Tonkin+Taylor

11 June 2025
Job No: 1017993.2000

West Coast Regional Council
388 Main South Road
Paroa
Greymouth
Greymouth 7805

Attention: Jo Armstrong

Dear Jo

Final review of NWA coastal hazards assessment for West Coast Region

In March 2022 West Coast Regional Council (WCRC) engaged Tonkin + Taylor Ltd (T+T) to undertake a review of the assessment methodology outlined in the NIWA (2022) report "Mapping for priority coastal hazard areas in the West Coast Region". T+T provided WCRC a review letter on 29 March 2022. The initial review concluded that overall T+T consider the inundation and erosion methodology is appropriate for the scale of assessment and data availability. Some modifications were suggested to improve the clarity of the reporting. Subsequently NIWA revised the report to address the review comments where appropriate. WCRC have requested that T+T provide a final review letter to confirm if the revised report adequately addresses the initial review comments.

Our initial review of the 2022 report is appended in Appendix A and a comment response table provided by NIWA is provided in Appendix B. We confirm that the response and revised report from NIWA has adequately addressed the various matters raised. We do note that the 2022 assessment was based on the best available data at the time (including satellite DEM products for majority of the sites), however there is now 1 m LiDAR available (from LINZ) for all of the West Coast sites. Future assessments would benefit updated mapping using the latest LiDAR, with improved accuracy.

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Applicability

This report has been prepared for the exclusive use of our client West Coast 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.

Tonkin & Taylor Ltd

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
	
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Rebekah Haughey Coastal Scientist	Peter Cochrane Project Director

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Appendix A Initial T+T review

Tonkin+Taylor

Job No: 1017993.2000
29 March 2022

West Coast Regional Council
PO Box 66
Greymouth 7840

Attention: Edith Bretherton

Dear Edith

Review of NIWA coastal hazards assessment for West Coast Region

1 Introduction

West Coastal Regional Council (WCRC) engaged the National Institute of Water and Atmosphere (NIWA) to undertake coastal inundation and erosion hazard mapping for select 'priority' sites along the West Coast as part of Te Tai o Poutini.

WCRC have subsequently engaged Tonkin & Taylor Ltd (T+T) to undertake a review of the assessment methodology outlined within the NIWA (2022) report, "Mapping for priority coastal hazard areas in the West Coast Region".

1.1 Scope of review

This technical review of the methodology has included the following scope of works:

- Undertake a review of the methodology and provide any suggestions for refinement, as well as consideration of limitations and the ability to resolve them.
- Meeting (teleconference) with NIWA to discuss our review comments.
- Provide WCRC with a summary of the technical review within a concise letter report.
- Meeting (teleconference) with WCRC following provision of the letter report to discuss findings.

2 Review comments

The following section provides commentary on the methodology. A copy of the report has also been attached with PDF mark ups.

2.1 Coastal inundation methodology

Overall, T+T consider the inundation methodology is generally appropriate given the level of information available for each site. Specific comments include:

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- Section 2.1 – The use of LiDAR DEMs (where available) and satellite DEM products (where LiDAR is not available) is appropriate until there is further LiDAR captured across the region. NIWA have appropriately noted the uncertainties associated with the data.
- Section 2.3 – T+T agree with the methodology for calculating extreme sea levels. MSL offsets and storm tide values are sensible and are based on the best available information.
  - Section 2.3.3 – Wave setup assessment:
    - TC Fehi was used as a benchmark event, but the components of the observed water level during Fehi are not presented, neither were the offshore wave conditions during the event. What was the max observed level of debris and what was the contribution of storm surge, tide, river flow, and wave setup?
    - What is the ARI of a 4.5 m wave? We would expect 50- and 100-year wave height is much higher – which means there could be a small under prediction when representing an extreme future event?
    - Is there is spatial variation in wave height / setup across the region, like there is with storm tide?
    - There is not much detail on the wave climate that influences coastal erosion and inundation hazards. This could be included in background, with sections on the typical and extreme conditions.
- Section 2.4 – T+T agree with the 0.2 m SLR increment approach instead of tying SLR values to specific RCP projections. The report clearly outlines the benefits of this approach.
- Section 2.6 – The inundation has been assessed using the bathtub approach (except at Orowaiti Lagoon where hydrodynamic modelling has been undertaken). T+T agree that a bathtub approach is suitable for identifying areas of land susceptible to coastal inundation. The report clearly outlines the limitations associated with bathtub mapping.
- Section 2.7 – There is not much detail on the Orowaiti hydrodynamic model:
  - It would be useful to include a figure of the model domain and boundary processes in Section 2.7.
  - XBeach is mentioned for generating the ocean boundary signal, but it does not appear XBeach was used to run the model (since setup is added separately). What model was used (assuming BG Flood?) What was the spectral Hs and Tp used to generate the surf-beat signal?
  - The report states that '*The wave setup was then added as an additional shift so that the maximum ESL matches the values in Table 2-3. With the training wall extending beyond the surf zone, the forcing for the Buller River mouth does not include wave setup.'* – This sounds sensible; however it would be useful to include a schematic of this on the model domain map.
  - Is setup included for the Orowaiti lagoon mouth?
  - Comparison of hydrodynamic model with observations is very good and provides confidence in the method.

2.2 Coastal erosion methodology

- Section 3.1 – There is an inconsistency with the terms 'zones' and 'areas' used throughout the report. T+T note that 'zones' tend to be used in a planning context and areas or lines in a hazard assessment context.
- Section 3.1 – The formula provided to assess the erosion hazard is a relatively dated version. MfE (2017) and Envirolink (2013) outline more contemporary formula for defining the erosion hazard.

- Section 3.1 – Hybrid-probabilistic approach has been adopted to manage the uncertainty associated with the data. A normal distribution is assumed for all terms and where there is lack of data the distributions are based on expert knowledge and approximation. T+T agree with this approach, however, it would be useful to see the distributions/values adopted for each site. It is unclear if a single distribution has been used for long-term and SLR components ('r') or a distribution for each.
- Section 3.1 – It is unclear where the reference line is for mapping and what values are (or aren't) included for each site. It would also be useful to see the resultant distances for each site.
    - Section 3.1.1 – T+T consider the manual review/correction of hazard lines to account for geomorphical features and underlying geology is important, given the varied morphologies along this coastline. T+T suggest adding a statement that only unconsolidated shorelines have been assessed (i.e. beaches) and consolidated shorelines (i.e. banks and cliffs) have not been considered.
- Section 3.2 – T+T agree digitized shorelines from historic aerials is suitable to assessing trends in shoreline movement. However, it is unclear how the shoreline is defined on the gravel beaches. Is the back of the barrier the same as the vegetation line (i.e. Rapahoe example)? Also, section 4.1.3 notes that 1878 cadastral charts were used. There is high uncertainty around this shoreline data and what features the mapped shoreline represent.
    - Section 3.2.2 – There appears to be an inconsistent approach for protection structures. Some structures are excluded, some are included, and some are partially included. In some locations with private structures, the impact of SLR has been excluded (i.e. Granity school, Hector). This may not be an appropriate approach as there is uncertainty around if the structures will be maintained and upgraded in the future. There is also mention of the rock revetment near Rapahoe being destroyed during TC Fehi which highlights why structures might need to be excluded from the assessment. It may be useful to provide a map at each site which shows the location of known structures. If feasible, then an estimate of erosion hazard in absence of structures (i.e. based on values from adjacent unprotected sites), would be appropriate and useful for adaptation and planning purposes.
    - Section 3.2.2 – T+T agree with the Bruun rule for assessing shoreline response to SLR. However, it is unclear what values have been used for the closure depths and do these differ between the MSG beach and a sandy beach? It could be useful to provide values for the adopted closure slopes/depths.
- Section 3.3 – Roll-over (short-term retreat) has been assessed based on judgement and field observations. We consider this is reasonable given the lack of profile data available. However, a berm 'roll-over' response may not be applicable for the sandy beaches (ie. Beach Road, CHA 3). Storm cut/erosion of the dune toe is likely to be more appropriate for sandy beaches.
- Section 3.3 – 30 m sounds reasonable for an upper bound storm cut distance on the sandy open coast. However, it is unclear what the 30 m is set back from on the gravel beaches? Is it the berm crest? Or back of the gravel barrier?
- Section 4.3.3 – Report states *"For the coastal erosion hazard zone, the structure only prevents acceleration in the rate of erosion from acceleration of sea level rise. The recent historical erosion rate is maintained in the calculation to account for failure of the structure."* This needs further explanation.
- Section 4.7.3 – The probabilistic erosion assessment has not been completed for the Haast-Jackson Bay Road due to the nature of the site. A 'low-lying near-coast' hazard zone has been adopted instead. It is unclear what defines this zone? What elevation and shoreline proximity?
- Section 4.7.4 – As above, for the Jackson Bay village.

- Section 6 – The summary states that 50-year and 100-year outlooks have been mapped. What probabilities and SLR scenarios have been used to define these lines?

2.3 Other comments

- Equation numbers and referencing need to be checked throughout the document.
- There are several typos that have been noted within the attached marked-up PDF document.

3 Conclusion

Overall T+T consider the inundation methodology is appropriate for the scale of assessment and availability of data. Suggested improvements include:

- Some further comment on extreme wave conditions and the resultant wave setup to improve confidence that this component is adequately incorporated.
- Further detail on the application of boundary conditions in the Orowaiti Lagoon hydrodynamic model and adjacent coastline.

The general approach used for the erosion assessment is appropriate for the scale of assessment and data availability, however, some modifications are suggested to improve clarity:

- Further clarification around the adopted values and resultant hazard distances for each site.
- A consistent approach, or further clarification around the methodology, for erosion protection structures would also be beneficial.
- Clarification on the reference line from which erosion hazard distances are mapped.
- Clarification on what probability and SLR scenarios have been mapped within the report.

4 Applicability

This report has been prepared for the exclusive use of our client West Coast 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.

Tonkin & Taylor Ltd

Environmental and Engineering Consultants

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
.....	.....
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Review by:
Dr Tom Shand
Technical Director – Coastal Engineering

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Appendix B Comment response table

Response to review comment

Comments	Response
Coastal inundation methodology	
Section 2.1 – The use of LiDAR DEMs (where available) and satellite DEM products (where LiDAR is not available) is appropriate until there is further LiDAR captured across the region. NIWA have appropriately noted the uncertainties associated with the data.	agreed
Section 2.3 – T+T agree with the methodology for calculating extreme sea levels. MSL offsets and storm tide values are sensible and are based on the best available information.	agreed
Section 2.3.3 – Wave setup assessment:	
TC Fehi was used as a benchmark event, but the components of the observed water level during Fehi are not presented, neither were the offshore wave conditions during the event. What was the max observed level of debris and what was the contribution of storm surge, tide, river flow, and wave setup?	The different component of the total water level for Fehi are presented in details in section 2.7.2 (storm tide ~= 2.4m LVD and ave setup 0.6m at high tide and 0.8m during low tide). We have added more information on the wave setup analysis.
What is the ARI of a 4.5 m wave? We would expect 50- and 100-year wave height is much higher – which means there could be a small under prediction when representing an extreme future event?	Based on Godoi et al. analysis. 4.5m is the mean annual maxima for significant wave height. The 1% AEp is 5-6m on the west coast
Is there is spatial variation in wave height / setup across the region, like there is with storm tide?	No, because of the lack of accurate hindcast at a scale relevant for we used a constant wave setup across the whole region. Ideally future hindcast can produce a joint probability with a spatially variable storm tide and wave setup contribution. More information was added
There is not much detail on the wave climate that influences coastal erosion and inundation hazards. This could be included in background, with sections on the typical and extreme conditions.	Agreed we've added some more information in the paragraph

Section 2.4 – T+T agree with the 0.2 m SLR increment approach instead of tying SLR values to specific projections. The report clearly outlines the benefits of this approach.	Noted
Section 2.6 – The inundation has been assessed using the bathtub approach (except at Orowaiti Lagoon where hydrodynamic modelling has been undertaken). T+T agree that a bathtub approach is suitable for identifying areas of land susceptible to coastal inundation. The report clearly outlines the limitations associated with bathtub mapping.	Noted
Section 2.7 – There is not much detail on the Orowaiti hydrodynamic model: – It would be useful to include a figure of the model domain and boundary processes in Section 2.7. – XBeach is mentioned for generating the ocean boundary signal, but it does not appear XBeach was used to run the model (since setup is added separately). What model was used (assuming BG Flood?) What was the spectral Hs and Tp used to generate the surfbeat signal? – 'The wave setup was then added as an additional shift so that the maximum ESL matches the values in Table 2-3. With the training wall extending beyond the surf zone, the forcing for the Buller River mouth does not include wave setup.' – This sounds sensible; however it would be useful to include a schematic of this on the model domain map. – Is setup included for the Orowaiti lagoon mouth? – Comparison of hydrodynamic model with observations is very good and provides confidence in the method.	Agreed. A paragraph was added to describe the model. Most of the required details to the model are provided in Gardner 2017 and in the note accompanying the report.
Coastal erosion methodology	
Section 3.1 – There is an inconsistency with the terms 'zones' and 'areas' used throughout the report. T+T note that 'zones' tend to be used in a planning context and areas or lines in a hazard assessment context	Agreed. We have changed the use of "zones" and "area" throughout the document to be more consistent.

Section 3.1 – The formula provided to assess the erosion hazard is a relatively dated version. MfE (2017) and Envirolink (2013) outline more contemporary formula for defining the erosion hazard.	Agreed, however the essential components are the same. The formula here is used to describe the component of the analysis that use a probabilistic approach.
Section 3.1 – Hybrid-probabilistic approach has been adopted to manage the uncertainty associated with the data. A normal distribution is assumed for all terms and where there is lack of data the distributions are based on expert knowledge and approximation. T+T agree with this approach, however, it would be useful to see the distributions/values adopted for each site. It is unclear if a single distribution has been used for long-term and SLR components ('r') or a distribution for each	The distribution are specific to each transect and difficult to represent without overwhelming the report. Details to try to summarize the result for each priority area. Details were added to the methodology text to confirm the distribution used to account for acceleration of SLR.
Section 3.1.1 – T+T consider the manual review/correction of hazard lines to account for geomorphical features and underlying geology is important, given the varied morphologies along this coastline. T+T suggest adding a statement that only unconsolidated shorelines have been assessed (i.e. beaches) and consolidated shorelines (i.e. banks and cliffs) have not been considered.	Added a statement to confirm the erosion analysis is only for unconsolidated shorelines.
Section 3.2 – T+T agree digitized shorelines from historic aerials is suitable to assessing trends in shoreline movement. However, it is unclear how the shoreline is defined on the gravel beaches. Is the back of the barrier the same as the vegetation line (i.e. Rapahoe example)? Also, section 4.1.3 notes that 1878 cadastral charts were used. There is high uncertainty around this shoreline data and what features the mapped shoreline represent	Noted. Back of gravel barrier is used where it is detectable otherwise vegetation line is used. Add a statement to section 3.2.1 to clarify that. I greed with the caution with the cadastral map. For cadastal as well as aerial imagery a component of uncertainty in georeferencing and in the quality of the digitized line has been used. This is accounted for in the trend analysis so it does not weigt as much as say the high res 1940s aerial pictures or 2014 satelite imagery. We believe the section 3.2.1 highlight that uncertainty well. We have also added a registry of summary of assumption in table 5.1 that includes a statemen about georeferencing and digitizing.

Section 3.2.2 – There appears to be an inconsistent approach for protection structures. Some structures are excluded, some are included and some are partially included. In some locations with private structures, the impact of SLR has been excluded (i.e. Granity school, Hector). This may not be an appropriate approach as there is uncertainty around if the structures will be maintained and upgraded in the future. There is also mention of the rock revetment near Rapahoe being destroyed during Ex TC Fehi which highlights why structures might need to be excluded from the assessment. It may be useful to provide a map at each site which shows the location of known structures. If feasible, then an estimate of erosion hazard in absence of structures (i.e. based on values from adjacent unprotected sites), would be appropriate and useful for adaptation and planning purposes.	Agreed. We added a segment in section "3.4 Treatment of coastal defence structures". Only a few locations in this analysis were considered with suitable rock revetment (and may not need a map.). These are listed in section 3.4. The section also includes detail about what treatment is done for protected shorelines to include a measure of residual risk.
Section 3.2.2 – T+T agree with the Bruun rule for assessing shoreline response to SLR. However, it is unclear what values have been used for the closure depths and do these differ between the MSG beach and a sandy beach? It could be useful to provide values for the adopted closure slopes/depths.	Agreed. Section 3.2.2 was amended to include details of distribution for depth of closure calculations.
Section 3.3 – Roll-over (short-term retreat) has been assessed based on judgement and field observations. We consider this is reasonable given the lack of profile data available. However, a berm 'roll-over' response may not be applicable for the sandy beaches (ie. Beach Road, CHA 3). Storm cut/erosion of the dune toe is likely to be more appropriate for sandy beaches.	Agreed although the underlying treatment remains the same we rename this section 3.3 Short-term retreat Roll-over (Short-termRoll-over /storm cut).
Section 3.3 – 30 m sounds reasonable for an upper bound storm cut distance on the sandy open coast. However, it is unclear what the 30 m is set back from on the gravel beaches? Is it the berm crest? Or back of the gravel barrier?	Back of the barrier. We added this detail in section 3.3.

Section 4.3.3 – Report states "For the coastal erosion hazard zone, the structure only prevents acceleration in the rate of erosion from acceleration of sea level rise. The recent historical erosion rate is maintained in the calculation to account for failure of the structure." This needs further explanation.	Agreed. Original statement in the report was wrong. We added a whole section to detail the treatment in the presence of structures.
Section 4.7.3 – The probabilistic erosion assessment has not been completed for the HaastJackson Bay Road due to the nature of the site. A 'low-lying near-coast' hazard zone has been adopted instead. It is unclear what defines this zone? What elevation and shoreline proximity?	The zone was defined as a fixed distance from the coast. This was added to the text
Section 4.7.4 – As above, for the Jackson Bay village.	Same as above
Section 6 – The summary states that 50-year and 100-year outlooks have been mapped. What probabilities and SLR scenarios have been used to define these lines?	Only lines for the 95th percentile outlook are being used. This was added to the text
Equation numbers and referencing need to be checked throughout the document.	Agreed. We have now fixed this issue
There are several typos that have been noted within the attached marked-up PDF document.	Thanks. We have addressed these throughout the document