1.0 TECHNICAL MEMO – MARINE ECOLOGY

To:	Stacey Sharp & Blair Masefield, Beca (consultant planners)
From:	Drew Lohrer, Principal Scientist and Strategy Manager, Coasts & Oceans Centre, NIWA
Date:	19 July 2023

1.1 Statement of Qualifications and Experience

My full name is Andrew Martin Lohrer. I hold a Bachelor of Science degree in Ecology, Behaviour and Evolution from the University of California at San Diego, USA (1992, Cum Laude), and a PhD in Ecology and Evolutionary Biology from the University of Connecticut, USA (2000).

I have conducted marine ecology research in coastal and estuarine habitats since 1995. I have been employed as a marine ecologist at the National Institute of Water & Atmospheric Research (NIWA) in New Zealand full time since April 2002 (21 years). My current position is Principal Scientist – Marine Ecology and Strategy Manager – Coasts & Estuaries.

My area of expertise includes coastal and estuarine seafloor ecology, disturbance-recovery dynamics, and the contributions of seafloor organisms to ecosystem functioning. I have designed and carried out ecological investigations in both intertidal and subtidal habitats, and have published 104 papers in the international peer-reviewed literature in addition to 46 technical reports.

I am familiar with Whangarei Harbour, where I recently measured the productivity of intertidal and subtidal seagrass at four sites in the Takahiwai area and assessed biodiversity at twenty-four sites in the outer Harbour and Bream Bay. I have also sampled Snake Bank and around Mair and Marsden Banks. I received a tour of the Northport facility on 2-June-2021, visited and photographed intertidal sandflats to the east and west of Northport on 3-June-2021 and 22-August-2022.

I confirm that the statements made within this memorandum are within my area of expertise and I am not aware of any material facts which might alter or detract from the opinions I express. Whilst acknowledging this consenting process is not before the Environment Court, I have read and agree to comply with the Code of Conduct for Expert Witnesses as set out in the Environment Court practice note (2023). The opinions expressed in this memorandum, are based on my qualifications and experience, and are within my area of expertise. If I rely on the evidence or opinions of another, my statements will acknowledge that.

2.0 APPLICATION DESCRIPTION

Applicant's Name:	Northport Limited (Northport)
Activity type:	**Land Use (s9), Coastal Permit (s12), Water Permit (s14), Discharge Permit (s15)**

Purpose description:	Northport seek to construct, operate, and maintain an expansion of the existing port facility to increase freight storage and handling capacity, and transition into a high-density container terminal.
Application references:	Northland Regional Council: APP.005055.38.01 Whangārei District Council: LU2200107
Site address:	Ralph Trimmer Drive, Marsden Point, Whangārei

3.0 SITE AND PROPOSAL DESCRIPTION

1.2 Site and Environmental Setting

A description of the subject site and surrounding environment was provided in section 4.0 of the Assessment of Environmental Effects (AEE) entitled: *Application for resource consents for the expansion of Northport*, prepared by Reyburn & Bryant, dated 6 October 2021.

I concur with the description of the site and surrounding environment in the AEE and adopt that description for the purpose of this assessment.

1.3 Proposal

The proposal is as described in section 3.0 of the AEE and depicted on the design drawings attached as Appendix 3 of the application (referenced in Section 2.3 below).

I note the following key elements of the proposal:

- Construction of a 11.7ha reclamation to extend the existing Port facility to the east
- Dredging of approximately 1.72 million m3 of material to construct the reclamation and extend/deepen the existing swing basin
- Construction activities within the coastal environment, including pile-driving (via vibro and top-driven impact hammers), construction of seawalls and abutments, and discharge of decant water
- Discharge of operational stormwater from the extended and existing Port
- Construction of a high tide bird roost to the west of the existing Port facility.

The memorandum is limited to the consideration of matters relating to marine ecology.

1.4 Reference documents

The following application documents have been reviewed and inform this technical memorandum.

<u>Application</u>

- Assessment of Environmental Effects entitled: *Application for resource consents for the expansion of Northport*, prepared by Reyburn & Bryant, dated 6 October 2021 (henceforth referred to as AEE)
- Design Drawings entitled: *Northport – Proposed Reclamation and Dredging*, prepared by WSP, sheets C01 – C04, plan set dated 18 August 2022
- *Assessment of Marine Ecological Effects,* prepared by Coast and Catchment, dated September 2022.
- *Peer Review of Assessment of Ecological Effects,* prepared by Cawthron Institute, dated 5 October 2022.

s92 Request for Information

- Further information response prepared by Shane Kelly (Coast & Catchment Environmental Consultants, dated 10 January 2023 (henceforth referred to as s92 Response).

- Draft conditions of consent, working drafts, dated 21.04.2023.

4.0 REASON FOR CONSENT

4.1 Reasons for Consent

A list of resource consents sought (as per the application documents as lodged) are summarised in Sections 1.5 – 1.7 of the AEE, and are as amended by the s92 Response.

4.2 Overall Activity Status

Overall, the resource consent is considered as a **Discretionary Activity**.

5.0 TECHINICAL ASSESSMENT OF APPLICATION AND EFFECTS

5.1 Assessment of Effects on the Environment

As part of the application for resource consents for the expansion of Northport, the Assessment of Marine Ecological Effects document (Appendix 11, Kelly and Sim Smith 2022, Coast & Catchment Environmental Consultants, hereafter "AMEE") identified and assessed multiple potential effects. I consider that all of the major effect types have been assessed [1]. These included (quoted from Tables 20 and 21 on pp 141-142):

- Effects on intertidal sediment habitats and macrofauna (moderate)
- Effects on kaimoana shellfish (low)
- Effects on subtidal habitat and benthic macrofauna – Reclamation (moderate)
- Effects on subtidal habitat and benthic macrofauna – Dredging (moderate to high)
- Effects on seagrass (low)

- Effects on macroalgae (moderate to high)
- Effects on fish (low)
- Effects on reef habitat (positive in medium to long term)
- Effects of stormwater discharges (low)

The indications of low, moderate, and high in the bullets above refer to Environmental Institute of Australia and New Zealand (EIANZ) guidelines for ranking the magnitude of adverse environmental effects. According to the AMEE, a "Low" EIANZ effect is considered to be a "less than minor" effect under the applicable RMA planning/legal framework; and a "Moderate" EIANZ effect is considered to straddle a "minor" and "more than minor" range. Table 7 of the AMEE (p 96) details the EIANZ ranking system in full.

The following summary comments were made with respect to effects on page 11 of the AMEE:

> "*The ecological effects of the proposal on threatened or at risk species (seagrass and macroalgae), or the Significant Ecological Areas (SEAs) identified in the Proposed Regional Plan will be in the range of negligible to less than minor (and in some cases temporary).*
>
> *Noting that, most of proposed dredging area is already subject to dredging — if best practice methods for managing dredging effects are applied, then the ecological effects on any other potential areas of significant indigenous vegetation and habitats of indigenous fauna under Appendix 5 of the Regional Policy Statement (RPS) could also be kept within minor and/or transitory levels.*"

5.1.1 Comments on the Methodology of the AMEE

I will not comment on the methodology used to assess the individual ecosystem components of Whangarei Harbour. I stipulate that the methods used were appropriate and that there is sufficient physical (e.g., sediment type, depth, currents) and ecological (e.g., soft-sediment infauna, shellfish kaimoana, seagrass, reef epifauna, finfish) data from which to make assessments. Some of the data have been collected on multiple occasions in recent years, shedding light on their temporal dynamics.

Assessments were made at three spatial scales (specified in Table 20 on page 141 of the AMEE): whole harbour ('Harbour'), outer harbour and entrance zone ('OHEZ'), and development footprint ('Footprint'). These scales, defined in Section 6.1 of the AMEE, are clear and understandable, although they are arbitrary, as water, materials, and organisms can readily move across zone boundaries.

The assessment framework of the AMEE was consistent with planning policy directives[1] to consider that the scale of the effect of an activity is generally proportional to its size. However, the assessment methodology treats all areas within a zone as homogenous, despite available data showing otherwise (e.g., within-OHEZ variation in depth, substrate

[1] Policy D.2.18(5)(a) of the Proposed Regional Plan – Appeals Version.

type, current speeds, exposure, seafloor community composition, etc.). The assessment methodology did not consider that the loss of small but critical areas (e.g., breeding grounds, migration corridors) can have disproportionately large effects on populations and communities.

5.1.2 Comments on conclusions of the AMEE

Conclusions of the AMEE appear to have been drawn based on the following:

> **Only a small amount of habitat will be affected**, relative to the overall amount of similar habitat within Whangārei Harbour and the OHEZ. For example, only 1.08% and 0.28% of intertidal and subtidal habitat, respectively, in the OHEZ will be eliminated by the proposed reclamation.
>
> **Some of the area designated for reclamation and dredging is already consented for reclamation and dredging**. For example, the proposed dredging will affect a total of "*61 ha of subtidal seabed, most of which is within an area covered by an existing dredging consent*". The implication is that additional reclamation and dredging will not likely markedly increase effects over those that have already been consented to.
>
> **The organisms and communities that will be eliminated by reclamation and dredging are not unique.** In other words, they occur elsewhere in the OHEZ and in other North Island estuaries and thus their loss is of minor consequence.
>
> **Species listed as 'threatened' or 'at-risk' are not common in the proposed reclamation and dredging areas.** For example, only small, sparse patches of seagrass occur in the reclamation footprint, whereas seagrass is widespread and expanding in the OHEZ at present (especially west of Northport in the Takahiwai area).
>
> **Rocky revetments host diverse reef communities** (e.g., sponges, ascidians, algae, and associated mobile fauna) **and will increase in net extent** if the proposed reclamation proceeds as planned, therefore, the reclamation has the potential to deliver some net positive biodiversity effects.
>
> **Ecological values in the area are high, despite the presence of Northport** and the stressors and discharges associated with its operation. Therefore, Northport activities must not be having major impacts, and expansions to it will be similarly benign.

The statements written in bold are factually accurate. However, I do not agree with the reasoning or conclusions drawn from them, individually or together. My logic is outlined below:

> Section 6.3 of the AMEE (p 98) states that approximately 73 ha of subtidal seafloor habitat will be directly impacted by the proposed reclamation and dredging. The AMEE concludes that the impact of reclamation and dredging will be small because 73 ha is a small percent of the OHEZ. However, in my opinion, both percentage and absolute magnitude require consideration. Seventy-three

hectares is a small percentage of the OHEZ because Whangarei Harbour's OHEZ is very large (2580 ha; AMEE p 94). Yet 73 hectares of seabed habitat is large enough—by my highly conservative estimates—to host close to 2 billion benthic invertebrate animals. Benthic organisms contribute to range of valued ecosystem functions and services (e.g., primary production to support food webs, organic matter breakdown, nutrient cycling, sediment irrigation/oxygenation, sediment stabilisation/armouring, provision of nursery habitats for fish, etc.; see also AMEE Section 6.5.3). Thus, in my view, 'direct impact' to 73 ha of healthy and functioning seabed habitat and the biodiversity living therein is not small in magnitude.

Further, contrary to the 'small proportion' statements made in the AMEE, habitats crucial for the production, survival, or transport of key organisms or life-stages can make disproportionately large contributions to populations or ecosystem functions. In other words, eliminating small but critical areas can have consequences well beyond the area of direct impact. In particular, I hold residual concerns regarding the proposed reclamation area interfering with the transport of sand and juvenile pipi along the outer southern shoreline of the OHEZ (discussed in section 5.1.2 below).

Unlike the dredged areas, which have some scope for recovery after impact, all habitats and organisms within the proposed reclamation areas will be permanently eliminated from the Whangarei marine ecosystem. Nothing east of Northport has been reclaimed yet. According to Table 8 of the AMEE, the applicants already have consent to reclaim 0.14 ha of intertidal habitat and 4.35 ha of subtidal habitat. The applicants are seeking to reclaim what is already consented plus an additional 6.6 ha of intertidal habitat and 5.1 ha of subtidal habitat. The applicant is therefore proposing to reclaim to total of 16.19 ha. This means the permanent elimination of habitats that contribute to ecosystem functions (e.g., primary production, provision of nursery habitat) and food webs (e.g., microalgal primary producers, which are consumed by shellfish and other macrofauna, which are consumed by vertebrates such as eagle rays; which are consumed by orca) that may be disproportionately important relative to their size, such as

- **Area with relatively high primary production capacity** due to its shallow depth and location in clear water near the harbour entrance, which results in ample light reaching the seabed to support microalgal, macroalgal, and seagrass photosynthesis.
- **Area containing seagrass patches** (e.g., Figure 64 on p 116 of the AMEE), an "At Risk" species under the New Zealand Threat Classification System, and a species known as a refuge/settlement habitat for juvenile snapper and other fish and invertebrates (Figure 1).
- **Area that once had higher densities of bivalve shellfish** (see submission 164a) and served/serves as a settlement site and transport corridor for juvenile pipi. Reclamation eliminates the chances of pipi population recovery in the reclamation footprint and reduces the likelihood in adjacent areas such as Marsden/Mair bank.

In short, I consider that the AMEE conclusions are based primarily on proportional size (relative to OHEZ or Harbour) and do not adequately consider the potential broader importance of the taxa, habitats, and ecosystem functions of the affected areas.

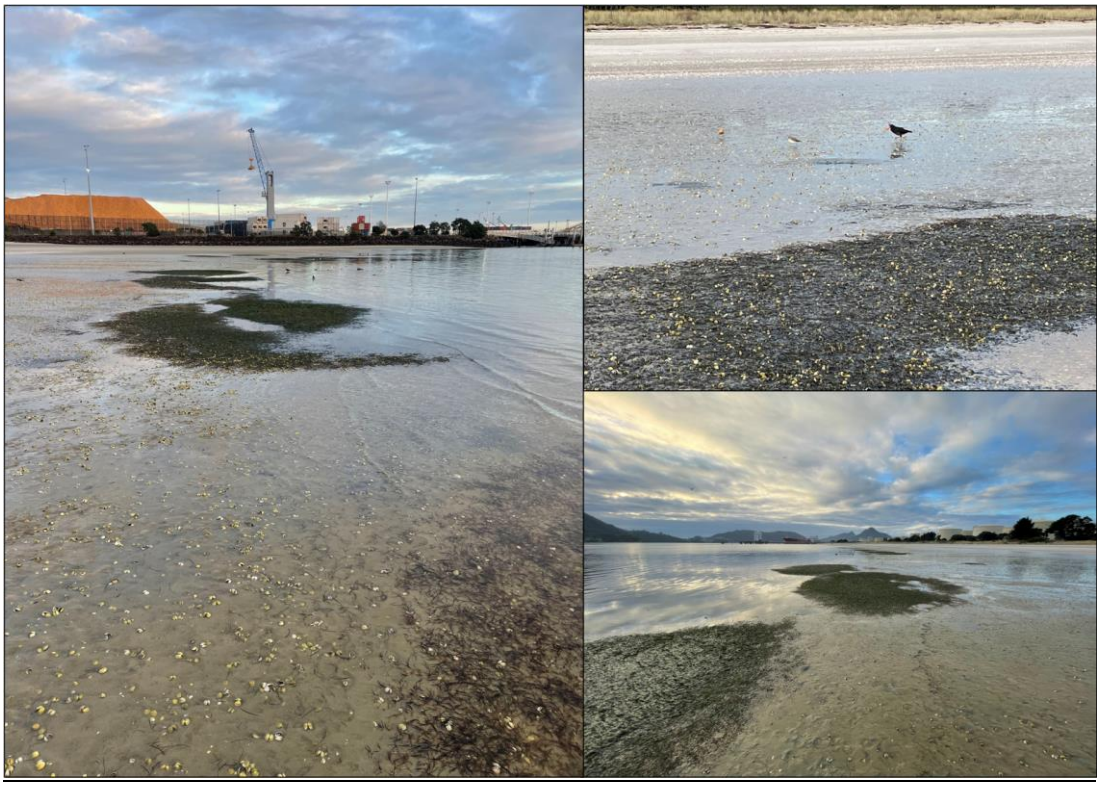

Figure 1. Seagrass patches on the sandflat east of Northport. Also note the cockle shells and the shorebirds present in the area. Birds were observed inside and around the seagrass patches. Photos: D. Lohrer, 4-June-2021.

<u>Concluding summary of individual effect magnitudes</u>

In conclusion, I consider the magnitudes of individual effects to be as follows.

Effect Type	AMEE Conclusion	My Conclusion	Reasoning
Effects on intertidal sediment habitats and macrofauna	Moderate (Harbour-scale)	Moderate (OHEZ scale)	• Agree with AMEE conclusion, but appropriate assessment scale should be OHEZ, given dissimilarity of muddy upper harbour and Pārua Bay intertidal sediment habitats relative to those affected by proposal
Effects on kaimoana shellfish	Low (Harbour-scale)	Moderate (OHEZ scale)	• Disruption of sediment and propagule transport pathways that likely support kaimoana shellfish populations on sandbanks (pipi, cockles, mussels). • Elevated suspended

			sediment concentrations and deposition rates from dredging activities will have deleterious effects on suspension-feeding shellfish kaimoana including pipi, cockles, mussels and scallops. • Assessment scale should be OHEZ, given this is where kaimoana densities are highest (Snake Bank, Mair/Marsden Bank, Urquharts Bay) and where impacts will be most intense
Effects on subtidal habitat and benthic macrofauna – Reclamation	Moderate (OHEZ)	Moderate (OHEZ)	N/A – agree with AMEE
Effects on subtidal habitat and benthic macrofauna – Dredging	Moderate to high (OHEZ)	Moderate to high (OHEZ)	N/A – agree with AMEE
Effects on seagrass	Low (Harbour)	Low (Harbour)	Agree with AMEE, but note seagrass is an "At Risk" species under the New Zealand Threat Classification System
Effects on macroalgae	Moderate to high (OHEZ)	Moderate to high (OHEZ)	N/A – agree with AMEE
Effects on fish	Low (Harbour)	Low (Harbour)	N/A – agree with AMEE
Effects on reef habitat	Positive in medium to long term (Harbour)	Positive in medium to long term (Harbour)	• Agree that net availability of hard substrate for reef organism settlement will increase. However, this is artificial reef habitat where public access for collection of reef species (kina, crayfish) will be limited. • Net gains of this habitat type are very small relative to losses and alterations to other habitat types.
Effects of stormwater discharges	Low	Low	

5.1.3 Comments on cumulative effects

The AMEE (p 127) acknowledges the potential for cumulative disturbance and loss of habitat and biota through the combined impacts of dredging and reclamation. The AMEE covers nine types of potential impacts to the marine environment but does not meaningfully consider the potential cumulative effects of these.

The Whangarei/Bream Bay system, and the OHEZ specifically, has a diverse range of habitats that have high biological diversity. Few other harbours in Aotearoa New Zealand that are navigable to large vessels have an estuarine mouth channel with diverse shell-armoured sediments, very clear water, and high abundances of birds, rays and marine mammals using both subtidal and intertidal habitats. Despite the high values remaining in the Harbour, the AMEE acknowledges that the area "*has been modified by decades of industrial, rural, urban, and coastal activities*" (p 126).

High density horse mussel beds (*Atrina zelandica*) have almost completely disappeared [2-4]. Scallop fishing has been paused due to low numbers [5]. Pipi beds (*Paphies australis*) have undergone a ~10,000 tonne collapse in a little more than a decade [6-8]. The AMEE remarks on the presence of *Atrina*, scallops, and pipi when describing the Harbour's Northeastern Bays 'Significant Ecological Area' (SEA). These species are ecologically important [submission 139] and culturally important [submissions 164a,158] and known to be negatively influenced by seabed disturbances including dredging and elevated sediment deposition rate, both of which are pertinent given the proposed activities. The AMEE (p. 32) also notes that "*Mair and Marsden Banks at the southern entrance to the harbour…provide regionally and nationally significant shellfish habitat, and until recently, supported the largest commercial harvest of pipi (Paphies australis) in the country*".

The existing Northport structure appears to have disrupted the transport of sand, and likely the dispersal of pipi, along the southern shore of the OHEZ. Aerial photographs indicate how sand and materials moving parallel to the southern shore in flooding and ebbing currents are redirected by the Northport structures (Figures 2-4). Evidence of this is provided in Section 3.1.1 of a 2010 Tonkin and Taylor report [8], excerpted below (bold emphasis is mine):

> *3.1.1 NorthPort Ltd reclamation*
>
> *A 30 hectare reclamation as part of NorthPort Ltd expansion was constructed from 2000 to June 2002. As part of the Resource Consent process an environmental impact assessment (EIA) was undertaken (Den Ouden Asssociates 1993). The aim of the AEE was to assess the effects of the reclamation, including coastal process, particularly changes in water currents and associated sediment transport.*
>
> *A numerical model was used to assess the effects of the reclamation on water movement (Barnett Consultants Limited 1993). The results of the modelling concluded that the current and sediment regime in the Blacksmiths Creek/Marsden Bay would be little changed with the reclamation.*
>
> *However,* ***evidence below suggests that sediment regime along the coast has been affected by the reclamation****.*
>
> *The reclamation is located along the southern shoreline of Whangarei Harbour, near the harbour entrance. Along this shoreline the predominant westerly along shore transport is likely to be due to the predominant wave direction from the east entering the harbour (especially low period swell). However, considering the predominant wind direction is from the west, there are likely to be periods of*

easterly along shore transport.

Evidence for net westerly along shore transport is shown by the orientation of the spit at Blacksmiths Creek pre-reclamation. More recent evidence of westerly alongshore transport is the ***accumulation of sediment immediately east of the reclamation, resulting in significant progradation of the shoreline****.*

The resulting ***decrease of along shore sediment supply due to the reclamation has caused the shoreline east of Blacksmiths creek to significantly erode****. The eroding shoreline is likely to reach an equilibrium position sometime in the future. However, the location of the equilibrium shoreline is difficult to predict. Increased wave energy may enter Blacksmiths creek, should the shoreline erode further. The possible increased wave energy may cause accelerated erosion along the shoreline south of the Blacksmiths Creek training groyne.*

Figure Error! No text of specified style in document.**.** Evidence suggestive of sediment trapping by Northport structures along the southern shore of Whangarei Harbour. Annotation of Figure 19 from Poynter 2021a [9]. Area (a) shows area of organic matter/algae/seagrass detritus retention to the left of the western revetment. Area (b) shows area of sand build-up and shoreline progradation next to the eastern revetment.

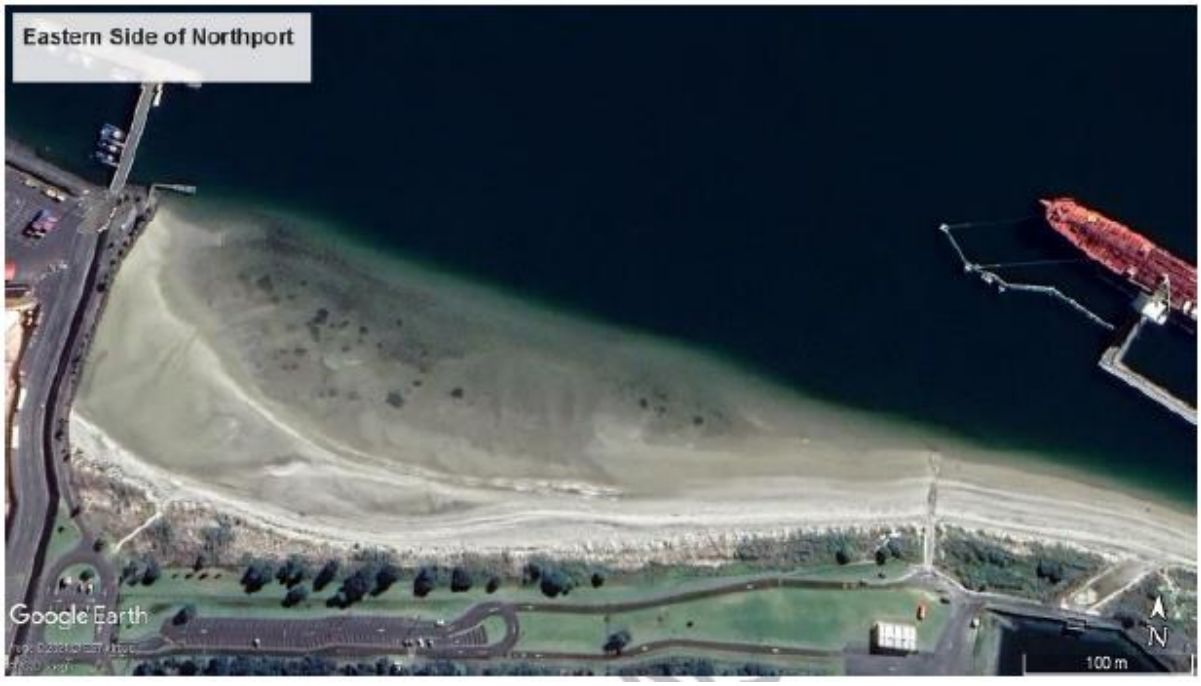

Figure 3. Close-up of area (b) from Figure 2 showing evidence of sand build-up and shoreline progradation next to the eastern revetment.

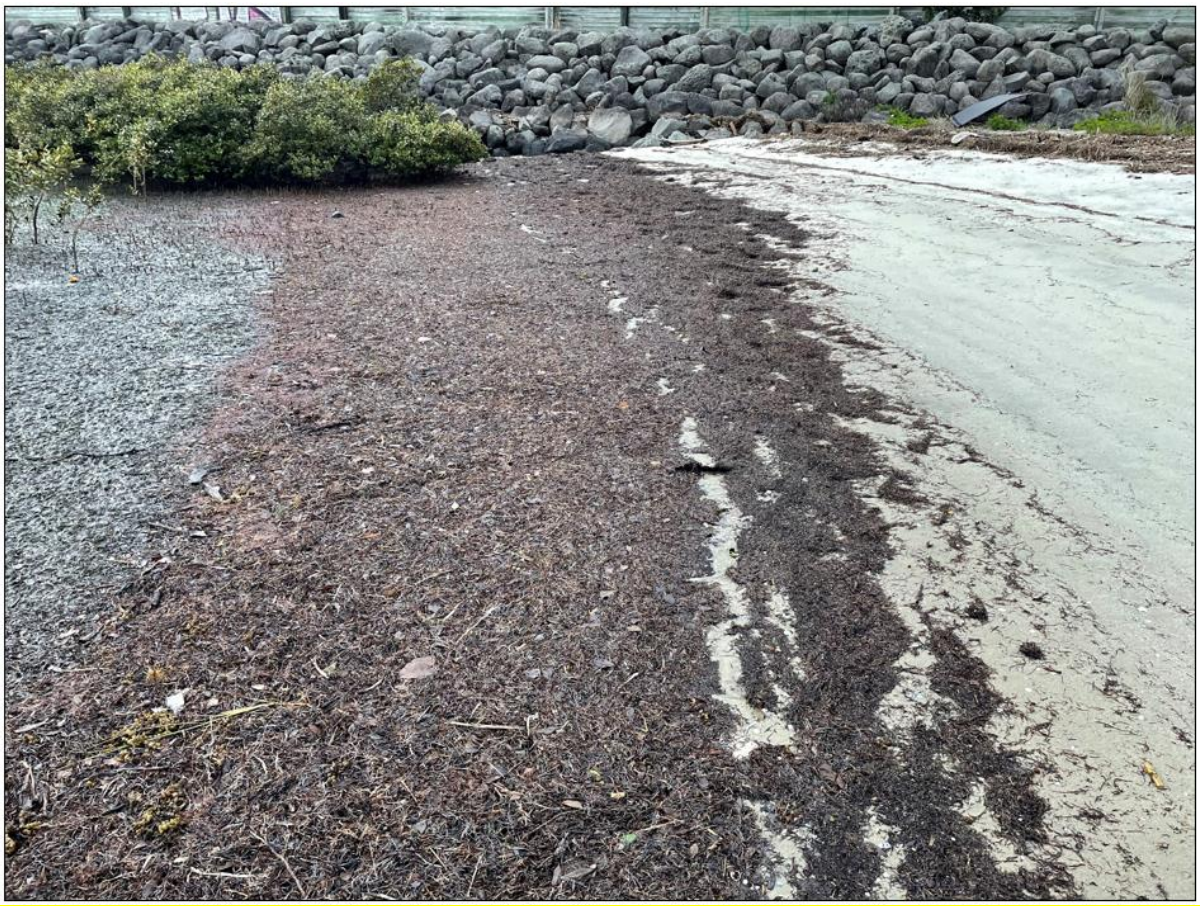

Figure 4. Ground-level close-up view of decaying detrital seagrass trapped against the western revetment. Photo: D. Lohrer, 3-June-2021.

It is worth noting that the Barnett Consultants Limited modelling in 1993 (referenced 2010 Tonkin and Taylor report [8]), which as part of the environmental impact assessment prior to the construction of Northport, predicted "*little change*" to the current and sediment regime, yet evidence by 2010 indicated that the "*sediment regime along the coast has been affected by the reclamation*"[8].

In terms of the biology, invertebrate larvae can be thought of as particles (though not necessarily passive drifting particles). Bedload transport of juveniles and adults (i.e., with the drift of the sediment along the seafloor) is a well-known pathway by which invertebrates disperse and colonise new habitats. This is particularly relevant for organisms like pipi, which settle as juveniles on intertidal flats and actively ride the currents to more suitable subtidal habitats when larger. The productive adult pipi beds once present on Mair and Marsden banks have dwindled [6-8], and changes in along-shore currents following the construction of Northport may have blocked the secondary transport of juvenile pipis and contributed to their population declines on the banks.

While the existing Northport structure is unlikely to be removed, the loss (through reclamation) and alternation (due to dredging-related hydrodynamic and sediment effects) of additional habitat near where pipi were once highly abundant should be minimised so as to not further erode their contributions to ecosystem services such as, e.g, water filtration, seabed armouring, provision of wild seafood, and support of cultural heritage and identity. Further cumulative pressure on pipi populations could lead to irreversible damage.

Consideration of these matters are set out under Subclause (b) of Policy 11 of the New Zealand Coastal Policy Statement, which requires the avoidance, remediation or mitigation of adverse effects in six ecological circumstances. Three of the most relevant points (e.g., related to pipi) are highlighted in bold text below:

> *(i) areas of predominantly indigenous vegetation in the coastal environment,*
>
> *(ii)* ***habitats in the coastal environment that are important during the vulnerable life stages of indigenous species****,*
>
> *(iii) indigenous ecosystems and habitats that are only found in the coastal environment and are particularly vulnerable to modification, including estuaries, lagoons, coastal wetlands, dunelands, intertidal zones, rocky reef systems, eelgrass and saltmarsh,*
>
> *(iv)* ***habitats of indigenous species in the coastal environment that are important for recreational, commercial, traditional or cultural purposes****,*
>
> *(v) habitats, including areas and routes, important to migratory species, and*
>
> *(vi)* ***ecological corridors, and areas important for linking or maintaining biological values identified under this policy****.*

5.1.4 Sediments

Most of my past research on the impacts of sediments on marine benthic species pertains to terrigenous sediment. Only a few mm (e.g., 3-5 mm) of terrigenous sediment is enough to cause detectable ecological impacts [11-12]. Although the proposed dredging will only mobilise marine seabed sediments (not terrigenous sediments), the mechanisms of impact caused by the two types of sediments (e.g., smothering, interference with respiration and filter-feeding) is likely to be similar. This suggests that the thickness of the dredging-related deposits may be of significant ecological concern due to the potential negative effects on filter-feeding seafloor species including the aforementioned horse mussels, scallops, cockles, and pipi.

For example, in simulated dredging operations over a 1-month period using the more conservative of the two channel dredging methodologies (i.e., cutter section dredging, CSD), models predicted deposition thickness to be 10-100 mm across 10-16 ha of marine seabed and >100 mm deposition across ~2.7 ha (see pages 103-105 of the AMEE). Therefore, sediment thickness of 2 to >20 times higher than the levels capable of causing detectable impacts (i.e., 10 to >100 mm, relative to 3-5 mm) is predicted to occur across >10 hectares of OHEZ seabed. Although a review of the AMEE by Cawthron commented that the modelling assumption of constant accumulation of material into deposits (with no potential for resuspension from the bed once settled) likely overestimated deposition thicknesses, the modelling would have therefore been less conservative with respect to suspended sediment concentrations (SSC, which reduces water clarity and can harm the condition and growth of suspension-feeding species). Moreover, the potential cumulative effects of SSC and deposition occurring together were not addressed.

The AMEE suggests little concern for the potential for impacts of deposition, stating "*it is reasonable to assume that biota in energetic areas (such as Marsden Bay) are adapted to living in dynamic environments where marine sediments are regularly resuspended and redeposited by wave action*". This is contracted by experimental evidence from another North Island estuary, where sediment deposition was shown to cause 50-80% reductions in the richness and abundance of intertidal macrofauna taxa and where the dispersal and breakup of deposits by waves from storms did not facilitate a full recovery even more than a year later [13]. Moreover, there is evidence to suggest that communities living in clear waters like those of the OHEZ may have elevated sensitivity to the effects of suspended and deposited sediments [14,15]). The AMEE may not have appropriately considered the available evidence and I consider that the impacts of deposition stemming from the proposed activities will be greater than the AMEE suggests.

5.1.5 Climate extremes and uncertainty, and sea level rise

The outer Whangarei Harbour system has sharp bathymetric gradients, with deep channels directly adjacent to extensive intertidal banks of coarse shelly sand. The inundation time of intertidal habitats will increase over the next 35 years with sea level rise. The frequency and severity of storms is also expected to change in coming decades as the atmosphere and surface ocean temperatures around New Zealand rise. Therefore, climate change and sea level rise, in combination with losses of shellfish and associated natural seabed armouring (page 108 of AMEE), could alter patterns of sand movement and thus the shape, elevation, and characteristics of intertidal sandbanks in the OHEZ. These changes have the potential to further reduce the shellfish and the provisioning and cultural ecosystem services provided by these banks. The AMEE does not appear to have considered climate change or sea level rise in their assessment, individually or in

combination with stressors imposed by the proposed activities, despite their relevance to the marine ecology of OHEZ.

Finally, as we have seen during early 2023 following storms (e.g., Cyclone Gabrielle, which affected Northland and other parts of the country), major sediment loading events to the coastal zone can occur periodically, stressing the ecology of harbours and estuaries. Past research has shown that a proportion of the bed sediments in the OHEZ enter the estuary via the Hatea River catchment [16]. Therefore, elevated SSC and sediment deposition in the OHEZ due to the proposed dredging activities should not be considered separately from the influences of catchment sediment loading, especially given that storm-related sediment loads and impacts may increase with climate-related increases in storm frequency and intensity. The AMEE does not appear to have adequately considered the potential for climate interactions and effects when commenting on the potential impacts of dredging related sediment deposition and resuspension. Given the uncertainty, a more precautionary approach is warranted.

5.2 Conclusion

Overall, I conclude that the actual and potential adverse effects of the proposal on the marine ecology of the Whangarei/Bream Bay system will be significant.

6.0 TECHNICAL RESPONSE TO MATTERS RAISED IN SUBMISSIONS

6.1 Shellfish loss

Relevant submissions: 139 (Forest and Bird), 174a (S. Tyson), 164a (Patuharakeke), 220 (J. Pryor), and 229 (A. McKinnon)

- A concern has been raised about impacts to shellfish, with specific mention of bivalve shellfish species including pipi, cockles (tuangi), mussels (kutai), and scallops (tipa) that have been recreationally and traditionally harvested in and around areas proposed for dredging and reclamation in the OHEZ.

- The potential for shellfish loss, and the mechanisms by which the proposed activities may harm shellfish, has been addressed at several places in this technical memo. The AMEE considers the effects on shellfish kaimoana to be low, whereas my conclusion, summarised in section **5.1.2**, is that effects are likely to be at least ‘moderate’ due to (1) disruption of sediment and propagule transport pathways that likely support kaimoana shellfish populations on sandbanks such as Mair/Marsden bank and (2) elevated suspended sediment concentrations and deposition rates from dredging activities that will have deleterious effects on suspension-feeding shellfish kaimoana including pipi, cockles, mussels and scallops. The OHEZ and areas adjacent to proposed dredging and reclamation zones have been areas of traditionally high kaimoana shellfish abundance and recreational/cultural usage. Kaimoana shellfish populations are presently low and under pressure from multiple stressors at present and the proposed activities are likely to diminish the likelihood of recovery and the lifting of harvesting bans. The uncertainty of climate change, which could interact with the effects of proposed activities and alter the characteristics of the sandbanks and their suitability for

shellfish, is another factor that has not been adequately addressed in the AMEE given that the impacts of climate change and sea level rise are likely to manifest within the 35 year consent period.

6.2 Effects on marine ecology

Relevant submissions: 158 (P. Nelson), 164a (Patuharakeke)

- A concern has been raised about the use of percentages of intertidal and subtidal area within the outer harbour and entrance zone (OHEZ) as a means of evaluating actual or potential effects on marine ecology, as it assumes that such areas are similar throughout the OHEZ and therefore interchangeable.

- This is addressed in section **5.1.2.**, where I state that both percentage and absolute magnitude of area affected require consideration. I also demonstrate how the loss of proportionally small but crucial areas (such as settlement sites or transport corridors for key life-stages) can have large effects, and why I think this may be of particular importance to pipi populations at Mair/Marsden bank and along the southern shoreline of the OHEZ. The submitters are correct that different habitats of the same type in the OHEZ ('intertidal' or 'subtidal') are not necessarily interchangeable. I agree with the submitters that this was not adequately addressed in the AMEE.

7.0 STATUTORY CONSIDERATIONS

7.1 Resource Management Act 1991

Relevant statutory considerations under the RMA include:

- New Zealand Coastal Policy Statement
- Regional Policy Statement for Northland
- Proposed Regional Plan for Northland (Appeals Version)
- Operative Regional Coastal Plan.

7.2 Other Statutory Documents

Other relevant statutory considerations include:

- Wildlife Act 1953
- Reserves Act 1977

7.3 Duration and Review of Consents

The Applicant seeks 35 year durations for the regional consents. I have no comment on the duration of the consent period, although I note that the reversibility of the activities should impacts be greater than predicted is low regardless of the length of the consenting period.

Additionally, impacts of climate change and sea level rise will likely be increasingly evident in 35 years' time.

8.0 RECOMMENDATION

8.1 Adequacy of information

The above assessment is based on the information submitted as part of the application. It is considered that the information submitted is sufficient to enable the consideration of the above matters on an informed basis.

8.2 Recommended conditions

If the consent were to be granted, then ecological offset or compensation conditions would be necessary to account for the direct habitat loss from reclamation.

I have discussed turbidity above and reviewed the Crude Shipping project turbitiy conditions and these are appropriate for this proposal, with modifications.

Memo prepared by:	Drew Lohrer, Principal Scientist & Strategy Manager, Coasts & Oceans Centre, NIWA
Date:	28 February 2023

Memo reviewed and approved for release by:	Blair Masefield, Technical Director, Beca Limited On behalf of the Whangārei District Council and Northland Regional Council
Date:	2 August 2023

References/Notes:

1. Avifauna and marine mammals were considered separately and were not addressed in the AMEE or in this Marine Ecological Technical Memo.
2. Personal observations of A.M. Lohrer and NIWA colleagues in subtidal areas of Whangarei Harbour and Bream Bay in 2020 and 2021.

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12. Rodil, I.F., Lohrer, A.M., Chiaroni, L.D., Hewitt, J.E., and S.F. Thrush. 2011. Disturbance of sandflats by thin deposits of terrigenous sediment: consequences for primary production and nutrient release. Ecological Applications 21(2): 416-426.
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15. Lohrer, A.M., Thrush, S. F., Lundquist, C.J., Vopel, K., Hewitt, J.E., and P.E. Nicholls. 2006b. Deposition of terrigenous sediment on subtidal marine macrobenthos: response of two contrasting community types. Marine Ecology Progress Series 307: 115-125.
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