9 October 2024
Job No: 1091755.0000

Waikato Regional Council
Private Bag 3038
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Hamilton 3240

Attention: Christin Atchinson

Dear Christin

Second review of hydrodynamic assessments for west coast mussel nursery

1 Introduction

1.1 Scope

Waikato Regional Council (WRC) engaged Tonkin & Taylor Ltd (T+T) to assist in a regulatory peer review relating to technical matters contained in a hydrodynamic effects assessment report prepared by MetOcean Solutions Limited (MO) that was submitted as part of a resource consent application for a set of four mussel spat farms offshore of Raglan.

An initial review was undertaken of the MetOcean report '*North Western Mussels Spat Nursery Proposed Waikato West Coast Mussel Nursery: Assessment of potential impact on hydrodynamic conditions*' dated November 2022.

Our review Letter Report '*Initial review of hydrodynamic assessment for west coast mussel nursery*' was provided to WRC on 28 August 2023. Our recommendation was that additional assessment was needed to understand effects of the proposal.

The additional work was undertaken by MetOcean, presented in a report '*Mussel Spat Catching Farm, Waikato West Coast*' (July 2024).

This Letter Report presents an updated review of the effects assessment reports relating to hydrodynamics.

The review is based on the following key questions from WRC to inform potential effects of the application on hydrodynamics and coastal processes:

1 Whether the existing hydrodynamic conditions at the site have been sufficiently described.
2 Whether the assessment methodology and analysis are scientifically robust to reach evidence-based conclusions.
3 Whether the implications of any changes in hydrodynamic conditions as a result of the proposal have been appropriately evaluated and the level of significance of the effects has been stated.
4 Whether you agree with the conclusions and if not, please explain why not.

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5 Whether further information is required to undertake a robust assessment. Is so, please provide details of the further information required and reasons why.

6 Whether any mitigation and/or monitoring has been proposed to address effects and/or uncertainties and whether you consider these appropriate.

1.2 Summary of initial review

Our initial review of the 2022 report is appended in Appendix A and summarised here. The main finding was that more information was required to inform an assessment of how the proposal would affects waves before an understanding of the impact to surfing and coastal processes could be established. A detailed assessment was recommended to identify the extent of the area leeward of the proposed farm potentially influenced by wave shadowing and the magnitude of change. If effects on wave processes extend to the breaking location (e.g. surf-zone) more detailed investigation would then be required to understand potential effects on coastal processes and surf breaks.

This Letter Report presents the findings of our review of the 2024 MetOcean report to assist WRC inform progression of the application. We note that we have not discussed our findings with MetOcean.

2 Updated review comments

2.1 Activity and coastal setting

Both MetOcean reports clearly present the locations of the four proposed mussel spat farms and presents the layout and design of the farms with sufficient detail for understanding the structural elements that may influence hydrodynamic and coastal processes.

Our initial review identified that the coastal setting in terms of bathymetry, morphology and dynamics of the adjacent coastlines, and seabed characteristics was not presented in a way that characterises the potential sensitivity of the receiving environment to the activity. For example, highly dynamic environments are likely less sensitive to small alterations to the hydrodynamic regime caused by the farms. The updated (2024) report has more information on the bathymetry, but not on the sensitivity of the adjacent coastline.

The updated 2024 report presents suitable information on the wave climate offshore and hydrodynamic currents and has addressed comments in our initial review. This information is useful for informing the modelling that was undertaken and the potential effects.

2.2 Effects methodology

The updated report by MetOcean (2024) provides more clarity in terms of how effects are evaluated quantitatively and qualitatively, referencing literature and past cases to establish thresholds for defining an effect as minor.

2.3 Effects on waves

The updated report by MetOcean (2024) provides a more detailed assessment of wave effects compared to the initial report. This is informative for understanding the potential impact of the proposed spat farms on waves and utilises appropriate modelling software.

The adopted approach was to identify a spat line transmission coefficient by matching to a published net transmission coefficient based on Plew et al. (2005). This does appear to be the best available information, but also has uncertainties and limitations that are not fully understood. For example, the analytical model by Plew is based on drag by fixed objects and has only been tested using field

data on small waves (< 0.25 m wave height). The behaviour of spat lines in larger waves likely violates the assumption of a fixed structure, as the spat lines may become mobile in oscillating flow. The other key difference between the field data from Plew et al. and the proposed sites in Raglan is the wave steepness. The small waves measured by Plew et al. had swell periods, meaning the steepness is very low. The sites at Raglan will have relatively steeper waves, which may change the transmission.

The MetOcean (2024) reports states that adopting a net transmission coefficient of 64% based on Plew et al. is conservative. They also present a range of sensitivity results using a higher transmission rate (71%) and show how the number of lines can influence wave transmission. Our review is that the actual wave transmission through the proposed mussel farms is unknown, but we agree MetOcean used the best available information in a conservative way.

A range of maps are presented in the updated MetOcean report, showing the area of wave shadowing under different scenarios, which are useful for understanding the footprint of the effect. The maps and summary informing in the report are suitable for informing the application, notwithstanding there are some remaining uncertainties. The maps show the extent of wave shadowing can reach the adjacent shorelines, with a height wave reduction of 4-10% in locations that will influence coastal processes. A 1.2-degree change in wave direction was also modelled at the inshore environment.

2.4 Effects on currents

The updated assessment by MetOcean (2024) adopts a similar literature-based approach to the initial assessment but also clarifies the comments we raised in the initial review. The assessment method is appropriate and considers how the design is based on optimising alignment to currents to reduce effects.

2.5 Effects on the foreshore and coast

Our initial review identified that the spatial extent of wave shadowing needed to be understood before effects on the shoreline could be understood, in context of environmental sensitivity. The MetOcean (2024) report has presented a semi quantitative assessment of shoreline effect by using the change in wave height and direction to calculate a change to alongshore sediment transport. They present a 2 - 20% change (reduction) in alongshore sediment transport which they interpret to be a minor effect.

The MetOcean report does not explicitly discuss the sensitivity of the receiving environment to a 2 – 20% change in sediment transport. The coast adjacent to Sites A, B and C is a mixture of sandy beach and rocky headland, and is likely dynamic in terms of beach width, presence of bars and channels. The dominant sediment transport pathway is from south to north, with sediment eventually moving towards Port Waikato.

The Kamphuis equation is known to be sensitive to minor changes in wave height, period and direction but is suitable in terms of a high-level assessment presented in the MetOcean report. The range of 2 – 20% is wide and at the upper end of 20% the impact on coastal processes could be more significant in terms of locally altering the shoreline position and slowing transport to the north.

We consider a 20% reduction in alongshore transport to be more than minor, as this magnitude of change could be expected to locally change the shoreline position, which has associated effects on adjacent and upstream location. However, if this was derived using conservative approaches, the likelihood of this occurring is less and therefore may result in no more than minor changes.

2.6 Effects on surf breaks

The updated report comments on the change in wave height and direction at key surfing breaks, based on the numerical modelling results. The mussel farm sites are located outside of previously mapped swell corridors that WRC present in the Proposed Regional Coastal Plan[1]. Mussel farm D is located outside the WRC mapped swell corridor for the Raglan Points, which is a surf break of national significance. Mussel farms A, B and C are located north of the mapped swell corridor for surf breaks of regional significance. Therefore, the location of farms has specifically avoided known swell corridors.

The wave modelling in 2024 MetOcean report shows that the proposed site D does not affect waves at the Raglan Points but does some influence on waves approaching Ruapuke Beach (2 - 4% decrease in a W and NW swell). This is based on the results only showing changes that exceed 1%, which means wave height at the Point Breaks is within 1% of the baseline.

The modelling also identified a 3 - 4% decrease in wave height at Te Akau associated with Site A, but only in NW swell events, which are rare.

2.7 Level of effect summary

The Metocean (2024) report helpfully summarises the effects on each element in an executive summary table. The level of effect is mostly agreeable for wave attenuation, currents, and surfing. However, given the range of 2 - 20% in terms of alongshore sediment transport, this could be a more than minor impact on coastal processes. We provide recommendations below in terms of monitoring and adaptive management.

Physical elements	Qualitative and/or quantitative assessment	Effects statement
Wave attenuation	8.5-15% potential reduction in wave height in the lee of the farm depending on Site and incident wave direction. Change in wave direction less than 1.7 degrees.	Localised and minor Very small
Current attenuation	Farm is aligned with flow to minimise attenuation. More than 60% gap in water column giving local depth and length of longlines, i.e. not restricting flow. Sites present slow currents in a high wave energy area. Potentially more localised effect on the flow over a smaller area compared to areas with faster currents.	Localised and minor
Effect on foreshore	4-10% potential reduction in wave height on the nearshore directly in front of the sites. Percent reduction depending on Site and incident wave direction. Change in wave direction less than 1.2 degrees. 2-20% potential reduction in longshore transport along the beach, site dependent.	Minor Very small Very small and localized
Effect on surf breaks of national significance	1% change contour do not extend to the surf breaks of national significance. No change in wave direction near the surf breaks.	Less than minor
Effect on surf breaks of regional significance	Potential 3-4% change near Te Akau for northwest waves and 2-4% change near Ruapuke for northwest and west waves. Northwest waves have low occurrence. Change in wave direction less than 0.3 degrees.	Minor Very small

3 Review conclusion

The update hydrodynamic effects assessment has covered the outstanding points raised in our initial review. The effects assessment provides a suitable assessment of potential effects of the proposed mussel spat farms on the hydrodynamics and the coastal environment. As with any modelling and

[1] https://waikatomaps.waikatoregion.govt.nz/Viewer/?map=92b6ab92f36a439ab61698ded3200bf5

literature-based approach, there are limitations and uncertainties that may also factor into WRCs decision making. The main uncertainties are:

1 The actual wave transmission coefficient, which is based on an analytical model that is only validated for small wave environments.

2 The consequence of effects with regards to the receiving environments sensitivity has not been accounted in terms of coastal effects relating to the upper bound reduction in longshore transport (20%).

Sites A – C are generally located a depth of 25 – 30 m, approximately 3.5 km offshore. Based on the modelled scenarios, the proposed farms reduce wave height by 4 – 10% at the breaking zone and could change alongshore transport by 2 - 20% change. For these sites, the impact of wave shadowing on slowing alongshore transport has some remaining uncertainty in terms of the level of effect and how the shoreline and up-drift sites will respond. Monitoring of shoreline change is recommended in this location to understand the actual effects, and to allow adaptive management if an effect is observed.

Site D is in slightly deeper water (35 – 45 m) and is further offshore of the coast (4 km) when compared to sites A-C. Figure 1-5 of the MetOcean Report shows that Site D is not located inside a mapped swell corridor for surf breaks of national or regional significance. However, the results do show that wave shadowing does impact wave height and direction at Ruapuke Beach. The MetOcean models shows the Site D wave shadow does not extend to the Raglan Points surfing zone, but does extent to the north end of Ruapuke, which is a popular surf location, where up to 4% dissipation is modelled.

The coastline at Ruapuke is sandy beach, with dynamic bars, beach features and dunes. The coast north of Ruapuke is rocky, and the raglan points surf break is characterised by boulders. Therefore, the only sensitive site in terms of shoreline morphology is Ruapuke, where the prevailing SW wave direction is not affected by the spat farm.

The main risk with Site D relates to the consequence of the spat farm on surfing at the Raglan points and at Ruapuke Beach. Although the model results show there is a negligible effect at the Points, this is based on the best available information which does not include site specific wave transmission coefficients or local calibration.

4 Monitoring and conditions

To address the remaining uncertainty in the transmission coefficient and shoreline response, an adaptive monitoring approach is recommended, to be informed by monitoring of waves and the shoreline.

To confirm the transmission coefficient, wave buoys can be deployed on the offshore and inshore side of one of the sites to measure the actual transmission coefficient. These buoys would need to be deployed for at least three months prior to installing the spat farm to characterise the baseline change between the two measuring locations. A review of data should be undertaken 6 months, and 12 months after installation to confirm the transmission coefficient, noting that mussel growth will change over that timeframe. If the review identifies that more dissipation is occurring than was considered in the model, then an updated risk assessment on the shoreline and surfing breaks would need to be undertaken. If a higher level of risk to the shoreline is identified, then adaptive management could consider options to reduce the number of lines to lower the dropper density.

Shoreline monitoring is recommended to understand if the shoreline is locally accreting in the lee, which may have adverse effects up drift and on adjacent sections of coast, based on local accretion needing to be balanced by erosion elsewhere. This could be done using satellite mapping, or other survey methods (UAV or aerial survey, or fixed cameras). If a monitoring identifies a significant effect

on the shoreline, then adaptive management could be implemented to reduce the number of lines to lower the dropper density.

5 Applicability

This report has been prepared for the exclusive use of our client Waikato Regional Council, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that this report will be used by Waikato Regional Council in undertaking its regulatory functions in connection with assessing the resource consent application by North Western Mussels Ltd for a mussel spat / nursery marine farm.

Tonkin & Taylor Ltd

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Appendix A Initial review

28 August 2023
Job No: 1091755.0000

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Attention: Christin Atchinson

Dear Christin

Initial review of hydrodynamic assessment for west coast mussel nursery

1 Scope

Waikato Regional Council (WRC) engaged Tonkin & Taylor Ltd (T+T) to assist in a regulatory peer review relating to technical matters contained in a hydrodynamic effects assessment report prepared by MetOcean Solutions Limited (MO) that was submitted as part of a resource consent application for a set of four mussel spat farms offshore of Raglan.

The scope of work is for T+T to review the MetOcean report '*North Western Mussels Spat Nursery Proposed Waikato West Coast Mussel Nursery: Assessment of potential impact on hydrodynamic conditions*' dated November 2022 and respond to the following points provided by WRC:

1 Whether the existing hydrodynamic conditions at the site have been sufficiently described.
2 Whether the assessment methodology and analysis are scientifically robust to reach evidence-based conclusions.
3 Whether the implications of any changes in hydrodynamic conditions as a result of the proposal have been appropriately evaluated and the level of significance of the effects has been stated.
4 Whether you agree with the conclusions and if not, please explain why not.
5 Whether further information is required to undertake a robust assessment. Is so, please provide details of the further information required and reasons why.
6 Whether any mitigation and/or monitoring has been proposed to address effects and/or uncertainties and whether you consider these appropriate.

This Letter Report presents the findings of our review to assist WRC frame up a request for additional information in the form of a Section 92 request. We note that we have not discussed our findings with MetOcean but are assuming that this initial report will be provided to them for as part of a s92 request for more information, and we will provide a follow up review of the s92 response.

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2 Potential effects

A brief review was undertaken to identify the potential effects of open coast mussel farms on hydrodynamics (wave and currents) and the adjacent seabed and coast. The potential effects are summarised in this section.

2.1 Wave attenuation

Submerged mussel spat lines create drag on waves and can attenuate wave energy. Wave attenuation is a function of line density, geometry, farm size, and the level of mussel growth. Wave attenuation by the mussel spat farms could alter wave processes leeward of the site. The area subject to wave shadowing by the farm could be localised to the offshore area or may extend landward to influencing wave breaking and surf zone processes. Wave attenuation will depend on the spat farm size, attenuation coefficient of the internal structure (function of structural geometry, line spacing, dropper density, and growth) and would likely create a 'shadow' zone over the farm footprint and lee. Wave attenuation by a mussel spat farm may therefore alter wave height, direction, and energy in the lee (e.g., from wave refraction) which could alter wave breaking location, energy and direction.

2.1.1 Surfing

If wave attenuation by a mussel spat farm changes wave breaking processes, a flow on effect will occur for surfing. In this case, an assessment of surf break risk would be required, considering the surf break physical elements and quantifying the change in wave approach (refraction, shoaling) and breaking caused by the spat farm. The potential effect of the spat farm on surfing will depend on the magnitude of attenuation and the extent of area effected downstream of the spat farm.

2.1.2 Coastal processes

If wave attenuation by a mussel farm results in a change to wave breaking processes, a flow on effect will occur for coastal processes. The potential for a mussel farm to influence coastal processes will depend on the magnitude of wave attenuation and the extent of area effected by the farm. For example, a small farm located far offshore of the coast may not affect wave breaking processes, but a large farm relatively close to the shore may alter wave breaking location and surf-zone processes. If the mussel farm creates a wave shadow zone that alters wave breaking and surf-zone processes, sediment transport processes would be altered. A potential effect of this would be a 'low energy zone' like in the lee of an island or reef, where a saliant develops, locally moving the shoreline seaward as a bulge leeward of the marine farm. The effect of a salient forming in the lee could be significant on a sandy shoreline with limited new sediment supply, as the formation of a sediment bulge would cause flank erosion on either side as sediment is re-distributed. If the mussel spat farm causes effects on wave breaking processes, the effect on surf-zone currents and shoreline change would need to be assessed in context of the adjacent shoreline sensitivity. If the adjacent shoreline is very dynamic or not sedimentary, the effects of an altered breaking location would be naturally mitigated.

2.2 Currents

Three-dimensional ocean currents generated by local wind and tide processes, and larger scale ocean processes will interact with the mussel farm. The potential effects of an open ocean spat farm on currents include local attenuation and downstream adjustments to water flow (e.g., wake or turbulence). Localised adjustment of flow through the spat farm could result in changing seabed sedimentation conditions and nutrient cycling. Downstream effects could be adjusted water flow and turbulence or wake patterns that could vary spatially and temporally depending on the

conditions. For an open coast site such as the Waikato west coast, the potential effects on currents are likely less sensitive when compared to sheltered areas like the Firth of Thames or Marlborough Sounds. One reason for the move from inshore to offshore mussel farming is that more flushing occurs, which assists with decreasing potential adverse effects on nutrient cycling that can occur in sheltered environments.

3 Review recommendation

More information is required on the effects to waves and currents. This should include a more detailed assessment to identify the extent of the area landward of the proposed farm potentially influenced by wave shadowing and the magnitude of change. If effects on wave processes extend to the breaking location (e.g., surf-zone) more detailed investigation would then be required to understand potential effects on coastal processes and surf breaks. A detailed review is presented below.

4 Review summary

The hydrodynamic effects assessment submitted as part of the resource consent application concludes that hydrodynamic effects of the activity are likely less than minor. This conclusion is based on a review of the modelled wave climate and currents at each site, a literature review on wave and current attenuation, and inferred impacts on the adjacent coast and surf breaks.

On review of the effects assessment, we advise that more information is required before the level of effect can be determined. This is based on the following key points:

1 The magnitude of wave dissipation has been assessed based on existing attenuation coefficients established by analytical equations that have only been evaluated for low energy sites (e.g., Hs up to 0.25 m). No evidence is provided that this approach is representative at this location and confirmation is required of the relevance of this approach where wave energy is significantly higher.

2 The extent of the wave dissipation zone leeward of the proposed farms is unknown. This is important for understanding if there is a wave shadow zone of lower wave height and altered wave direction that extends landward to the wave breaking point. Wave attenuation modelling based on the spat farm design and a suitable drag coefficient is likely required to resolve this uncertainty. This would be required for a range of modal and extreme wave conditions (e.g., different wave height, period, directional and directional spread scenarios).

3 If the qualitative analysis of wave attenuation extent shows that wave attenuation from the proposed offshore farms has an influence on wave breaking (height, location, direction), a more detailed risk assessment would be required to assess the effects on coastal processes and surf breaks, as discussed above.

4 Some more detail is required related to the assessment of effects on currents, including a description on what is driving the current regime along the sites, and a quantitative assessment of the change in flow (near- and far- field) that may influence ecology and the seabed.

5 The level of effect adopted in the conclusions (e.g., likely less than minor) are not presented in a meaningful context. It would benefit from more description of what a low, minor, and significant effect are in this context. For example, the report states wave energy could be reduced by 20-35% in the lee of the structure, which is interpreted as having minor effect on the adjacent shoreline. However, no definition of 'minor' is presented based on the magnitude or extent of the area where waves are influenced.

6 The MO report does recommend additional analysis is undertaken before the effects are understood. We recommend that this additional work is undertaken for all sites.

7 The MO report also identifies Site D as being of notable attention due to its location inside the swell corridor of nationally significant surf breaks 'the Raglan Points'. Their suggestion of a modelling study is supported, as is the concept of adaptive management through wave buoy measurements. An adaptive management approach could include a staged construction (if other sites are granted) that allows effects to be monitored and quantified to inform the risk assessment for Site D.

8 No specific details for monitoring or management conditions are presented in the hydrodynamics assessment. This should be considered if the further information identifies potential effects have some remaining uncertain.

5 Detailed review comments

5.1 Existing hydrodynamic conditions at the site

5.1.1 Activity and coastal setting

The MO report clearly presents the locations of the four proposed mussel spat farms and presents the layout and design of the farms with sufficient detail for understanding the structural elements that may influence hydrodynamic and coastal processes.

The report is missing a description of the coastal setting in terms of bathymetry, morphology and geomorphology of the adjacent coastlines, and seabed characteristics. This information is important for understanding how sensitive the existing environment is to potential changes in hydrodynamics attributed to the spat farms.

5.1.2 Wave climate

The wave climate is presented for each of the 4 proposed mussel farm locations based on a wave hindcast model. It is unclear if the hindcast has been calibrated using site specific data. The presentation of information is simplified, but generally useful. The wave height statistics and extreme value analysis are useful, but an analysis of variability (seasonal, interannual) would also be useful for informing potential operational and maintenance requirements. Specific comments on improving this section include:

a It would be useful to present an overview map showing the location of each wave output location with reference to sea-bed contours, the shoreline, and the location of each spat site.

b Spatial presentation of the wave climate would also be useful for understanding differences in the exposure of each site. This would be useful for different events, such as the mean, the 1-year ARI and the 100-year event.

c It is unclear how variable the wave climate is at timescales of seasons and interannual climate oscillations. This could influence operational limits for accessing the site with regards to structural/mooring maintenance and spat collection. Exposure to extreme conditions could also result in damage that could litter the seabed or adjacent coastline.

5.1.3 Ocean currents

The underlying model appears robust and is based on a modelled current hindcast which has been calibrated at a national scale. It is unclear if local calibration or measurements have been considered. The currents sections are presented in an unclear and inconsistent way as the current roses all show the most frequent flow associated with a north direction, but it's not clear if this is flow from or to the north, as the diagrams are inconsistency described in the text and captions. For example, site D is described as flow 'to north' (e.g., from south), and Site A is described as flow from North or NW to South. The methods section mentions the use of a 3D ROMS model but there is no

information on whether the flows presented are depth averaged, mid water column, at the bed, or at the surface. It is also not clear if the currents are mainly driven by local tide and wind processes or if the currents at each site are influenced by a larger north island current system driven by ocean scale processes. Suggestions for improving the current information:

a Clarify above comments.

b Show an annotated (e.g., idealised streamline) map of the current direction and speed.

c Comment on or show how the currents vary through the water column.

5.2 Effects assessment methodology

The report does not appear to have a clear methodology for assessing the level of effect on different processes. The report comments generally on the potential effects based on a literature review and judgement. In terms of qualifying the effects on hydrodynamics, the approach is based on selecting an attenuation coefficient from literature, which may not be applicable for the site due to the unique wave climate and design (compared with the literature used).

5.2.1 Waves

Potential effects of the proposed spat nursery on wave attenuation were assessed by reviewing analytical relationships and field observations presented in Plew et al. (2005). The MO report acknowledge that the attenuation coefficients are only field validated for low energy sites (Hs up to 0.25 m) in Golden Bay and may not be applicable for the open coast offshore Raglan. This results in considerable uncertainty in how valid the attenuation assessment is, as even though wave frequencies may be similar, wave steepness will be very different at Raglan and Golden Bay, which could influence attenuation.

An attenuation coefficient of 0.65 – 0.8 is adopted for the proposed sites, with results in a 20 – 35% decrease in wave height across the length of a 2km spat farm, which is stated by MetOcean as being conservative. However, based on the assessment provided, the actual impact of the proposed activity on waves remains unknown. Further, for a localised attenuation in wave height of up to 35% it is not clear how far leeward this wave shadow area extends. The influence of each site, and cumulative sites on wave refraction, wave shadowing, and the impact of this on coastal processes cannot be obtained from the report.

5.2.2 Currents

The report states that the design incorporates a number of elements that reduce modification of currents, including orientation, only occupying a relatively small percentage of the water column (40%), and having mussels below 7 cm. These are sensible and well described statements.

In terms of effects on currents, the method is based on literature, other sites, and judgement. While the presentation of information is useful, the relevance to the proposed site remains uncertain. The report presents a graph of flow dissipation based on ‘dropper density’ and distance, based on analytical equations from Plew et al (2005) and then rationalises a conclusion on effects based on similarities and differences to the proposed open water Waikato site.

Based on the presented assessment, it appears that currents could be attenuated by 80% over a 1 km distance with a dropper density of 0.06 droppers per m^2 (which is representative of the Waikato proposal). However, based on the report, it is not clear how applicable the data in Figure 3-5 are to the Waikato site, or how far the effect would extend downstream.

5.2.3 Adjacent foreshore

No quantitative methods are used to assess effects on the adjacent foreshore. This is partly limited by not quantifying the effects on breaking wave conditions, or the extent of wave attenuation leeward of the marine farms. This section of the report introduces that effects on currents and waves are '*less than minor*', and states that therefore the impact on adjacent foreshore is '*likely to be minor*'. This assessment appears to be based on judgement but should be supported by more detailed assessment of wave shadowing effects.

A more suitable assessment of foreshore effects would require quantitative mapping of wave attenuation landward of the mussel sites to detect if any changes in breaking wave height occur at the adjacent coast under different wave conditions. Characterising the adjacent shoreline geomorphology and geomorphic sensitivity would be needed to assess whether changes to coastal processes pose a risk at the shoreline. For example, if the coast is very dynamic, and incident waves are variable, the effects may be un-detectable against background fluctuations.

5.2.4 Surf breaks

Site D is identified as likely being inside the swell corridor of 'The Points' surf-break. We agree that site D is likely in the swell corridor for the nationally significant surf breaks and could therefore influence wave conditions at the point breaks (e.g., Indicators, Whale Bay, and Manu Bay).

The potential effect of Sties A, B and C is assessed against surf breaks of 'lesser significance' being located on the adjacent coast.

Again, no quantitative assessment of the effect of mussel farms at the wave breaking point is presented to confirm the level of effect on surf breaks based on the dropper density and distance from breaks.

The report states that Side D will generate attention (opposition) from surfers, and states further work is recommended to assess the effects. This is a sensible approach, but additional work is still required to assess the effect of wave attenuation at the other sites.

5.3 Level of effects

The table below summarises how the MO report presents a level of effect for different physical elements. In general, the methods used to assess effects are overly simplistic and rely on a combination of assumptions and judgement that are not well justified by the data presented. A more qualitative, spatial, and detailed assessment is needed to assess potential effects for all processes that could be influenced by the proposed activity.

The level of effect adopted for each element is based on judgement but does not appear to be referenced against a definition. For example, we would suggest that a 35% decrease in wave height could be significant, but the reports adopts a '*less than minor*' conclusion.

Table 5.1: Summary of effects statements from the MetOcean hydrodynamics report

Physical elements	Qualitative assessment presented	Effects statement presented
Wave attenuation	20-35% attenuation across 2 km length of a site. No detail presented on how far the wave attenuation zone extends landward or this this influence wave breaking and surf zone processes.	'Some local attenuation' [p34]. 'Less than minor' [p39].
Current attenuation	80% attenuation across the farm based on a dropper density of 0.06 droppers per m^2 and a distance of 1km. Extent and magnitude of downstream effects not assessed.	'Localised and minor' [p38]. 'Less than minor' [p39].
Effect on foreshore	No quantitative assessment is presented to show the extent or magnitude of effects on the coast.	'No significant impact on dynamic equilibrium of the beach' [p38]. 'Impacts on coastal processes along the adjoining foreshore are likely to be minor' [p39].
Surf breaks	No qualitative assessment presented.	'Unlikely to have significant impacts on nationally or regionally significant surf breaks' [p40].

5.4 Comment on conclusions

The report concludes on page 41 that effects at the coast are expected to be 'minimal or negligible', with an overall effect on hydrodynamics being 'no more than minor'. The report continues to suggest that further work is recommended to ensure that effects are understood.

On review, the methods used in the report are overly simplistic and remain too uncertain to assess potential effects on waves, currents, adjacent coastlines, and surf-breaks. Therefore, further assessments, as outlined in this review are required to assess the actual and potential effects on waves, currents, coastal change and surf breaks.

5.5 Further information

Additional work is required to quantify the effects of the proposed nursery on waves and currents and the effect of those changes on coastal processes at each site. Additional analysis is recommended for assessing the spatial footprint of effects on wave and flow attenuation, using an appropriate method to represent drag from the mussel spat structure. Results from the study would show the magnitude and footprint of effect by the farms, which could be interpreted to assess the level of effect locally and at the coast.

Site D is identified as being the most sensitive in terms of perceived effects on surf-breaks. A high level of confidence in the effects methodology and conclusion at this site would be required.

5.6 Mitigation and monitoring

No specific mention of mitigation or monitoring is presented in the report, but adaptive management using wave buoy deployments is recommended in the context of some uncertainty in the assessment method. This is based on the analytical methods and existing literature being based on different sites. Some mitigation is built into the design, with orientation to currents.

Specific monitoring and conditions should be considered based on the outcome of the further analysis if there is still uncertainty on the effects on coastal processes and surf breaks. One approach could be to only approve Site D once monitoring is undertaken at Site A, B or C (if granted), as the risk of wave attenuation is highest at Site D being in the swell corridor of nationally significant surf breaks.

Applicability

This report has been prepared for the exclusive use of our client Waikato Regional Council, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that this report will be used by Waikato Regional Council in undertaking its regulatory functions in connection with assessing the resource consent application by North Western Mussels Ltd for a mussel spat/nursery marine farm.

Tonkin & Taylor Ltd

Report prepared by:

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Authorised for Tonkin & Taylor Ltd by:

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Richard Rinne-Hamill
Project Director

28-Aug-23
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