

Waikato District Council  
Private Bag 544,  
Ngaruawahia 3742

Attention: Kelly Nicolson

Dear Kelly

## Review of Coastal Hazards and Coastal Sensitivity Area at Te Akau South

### 1 Scope of review

Waikato District Council (“WDC”) have engaged Tonkin & Taylor Ltd. (“T+T”) to undertake a review of the Coastal Hazards and Coastal Sensitivity Area at Te Akau South contained in Appendix 2 of the report titled Waikato District Coastal Hazards - Response to submission on Waikato District Plan Stage 2: Coastal Hazard Area Maps, by Bronwen Gibberd - 4D Environmental Ltd and Jim Dahm - Eco Nomos Ltd (March 2021).

The intent of this review is to assess the information, approach and recommendations contained in the report are appropriate, defensible, and consistent with national and regional policy direction and national coastal hazard guidance. This includes a review of the methods and calculations used to predict current and future shoreline changes based on the shoreline type, and estimate the location and spatial extent of each hazard area (including future hazard areas assuming 1 m sea level rise over the next 100 years) and the recommendations for mapping these.

This review has been undertaken in accordance with guidance provided within Engineering New Zealand: Practice Note No.2: Peer Review – dated April 2018 and includes the following scope:

- Review of ‘Review of Coastal Hazards and Coastal Sensitivity Area at Te Akau South’ by Focus Resource Management Group (March 2021 version)
- Teleconference with authors (if required) to discuss methods and results
- Provide review within concise letter report to WDC (this document)
- Teleconference with WDC (if required) to discuss review findings

### 2 Review findings

Specific review comments are provided within the Report attached in Appendix A. Key review comments are as follows:

#### 2.1 Method

The section of coastline at Te Akau South is generally cliff or consolidated bank.

- A High Risk Coastal Hazard Area has been defined based on slope stability only with an assumed timeframe of 10-15 years and a Coastal Sensitivity Area considering 100 years of long-term erosion and potential sea level rise effects as well as a slightly flatter slope.
- This method utilised to assess erosion and instability hazard values is consistent with that used elsewhere within the district and with general good practice for this type of shoreline. While probabilistic assessments are sometimes undertaken at local scale, the lack of data at this location would make this difficult and unlikely to add much accuracy.
- The term site-specific is utilised within the Focus Resource Management Group report to describe their assessment. However, we consider their assessment is a local scale one with a site-specific assessment being a finer level of detail generally undertaken for a specific site (i.e. at an individual land parcel scale).

## 2.2 Values derived

- Minimum 20 m and 30 m widths are specified for Sections 2 and 3. This could be considered conservative for a site-specific assessment, but we consider they are likely appropriate for this local scale of assessment given the typical height of cliffs.
- The method used to develop long-term erosion rates is likely appropriate given the difficulty in identifying long-term rates from aerial photographs for this type of coastline, however, the method used should be more clearly explained.
- The slopes adopted look consistent with those used elsewhere in the district and likely reasonable for this type of material, although a detailed assessment by a geologist has not been undertaken within the Focus Resource Management Group assessment or this review by T+T.
- The use of two different slopes for the assessing the High Risk Coastal Erosion Hazard Area in Section 3 is slightly confusing, particularly as the alongshore extent applied to each is not presented within the report.
- The coastal edge shown within Figure 54 looks like it may have already experienced an (older) landslip. If so, it could be considered using the same 1(V):1.5(H) slope as adjacent sections but from the location of the assumed rock toe (beneath the landslip).
- We appreciate the difficulties assessing future erosion rates in the sheltered Section 4 environment but using an offset distance or extending to the toe of the cliff rather than to a contour might be more appropriate for the coastal sensitivity area.

## 2.3 Hazard mapping

- Mapping has been undertaken by projecting an assumed slope from either the current or an assumed future toe position. This is generally best practice and appears to have been undertaken carefully, although will be dependent on the quality and accuracy of topographic information utilised. Little information is provided on the source or accuracy of this data.
- The only query regarding mapping that has been raised is around the flatter slopes assumed adjacent 2E Ryan Road where the mapped high risk hazard line appears to project well inland compared to adjacent sections.

## 3 Conclusion

Overall T+T consider that the Focus Resource Management Group assessment is a robust local-scale one, has likely used appropriate values for erosion rates and stable slopes (based on the arguments presented by the authors) and, except for the points noted above, has likely identified appropriate areas susceptible to coastal erosion and instability.

This local scale assessment can be superseded by site-specific assessment by suitably qualified persons utilising higher resolution or improved information, as is stated in the report summary.

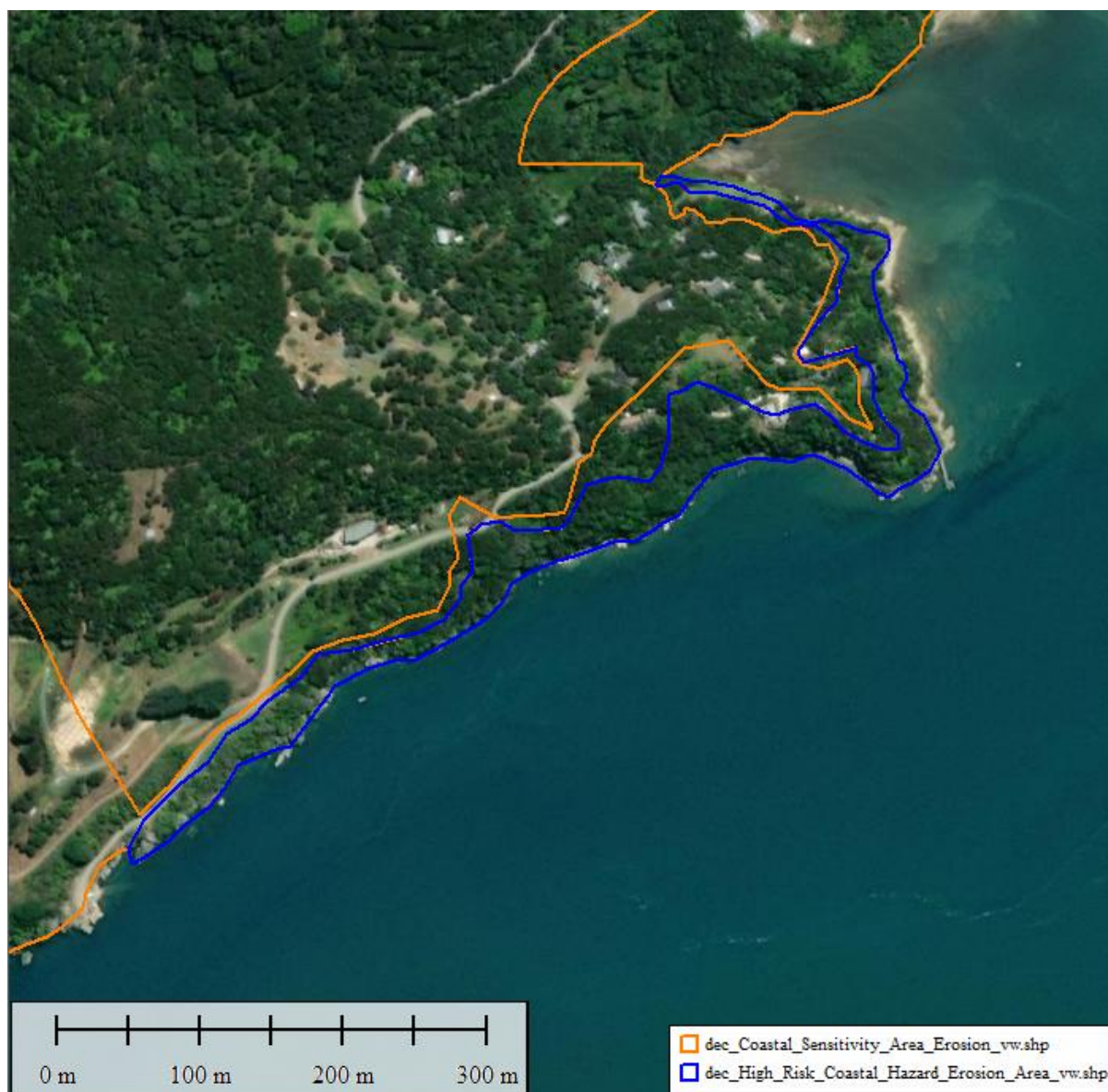


Figure 1 Extent of the mapped high risk coastal erosion hazard area and coastal sensitivity area for Te Akau South

## 4 Applicability

This report has been prepared for the exclusive use of our client Waikato District 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 District Council in undertaking its regulatory functions relating to the District Plan update.

Tonkin & Taylor Ltd

Environmental and Engineering Consultants

Report prepared by:

Authorised for Tonkin & Taylor Ltd by:



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Dr Tom Shand  
Technical Director Coastal Engineering



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pp Glen Nicholson  
Project Director

## 5 Conflict declaration:

As discussed with Kelly Nicolson prior to undertaking this assessment, Dr Shand's office is located in the same building as one of the Te Akau land owners, Mr Andrew Wilson. Mr Wilson had discussed the Focus assessment with Dr Shand prior to engagement by WDC. Dr Shand has not corresponded with Mr Wilson on matters related to this project since being engaged by WDC, except the email correspondence passed on by Kelly Nicolson. We do not know the exact location or address of Mr Wilson's property.

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Appendix A: Te Akau South Hazard Assessment  
including T+T comments

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# Appendix 2: Review of Coastal Hazards and Coastal Sensitivity Area at Te Akau South



*Cover: Shoreline of Horongarara Point and Ryan Road subdivision (looking west).*

**Prepared by:**        **Bronwen Gibberd<sup>3</sup>**  
                                 4D Environmental Ltd  
                                 **Jim Dahm<sup>3</sup>**  
                                 Eco Nomos Ltd

**For:**                    **Waikato District Council**

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<sup>3</sup> Member of Focus Resource Management Group

# Background

This report describes additional site-specific coastal hazard mapping undertaken to further refine the coastal hazard mapping areas described in Focus (2020) and notified as part of the review of the Waikato District Plan (Stage 2 – Natural Hazards).

Detailed mapping using site-specific criteria is complex and time consuming. Accordingly, we recommended that the Council adopt a single coastal sensitivity area (CSA) for undeveloped (rural zone) areas, within which more detailed site-specific investigation of coastal hazard should be required to support any future development. This sensitivity area is 100 m wide along the rural estuarine coast of the District.

The rural Coastal Sensitivity Area (Erosion) overlays the “village” zone area at Te Akau South, on the northern shore of the Raglan Harbour. The Ryan Road subdivision consists of 37 cliff top residential sections located on Horongarara Point, approximately 14 with coastal frontage (cover photo & Figure 41). The area is elevated (10-40 m above sea level) and fronted by near vertical cliffs of varied height and geology.

During notification of the proposed Plan, submissions were received from property owners in this area highlighting the need for a site-specific investigation to define coastal erosion hazard. Given the higher intensity of development and village zoning, it is appropriate to consider likely coastal erosion hazard in more detail. As part of the response to submissions, Council therefore commissioned a more detailed assessment of coastal erosion hazard in this area.



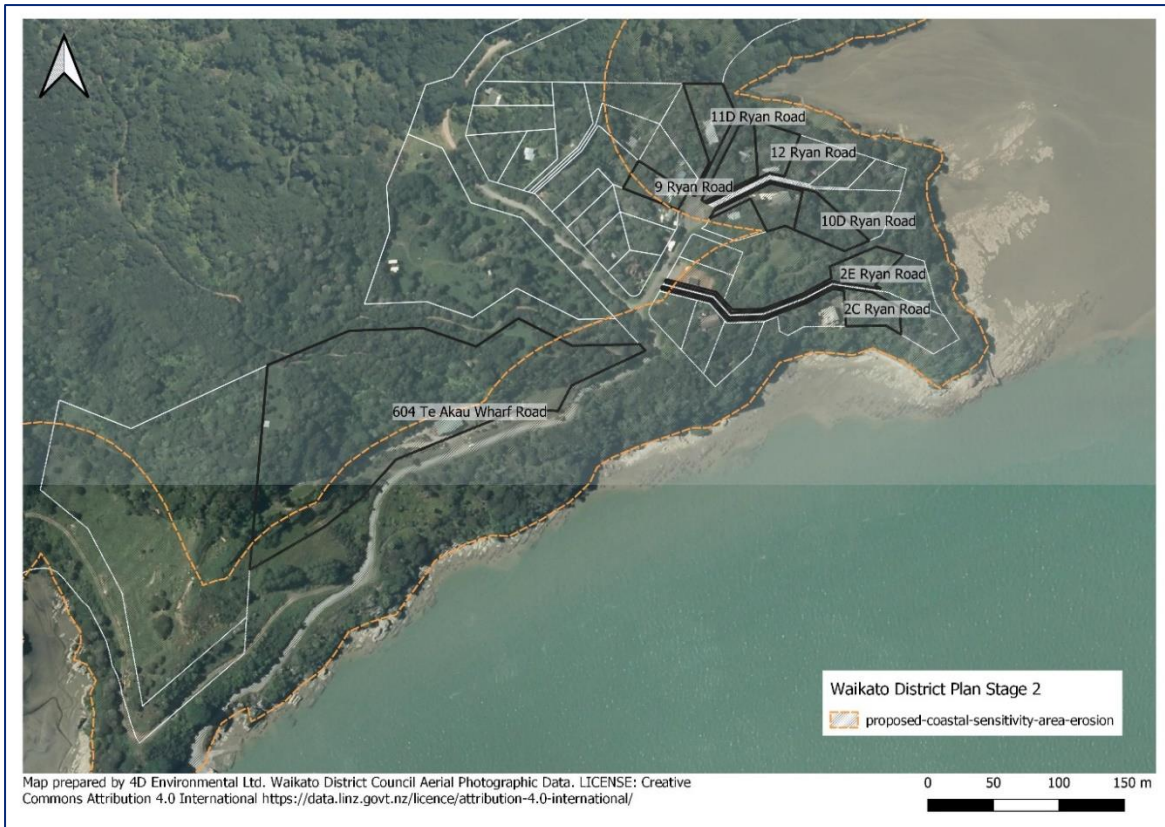


Figure 41: Horongarara Point (Te Akau south) area for revised coastal sensitivity assessment). Properties edged with black indicate submissions received.



# Coastal Erosion Hazard Assessment

## Approach

We considered a range of information in assessing the potential coastal erosion hazard, including (though not limited to):

- meeting on site with affected residents – gathering local knowledge about coastal erosion, land stability issues etc.
- vertical aerial photography dating from the 1940s to the present and historic shoreline data mapped from ortho-rectified aerial photography (Waikato Regional Council dataset).
- available topographic (LiDAR) data and bathymetric information
- geological maps and reports
- existing reports on coastal erosion and other relevant published resources (e.g. local history books and a range of technical reports and studies)
- physical and geomorphic characteristics of the coast
- field observations around the coast of Te Akau south

The Te Akau South coastline is backed by steep cliffs of varying geology. For the purposes of this report and for establishing an approach to mapping coastal erosion hazard, this shoreline has divided into four broad sections as described below (Figure 42):

1. South facing limestone shoreline, near vertical cliffs fronted by narrow shore platform and channel. Covers rural area west of Ryan Road subdivision and 604 Te Akau Wharf Road.
2. South facing siltstone cliffs, frontage of 2a-2c Ryan Road.
3. Eastern shoreline, mixed geology, evidence of active failures and some shoreline erosion. Wide shore platform, frontage of 2d, 10d Ryan Road.
4. Low lying coastal reserve (backed by 11d, 12 and 13 Ryan Road).

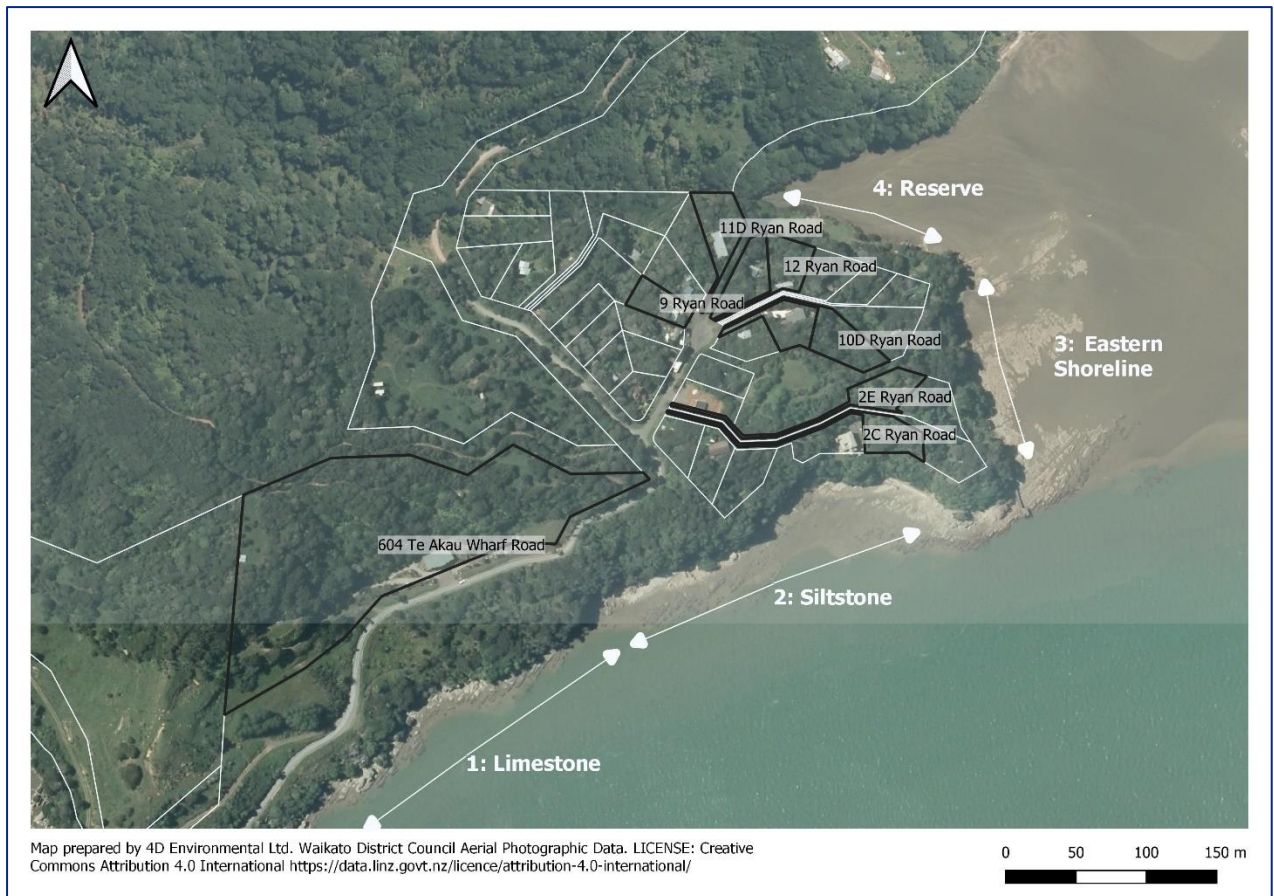


Figure 42: Te Akau south shoreline, showing sections defined based on cliff geology and topography.

Mapping of shoreline change by the Waikato Regional Council from orthorectified historical aerial photography (part of a region-wide project) indicates that shoreline change since 1944 is within the error of measurement. Accordingly, erosion in each area was assessed using field investigations, advice from local property owners and shoreline platform widths.

## Section 1: Limestone Cliffs

This section of the shoreline faces south and is backed by steep limestone cliffs (Te Akatea Formation – Raglan Limestone). The hard flaggy limestone weathers gradually, which together with very slow shoreline retreat has created “pillars” of rock on the upper shore platform (Figure 43). The steeply sloping coastal cliff is up to 8 m high (near vertical in places), backed by more gentle vegetated slopes (Figure 44 & Figure 45).

The road is approximately 70 m landward of the coast and 15 m above sea level. The nearest private property at 604 Te Akau Wharf Road is landward of the road (Figure 41).





*Figure 43: Limestone shoreline – fronting 604 Te Akau Wharf Road.*



*Figure 44: Limestone shoreline (taken looking east from Te Akau Wharf). Section 2 can be seen in the background.*

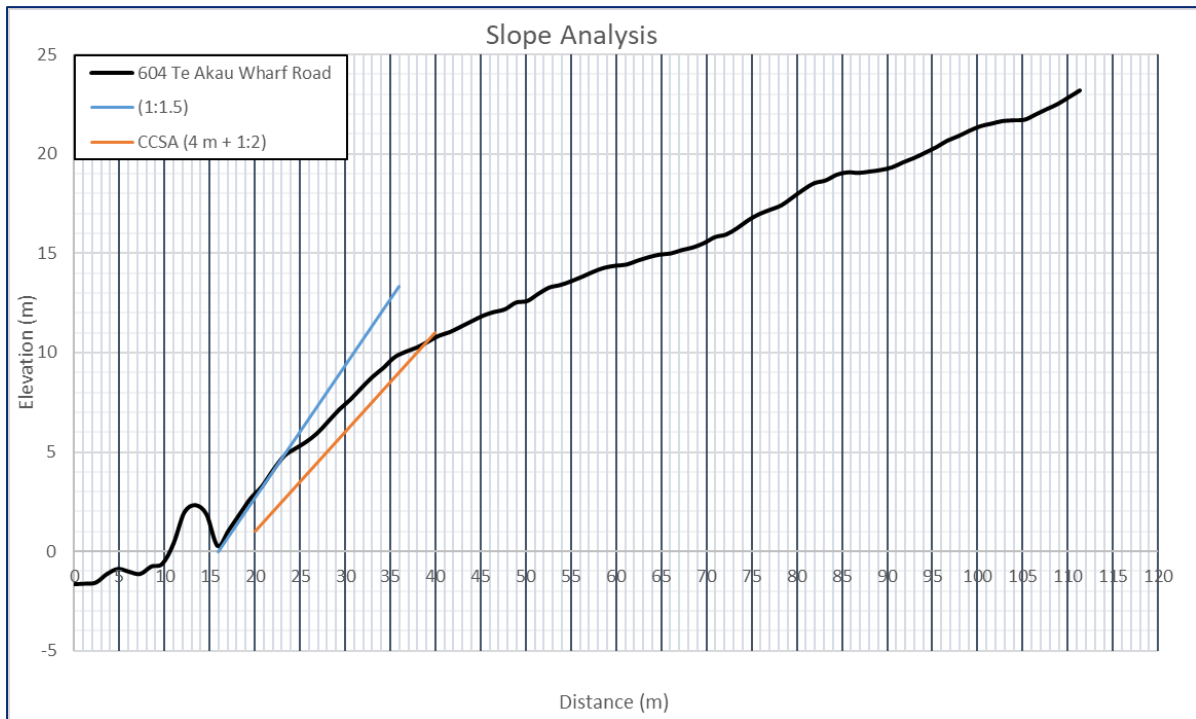


Figure 45: Cross section typical of Section 1 (Limestone Cliffs). Cross section location directly in front of dwelling on 604 Te Akau Wharf Road. Note limestone pillar at shoreline and toe of slope at ~0-1 m. The blue and orange lines indicate the method used to define High Risk Coastal Hazard Area (Erosion) (blue) and Coastal Sensitivity Area (Erosion) (orange).


The primary cause of erosion appears to be slow weathering processes (e.g. salt weathering, wetting and drying) acting on the rock surface with wave removal of the weathered debris. Accordingly, we would expect limited erosion of this hard material over planning timeframes, **shoreline retreat likely averaging in the order of 1.0 m per century or less**. This assessment is also supported by the narrow shore platform. Sea level rise may accentuate the erosion processes but is not likely to lead to excessive rates given the nature of the geology and the erosion processes operating at this site. We believe a **doubling of toe erosion rates to 2.0 m per century will provide adequate allowance for any change**.

In terms of potential slope instability associated with the toe erosion, the limestone exposed at sea level holds very steep gradients (near vertical), while the slopes to landward are typically in the order of 1V:1.5H. While the limestone appears to provide an effective buttress to slope failure and will likely remain so with expected sea level rise, we have nonetheless assumed potential for isolated slope instability by way of precaution.

## Recommendations

We recommend that the 100 m Coastal Sensitivity Area (Erosion) be amended here to produce a slope-based High Risk Coastal Hazard Area (Erosion) and a Coastal Sensitivity Area (Erosion) based on observations of local geology, and topographical data. The land adjacent to this section of land is the subject of a submission, and while zoned "rural", the available usable land area is relatively small. The shoreline in this area is particularly hard and it is relatively simple to identify that the coastal erosion hazard is limited to the coastal reserve landward of the road.



Given the limited potential for significant toe erosion in the short term, we recommend the High Risk Coastal Hazard Area (Erosion) be identified based on a stable slope of 1V:1.5H, measured from the toe of the cliff. This area is entirely within the coastal reserve and simply identifies the margin that may be subject to slope instability in the short term. 

We also recommend a Coastal Sensitivity Area (Erosion)<sup>4</sup> that incorporates 2 m of toe erosion and a conservative 1V:2H stable slope. This conservative slope has been applied throughout the study area and reflects the lack of detailed information about the nature and structure of the sub-surface materials. The area overlain by the revised Coastal Sensitivity Area (Erosion) is predominantly coastal reserve (Figure 46). However, the high steep slopes at the eastern end of the 604 Te Akau Wharf Road property result in a wider Coastal Sensitivity Area (Erosion) at this location, which extends across the road and into the property.



Figure 46: Revised High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) in Section 1 (Limestone Cliffs). The 100 m wide proposed Coastal Sensitivity Area (Erosion) is shown as notified for comparison.

<sup>4</sup> The Coastal Sensitivity Area (Erosion) is not a defined “hazard area”, but simply acts to trigger further site-specific consideration of coastal processes and associated land stability when significant development is proposed.

## Section 2: Siltstone Cliffs

This section of the shoreline is separated from Section 1 (Limestone) at the location of a known fault, where the geology at the shoreline changes. Materials exposed at the shoreline are varied but the area is broadly characterised by high siltstone cliffs (Figure 47) and a shore platform 30-60 m wide. The grey-white calcareous siltstone cliffs show evidence of recent slope failure in places. Where exposed, the siltstone is weathering and fracturing to pebble sized material through to small and large boulders. Typical cliff slopes in this area are 1V:1H and in some places are near vertical (Figure 48).

Relatively recent shallow land slips exist along this section of the coast, indicating that this shoreline is actively eroding (albeit slowly) and potentially vulnerable to slope failure. The top of a recent land slip (2015) fronting 2c Ryan Road is close to the property boundary (Figure 49). It is difficult to accurately map the slope of these failures as they post-date the elevation data available. However, based on field observations and aerial photography, the recent land slips are still generally within a 1V:1H slope.

While the exposed cliff faces suggest the slope is largely composed of in situ rock, the depth of weathered materials and regolith further landward is uncertain and accordingly we have taken a precautionary approach with regard to slope instability.



Figure 47: Shoreline near the Western end of Section 2 (west of Ryan Road).



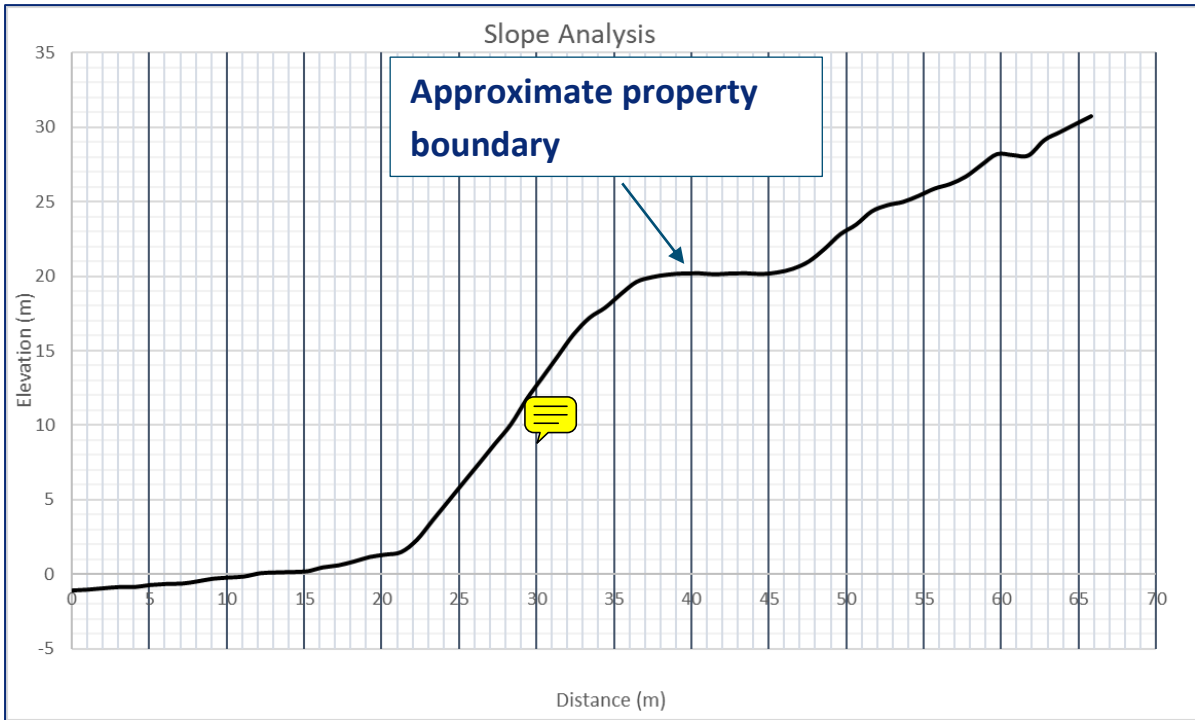


Figure 48: Typical cross section in Section 2.



Figure 49: Shoreline in Section 2 (fronting 2c Ryan Road). Note evidence of recent slope failure (slip occurred in 2020).

## Recommendations

We recommend that the 100 m Coastal Sensitivity Area (Erosion) be amended here to produce a slope-based High Risk Coastal Hazard Area (Erosion) and a Coastal Sensitivity Area (Erosion) based on observations of local geology, and topographical data. This approach is consistent with that taken along other developed estuarine coasts in the District.

We recommend the identification of a High Risk Coastal Hazard Area (Erosion) based on a stable slope of 1V:2H, measured from the toe of the cliff. Where the topography slopes steeply to landward, strict application of the slope-based approach can generate an unrealistically wide coastal management area. We therefore recommend that the width of the High Risk Coastal Hazard Area (Erosion) is limited to twice the height of the seaward cliff face.

This area identifies a margin that may be subject to slope instability in the short term. While site specific geotechnical investigations may demonstrate that the underlying materials can support a steeper slope closer to the 1V:1H observed, we do not have sufficient data to be confident about this, particularly in the higher areas.

We estimate that current rates of cliff toe erosion are likely to be no more than 2.0 m per century. Based on an increase in this rate with future sea level rise, we have revised the Coastal Sensitivity Area (Erosion)<sup>5</sup> to incorporate 4.0 m of toe erosion and a conservative 1V:2H stable slope. This conservative stable slope has been applied throughout the study area and reflects the lack of data on underlying materials. More detailed investigation may reveal that the slope is largely composed of in situ rock with a limited depth of overlying regolith but we are uncertain of this. Similarly, more detailed investigation would be required to assess the potential for slope instability of the in situ rock materials (e.g. due to fractures and jointing).

In defining the High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) we have also applied a minimum width of 20 m and 30 m respectively, measured from the toe of the cliff. This minimum distance provides for isolated lower lying areas with lower gradient slopes.

The revised coastal hazard and sensitivity areas vary in width from 20-60 m width (High Risk Coastal Hazard) and 30-80 m (Coastal Sensitivity) depending on the elevation and slope of the coastal margin (Figure 12). The area is widest where the coast is backed by high steep slopes at 2a and 2c Ryan Road and 585 Te Akau Wharf Road.

The identified High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) extend landward over several residential properties. We suspect (based on existing cliff slopes and the nature of materials exposed on the shoreline) that steeper stable slopes may be appropriate to

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<sup>5</sup> **The Coastal Sensitivity Area (Erosion) is not a defined “hazard area”, but simply acts to trigger further site-specific consideration of coastal processes and associated land stability when significant development is proposed.**

define coastal erosion hazard. However, this would need to be determined by a site-specific study by a suitably qualified engineering geologist or geotechnical engineer, in the context of any proposed activity.

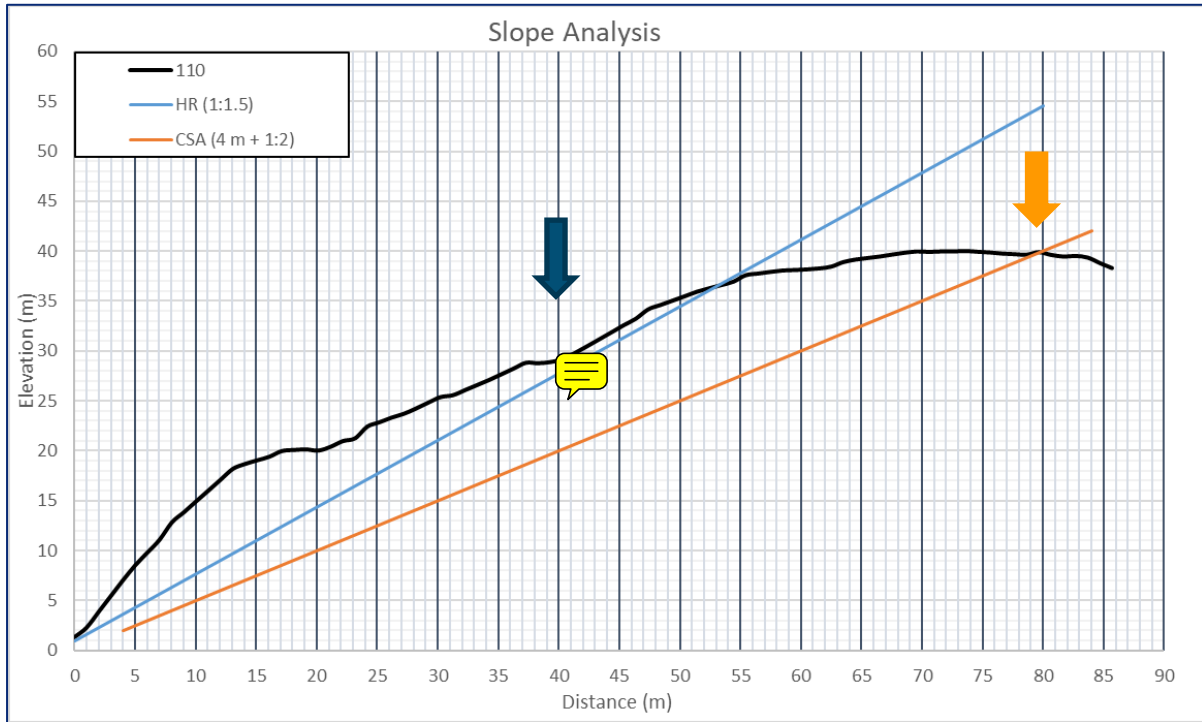


Figure 50: Cross section at Transect 110 (2a Ryan Road). In this location, the High Risk Coastal Hazard Area (Erosion) was limited to a distance of 40 m (blue arrow), based on a frontal cliff height of 20 m, and the closeness of the gradient to the land surface at that distance. The landward limit of the Coastal Sensitivity Area (Erosion) is shown by the orange arrow.



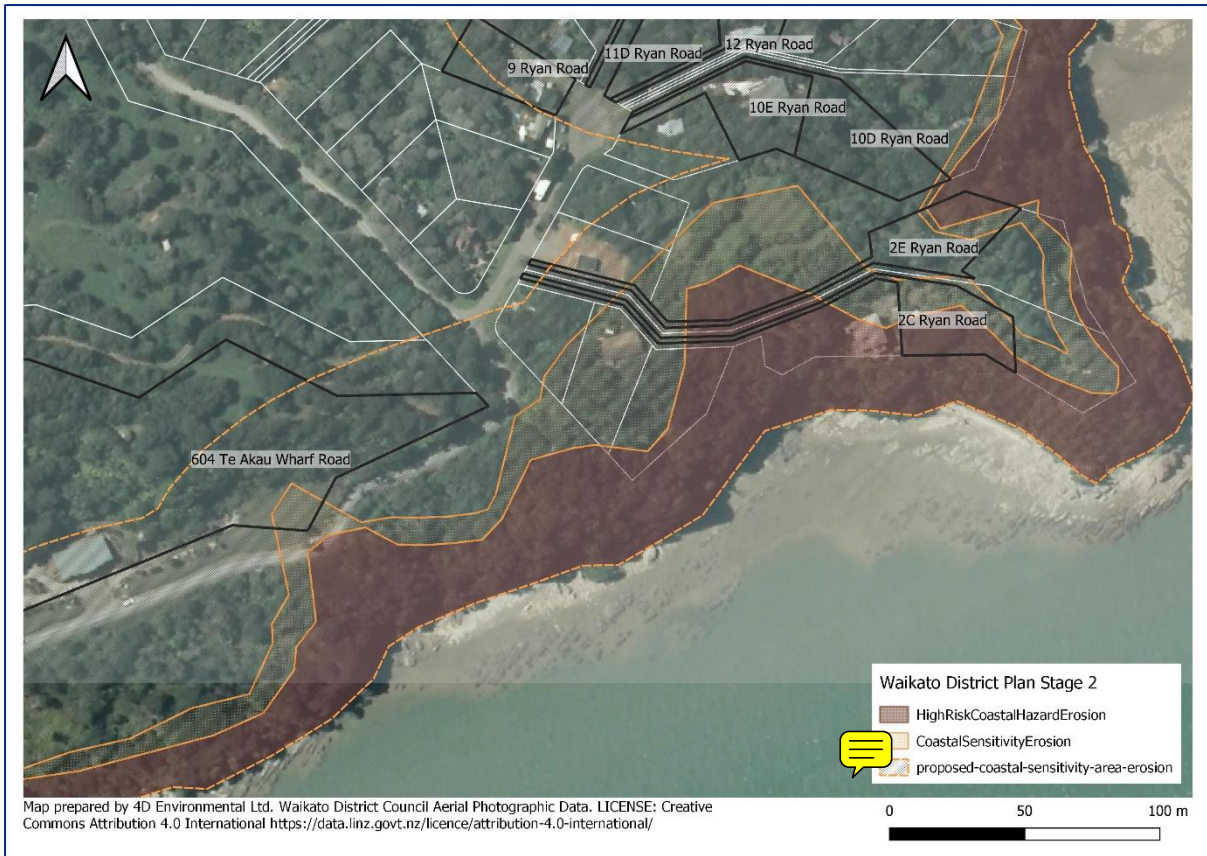


Figure 51: Revised High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) in Section 2 (Siltstone Cliffs).

## Section 3: Mixed Geology Eastern Shoreline

This section includes the eastern facing cliff shoreline north of Horongarara Point. This shoreline is fronted by a shore platform up to 100 m wide and has a varied backshore, including steep siltstone bluffs in some areas (Figure 52), and vegetated slopes in others (Figure 53). While some areas are relatively low lying (7-12 m), slopes near the centre of this shoreline rise to 25-30 m above sea level.

Field observations and information provided by local residents indicate that the shoreline is eroding more actively than Section 1 and Section 2. The wider shore platform in this area (up to 100 m) further supports this. Cliff erosion rates are estimated to average 2-3 m per century, though may exceed this in isolated areas during some periods. This shoreline appears to be slightly more vulnerable to toe erosion due to the nature of the geology and the greater high tide wave fetch.

Cliff slopes in the headland areas at either end vary from 1V:1H to 1V:1.5H but more gentle slopes (typically 1V:1.5H to 1V:2H) are noted in some central areas. A deep-seated landslide was observed on this shoreline fronting 2e Ryan Road (Figure 53). This failure is only 2-3 years old, so occurred since the land elevation data used for his study was collected (2015). Slopes may therefore vary slightly from those measured and reported in this area. Cracks developing on the upper slopes above steep areas near the north end of the Bay indicate further slope failures are likely to occur.



Figure 52: Shoreline at Transect 142 (10d Ryan Road).





Figure 53: Eastern Shoreline. Approximate location of recent land slip indicated by white arrow.

## Recommendations

We recommend that the 100 m Coastal Sensitivity Area (Erosion) be amended to produce a slope-based High Risk Coastal Hazard Area (Erosion) and a Coastal Sensitivity Area (Erosion) based on observations of local geology, and topographical data. This approach is consistent with that taken along other developed estuarine coasts in the District.

Given the complex shoreline and evidence of ongoing active slope failures, we recommend that the High Risk Coastal Hazard Area (Erosion) be defined by a 1V:2H stable slope in the more gently sloping areas (e.g. Figure 54). At locations fronted by steep siltstone cliffs, a slope of 1V:1.5H is appropriate, as applied in Section 2 (Figure 55). The highly varied nature of the shoreline makes slope-based mapping complex, and we have also applied minimum width of 20 m and 30 m to the High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) respectively, measured from the toe of the cliff.

We estimate that current rates of cliff toe erosion are likely to be 2-3 m per century. Based on an increase in this rate with future sea level rise, we have revised the Coastal Sensitivity Area (Erosion)<sup>6</sup>

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<sup>6</sup> The Coastal Sensitivity Area (Erosion) is not a defined “hazard area”, but simply acts to trigger further site-specific consideration of coastal processes and associated land stability when significant development is proposed.



to incorporate 5 m of toe erosion and a conservative 1V:2H stable slope. This conservative slope has been applied throughout the study area and reflects the lack of data on underlying materials. In defining the Coastal Sensitivity Area (Erosion) we have also applied a minimum width of 30 m, measured from the toe of the cliff. This minimum distance provides for isolated lower lying areas with lower gradient slopes.

The revised coastal hazard and sensitivity areas vary in width depending on the elevation and slope of the coastal margin from 20-60 m (High Risk Coastal Hazard) and 30-80 m (Coastal Sensitivity) (Figure 56). The area is widest fronting 2e Ryan Road, due to the steep slopes and high elevation. This is the location of the recent significant land instability. Detailed site-specific investigations may indicate that the 1V:2H stable slope is overly conservative, but we have taken a precautionary approach due to lack of knowledge about subsurface geology and characteristics.

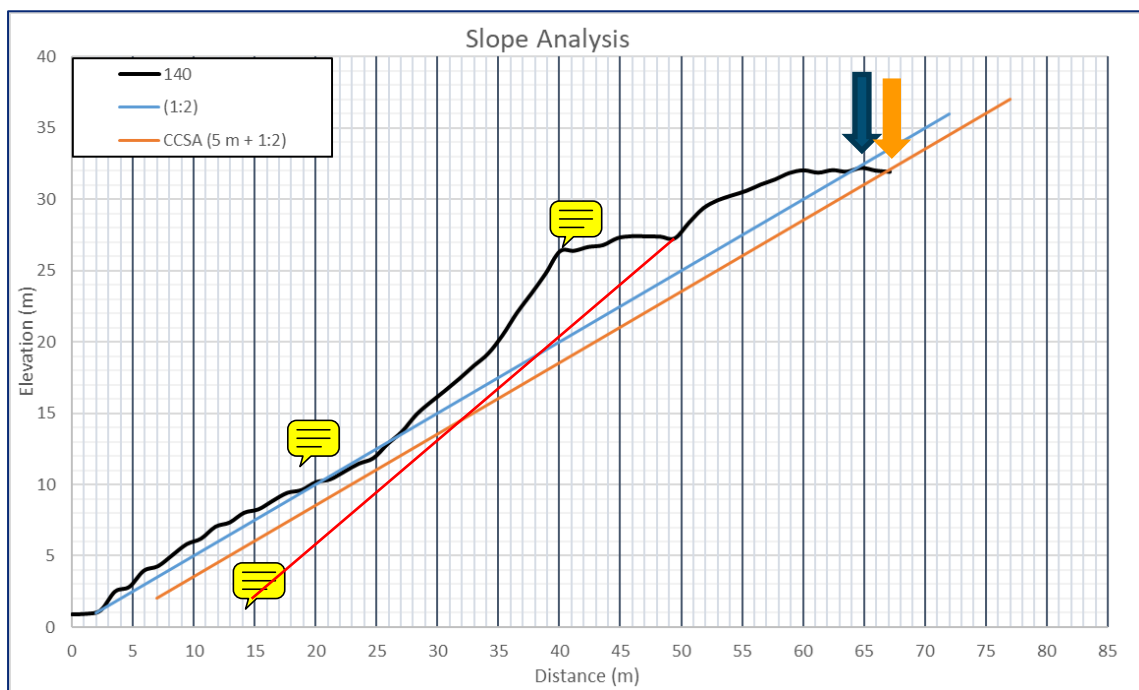


Figure 54: Cross shore profile in the vicinity of the recent land slip (elevation data pre-dates the landslip). Blue and orange arrows indicate the landward boundary of the High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) respectively.

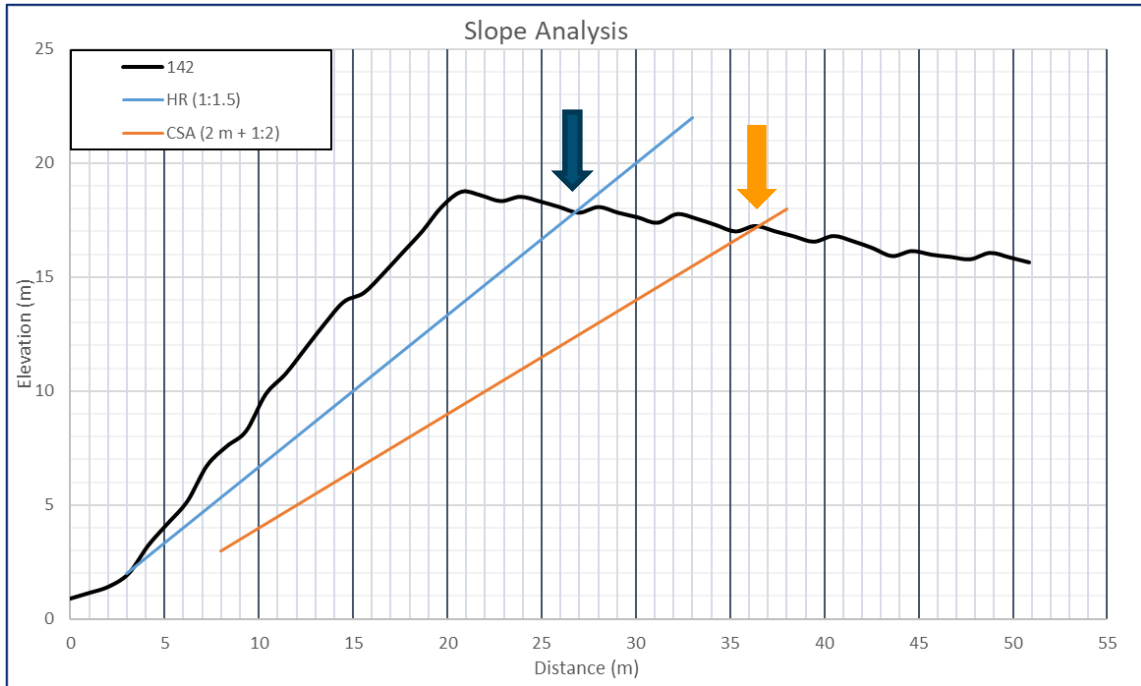


Figure 55: Cross shore profile near the northern end of the eastern shoreline at Transect 142 (Figure 52). Blue and orange arrows indicate the landward boundary of the High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) respectively.

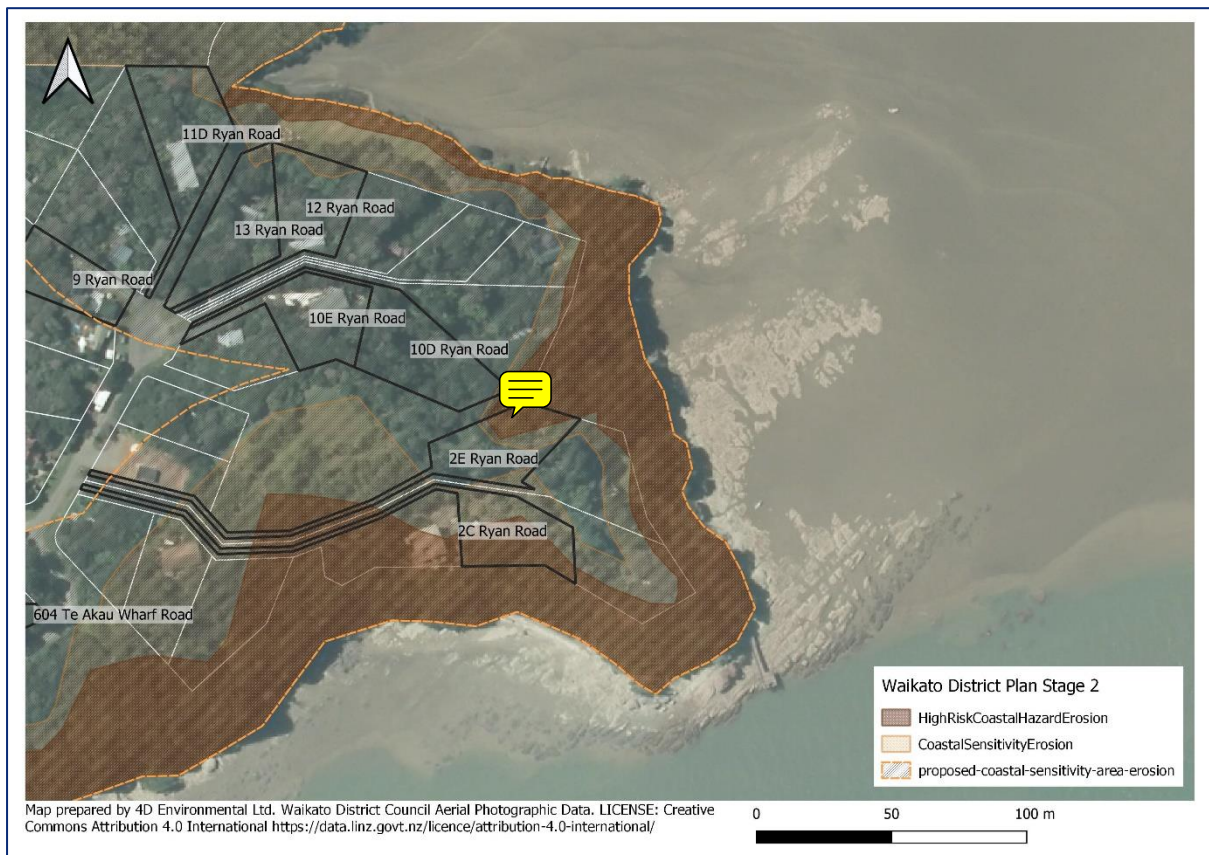


Figure 56: Revised High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) at Te Akau South.

## Section 4: Reserve and Embayment

Section 4 is backed mostly by a low-lying grassed reserve up to 20 m wide (Figure 57). Residential sections are located on the elevated slopes to landward. During the site visit, it was noted by residents that there has been some minor erosion of the frontage over time. Works have been undertaken to stabilise and revegetate some areas. This area is relatively sheltered from wave action. The seaward edge of the reserve is relatively low lying (RL 2-3 m), so is potentially susceptible to occasional coastal inundation during extreme events.

In the short term, erosion is unlikely to be severe, but with increased sea level, the area will be frequently overtopped and exposed to wave and current action for greater periods over the tidal cycle. This could increase the hazard from coastal erosion.



*Figure 57: Coastal reserve at Section 4. The reserve is potentially susceptible to coastal inundation with future sea level rise.*

### **Recommendations:**

We recommend that the 100 m Coastal Sensitivity Area (Erosion) be amended here to produce a High Risk Coastal Hazard Area (Erosion) and a Coastal Sensitivity Area (Erosion) based on a pragmatic approach that reflects the local setting (Figure 58).



In the relatively short term, significant shoreline erosion is unlikely, and will only affect reserve land. We propose a 5.0 m wide High Risk Coastal Hazard Area (Erosion) measured from the toe of the bank.

The residential properties in this area are located well landward of a very sheltered coastline and are unlikely to be impacted by coastal erosion even in the longer term with future sea level rise. However, we do not have detailed information about the materials within the low-lying reserve area, which may be fill, or other readily erodible substrate. As such we suggest that this area is flagged as a Coastal Sensitivity Area (Erosion). In defining the low-lying reserve, we have adopted the 5 m contour as the landward limit. This is equivalent to the extent of the Coastal Sensitivity Area (Inundation). These two overlays reflect the potential of the area to be influenced by coastal processes in the long term with sea level rise.

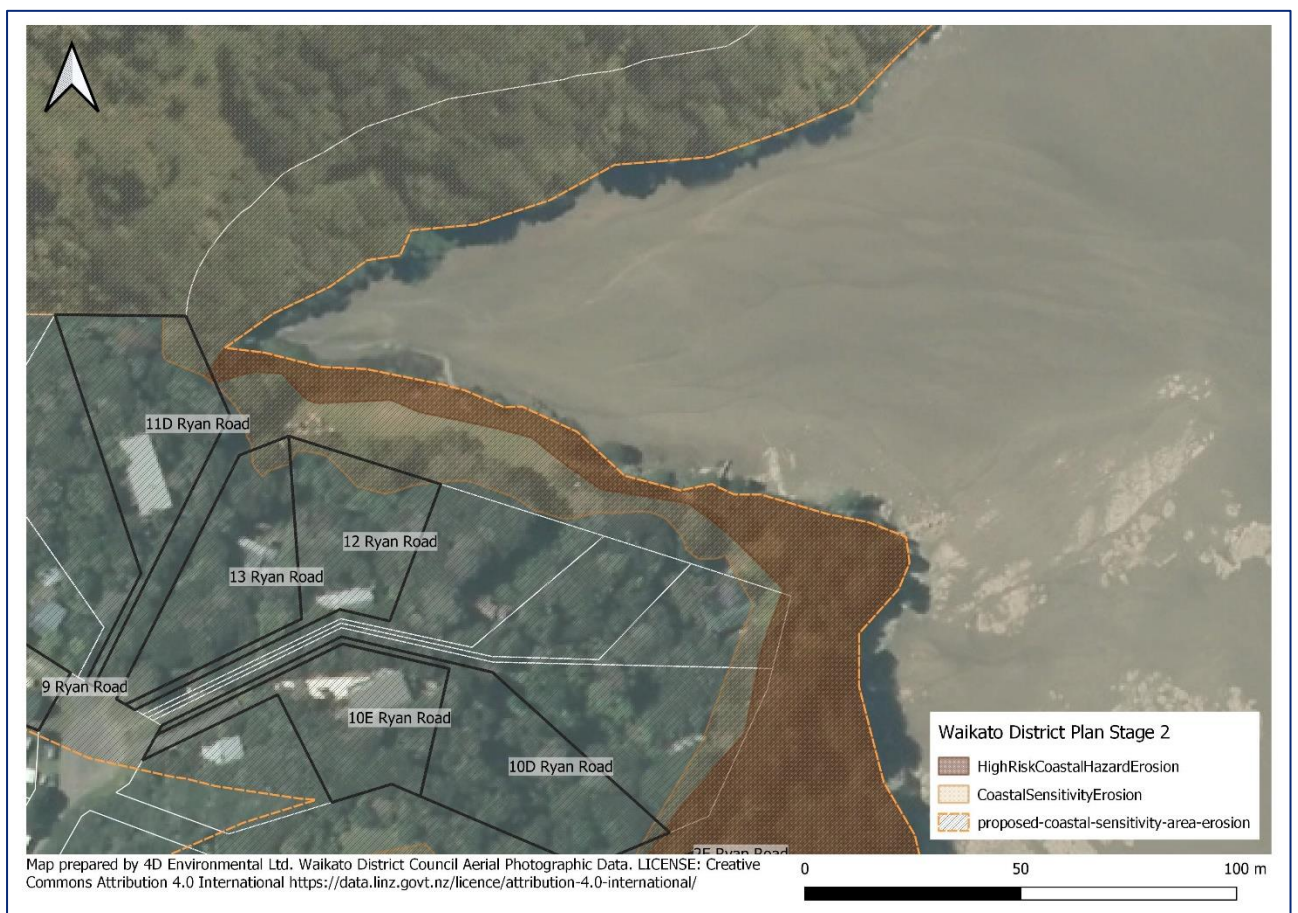






Figure 58: Revised High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) at Te Akau South (Section 4).



# Summary

We have undertaken a  broad assessment of coastal geomorphology and coastal hazards at the Horongarara Peninsula, Te Akau south. From the available information and site observations we have made some recommendations for amendment of the (previously 100 m wide) Coastal Sensitivity Area (Erosion) in the proposed Waikato District Plan.

The area is predominantly a cliff shoreline, with complex and variable geology and elevation. We recommend two coastal management areas at this site, in an approach that is consistent with other developed cliff shorelines in the District:

- High Risk Coastal Hazard Area (Erosion): the area potentially  vulnerable to slope failure associated with coastal cliff processes in the short term (10-15 years).
- Coastal Sensitivity Area (Erosion): the additional area that MAY be impacted by coastal erosion processes in the next 100 years, including the effects of projected sea level rise of 1.0 m.

In identifying these areas, we have  assumed relatively low rates of cliff toe erosion, particularly on the south facing shoreline (Section 1 and Section 2). We expect the impact of sea level rise on these sections of coast to be limited but have allowed for a small  variation of toe erosion due to increased time of exposure to coastal processes and wave exposure. The toe erosion component is generally a small proportion of the total sensitivity area. The amount of land affected is a function of both the slope angle and the height of the cliff and adjacent land. The criteria used to define the High Risk Coastal Hazard Area (Erosion) and Coastal Sensitivity Area (Erosion) are summarized in Table 1 below.

We acknowledge here that the proposed Coastal Sensitivity Area (Erosion), while considerably refined in relation to the 100 m wide generic area, still extends inland to overlay a number of existing residential properties. We emphasise that the Coastal Sensitivity Area (Erosion) is not a defined hazard area. It is an area within which we  feel that coastal erosion processes should be considered (including the effects of sea level rise). We suspect (based on existing cliff slopes and the nature of materials exposed on the shoreline) that steeper stable slopes may be appropriate to define coastal erosion hazard. However, the geology at this site is complex and highly variable, and implementation of this steeper slope would need to be based on more detailed information about the underlying geology and associated failure mechanisms. Such investigations are best undertaken on a site-specific basis, by a suitably qualified engineering geologist or geotechnical engineer, in the context of the proposed activity. The provisions of the proposed District Plan provide for development within the Coastal Sensitivity Area (Erosion), provided that coastal hazards are  considered.

We note that the Ryan Road subdivision is located on steeply sloping land and there may be other (land-based) hazards associated with the steep nature of these sections. We have only considered those processes that are influenced by coastal erosion.

Table 4: Coastal sensitivity mapping approaches for Te Akau Coast.

	Location	High Risk Hazard Area	Coastal Sensitivity Area
<b>TE AKAU SOUTH</b>			
Section 1: Limestone Cliffs (Transects 80-89)	Coastline fronting 604 Te Akau Wharf Road	1V:1.5H slope. Measured from toe of cliff. 2 m provided from profile toe to allow for limestone shoreline – pillars.	2 m of erosion + 1V:2H slope. Measured from toe of cliff (+ 1.0 m for sea level rise). 2 m provided from profile toe to allow for limestone shoreline – pillars.
Section 2: Siltstone/Sandstone Cliffs (Transects 90-129)	Coastline fronting 2a- 2c Ryan Road.	1V:1.5H slope. Minimum width 20 m. Measured from toe of cliff.	4 m of erosion + 1V:2H slope. Measured from toe of cliff (+ 1.0 m for sea level rise).
Section 3: Eastern Shoreline (Transects 130-149)	Coastline fronting 2d, 10d Ryan Road	1V:1.5H slope in rock/bluffed areas. 1V:2H in sloped areas. Minimum width 20 m. Measured from toe of cliff.	5 m of erosion + 1V:2H slope. Measured from toe of cliff (+ 1.0 m for sea level rise).
Section 4: Low Lying Reserve (Transects 150+)	Area fronting 11d, 12 and 13 Ryan Road	5.0 m Measured from toe of bank.	Width of low-lying reserve. 5.0 m contour to define landward boundary.