 0.1 m to 0.3 m, to achieve a relative level of 10.35 (Figure 8). Across 0.36 ha, this equates to up to c.1,080 m³ in earthworks volume.
- Works should occur outside the indigenous bird breeding season and the period when seasonal migrant birds (e.g., bar-tailed godwits) are present in the estuary. This means that April-August are the ideal preferred months to undertake works.
- Machinery should access the offset area via existing tracks, avoiding existing saltmeadow areas as much as possible. Temporary ground cover mats could be used to enable tracking across areas that cannot be avoided.
- Spoil could be deposited at the edge of the offset area adjacent to dune / marram grass areas but should not be placed within it (avoiding possible lizard habitat, and dune areas that represent opportunities for e.g., separate CCC dune restoration projects). Heaped spoil represents an opportunity to establish additional plantings of indigenous species (e.g., tauhinu, knobby clubrush) to screen saltmeadow areas and minimise existing / ongoing human disturbance of avifauna (e.g., by walkers) using the saltmeadow areas to roost. There is also an opportunity to use the spoil to establish a raised mound (ideally with a viewing hide) near the estuary edge, to enable bird spotting and estuarine wading bird counts; this option could be discussed with CCC ecologists. Neither of these measures are required in respect of adverse effects, but would incidentally achieve further beneficial outcomes from the offset.
- The offset should be implemented ideally prior to but otherwise within 2 years of the commencement of the proposed erosion and flood protection works. This is to avoid time lags between losses and gains.
- Monitoring of the saltmeadow offset area by a suitably experienced ecologist / botanist should occur after 2 and 5 years of offset implementation to assess whether the offset targets have been achieved (**>45% indigenous saltmeadow herbfield cover with at least 5 indigenous saltmeadow herbfield species across >0.25 and ideally 0.36 ha**).
 - o If targets have not been achieved or maintained at each monitoring stage, advice from the suitably experienced ecologist / botanist as to appropriate additional steps should be sought, with measures to be required as soon as practicable after the monitoring.
 - o This could include adaptive measures such as weed control, further scraping (in the same areas to lower levels, or in adjacent suitable areas), or supplementary plantings if considered necessary to accelerate saltmeadow establishment.

5.0 Assessment against ‘Principles for Biodiversity Offsetting’ (Appendix 3, NPS-IB).

Table 1. Adherence of offset proposal to offsetting principles in the NPS-IB.

Principle (per NPS-IB, Appendix 3)	Comment in relation to proposed offset
Adherence to effects management hierarchy: A biodiversity offset is a commitment to redress more than minor residual adverse effects and should be contemplated only after steps to avoid, minimise, and remedy adverse effects are demonstrated to have been sequentially exhausted	The EclA and AEE for the erosion and flood protection project describes in detail the sequential process used to exhaustively apply the effects management hierarchy. Ultimately, this process determined that it was not possible to avoid, minimise or remedy all losses of significant habitat at the point of impact, and an offset is required.
When biodiversity offsetting is not appropriate: Biodiversity offsets are not appropriate in situations where indigenous biodiversity values cannot be offset to achieve a net gain. Examples of an offset not being appropriate include where: (a) residual adverse effects cannot be offset because of the irreplaceability or vulnerability of the indigenous biodiversity affected: (b) effects on indigenous biodiversity are uncertain, unknown, or little understood, but potential effects are significantly adverse or irreversible: (c) there are no technically feasible options by which to secure gains within an acceptable timeframe	None of the limits to offsetting apply. The proposed offset is easily created, the effects are known, and outcomes are achievable within only a few years (potentially only 2 years, and less than 10 years).
Net gain: This principle reflects a standard of acceptability for demonstrating, and then achieving, a net gain in indigenous biodiversity values. Net gain is demonstrated by a like-for-like quantitative loss/gain calculation of the following, and is achieved when the indigenous biodiversity values at the offset site are equivalent to or exceed those being lost at the impact site: (a) types of indigenous biodiversity, including when indigenous species depend on introduced species for their persistence; and (b) amount; and (c) condition (structure and quality)	The same type of saltmeadow herbfield habitat would be created, in a greater amount, and the created area is expected to achieve a better condition (indigenous cover / diversity) than existing saltmeadow areas. An offset accounting model has been used to demonstrate a net gain, using highly conservative model inputs (metrics) supported by qualitative evaluation.
Additionality: A biodiversity offset achieves gains in indigenous biodiversity above and beyond gains that would have occurred in the absence of the offset, such as gains that are additional to any minimisation and remediation undertaken in relation to the adverse effects of the activity	Under existing Southshore Spit Reserve management there is no proposal or anticipation that the proposed offset measures will occur. Natural expansion of saltmeadow due to sea level rise in the offset area may occur in future years in the absence of the offset, but

	the offset does not prevent this expanded saltmeadow also expanding due to sea level rise.
Leakage: Biodiversity offset design and implementation avoids displacing harm to other indigenous biodiversity in the same or any other location	'Leakage' essentially refers to unintended consequences, such as (hypothetically) introducing a bird species to a new area, and then that bird species predate on lizards in that area. No 'leakage' principles are considered relevant to the offset.
Long-term outcomes: A biodiversity offset is managed to secure outcomes of the activity that last at least as long as the impacts, and preferably in perpetuity. Consideration must be given to long-term issues around funding, location, management and monitoring	The offset will occur in a protected CCC reserve. Following offset establishment, no specific maintenance or ongoing management is expected to be required.
Time lags: The delay between loss of, or effects on, indigenous biodiversity values at the impact site and the gain or maturity of indigenous biodiversity at the compensation site is minimised so that the calculated gains are achieved within the consent period or, as appropriate, a longer period (but not more than 35 years)	The offset should be time bound via conditions of consent and is recommended to be implemented within 2 years of the commencement of the proposed erosion and flood protection works.
Landscape context: Biodiversity offsetting is undertaken where this will result in the best ecological outcome, preferably close to the impact site or within the same ecological district. The action considers the landscape context of both the impact site and the offset site, taking into account interactions between species, habitats and ecosystems, spatial connections, and ecosystem function	The offset site is within c.2 km of the furthest impact site, and is within the same estuary context within the same ecological district.
Time lags: The delay between loss of, or effects on, indigenous biodiversity values at the impact site and the gain or maturity of indigenous biodiversity at the offset site is minimised so that the calculated gains are achieved within the consent period or, as appropriate, a longer period (but not more than 35 years)	Based on previous examples of similar projects, the proposed offset is likely to be effective within 10 years, but potentially substantially less (2 years has been observed previously). The offset should be time bound via conditions of consent.
Science and mātauranga Māori: The design and implementation of biodiversity offset is a documented process informed by science, and mātauranga Māori	The offset proposal uses recognised offset accounting methods based on scientific botanical survey, but is not informed specifically by mātauranga Māori
Tangata whenua and stakeholder participation: Opportunity for the effective and early participation of tangata whenua and stakeholders is demonstrated when planning for biodiversity offsets, including its evaluation, selection, design, implementation, and monitoring	Tangata whenua and stakeholder participation has not yet occurred in relation to the offset proposal.
Transparency: The design and implementation of biodiversity offset, and communication of its results to the public, is undertaken in a transparent and timely manner	This offset plan is to be made public via the consent application process. It transparently documents the design and proposed implementation process of the offset.

The table above demonstrates that the proposed offset accords well with the NPS-IB principles.

6.0 References

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Appendix 1: Southshore RRZ saltmeadow plant species list and vegetation plots, and plot location map

Table A1. Plant species present in saltmeadow areas that will be lost as a result of the proposal. Note that this does not include species observed only in saltmeadow areas avoided by the proposal e.g., at 172c Rocking Horse Road.

Species name	Common name	Growth Form	Species Status	Threat Status
<i>Agrostis stolonifera</i>	Creeping Bent	Grass	Exotic	
<i>Apodasmia similis</i>	Jointed Wire Rush	Grass	Indigenous	Not Threatened
<i>Beta vulgaris</i>	Beet	Dicot Herb	Exotic	
<i>Cotula coronopifolia</i>	Batchelors Button	Dicot Herb	Indigenous	Not Threatened
<i>Elytrigia repens</i>	Couch	Grass	Exotic	
<i>Grass species</i>	Unidentified Exotic Grass	Grass		
<i>Juncus kraussii subsp. australiensis</i>	Sea Rush	Grass	Indigenous	Not Threatened
<i>Leontodon species</i>	Hawkbit	Dicot Herb	Exotic	
<i>Lepidium africanum</i>	Peppercress	Dicot Herb	Exotic	
<i>Malva arborea</i>	Tree Mallow	Low Shrub	Exotic	
<i>Plagianthus divaricatus</i>	Salt Marsh Ribbonwood	Shrub	Indigenous	Not Threatened
<i>Plantago coronopus</i>	Buck's Horn Plantain	Dicot Herb	Exotic	
<i>Polygonum aviculare</i>	Wireweed	Dicot Herb	Exotic	
<i>Puccinellia stricta</i>	Saltgrass	Grass	Indigenous	Not Threatened
<i>Salicornia quinqueflora subsp. quinqueflora</i>	Glasswort	Dicot Herb	Indigenous	Not Threatened
<i>Soliva sessilis</i>	Onehunga Weed	Dicot Herb	Exotic	
<i>Spergularia media</i>	New Zealand Sea Spurrey	Dicot Herb	Exotic	
<i>Suaeda novae-zelandiae</i>	Sea Blite	Low Shrub	Indigenous	Not Threatened
<i>Tetragonia implexicoma</i>	Native Spinach	Dicot Herb	Indigenous	Not Threatened
<i>Trifolium repens</i>	White Clover	Dicot Herb	Exotic	

Table A2. Results from four 2x2 m temporary vegetation plots in a representative saltmeadow area at Southshore RRZ used to confirm wetland status (Ministry for the Environment, 2022) and to determine indigenous saltmeadow herbfield species cover / diversity. See the figure on the next page for plot locations based on corresponding GPS waypoint numbers.

Species name (* - indicates exotic species)	% cover of that species	Wetland plant indicator status (Clarkson et al., 2021)	Wetland prevalence index score ⁷	% cover indigenous species	Number of indigenous species
Plot 1 – GPS 576					
<i>Juncus kraussii</i> subsp. <i>australiensis</i>	7	FACW	2.4	66	5
<i>Salicornia quinqueflora</i>	50	FACW			
<i>Plantago coronopus</i> *	30	FAC			
<i>Cotula coronopifolia</i>	0.1	FACW			
<i>Suaeda novae-zelandiae</i>	3	FAC			
<i>Puccinellia stricta</i>	6	FAC			
<i>Beta vulgaris</i> *	0.1	FACU			
<i>Agrostis stolonifera</i> *	0.1	FACW			
Plot 2 – GPS 577					
<i>Juncus kraussii</i> subsp. <i>australiensis</i>	0.1	FACW	2.6	55	4
<i>Plantago coronopus</i> *	43	FAC			
<i>Puccinellia stricta</i>	10	FAC			
<i>Salicornia quinqueflora</i>	43	FACW			
<i>Suaeda novae-zelandiae</i>	2	FAC			
Plot 3 – GPS 578					
<i>Elytrigia repens</i> *	45	FACU	3.4	5	2
<i>Plantago coronopus</i> *	46	FAC			
<i>Juncus kraussii</i> subsp. <i>australiensis</i>	4	FACW			
<i>Salicornia quinqueflora</i>	1	FACW			
Plot 4 – GPS 579					
<i>Juncus kraussii</i> subsp. <i>australiensis</i>	10	FACW	2.5	51	4
<i>Plantago coronopus</i> *	43	FAC			
<i>Suaeda novae-zelandiae</i>	1	FAC			
<i>Salicornia quinqueflora</i>	40	FACW			
<i>Agrostis stolonifera</i> *	0.1	FACW			
<i>Puccinellia stricta</i>	0.1	FAC			

Next page: Figure A1 – Field data map showing plot locations.

⁷ Generally, a score of <3.0 indicates wetland, but any scores of 2.5-3.5 may indicate wetland in the presence of wetland hydrology indicators. All plots had wetland hydrology indicators.

This plan has been prepared by Boffa Miskell Limited on the specific instructions of our Client. It is solely for our Client's use in accordance with the agreed scope of work. Any use or reliance by a third party is at that party's own risk. Where information has been supplied by the Client or obtained from other external sources, it has been assumed that it is accurate. No liability or responsibility is accepted by Boffa Miskell Limited for any errors or omissions to the extent that

LEGEND

- Field data (6 Oct 2023)
- Tracking
- Cadastre



Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors

Figure 1

Appendix 2: Offset Calculations

Impact Model:

IMPACT MODEL

Key:

	User input
	Auto-filled

	BIODIVERSITY TYPE
1	Southshore saltmeadow

 (Ctrl) *

READ ME:

Note 1: The Impact Model must be populated before data is entered into the Offset Model.

Note 2: Use a new workbook for each additional Biodiversity Type.

Steps 1 & 2: Input the Biodiversity Type to be accounted for into Cell C11 and corresponding number (e.g. 1 if it the first Biodiversity Type, 2, if it is the second etc.) into Cell B11..

Step 3: Input the first Biodiversity Component into Cell C15.

Steps 4–10: Work through the Impact Model for each Biodiversity Attribute (Columns E–L) entering values into all cells coloured light brown. Cells coloured light green will auto-populate.

Step 11: Repeat Steps 4–10 for as many Biodiversity Attributes as required.

Step 12: Repeat Steps 3–10 for as many Biodiversity Components as required (scrolling down the sheet).

This section captures which elements of biodiversity, and over what area, will be impacted by the proposal					This section is where the change in measure of each Biodiversity Attribute due to the proposed Impact is quantified, and Attribute Biodiversity Value calculated. Inputs are derived from direct measures, existing data or models where available, or expert estimated predictions				
Biodiversity Component	Biodiversity Attribute		Measurement Unit	Area of Impact (ha)	Benchmark	Measure prior to Impact	Measure after Impact	Biodiversity Value	
1.1	Southshore saltmeadow	1.1a	Cover of indigenous saltmeadow herbfield species	Percentage	0.2	95	45	0	-0.09
		1.1b	Number of indigenous saltmeadow herbfield species	Number	0.2	8	5	0	-0.13
		1.1c							Not calculated

Offset model:

OFFSET MODEL

Key

	User Input		Dropdown list
	Auto-filled		Not Required

	BIODIVERSITY TYPE	DISCOUNT RATE
1	Southshore saltmeadow	

READ ME:

Step 1: Biodiversity Attributes must be entered into the Impact Model prior to commencing input into the Offset Model.

Step 2: Input the Biodiversity Type identifier (e.g. 1 if it is the first Biodiversity Type, 2, if it is the second etc.) into Cell B11. The same identifying number needs to be used for the same Biodiversity Type within the Impact and Offset Models. The Biodiversity Type (Cell C11) will be auto-populated.

Step 3: Input time preference Discount Rate (Cell E11)

Step 4: Biodiversity Components will be auto-populated once Cell B11 is populated.

Step 5: Biodiversity Attributes will be auto-populated once Cell B11 is populated.

Step 6: Work through accounting model for each Biodiversity Attribute entering values into light brown cells. At Column K choose method of accounting for time and follow instructions. If using a finite end point, continue on this sheet. If calculating the offset as accrued over time use the Offset Model_5 yearly worksheet.

Step 7: Repeat for additional Biodiversity Components (scrolling down the sheet)

This section captures which elements of biodiversity are to be accounted for, and the benchmark value for the Attribute. The information matches that in the Impact Model						These cells provide information about the proposed Offset Actions			Calculations can be made for a finite end point, or at five yearly time-steps over 35 years. Indicate preference in Column K and Follow the instructions in Column L	
Biodiversity Component	Biodiversity Attribute		Measurement Unit	Benchmark	Proposed Offset Actions	Offset area (ha)	Confidence in Offset Actions			
1.1	Southshore saltmeadow	1.1a	Cover of indigenous saltmeadow	Percentage	95	Create saltmeadow at Southshore Spit Reserve	0.25	Very confident >90%	Finite end point	Continue to Column M
		1.1b	Number of indigenous saltmeadow	Number	8	Create saltmeadow at Southshore Spit Reserve	0.25	Very confident >90%	Finite end point	Continue to Column M

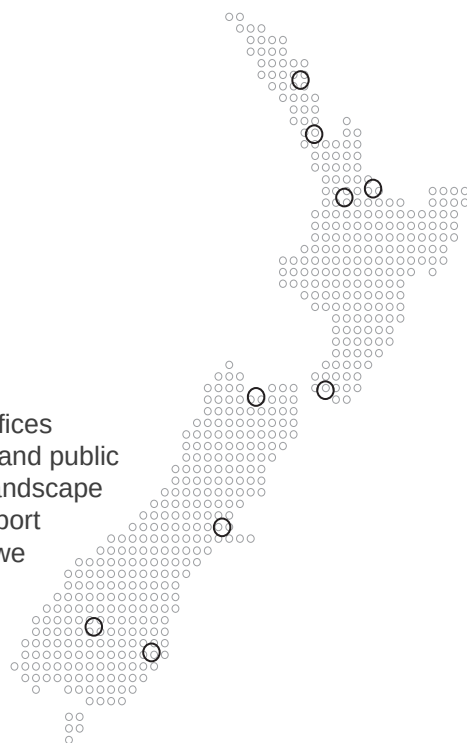
Offset model (continued):

This section is where the marginal change in the measure of Biodiversity Attribute due to the Offset Action is quantified. Inputs are derived from direct measure, existing data or models where available, or expert estimated predictions. Attribute Biodiversity Value at the Offset Site is compared to the Attribute Biodiversity Value at the Impact Site to calculate the Net Present Biodiversity Value for each Attribute					
Measure <u>prior</u> to Offset	Measure <u>after</u> Offset	Time till endpoint (years)	Biodiversity Value at Offset Site	Biodiversity Value at Impact Site	Attribute Net Present Biodiversity Value
0	45	10	0.11	-0.09	0.02
0	5	10	0.15	-0.13	0.02

This is the average Net Present Biodiversity Value for the Biodiversity Component
Component Net Present Biodiversity Value
0.02

Together. Shaping Better Places.

Boffa Miskell is a leading New Zealand environmental consultancy with nine offices throughout Aotearoa. We work with a wide range of local, international private and public sector clients in the areas of planning, urban design, landscape architecture, landscape planning, ecology, biosecurity, Te Hīhira (cultural advisory), engagement, transport advisory, climate change, graphics, and mapping. Over the past five decades we have built a reputation for creativity, professionalism, innovation, and excellence by understanding each project's interconnections with the wider environmental, social, cultural, and economic context.



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