

Peer review of Assessment of Seabed Effects report provided to Ngai Tahu Seafoods in support of the Hananui proposal to farm salmon off northern Stewart Island (Cawthron Report 4188). Nigel Keeley Focus areas for the benthic model and effects assessment review as requested by Environment Southland (e-mail on 9/9/2025):

Question 1: Review of relevant information provided by the applicant and commentary on whether you consider the information provided to be commensurate with the scale and magnitude of potential effects, and accurately assesses potential adverse impacts.

Question 2: is the seabed across the site sufficiently characterised to conduct an appropriate assessment of the potential effects of the proposed activity?

Incorporate into report prior to submission:

The elongated ridges, especially in the NE area of the site appear from the backscatter data to be more reflective and therefore harder in composition, yet these have not been recognised as such? Is it the case that the solid material is subsurface? Some clarification or comment on this would be informative.

Video footage indicates that the surface sediments of most subtidal dune features across the proposal area are composed of unconsolidated sand. While these surface layers are mobile, the overall dune structures appear relatively persistent, likely maintained by underlying geomorphic controls or gravel waveforms, as observed elsewhere in Foveaux Strait.

In the northeastern part of the proposal area, as the reviewer notes, backscatter data shows higher reflectivity compared to the sandy substrate found elsewhere. This area has been mapped as predominantly coarse gravel, sand, and shell, with some sandy shell hash. The substrate here appears more consolidated than the sandy waveforms in other parts of the site. However, peaks of the ridges show darker zones in the backscatter data, suggesting the presence of softer sediments. This is supported by video footage, which reveals intervening areas with less consolidated sand and shell where sediment resuspension is actively occurring.

While differences in habitat types have been accounted for in the habitat model and depositional modelling to date, the specific discussion above regarding the nature of the ridges throughout the proposal area will be incorporated into the finalised version of the AEE; it is not included in the current version.

On Fig. 2, it would be informative for the reader to colour code the video survey sites according to when they were obtained, i.e. which survey. Gives an idea of temporal comparability.

Thank you for the suggestion. We agree that colour coding the video survey sites by survey date would improve clarity and help readers assess temporal comparability. This enhancement will be incorporated into the finalised version of the AEE report to better distinguish when each dataset was collected. Due to time constraints, we are unable to include it in the current version.

Regarding the pronounced NE-SW elongated ridges in NE area, which are potential capture points for waste. Have you given any thought to discerning: a) whether these ridges are mobile and constantly burying or resuspending sediments (promoting decay and metabolization) or b) whether they are stable and waste may accumulate along fringes, potentially causing hotspots?

As noted above, video footage indicates that the surface sediments of most subtidal dune features across the proposal area are composed of unconsolidated sand. While these surface layers are mobile, making burial and resuspension processes likely and thereby enhancing waste metabolisation, the underlying dune structures appear relatively persistent. This suggests that although surface sediments are dynamic, the features themselves are stable enough to allow for temporary waste accumulation, particularly in troughs.

This is especially relevant in the northeastern part of the proposal area, where troughs within the pronounced NE–SW ridges appear to be composed of more consolidated (and potentially stickier) coarse gravel, sand, and shell. Ridges throughout the proposal area have been resolved in the hydrodynamic model bathymetry, and modelling indicates that particles tend to accumulate in the troughs of these features until they are periodically flushed by strong tidal currents. This reflects a dynamic in which temporary accumulation may occur along flanks or in troughs, with periodic resuspension promoting decay and metabolisation of deposited waste.

The more consolidated substrates in the northeastern ridges may enhance temporary retention of waste in these troughs and flanks. In contrast, the predominantly sandy dune features elsewhere in the proposal area are likely to facilitate more frequent redistribution of deposited material, reducing the potential for localised accumulation but potentially enhancing dispersal.

It is important to note that these sediment dynamics, particularly the variability in substrate cohesion and the potential for temporary waste retention have been considered in the residual solids footprints through the variable resuspension

component of the depositional modelling, as well as within the hydrodynamics underlying the model. Nevertheless, the specific discussion above will be incorporated into the finalised version of the AEE (not included in this version) to highlight the contrasting sediment characteristics between the more consolidated northeastern ridges and the more mobile sandy dune features elsewhere in the proposal area.

Useful to have going forward:

Why no grab samples in NE area? Might the macrofauna be different due to greater depth and potentially increased stability? It appears that it will be more fauna rich (probably due to increased stability) which may have implications for the monitoring and management approach. Given this is a back-up area, this can perhaps be planned as part of baseline?

The northeastern area was introduced at a later stage in the proposal as an alternative location, which is why it was not included in the original grab sampling plan. Video imagery from the most recent survey indicates that the habitat is broadly consistent with other sites of similar type, and it was agreed that sediment sampling for this area would be addressed during the baseline monitoring phase.

As the reviewer noted, the area shares comparable depth and substrate characteristics, coarse gravel, sand, and shell hash, with sites such as grab stations 16, 29, and 20. Based on this, it is reasonable to presume that the northeastern area is compositionally similar and may support a more diverse macrofaunal community. We will include specific reference to this in the finalised version of the AEE (not included in this version), along with a recommendation that targeted sediment sampling for this area is incorporated into the baseline monitoring programme.

It would have been useful to revisit a selection of the previous grab sites to evaluate temporal stability, especially in the macrofauna communities, which appears variable and naturally depauperate at this site. Is it possible to make any comment on this now? Has relevance to temporal stability for planning monitoring etc.

We have repeat-sampled and analysed macrofauna at four stations as part of the eDNA work, which may offer some insight into temporal stability. Sampling was conducted twice at these sites over the study period, providing a limited temporal comparison. We'll review these results and include a summary in the final version of the AEE (not included in this version). However, given the limited sample size, we consider it more appropriate to address this through the baseline monitoring phase.

Current recommendations for baseline monitoring of soft sediments include sampling over a one-year period to capture seasonal environmental and ecological variation. To support this, we suggest that where possible, existing grab sampling sites be resampled during the baseline phase to enable direct temporal comparison. Where feasible, targeted surveys following major weather events (e.g. prolonged high winds or swell) are also recommended to better understand the natural movement and redistribution of sandy substrates.

Question 3: Are there logical connections between model outputs and reported environmental effects.

Specific questions or recommendations. Incorporate into report prior to submission:

I would like to see a bit more information about:

a) how the forcing conditions used in the model runs incorporated storm surge (and what the events look like, I don't see this clearly in Zyngfogel et al), and

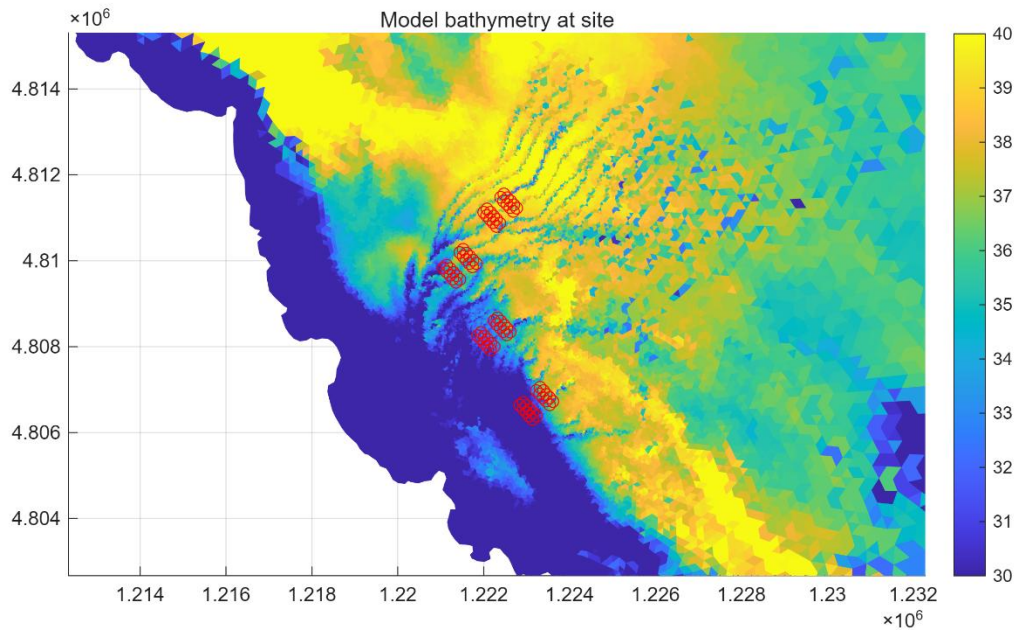
A summary of the forcing conditions at the site and how they are represented in the model has been added to the report (page 43). This is good context for readers.

b) what the exposure is to long-period waves and how that might affect particle distribution.

Details have been added to the report, with quantification of how long-period waves may impact particle resuspension (page 43). Detailed methods of the approach used are provided in an additional appendix (page 105).

If possible, give some consideration to how the particles on the seabed might behave around the elongated ridges, especially toward the NE area where they seem to be most pronounced (even if it is necessarily speculative).

The discussion above regarding ridges will be included in the finalised version of the AEE. As mentioned, these ridges have been resolved in the hydrodynamic model bathymetry, which means that the horizontal velocities and vertical velocities have also been incorporated into the modelling. Modelling indicates that particles accumulate in the troughs of these ridges until they are periodically washed out by strong tidal currents.



Consider showing total accumulated feed input on Fig 4.

A line showing the cumulative sum of feed in the simulation has been added to Figure 13 (page 45).

NB: Some details missing on P54 (highlighted text). Delete first use of 'Table 8' at start of second paragraph on P54

Thanks for spotting these. We've relocated the Table 8 reference to a more appropriate point in the text and have rewritten the missing section to reflect the updated water quality modelling results (page 55).

Useful to have going forward

A better understanding of what the driving forces (and climatic conditions) are that control dispersion and sediment movements at the site

A section has been added to the report on major driving forces in the area and how these have been considered in the modelling, or in the case of waves, how they may impact the modelling results (page 43). A better understanding of how these various forces truly impact dispersion and sediment movements at the site will be gained from monitoring the proposed operation at Stage 1 and reviewing model outputs in relation to field measurements. This will inform a site-specific validation of the model before advancing to Stage 2, which has been recommended in the monitoring report.

Site-specific validation of model outputs

Site-specific validation of model outputs is an important step, and we agree on its importance. This has been included in the monitoring recommendations document as a

requirement for progression to Stage 2, ensuring that model predictions are ground-truthed and refined based on observed data.

Question 4: A statement on whether you agree/disagree with the applicant's conclusions on the potential ecological effects of the fish farm (with evidence to support your conclusions where appropriate).

I have a couple of minor suggestions for the authors:

Incorporate into report prior to submission:

Paragraph 4, P55: I see that you have acknowledged that outside of Zone 2 moderate enrichment in dispersive locations (and generally) can actually manifest as increased abundance and increased richness for 'outside of the proposed area', which is a valid point. But I think it should also be acknowledged as a scenario under Zone 2 - especially the early stages of the development.

We agree that increased macrofaunal abundance and richness can occur within Zone 2, particularly during the early stages of development at dispersive sites. This may reflect a fertilisation effect associated with the onset of farming, where organic inputs stimulate benthic productivity. To help clarify the range of ecological responses that may occur, we have updated this section in the current version of the seabed AEE to include the following statement (page 56):

“It is important to note that this enhancement effect may also occur within the primary footprint, particularly during the early stages of development, as organic inputs stimulate benthic productivity.”

Last para P56: This is where you could acknowledge that some particles may get trapped by the uneven / 'rough' nature of the reef habitats, potentially creating very localised fringes or pockets of anoxia. But probably insufficient to impact the habitability of the habitat when at low levels?

We have added the following discussion to the seabed AEE (page 58):

“The uneven and rough nature of these reef habitats has been represented in the depositional modelling through the adoption of variable resuspension thresholds. Specifically, the threshold applied to bryozoan-sponge reef habitat was based on a value determined for fragmented rock, which shares a similar structural scale to the reef features observed near the site. That said, particles could still become more trapped than modelled, particularly if they become wedged in cracks or gaps between reef structures. Nevertheless, modelling indicates that deposition levels in these reef habitats remain low ($<0.7 \text{ g}\cdot\text{m}^{-2}$), and it is considered unlikely that any localised pockets

of deposition would result in meaningful enrichment or adverse effects on epibiotic communities.”

Useful to have going forward / things to consider

Top of P55: I would question the likelihood of ‘some increase in organic content’ beyond the ZME. Dispersive sites often have very little or variable responses with respect to accumulation of organic carbon (Keeley et al. 2019, Keeley et al. 2024). It tends to be readily metabolised and / or dispersed and exported where it occurs in dilute form and able to be assimilated without measurable consequences. But probably ok to give precautionary warning of this.

We agree that elevated organic content beyond the ZME is unlikely (and or likely to be highly variable) at dispersive sites. However, given that predicted residual solids within the proposal area reach levels associated with moderate enrichment in Tory Channel, we’ve chosen to retain the precautionary note though have updated the section in the seabed AEE as follows (page 56):

“Beyond the ZME, sediment chemistry may exhibit moderate changes relative to baseline and reference conditions (Fletcher et al. 2022), including elevated sulphide concentrations and reduced redox potential across the primary footprint. While some increase in organic content is possible, these effects are expected to be less pronounced and more spatially variable than those observed directly beneath the pens. This is particularly true at a high-flow site like this, where organic material is likely to be readily metabolised, dispersed, or exported when present in dilute form, and typically assimilated without measurable consequences (Keeley et al. 2019; Keeley et al. 2024).”