Campana Road, Wiri

Coastal Erosion and Hazards Assessment

for: Campana Landowners Consortium c/ Capstone Projects

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EXECUTIVE SUMMARY

Babbage Consultants Limited (Babbage) has been engaged by Campana Landowners Consortium c/ Capstone Projects Limited (CLC) to undertake a desktop Coastal Hazzard and Erosion Assessment (CHEA) across multiple sites at Campana Road, Wiri, Auckland.

This report evaluates the potential impacts of coastal hazards and erosion on specific lots in the area. The assessment aims to guide future development and hazard mitigation strategies by estimating future shoreline changes and inundation extents.

The results of the assessment are as follows:

- The future Average Shoreline Change and Inundation Extent (ASCIE) is estimated at 0-3.6 meters (based on the Site setting) and 2.8-16.6 meters (based on AVF/CVZ lithology information).
- The lots with relatively higher potential effects include Lot 3 DP 71211, Lot 2 DP 71211, and Allot 190 PSH OF Manurewa. It must be noted that most of the area susceptible to coastal erosion and inundation at the Site are areas of the respective lots that are below the cliff.
- For the 2130 planning horizon, a maximum inundation potential of 5.1 meters is derived. Given the site elevation of 5 to 10 meters, the inundation risk is considered low.
- An Open Space setback zone (from the CMA) was proposed by CLC to account for the effects of the ASCIE 8.5+ prior the CHEA. Based on the calculations above, a 30 m setback will be sufficient to mitigate the predicted effects of ASCIE8.5+.

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1 INTRODUCTION

Babbage Consultants Limited (Babbage) has been engaged by Campana Landowners Consortium c/ Capstone Projects Limited (CLC) to carry out a Coastal Erosion and Hazards Assessment (CEHA) for Campana Road, Wiri, Auckland - Allot 190 PSH FO Manurewa, Lot 2 DP402013, Lot 1 DP 402013, Lot 2 DP 71211 and Lot 3 DP 71211 (the Site). The assessment is intended to support the Plan change for the proposed Site redevelopment and follows the 2021 Guidelines set out in Carpenter (2021)[1], 'Coastal hazard assessment in the Auckland region, as required by the AUP:OP.

To be able to proceed with the redevelopment, a CEHA has been requested by Council.

Areas of concern provided by the council are:

- MHWS sits at a contour level of about 2 m in the Auckland council GIS maps.
- The Site is also within the Coastal Inundation 1 per cent AEP plus 1 m Control in the Auckland Unitary Plan – Operative in Part (AUP:OP).
- Policy 24 of the New Zealand Coastal Policy Statement (NZCPS) requires that coastal hazard assessments for development, are based on a 100 year projection. This 100 year projection needs to consider the effects of climate change on coastal erosion and instability over that time frame.
- The RMA, and Policy 25 of the NZCPS require avoiding increased risk of development in area affected by coastal hazard areas over at least the next 100 years.
- AUP:OP Policy E36.3 requires identification of land that may be subject to natural hazards, considering the likely effects of climate change including coastal erosion, coastal inundation and land instability.
- The Proposed Plan Change area is within a coastal erosion hazard area (CEHA) as per the AUP:OP definition. The site triggers part (b)(i)) of the CEHA definition (as below from Chapter J of the AUP:OP).

> (b) at an elevation less than 7m above mean high water springs if the activity is within:
>
> (i) Inner Harbours and Inner Hauaraki Gulf: 40 m of mean high water springs; or
>
> (ii) Open west, outer and Mid Hauaraki Gulf: 50 m of mean high water springs.

The overall aim of this assessment is to understand the coastal processes acting in the proposed location and identify existing shoreline movement trends. This will assess local shore morphology and

[1] Roberts, R., N Carpenter and P Klinac (2020). Predicting Auckland's exposure to coastal instability and erosion, Auckland Council, technical report, TR2020/021

position, inundation and erosion hazards, and take into consideration future sea-level rise and climate change effects to inform an assessment of the effects.

1.1 Site location and land use

The addresses of the lots that form the Site proposed for redevelopment and plan change are presented in Table 1 and Figure 1.

Table 1. Site identification.

Address	Legal description	Area (ha)
11 Campana Road, Wiri	Lot 2 DP 71211	8.12
467 Puhinui Road	Allot 190 PSH OF Manurewa	3.44
485 Puhinui Road	Lot 2 DP402013	7.16
5 Campana Road	Lot 1 DP 402013	2.00
10 Campana Road	Lot 3 DP 71211	9.90

Note: Source – Auckland Council GIS maps (AC Geomaps) data service website[2].

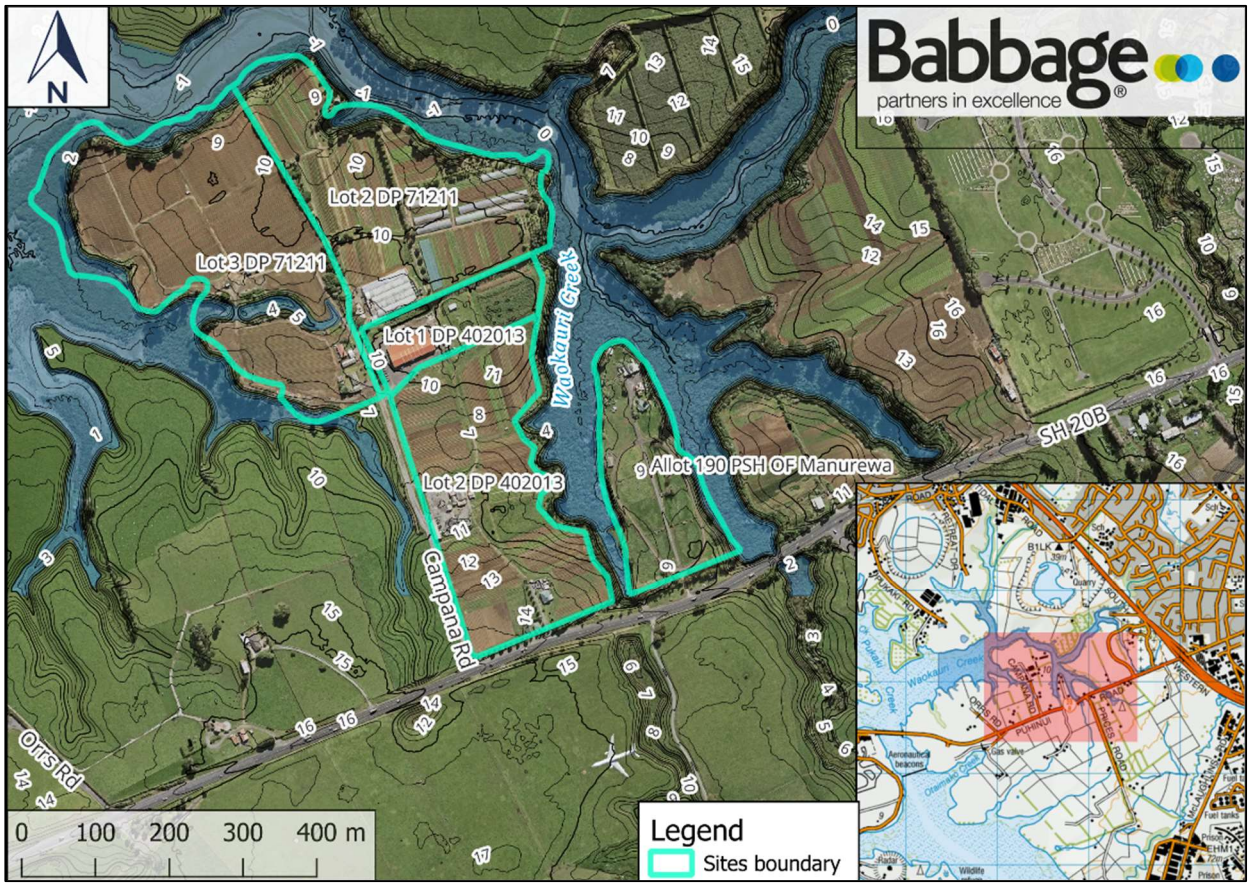


Figure 1. The Site surrounded by channels of the Waokauri Creek system and Puhinui Road.

[2] Auckland Council GEOMAPS 8 July 2024. Retrieved from https://geomapspublic.aucklandcouncil.govt.nz/viewer/index.html

The existing topography of the Site is predominantly flat, with a maximum elevation of around 10 m RL, gently sloping downwards to approximately 5 m RL at the edges of sites. The slopes from the Site to the creek are ranging from 5 to 8 meters in elevation and descend to sea level at angles ranging from 14 to 33 degrees. These slopes are densely vegetated and well protected at the toe by mature mangroves.

The Site features various low-set farm buildings, greenhouses, and associated farm pathways. The Site is surrounded by channels of the Waokauri Creek system to the East, North and West. To the South the Site borders on Puhinui Road (part of SH20B).

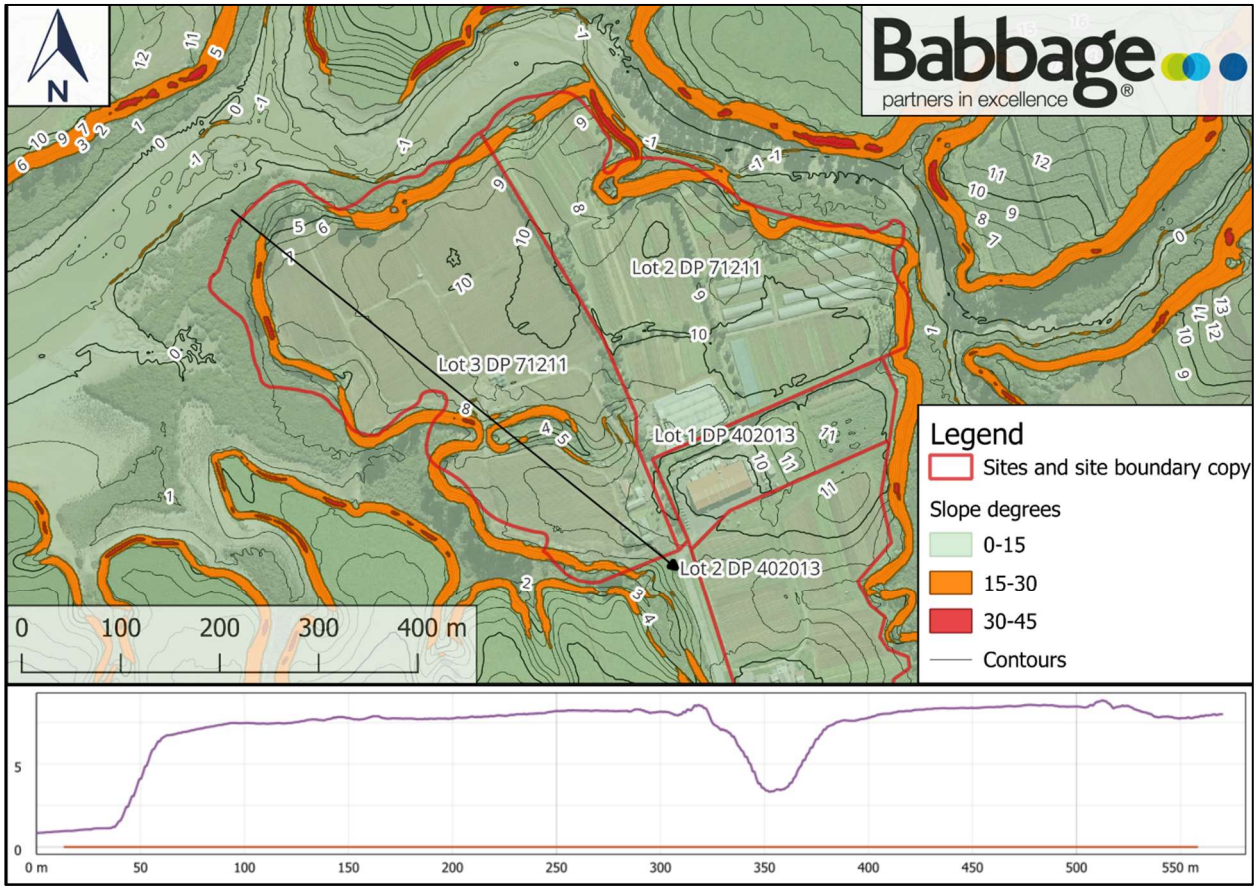
1.2 Topography

1.2.1 Lot3DP71211 (10 Campana Road, Wiri, Auckland)

The property extends 520 m inland from the most northeastern point to the base right corner. The property is surrounded by Waokauri Creek and dense mangrove vegetation to the North and West parts of the lot. The vegetation extends from the edge of the property into the creek by 30 to 180 m. The lot is situated north of Puhinui Road (part of SH20B) and to the left of Campana Road.

Covering 9.9 ha, the property lies at an elevation of 0 to 10 m above sea level. The shoreline area features steep slopes 15° to 30° with localised very steep sharp inclines of 30° to 45°, while the main body of the lot is predominantly flat with gentle slopes of 0° to 3°. The property and the surrounding lots are used for agriculture and glasshouses.

The topography of the site can be seen in Figure 2.



Note: the black arrow indicates the direction of the cross-section; the orange line in the plot area is indicating site area.

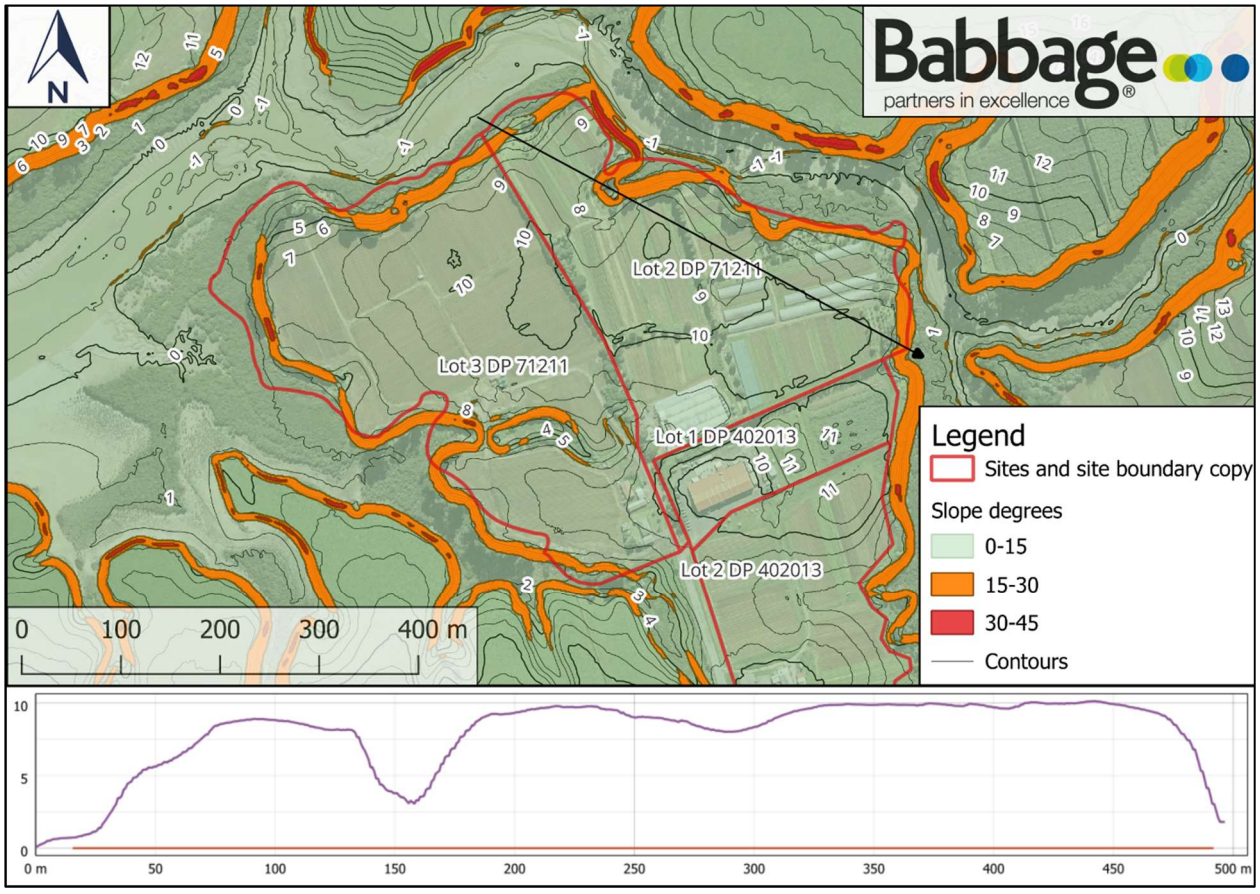
Figure 2. Lot 3 DP 71211 topography.

1.2.2 Lot2DP71211 (11 Campana Road, Wiri, Auckland)

The property extends 400 m inland from the most northeastern point to the base. The property is surrounded by Waokauri Creek and dense mangrove vegetation the North and East parts of the lot. The vegetation extends from the edge of the property into the creek by 30 to 60 m. The lot is situated north of Puhinui Road (part of SH20B) and to the right of Campana Road.

Covering 8.12 ha, the property lies at an elevation of 0 to 10 m above sea level. The shoreline area features gentle to moderately steep slopes of 15° to 30°, with localised areas of 30° to 45° of steep sharp inclines, while the main body of the lot is predominantly flat with gentle slopes of 0° to 3°. The property and the surrounding lots are used for agriculture and glasshouses.

The topography of the site can be seen in Figure 3.



Note: the black arrow indicates the direction of the cross-section; the brown line in the plot area is indicating site area.

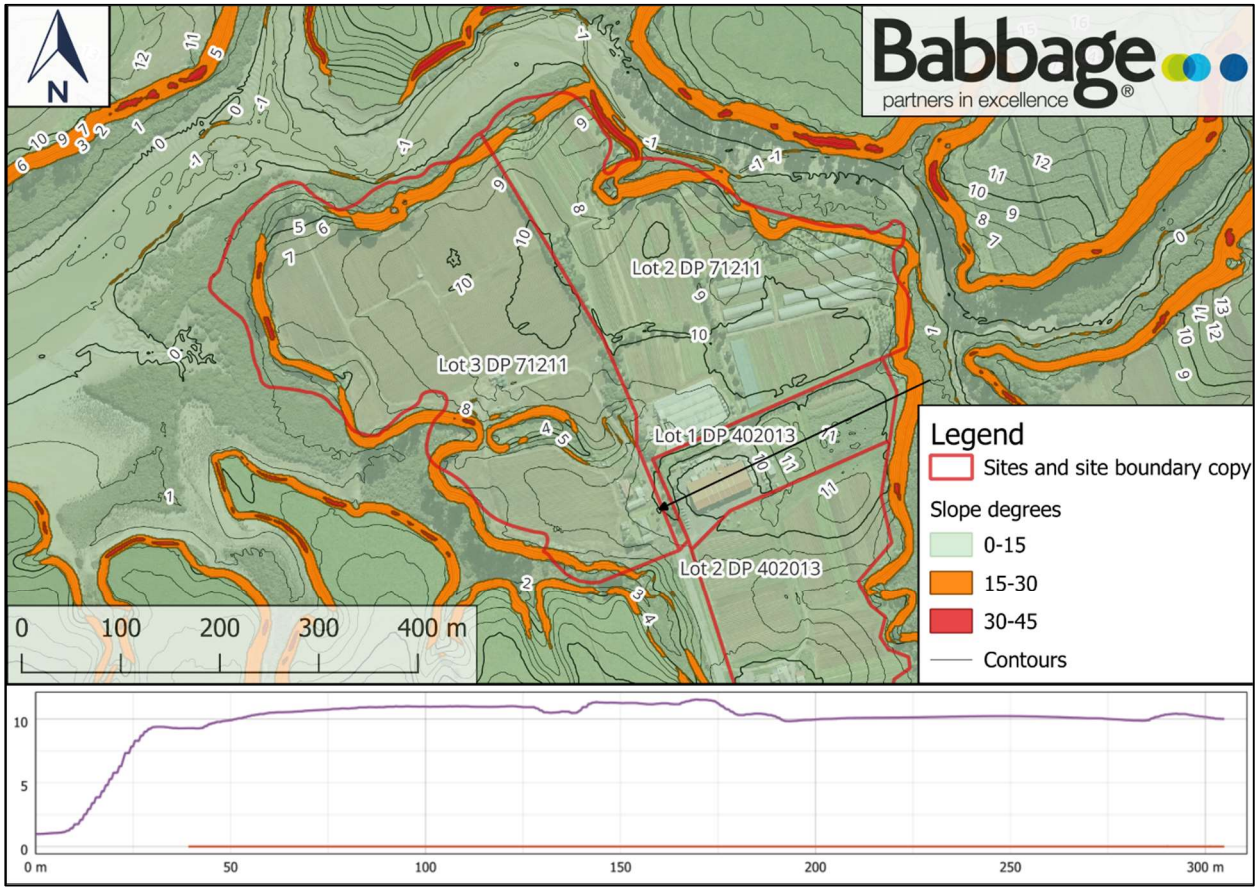
Figure 3. Lot 2 DP 71211 topography.

1.2.3 Lot1DP402013 (5 Campana Road, Wiri, Auckland)

The property extends 250 m inland from the most east shore and borders Campana Road on the west side of the lot. The shoreline of the property borders the Waokauri Creek and dense mangrove vegetation, which extends from the edge of the property into the creek by 60 to 80 m. The lot is situated north of Puhinui Road (part of SH20B) and to the right of Campana Road.

Covering 2 ha, the main body of the property lies at an elevation of 9 to 12 m above sea level. The shoreline area features gentle to moderately steep slopes of 15° to 30°, with the main part of the lot predominantly flat with gentle slopes of 0° to 5°. The property and the surrounding lots are used for agriculture and glasshouses.

The topography of the site can be seen in Figure 4.



Note: the black arrow indicates the direction of the cross-section; the blue line in the plot area is indicating site area.

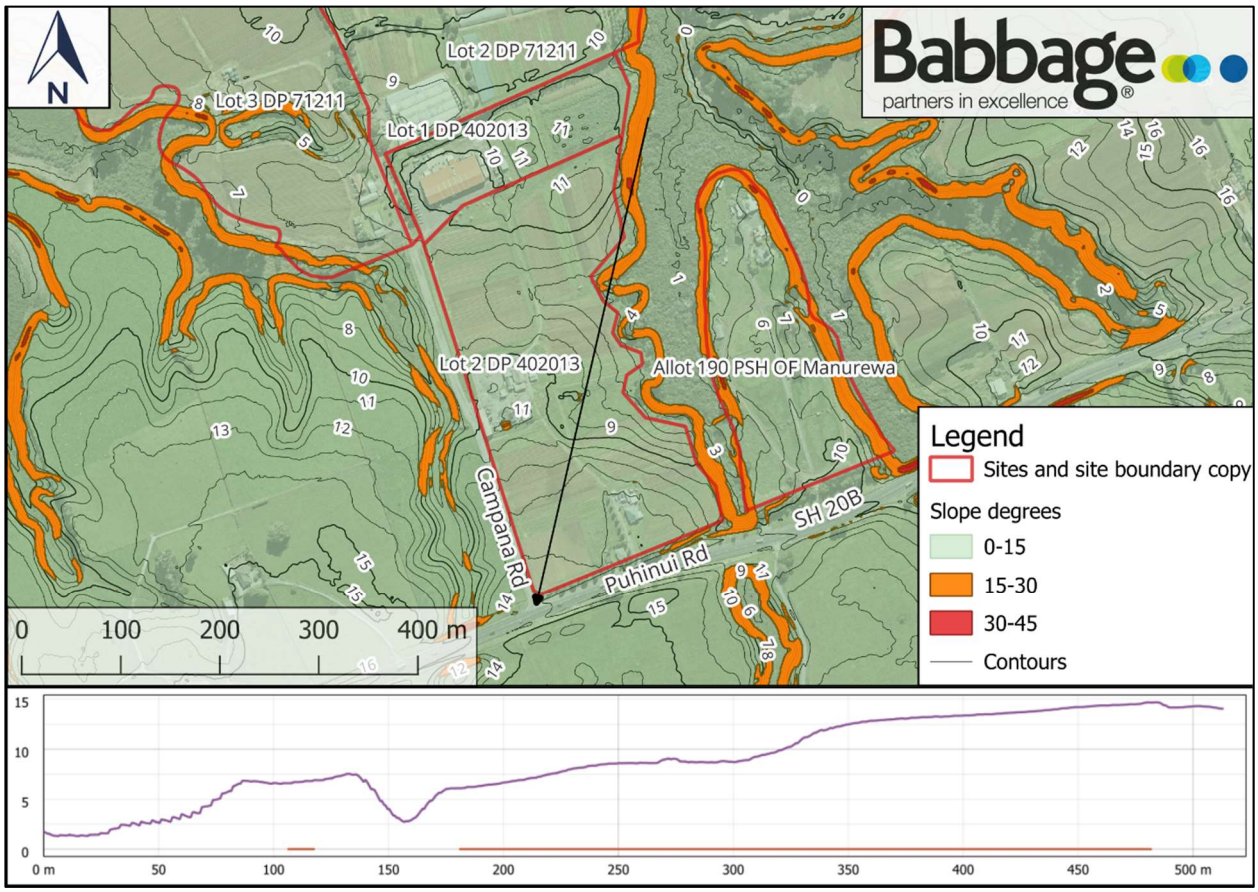
Figure 4. Lot 1 DP 402013 topography.

1.2.4 Lot2DP402013 (485 Puhinui Road, Wiri, Auckland)

The property extends 200 m inland from the most east border and borders Campana Road on the right side of the road. The shoreline on the east of the property borders Waokauri Creek and dense mangrove vegetation, which extends from the edge of the property into the creek by 60 to 100 m. The lot borders Puhinui Road (part of SH20B) at the southern boundary and Campana Road to the western boundary.

Covering 7.16 ha, the main body of the property lies at an elevation of 5 to 15 m above sea level. The shoreline area features gentle to moderately steep slopes of 15° to 30° with localised area of steep slope of 30° to 45°, while the main part of the lot is predominantly flat with gentle slopes of 0° to 15°. The property and the surrounding lots are used for agriculture and glasshouses.

The topography of the site can be seen in Figure 5.



Note: the black arrow indicates the direction of the cross-section; the green line in the plot area is indicating site area.

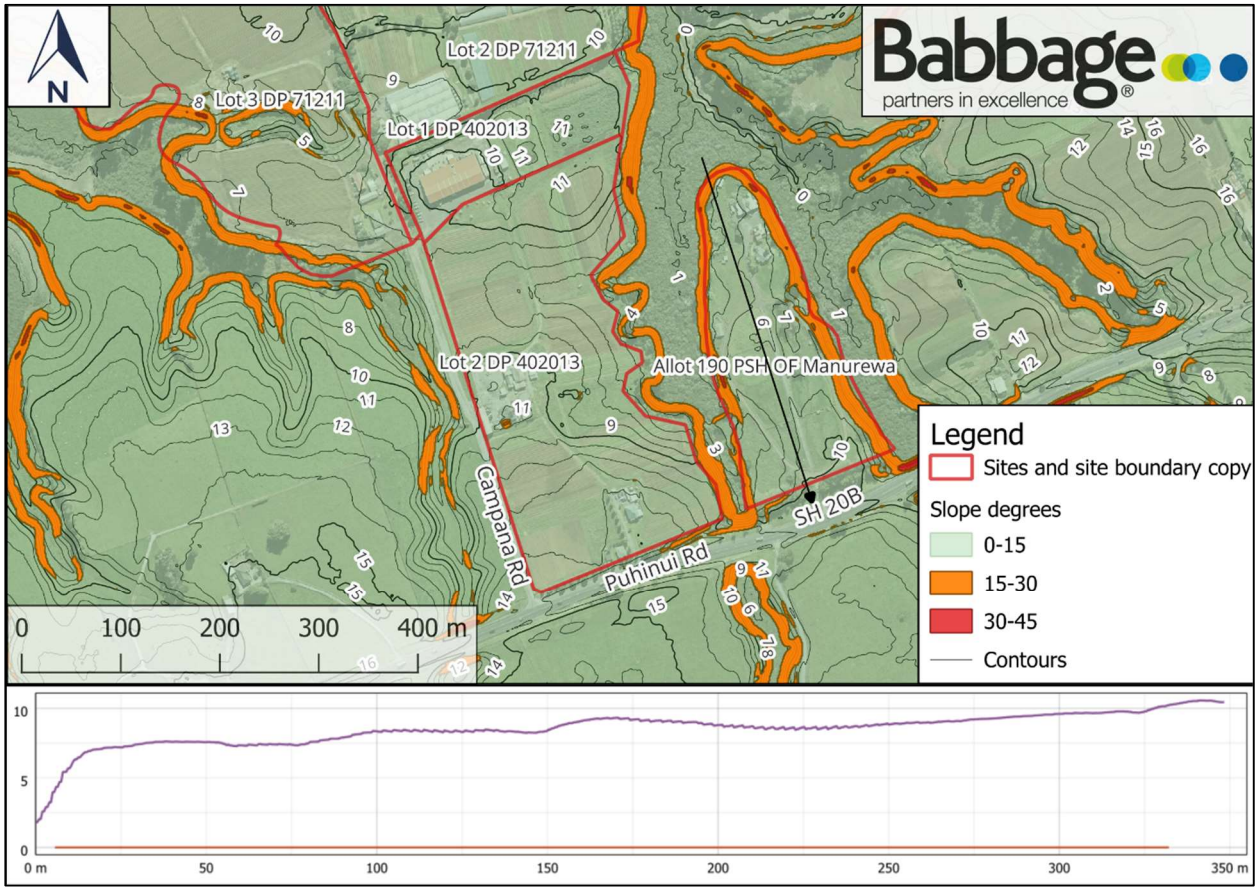
Figure 5. Lot 2 DP 402013 topography.

1.2.5 Allot190PSF OF Manurewa (467 Puhinui Road, Wiri, Auckland)

The property extends 330 m inland from its northern border and borders Puhinui Road on the southern lot boundary. The shoreline surrounds the property from west to north to east, edging Waokauri Creek and dense mangrove vegetation, which extends into the creek by 60 to 70 meters.

The lot covers 3.44 ha with the main body of the property lying at an elevation of 4.5 to 10.3 m above sea level. The shoreline area features gentle to moderately steep slopes of 15° to 30° with localised areas of steep slopes of 30° to 45°, while the main part of the lot is predominantly flat with gentle slopes of 0° to 3°. The property and the surrounding lots are used for agriculture and glasshouses.

The topography of the site can be seen in the Figure 6.



Note: the black arrow indicates the direction of the cross-section; the black line in the plot area is indicating site area.

Figure 6. Allot190PSF OF Manurewa topography.

1.3 Historic Shoreline Change

A desktop assessment of aerial imagery suggests a low energy environment, with heavy vegetation growth observed around the Site. An analysis of historical aerial imagery from AC Geomaps and Retrolens[3] (1972 - 2016) reveals shoreline changes as can be seen in Figure 7.

Most of the shoreline changes have been caused by the growth of mangrove forests at the toe of the cliff and other stabilising vegetation growing on the slopes. This results in the movement of the shoreline outward by 10-150 meters.

According to Roberts, R., N Carpenter and P Klinac (2020), the cliff toe erosion for the area of Manukau Harbour is estimated at 10 – 15 meters per century (0.12m/yr) as shown in Figure 8.

This estimsate is not in line with the observations made from historical aerial immagery and does not take into the account the vegetation and the coastal setting of the Site.

Based on the historical aerial photos, no significant cliff toe movement/errosion was observed.

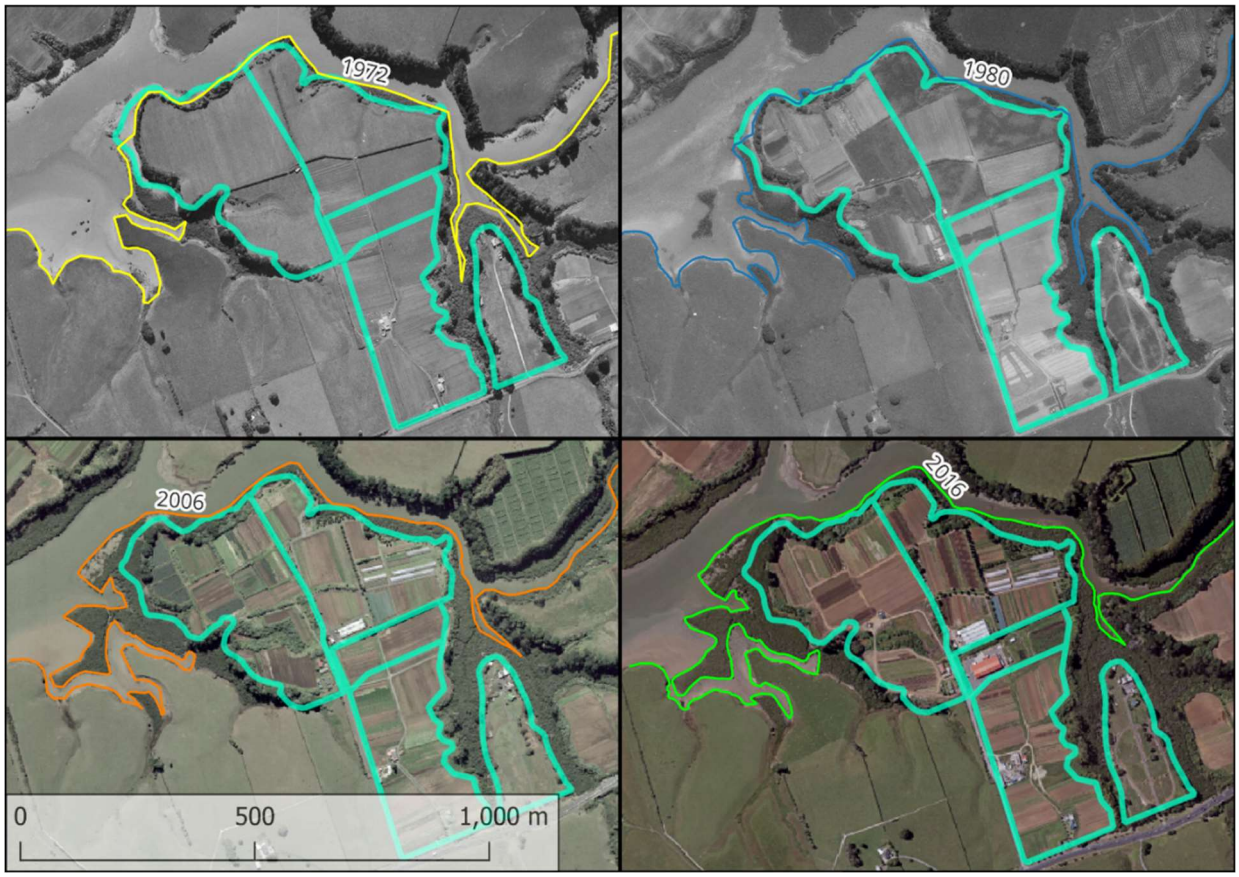


Figure 7. Historical aerial images from 1972, 1980, 2006 and 2015-2016 (AC Geomaps).

[3] Retrolens Aerial Photography, sourced from http://retrolens.nz and licensed by LINZ CC-BY 3.0.

1.3.1 Accretion calculations for the Site

West Part of the Site (Lot 3 DP 71211)

From 1972 to 2016 (44 years), the western part of Lot 3 DP 71211 has experienced significant shoreline movement due to accretion. The shoreline has moved by approximately 7 to 9 meters. In certain localised areas of the lot, accretion has been as much as 150 meters.

Rate of Movement:

- General Accretion: (7m to 9m)/44years ≈ 0.16m/year - 0.20m/year
- Localised Accretion: 150/44years ≈ 3.41m/year

Thus, general accretion for the western part of the Site would be **0.18** m/year and localised accretion of **3.41** m/year.

North-Western Border (Lot 3 DP 71211)

The north-western border of Lot 3 DP 71211 has also seen considerable accretion, with the shoreline movement between 30 to 60 meters.

Rate of Movement:

- (30m to 60m)/44years ≈ 0.68m/year - 1.36m/year

Thus, general accretion for the western part of the lot would be **1.02** m/year.

Northern Border (Lot 3 DP 71211 and Lot 2 DP 71211)

The northern border shared by Lot 3 DP 71211 and Lot 2 DP 71211 has experienced accretion of 10 to 15 meters.

Rate of Movement:

- (10m to 15m)/44years ≈ 0.23m/year - 0.34m/year

Thus, general accretion for the western part of the lot would be **0.28** m/year.

Eastern Part (Allot 190 PSH OF Manurewa, Lot 2 DP 402013, Lot 1 DP 402013, and Lot 2 DP 71211)

In the eastern part of the Site, including Allot 190 PSH OF Manurewa, Lot 2 DP 402013, Lot 1 DP 402013, and Lot 2 DP 71211, the shoreline has moved by 5 to 30 meters.

Rate of Movement:

- (5m to 30m)/44years ≈ 0.11m/year -0.68m/year

Thus, general accretion for the western part of the Site would be **0.39** m/year.

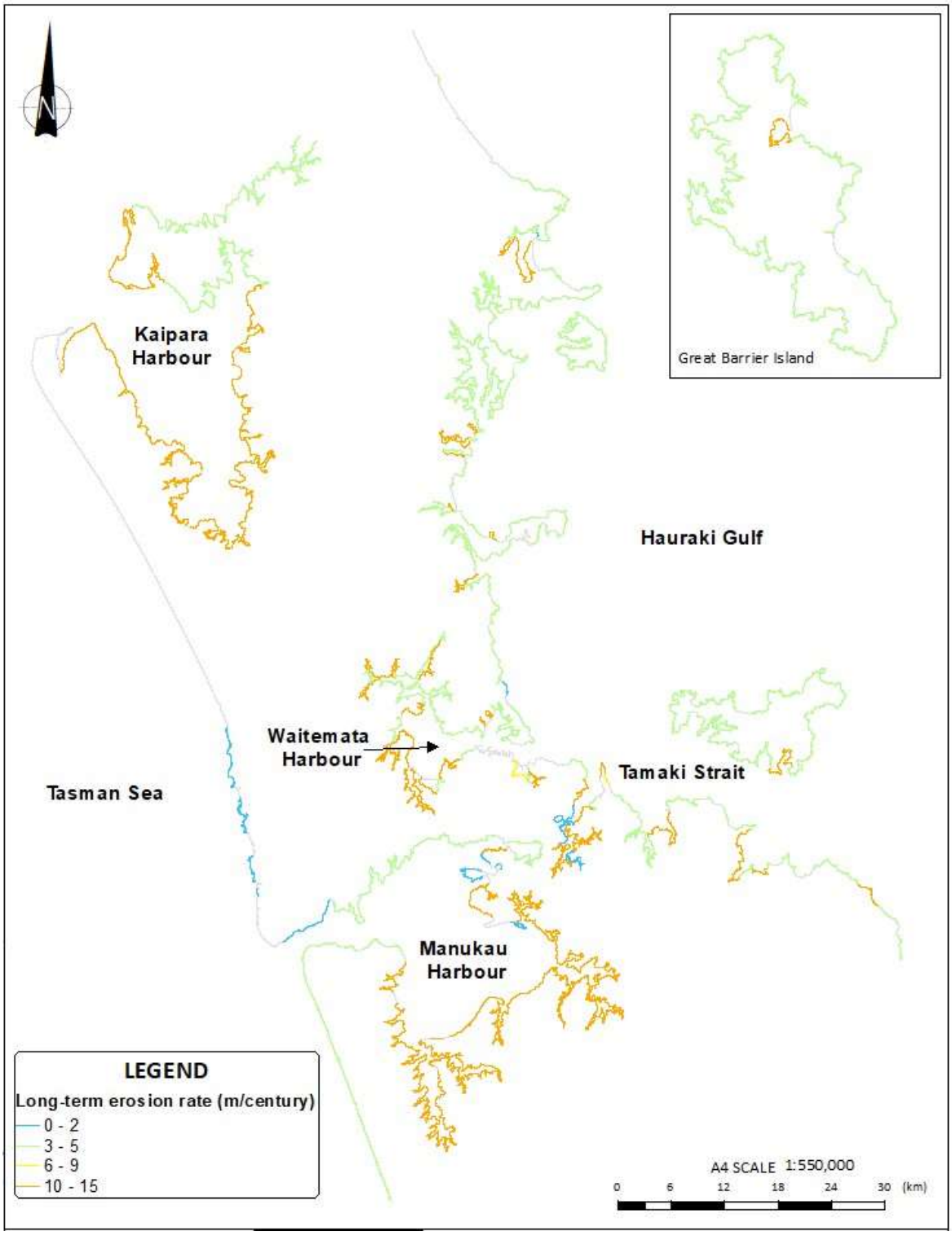


Figure 8. Long-term erosion rates (m/century) for cliffs excluding uncertainty (Roberts et al. 2020)[4]

[4] Roberts, R., N Carpenter and P Klinac (2020). Predicting Auckland's exposure to coastal instability and erosion, Auckland Council, technical report, TR2020/021 (p.204)

2 GEOMORPHIC SETTING

The Geological map GNS (Science, 2020), extract shown in Figure 9, classifies the Site area as situated at the junction between two soil formations:

- Takaanini Formation (previously referred to as Puketoka Formation) consisting of conglomerate, sandstone, ignimbrite, breccia, tephra, peat and lignite of Late Pliocene to Middle Pleistocene River deposits
- the Kerikeri Volcanic Group (part of Auckland Volcanic Field) (AVF) consisting of lithic tuff, comprising comminuted pre-volcanic materials with basaltic fragments, and unconsolidated ash and lapilli deposits.

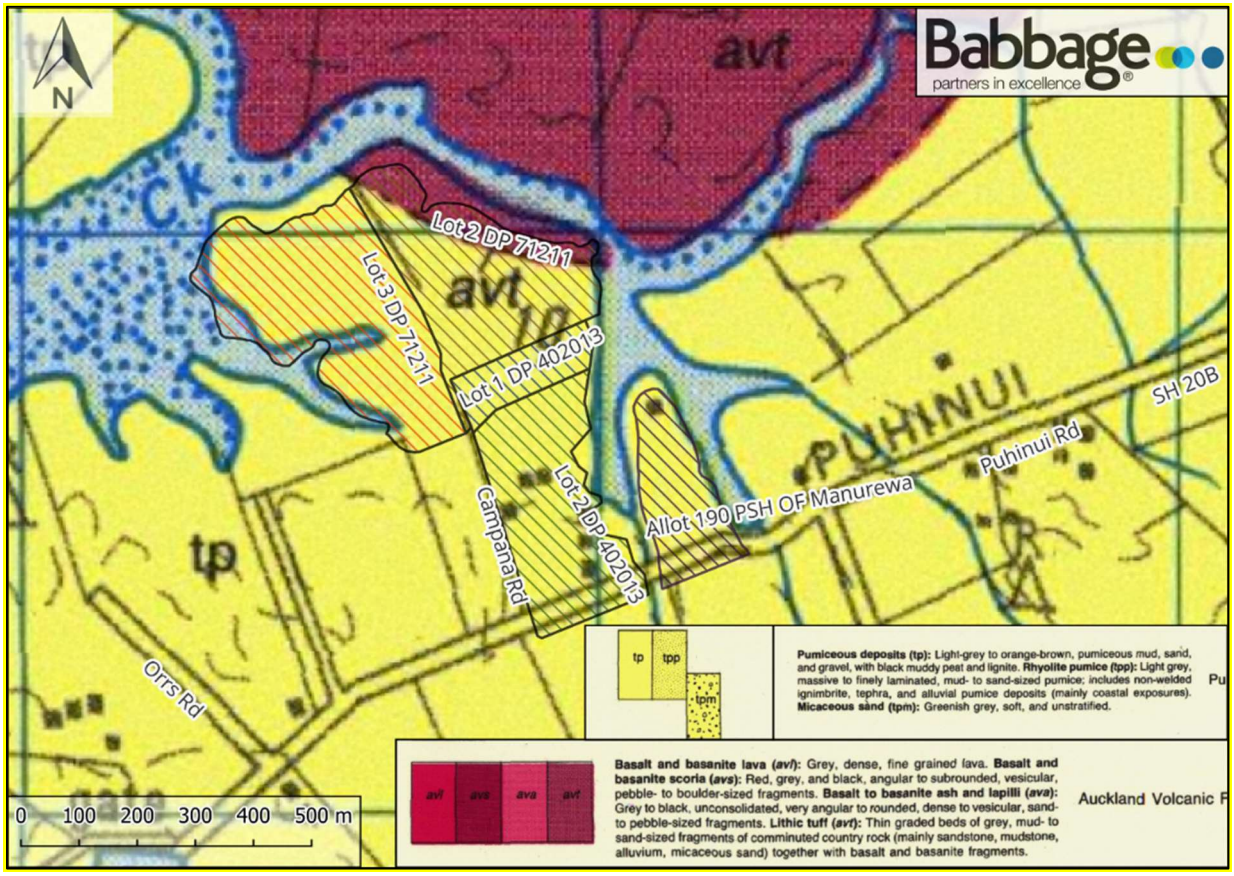


Figure 9. Local geology in the area of the area of interest. Campana road, Wiri, Auckland (GNS, 2022).

In the "Predicting Auckland's Exposure to Coastal Instability and Erosion" (TR2020/021)[5], presents a summary of adopted long-term erosion values for lithologies within the Auckland Region. As observed in

[5] Roberts et al. (2020) for Auckland Council

Table 2, retreat rates (LTR_h) for AVF range are between 2-10 meters per 100 years, or 0.02–0.1 meters per year, with the Geological Strength Index (GSI) estimated as 65±5 [6].

The value of 6 meters per 100 years as a weighted average. Based on the information available, values of 0.02 m/yr (minimum), 0.06m/yr (as best estimate) and 0.1m/yr (maximum) will be adopted for the future ASCIE calculations.

Table 2. Summary of adopted LT values per lithology of the Auckland Region (Roberts et al., 2020)

Lithology	LT (m/century) excluding uncertainty
Puketoka Formation	2 to 15
Awhitu Group	3
AVF/CVZ	2 to 10
Waitakere Group	1 to 2
ECBF	1 to 15 (typically 3-6)
Pākiri Formation	1 to 10
Northland Allochthon	4 to 10
Waipapa Group	3 to 5

Note: Extracted from Roberts et al (2020) Table 5.3. Values adopted for calculations are highlighted.

Table 3. Geological rock units Domain assignment

Domain	Sub-domain	Domain description	Spatial description
Auckland Volcanic Field (AVF) and Coromandel Volcanic Zone	N/A	Lava / lava-breccia, andesite, dacite, tuff, ash, lapilli and scoria. The lavas range from moderately strong, to very strong (20 to 250 MPa). GSI values greater than 40	

Note: Extracted from Roberts et al (2020) Table 2.3.

Table 4. Average historical long-term retreat (LTRh) values based on GSI.

GSI range	Historical LTR_H (m/100yrs)	LTR_H x F (m/100yrs)
>80	1	1.25
75 ±5	2	2.5
65 ±5	3	3.75
52.5 ±5	4	5
35 ±5	5	6.25
<20, soft cliffs	10	12.5

Note: Extracted from Roberts et al (2020) Table 1.3. Values adopted for calculations are highlighted.

[6] Marinos & Hoek, 2001, and Cai et al., 2004

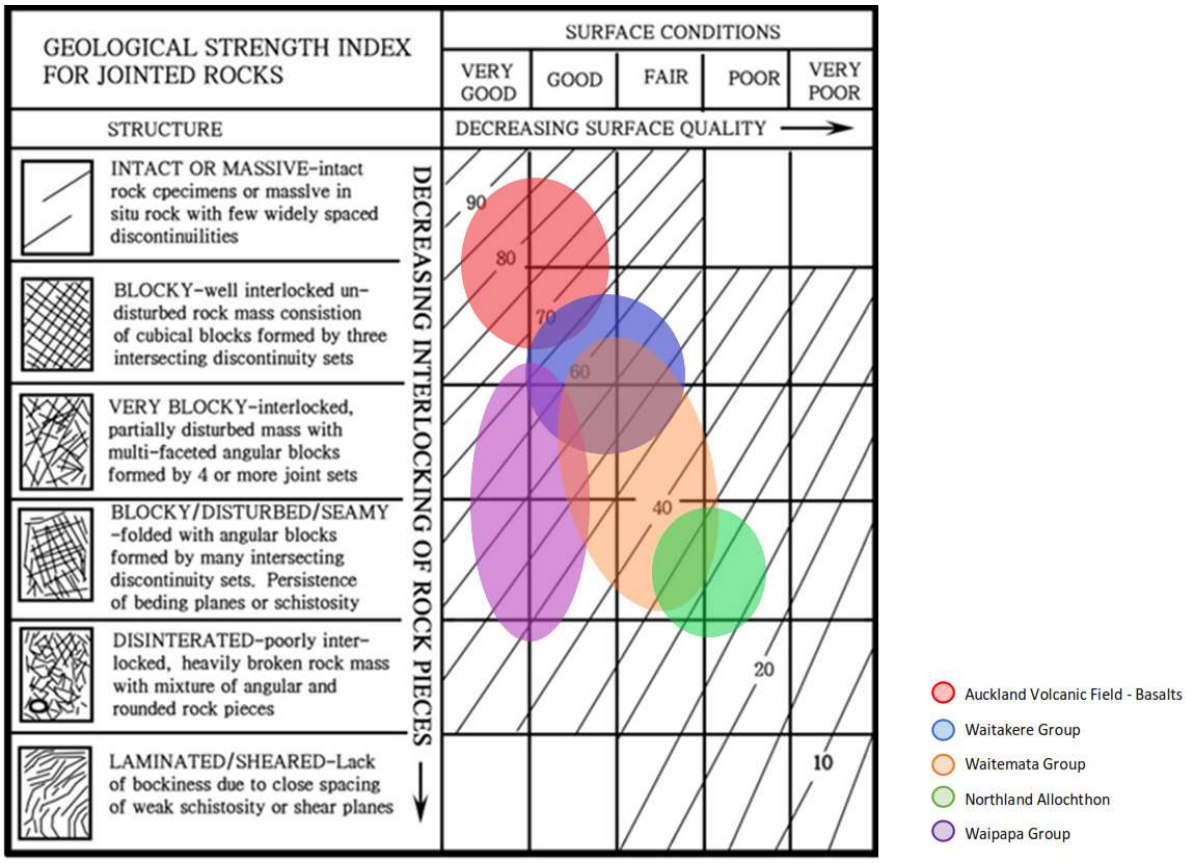


Figure 10. Geological Strength Index (GSI)[7]

Table 5. Geological strength index (GSI), slope angles for determining coastal areas susceptible to erosion.

GSI/Category	Slope angles (°)	
	Possible	Unlikely
Alluvium	26	18
Coastal Sediments	32	22
GSI: 20 ±10	32	22
GSI: 40 ±10	36	26
GSI: 60 ±10	49	36
GSI: 80 ±10	67	45

Note: Extracted from Roberts et al (2020) Table 5.8. Values adopted for calculations are highlighted.

[7] Adapted from Roberts, R., N Carpenter and P Klinac (2020). Predicting Auckland's exposure to coastal instability and erosion, Auckland Council, technical report, TR2020/021 (p.221)

3 COSTAL PROCESSES

3.1 Tides

The astronomical tidal range (lowest astronomical tide (LAT) to highest astronomical tide (HAT)) in the Auckland Harbour is approximately 3.6 m. The mean spring and neap tidal range are presented in Table 6. Port of Auckland astronomical tidal range (source LINZ, Standard Port Tidal Levels)

Table 6. Port of Auckland astronomical tidal range (source LINZ, Standard Port Tidal Levels)

	MHWS	MHWN	MLWN	MLWS	MSL
To CD (chart datum)	3.3	2.8	1.1	0.5	1.9
To MSL (mean sea level)	1.4	0.9	-0.8	-1.4	0.0

Note: these are astronomical, or predicted tides; several metocean factors such as wind speed and direction, wave height, period and direction, barometric pressure, etc., influence the actual tidal level at a site at any one time.

Linear interpolation was used to interpolate tide levels to all vertices along the guiding coastline using the known levels for points that were nearest to tide output locations. Near the site of interest, the tidal elevation was interpolated from Figure 11 and estimated to be between 2.01-2.05 m RL (AVD-46). Therefore, for the purpose of this assessment, a MHWSC of 2.03 m RL (AVD-46) is adapted as the MHWS for the Site.

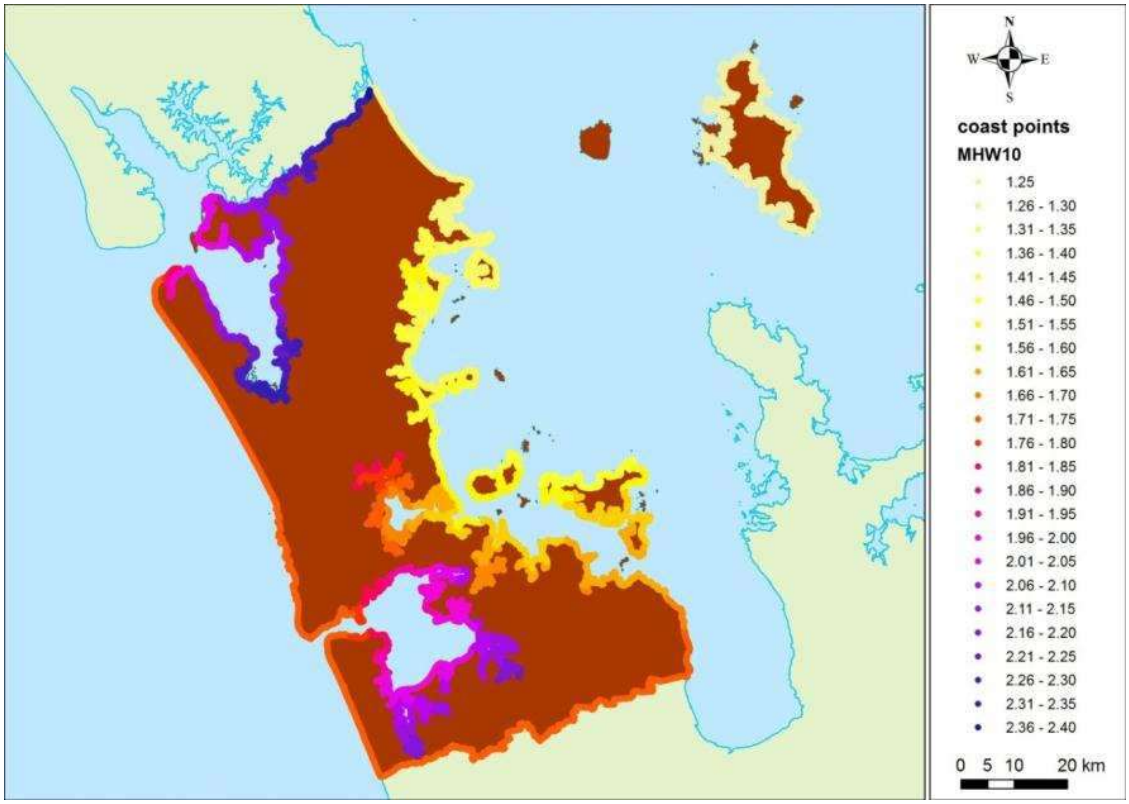


Figure 11. MHWS-10 tide elevation interpolated onto vertices along the guiding coastline. [8]

[8] Stephens & Wadhwa (2012)

3.2 Storm Tides

Storm tide is a combination of components that represent a major portion of extreme water levels. It is defined as the sea-level peak reached during a storm event, resulting from a combination of the monthly mean sea-level anomaly, tide level (usually Mean High Water Springs, MHWS), and storm surge.
NIWA (2013; TR2016/07) undertook a comprehensive study to predict storm tide levels for the Auckland Region, including the Site.
Mean sea-level offsets to AVD-46 for Manukau Harbour is +0.22 m.
The 1 in 100-year return period storm tide at site #47 was determined to be 2.92 meters (relative to AVD-46), including a +0.22 meter offset for baseline mean sea level (present-day estimate) Table 7 and Figure 13.

Table 7. Extreme sea-level in the Manukau Harbour.[9]

Site	Easting (NZTM)	AEP:	0.39	0.18	0.1	0.05	0.02	0.01	0.005
		ARI: Northing (NZTM)	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr	200 yr
47	1761037	5903271	2.55	2.61	2.66	2.72	2.83	2.92	3.02

Note: Elevations are relative to AVD-46 including +0.22 m offset for baseline mean sea level (present-day estimate). Elevations calculated from simulated data.

3.3 Sea Level Rise

Sea level rise projections are crucial for planning projects that consider future hazards.
The NZ SeaRise program offers various scenarios for this purpose. For long-term planning with adaptation strategies, such as land-use changes or redevelopment, a dynamic adaptive pathways planning approach is recommended. This approach utilizes a range of "medium confidence" sea level rise scenarios, including Vertical Land Movement (VLM) data, extending out to the year 2130.
However, for situations requiring immediate decisions and prioritizing risk avoidance, a more conservative approach is advisable. In such cases, the "medium confidence" scenario with a higher projection, like the SSP5-8.5 H+ (83rd percentile of SSP5-8.5 or p83) out to 2130, should be used.

The location closest to the site has a VLM rate of -2.6 mm/year, Figure 12; which is adopted as the VLM rate for the Site. Historical sea level rise (s_h) is estimated as 1.7 ± 0.1 mm/year (Hanna & Bell, 2012) and will be used in our ASCIE calculations. To determine the future sea level rise (s_f), the value from RCP8.5H+ was adopted, Figure 13.

[9] Stephens, S., Wadhwa, S and Tuckey, B (2016). Coastal inundation by storm-tides and waves in the Auckland region. Prepared by the National Institute for Water and Atmospheric Research, NIWA and DHI Ltd for Auckland Council. Auckland Council technical report, TR2016/017

Figure 12. Vertical Land Movement rate -2.6 mm/year near the site.

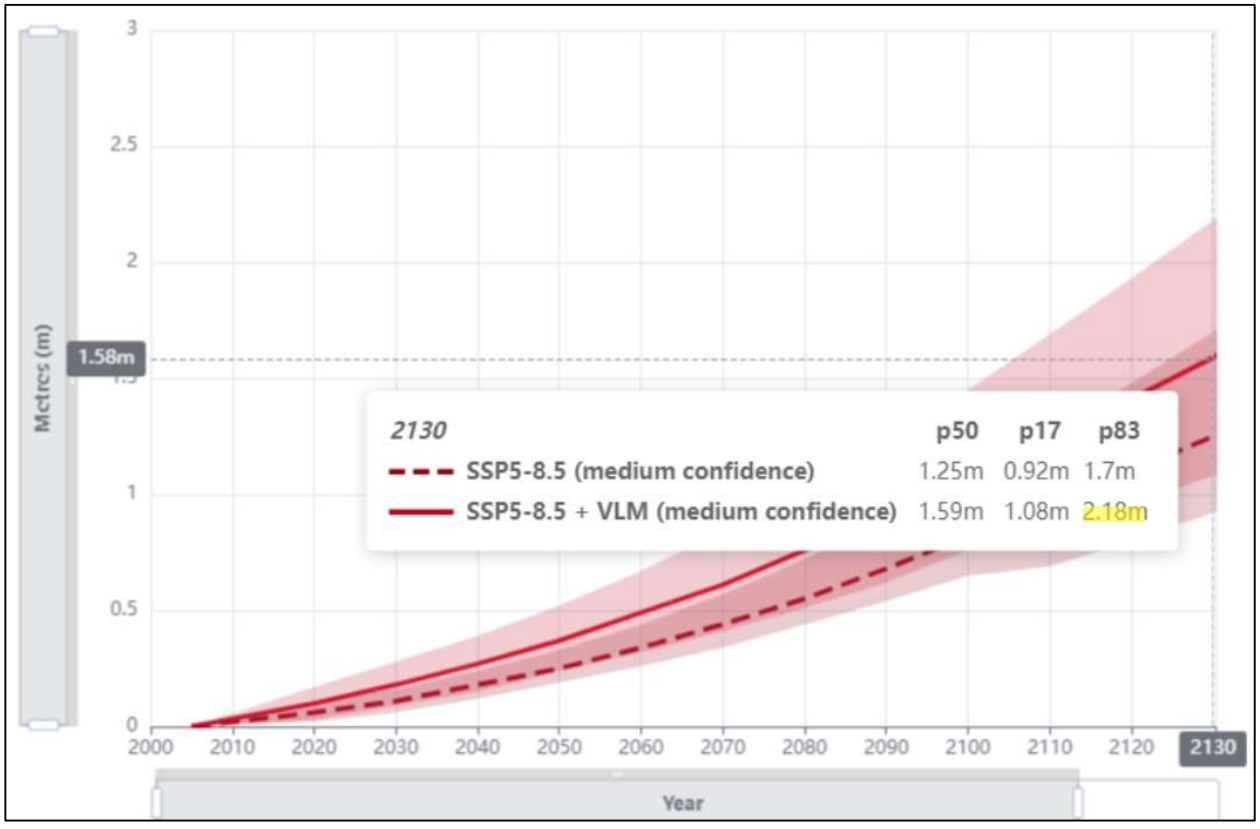


Figure 13. Sea level rise projection to 2130 (SSP-8.5 H)

3.4 Wave Set-up

The SSP5-8.5 (medium confidence) SLR + VLM (p83) projection to the 2130 planning horizon is 2.18 meters, combined with 1 in 100/yr storm tide prediction of 2.92 m (Table 7), we can assume a maximum inundation potential of 5.1 m for the Site Figure 14. The inundation level considering a 1 in 100-year return period storm tide at the Site for the present day and for a 1 m and 2 m sea level rise (SLR) projection can be seen in the AC Geomaps coastal inundation map (Figure 15).

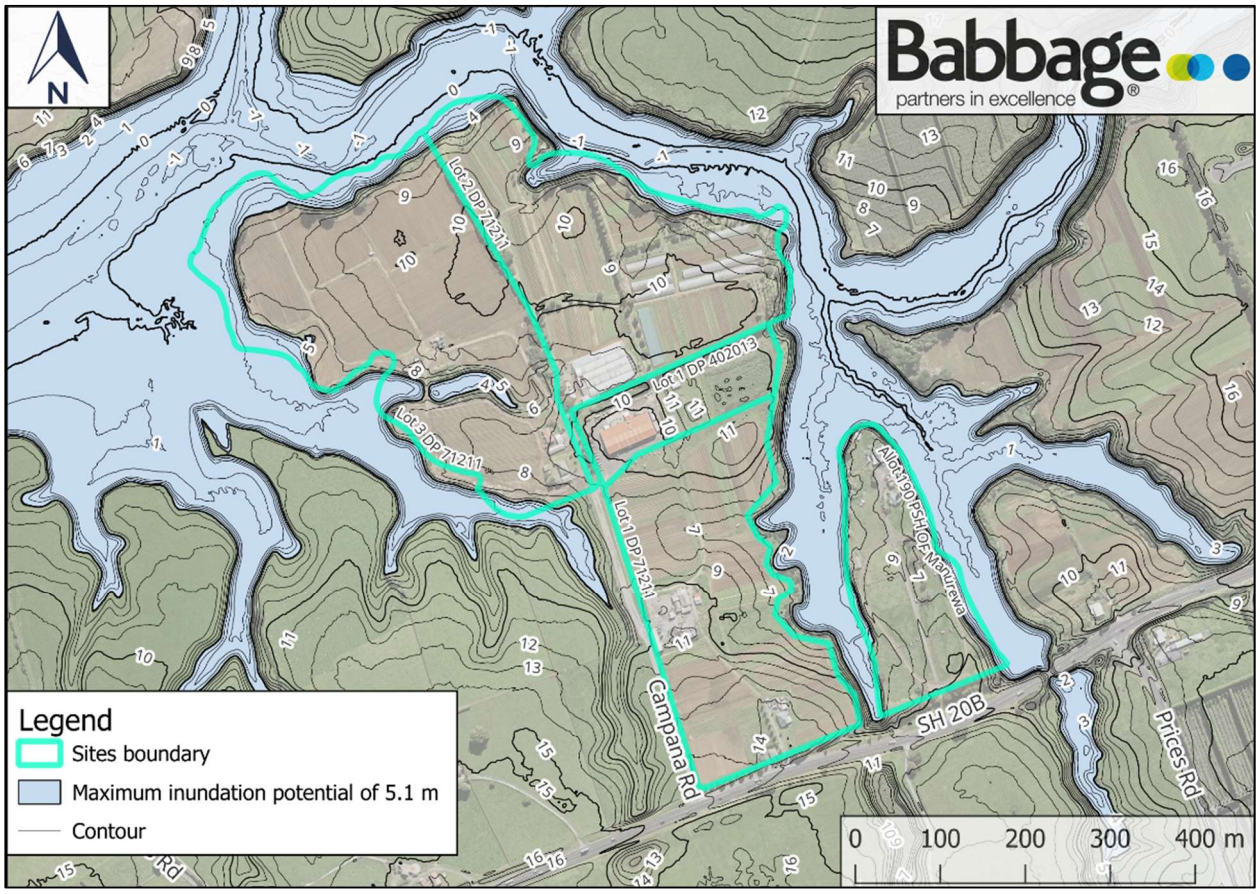


Figure 14. Maximum Inundation Potential of 5.1 meters

Figure 15. AC Geomaps Plan illustrating the Coastal Inundation (1% AEP) and (ARI) .

4 FUTURE ASCIE CALCULATIONS

The Areas Susceptible to Coastal Instability and Erosion (ASCIE) lines identified in (Auckland Council Geomaps) Figure 16 indicate a potential for coastal instability and erosion hazards affecting most lots on the Site. Future erosion predictions for the 2130 RCP8.5+ scenario suggests ~20 m of land loss (approximately measured back from current slope crests). Values from Geotechnical Investigation by Babbage Consultants[10] and the values relevant to the local geology were adopted and used for the further calculation of the Site specific ASCIE.

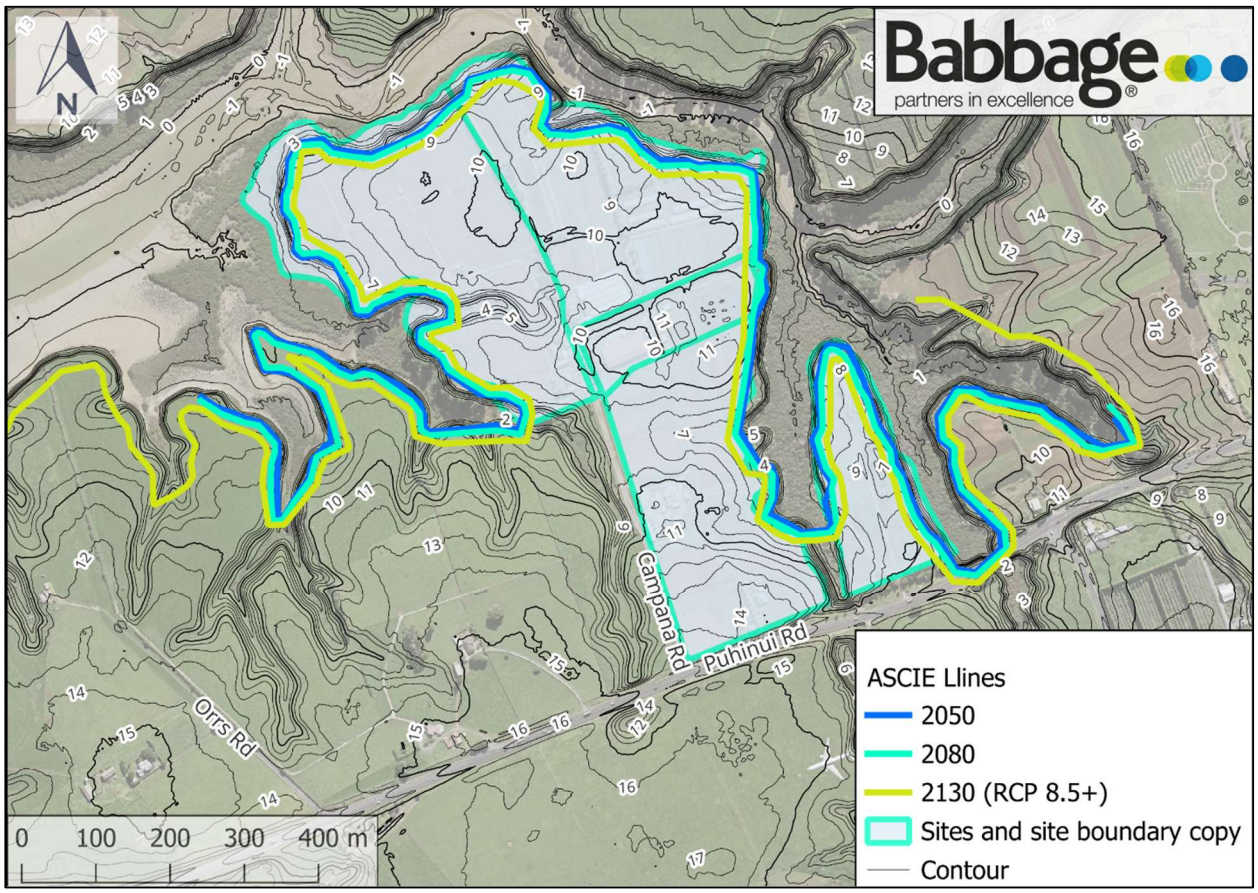


Figure 16. AC Geomaps (adapted) ASCIE indication lines

For the Site, no erosion has been observed, though shoreline accretion of 0.18 m/yr to 3.41 m/yr was estimated by georeferencing historical images Figure 7.

The minimum adopted consolidated shoreline response factor to SLR for Auckland geological units for AVF/CVZ lithology, the rate of **0.01** m/yr (m -value) was adopted and applied to the future ASCIE calculations (Roberts et al., 2020). Values for the cliff (hc) elevation were extrapolated from the Digital

[10] Babbage 2024. 11 Campana Road, Wiri, Auckland Geotechnical Assessment Report. A report prepared for Campana Landowners Consortium c/ Capstone Projects Limited by Babbage Consultants Limited. July 2024.

Elevation Model (DEM)[11] for the calculation of ASCIE and are considered as 5 m.

For calculating of AVF/CVZ averages, values from (Roberts, R., (2020)) were adopted and can be found in Table 8. The future ASCIE cliff retreat calculations for Site are presented in Appendix A. Based on the values extrapolated from local DEM, the elevation (hc) of the soil layer was estimated as 5 m. The range of 15°, 30°, 45° were assumed as the most common cliff slopes degrees(α_s) around the Site. To provide a range for the cliff erosion, the weighted average (best estimate), minimum and maximum values were used in calculating future ASCIE. The results can be found in Appendix A.

Table 8. Analysed slope profile (rock, soil and combined) for each lithology.

Geotechnical Domain	Rock (°)				Soil (°)					Composite (°)			
	Mean height (m)	50%	10%	1%	Mean height (m)	50%	10%	1%	Rock/Soil ratio	Mean height (m)	50%	10%	1%
Tauranga Group / Puketoka Formation					15	48	34	31		13	48	34	31
Awhitu Group	50	39	35	31	15	21	18	15	77%	53	38	33	30
Auckland Volcanic Field / Coromandel sub-group (East)	30	42	26	15	18	36	22	15	63%	37	42	24	15
Waitakere / Volcanic (West)	68	66	40	29	47	52	33	26	59%	48	63	38	28
Waitemata - ECBF	20	51	27	23	7	26	14	11	74%	24	48	27	24
Waitemata - Pakiri Formation	28	54	28	25	16	40	36	25	64%	29	54	28	25
Northland Allochthon	7	26	14	9	-	-	-	-		-	26	14	9
Waipapa Group	19	42	30	16	10	25	16	13	67%	20	42	31	16

Note: Extracted from Roberts et al (2020) Table 5.6. Values adopted for calculations are highlighted.

Based on the historical aerial photography shoreline change investigation, the average accretion rate in the site area ranges between 0.18 m/year and 3.41 m/year. Observations of accretion, combined with the insignificant cliff slope erosion rates concluded from historical aerial photography between 1972 and 2016, suggest that the future ASCIE values provided by Auckland City Council and calculated for the area are very conservative for the site.

In summary, based on the above calculations and the information provided by the Auckland City Council, the percentages of the area affected by cliff erosion (not considering stabilizing effects from vegetation and coastal setting of the Site) are mentioned in the summary.

[11] Toitū Te Whenua Land Information New Zealand. (2018). *Auckland North LiDAR 1m DEM (2016-2018)* [Data set]. Retrieved from https://data.linz.govt.nz/layer/106410-auckland-north-lidar-1m-dem-2016-2018/

5 CONCLUSION AND RECOMMENDATIONS

Based on the Coastal Hazard and Erosion Assessment for Campana Road, the best estimate of future ASCIE relative to the 5 meter cliff slope elevation, is 15-32 meters (site specific) and 33-50 meters (based on AVF/CVZ lithology information).

Table 9. Summary of lot areas within coastal cliff by slope bands.

Lot Name	Lot area	5-10°	10-15°	15-20°	20-25°	25-30°	30-35°	35-40°
LOT2 DP 402013	**71,626**	1,363 (3%)	50 (3%)	52 (3%)	28 (3%)	0 (0%)	0 (0%)	0 (0%)
LOT2 DP 71211	**80,892**	2,778 (7%)	2,369 (2%)	2,652 (0%)	2,664 (0%)	321 (0%)	3 (0%)	0 (0%)
LOT1 DP 402013	**19,998**	1,343 (9%)	329 (5%)	1 (4%)	0 (2%)	0 (1%)	0 (0%)	0 (0%)
LOT3 DP 71211	**106,749**	9,658 (48%)	5,479 (27%)	4,622 (26%)	2,290 (21%)	1,002 (9%)	187 (1%)	11 (0%)
Allot 190 PSH	**35,785**	17,054 (0%)	9,500 (0%)	9,214 (0%)	7,404 (0%)	3,116 (0%)	348 (0%)	11 (0%)

Note: the table shows the size of the area per lot in relation to slope degrees and the percentage of the property affected. All of the values are in m^2 unless mentioned otherwise.

Table 10. Calculated ASCIE averages based on the site specific slope degrees.

Slope (degrees)	Future ASCIE (m)	Average ASCIE (m)
5-10	65 - 37	51
10-15	37 - 27	32
15-20	27 - 22	24
20-25	22 - 19	20
25-30	19 - 17	18
30-35	17 - 15	16
35-40	15 - 14	15

Table 11. Results summary

Lot name	Lot area (m^2)	unaffected by ASCIE (m^2)	affected by ASCIE (m^2)
LOT2 DP 402013	71,626	58,488 (82%)	13,138 (18%)
LOT2 DP 71211	80,892	59,917 (74%)	20,975 (26%)
LOT1 DP 402013	19,998	19,229 (96%)	769 (4%)
LOT3 DP 71211	106,749	70,282 (66%)	36,467 (34%)
Allot 190 PSH OF Manurewa	35,785	15,891 (44%)	19,894 (56%)

Notes: this table shows the area of each lot and the percentage of areas within ASCIE.

The sections of interest are:

For each lot, the areas affected by different slope degrees (e.g., 5–10°, 10–15°) were taken from the calculated data in square meters.

Each slope degree range has a corresponding ASCIE value (e.g., 65 for 5–10°, 37 for 10–15°, etc.).

The area of each slope degree is multiplied by its corresponding ASCIE value. These products are then summed across all slope degrees for the lot.

$$\text{Weighted Sum} = (\text{Area}_1 \times \text{ASCIE}_1) + (\text{Area}_2 \times \text{ASCIE}_2) + \dots$$

The weighted sum is divided by the total affected area of the lot to get the weighted average ASCIE.

$$\text{Weighted Average ASCIE} = \frac{\text{Weighted Sum}}{\text{Total Affected Area}}$$

Table 12. Weighted average ASCIE for each lot

Lot Name	Average ASCIE	Proposed buffer from MHWS (5m)
LOT2 DP 402013	49	30
LOT2 DP 71211	32	30
LOT1 DP 402013	47	30
LOT3 DP 71211	36	30
Allot 190 PSH Manurewa	35	30

Notes: values are in m.

Rationale for Proposed Buffers:

- LOT2 DP 71211, LOT3 DP 71211 and Allot 190 PSH Manurewa: A 30 m buffer is recommended, despite calculated average ASCIE values of 35 m, 47 m and 49 m. These values are derived from highly conservative CEHA calculations, which do not account for the stabilizing effects of vegetation, observed historical accretion, or the low-energy coastal environment. The proposed buffer effectively balances risk mitigation with minimal impact on development potential.
- LOT2 DP 402013, LOT1 DP 402013: A 30 m buffer is also recommended, reflecting the sheltered positioning of these lots, historical evidence of accretion, and their reduced susceptibility to slope-related risks.

The recommended buffers are based on the weighted average ASCIE and historical observations of coastal accretion rather than erosion. These recommendations aim to provide sustainable development setbacks while accounting for site-specific risks. It must be noted that most of the area susceptible to coastal erosion and inundation at the site are areas of the respective lots that are below the coastal cliff. Furthermore, these calculations are highly conservative, as they do not consider the historical accretion rate (determined from historical aerial imagery), the low-energy environment due to the coastal setting deeper into the harbour, and the presence of established stabilizing vegetation on and below the cliff slope.

For the 2130 planning horizon, under the SSP5-8.5+ (medium confidence) SLR + VLM (p83) projection, a sea level rise of 2.18 meters is anticipated. Combined with a predicted storm tide of 2.92 meters, this

results in a maximum inundation potential of 5.1 meters. However, given that the cliff crest elevation is 5 meters, the potential inundation does not pose a high risk to the site.

The 20 meters Open Space setback zone (from the CMA) was proposed to account for the effects of the ASCIE 8.5+ prior the CHEA. Based on the calculations above, a 30 m setback will be sufficient to mitigate the predicted effects of ASCIE8.5+ as shown in Figure 17.

Provided that set-back of at least 30 m from MHWS of 3 meters is maintained (or from the CMA), the policies as set out in E36 (Natural Hazards and Flooding), E38 (subdivision-urban), and 106 of the RMA (1991) (Subdivision Consents) are considered to be satisfied. Consequently, the coastal inundation and erosion hazards are likely to have little to no impact to future buildings over a planning horizon to the year 2130 (as per MfE, 2022 [12]).

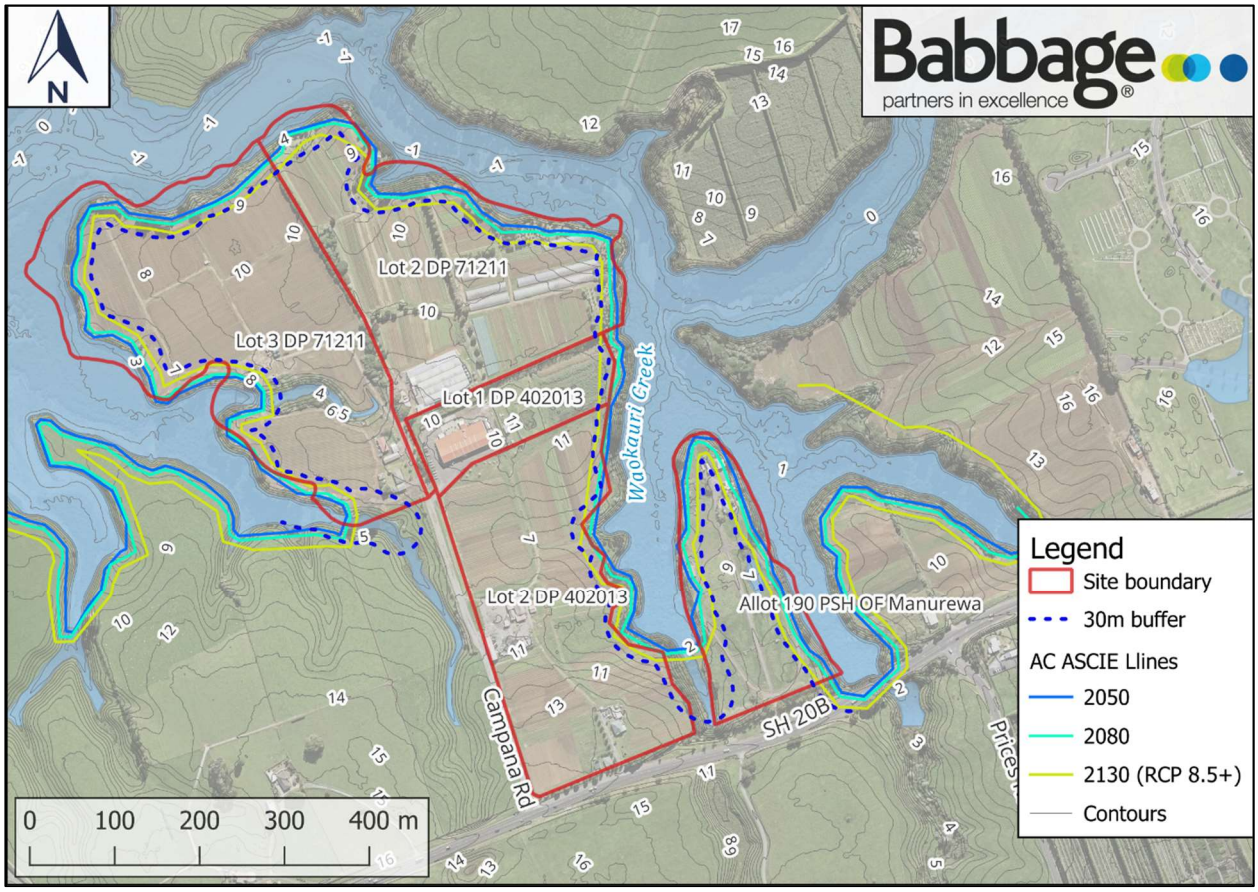


Figure 17. Setback boarder to mitigate the effects of the ASCIE 2130 compared to AC ASCIE 2130.

[12] Ministry for the Environment (MfE). (2022). Interim guidance on the use of new sea-level rise projections. Compiled by R.G. Bell with input and reviews by J. Lawrence, T. Naish, R. Levy and, S. Allan and reviewed by the Ministry for the Environment and a few local government practitioners.

References

Books

1. Stephens, S., & Wadhwa, S. (2012). Development of an updated Coastal Marine Area boundary for the Auckland Region. National Institute of Water & Atmospheric Research Ltd (HAM2012-111). Hamilton, New Zealand.
2. Stephens, S., Wadhwa, S and Tuckey, B (2016). Coastal inundation by storm-tides and waves in the Auckland region. Prepared by the National Institute for Water and Atmospheric Research, NIWA and DHI Ltd for Auckland Council. Auckland Council technical report, TR2016/017
3. Roberts, R., N Carpenter and P Klinac (2020). Predicting Auckland's exposure to coastal instability and erosion, Auckland Council, technical report, TR2020/021
4. Riley. (2015, February 2). Geotechnical Investigation Proposed Residential Development 259 Beach Road, Campbells Bay. 01281/1-A. Unpublished report prepared for Mr Felton, PO Box 653, Orewa, Auckland 0946.

Websites

1. www.searise.takiwa.co
2. www.geomapspublic.aucklandcouncil.govt.nz
3. https://www.linz.govt.nz/guidance/marine-information/tide-prediction-guidance/standard-port-tidal-levels

APPLICABILITY AND LIMITATIONS

Restrictions of Intended Purpose

This report has been prepared solely for the benefit of Campana Landowners Consortium c/ Capstone Projects as our client with respect to the brief. The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such party's sole risk.

Legal Interpretation

Opinions and judgements expressed herein are based on our understanding and interpretation of current regulatory standards, and should not be construed as legal opinions. Where opinions or judgements are to be relied on they should be independently verified with appropriate legal advice.

Maps and Images

All maps, plans, and figures included in this report are indicative only and are not to be used or interpreted as engineering drafts. Do not scale any of the maps, plans or figures in this report. Any information shown here on maps, plans and figures should be independently verified on site before taking any action. Sources for map and plan compositions include LINZ Data and Map Services and local council GIS services. For further details regarding any maps, plans or figures in this report, please contact Babbage Consultants Limited.

Reliability of Investigation

Babbage has performed the services for this project in accordance with the standard agreement for consulting services and current professional standards for environmental site assessment. No guarantees are either expressed or implied.

Recommendations and opinions in this report are based on discrete sampling data. The nature and continuity of matrix sampled away from the sampling points are inferred and it must be appreciated that actual conditions could vary from the assumed model.

There is no investigation that is thorough enough to preclude the presence of materials at the site that presently, or in the future, may be considered hazardous. Because regulatory evaluation criteria are constantly changing, concentrations of contaminants present and considered to be acceptable may in the future become subject to different regulatory standards, which cause them to become unacceptable and require further remediation for this site to be suitable for the existing or proposed land use activities.

Appendix A
Calculation Sheets

Area Susceptable to Coastal Instability and Erosion

Babbage Consultants Limited
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PO Box 2027, Shortland Street
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Project No:	67471		
Project:	Campana Road, Plan Change		
Calc:	SE	**Date:**	11/11/2024
Check:		**Date:**	

Details: Calculation based on the Local geology (composite) and the typical slope angles and cliff heights. Values are used for calculation of Future ASCIE for LOT2 DP 402013; LOT2 DP 71211; LOT1 DP 402013; LOT3 DP

The areas susceptable to coastal instability and erison has been calculated as per Auckland Council Technical Report 2020/021.

Values used for the calculation of Future ASCIE for Campana Road, Wiri, Auckland.

Approximate Existing Cliff Profile

						Existing	"Typical slope" based on local Geology
Cliff height	m	37	Cliff face rock slope **(αr):**	°		42	42
Cliff face rock height **(hcr):**	m	37	Cliff face soil slope **(αs):**	°		0	36
Cligg face soil height **(hcs):**	m	0	Cliff face rock slope **(αr):**	rad		0.73	0.73
Years **(T)**		106	Cliff face soil slope **(αs):**	rad		0.00	0.63
Typical Height	m	37					

Toe Erosion

Geological Unit	AVF		
Exposure (environment energy)	Low		
Long-term historical retreat **LTRH**	0.060	m/yr	average of min and max *(Robert,R.,(2020)) Apendix D cp 1.1 Tbl 1.3*
Geological Stability Index **GSI**	70	-	*(Robert,R.,(2020)) Apendix D cp 5.2*
Consolidated response factor **(m)**	0.1	-	Based on Table 5.6 for Auckland geological units and exposures
Historic toe erosion	0.18-1.02	m/yr	Based on review of public information (e.g, aerial photographs, site records, property file information).
Historic sea level rise **(sh)**	0.0017	m/yr	*(Robert,R.,(2020)) cp 2.7.3*
Theoretical sea level rise **(sf)**	0.0206	m/yr	*((RCP8.5H+)) / T) equastion 5.3*
Theoretical toe erosion **(LTf)**	0.077	m/yr	*(Robert,R.,(2020)) cp 5.5.2 Eq.5.3*
Theor. SLR **(RCP8.5H+VLM)**	2.18	m	www.searise.takiwa.co (year 2130)

Future ASCIE

Cliff Toe Erosion	**8.2**	m	*Cliff Toe Erosion = LTF*T*
Current ASCIE (from existing toe)	**41.09**	m	*Current ASCIE = $(h_{Cr}/\tan\alpha_r) + (h_{Cs}/\tan\alpha_s)$* (Equation 4.3)
Future ASCIE (from existing toe)	**49.3**	m	*Future ASCIE = $(LT_F \times T) + (h_{Cr}/\tan\alpha_r) + (h_{Cs}/\tan\alpha_s)$* (Equation 4.4)
Future ASCIE	**0.46**		

A sketch summarising the definition of the ASCIE for cliffs and beaches is given in Figure 4 and Figure 5.

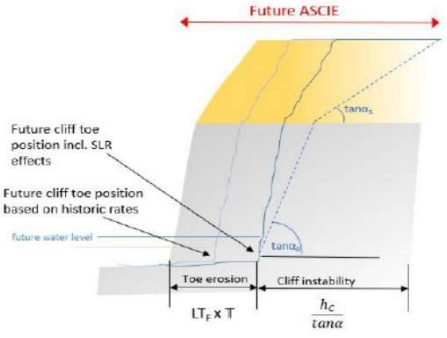

Figure 4: Definition sketch for Areas Susceptible to Coastal Instability and/or Erosion on consolidated (cliff) shoreline.
Soil is shown in yellow, with rock below in grey.

Area Susceptable to Coastal Instability and Erosion

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Project No:	67471		
Project:	Campana Road, Plan Change		
Calc:	SE	**Date:**	11/11/2024
Check:		**Date:**	

Details: Calculation based on the Local geology (soil) and the typical slope angles and cliff heights.
Values are used for calculation of Future ASCIE for LOT2 DP 402013; LOT2 DP 71211; LOT1 DP 402013; LOT3 DP

The areas susceptable to coastal instability and erison has been calculated as per Auckland Council Technical Report 2020/021.

Values used for the calculation of Future ASCIE for Campana Road, Wiri, Auckland.

Approximate Existing Cliff Profile

					Existing	"Typical slope" based on local Geology
Cliff height	m	18	Cliff face rock slope **(αr):**	°	36	42
Cliff face rock height **(hcr):**	m	18	Cliff face soil slope **(αs):**	°	0	36
Cligg face soil height **(hcs):**	m	0	Cliff face rock slope **(αr):**	rad	0.63	0.73
Years **(T)**		106	Cliff face soil slope **(αs):**	rad	0.00	0.63
Typical Height	m	37				

Toe Erosion

Geological Unit	AVF		
Exposure (environment energy)	Low		
Long-term historical retreat **LTRh**	0.060	m/yr	average of min and max *(Robert,R.,(2020)) Apendix D cp 1.1 Tbl 1.3*
Geological Stability Index **GSI**	70	-	*(Robert,R.,(2020)) Apendix D cp 5.2*
Consolidated response factor **(m)**	0.1	-	Based on Table 5.6 for Auckland geological units and exposures
Historic toe erosion	0.18-1.02	m/yr	Based on review of public information (e.g, aerial photographs, site records, property file information).
Historic sea level rise **(sh)**	0.0017	m/yr	*(Robert,R.,(2020)) cp 2.7.3*
Theoretical sea level rise **(sf)**	0.0206	m/yr	*((RCP8.5H+)) + T)*
Theoretical toe erosion **(LTf)**	0.077	m/yr	*(Robert,R.,(2020)) cp 5.5.2 Eq.5.3*
Theor. SLR **(RCP8.5H+)**	2.18	m	www.searise.takiwa.co (year 2130)

Future ASCIE

Cliff Toe Erosion	**8.2**	m	*Cliff Toe Erosion = LTF*T*
Current ASCIE (from existing toe)	**24.77**	m	*Current ASCIE = $(h_{Cr}/\tan\alpha_r) + (h_{Cs}/\tan\alpha_s)$* (Equation 4.3)
Future ASCIE (from existing toe)	**32.9**	m	*Future ASCIE = $(LT_F \times T) + (h_{Cr}/\tan\alpha_r) + (h_{Cs}/\tan\alpha_s)$* (Equation 4.4)
Future ASCIE	**0.31**	m/yr	

A sketch summarising the definition of the ASCIE for cliffs and beaches is given in Figure 4 and Figure 5.

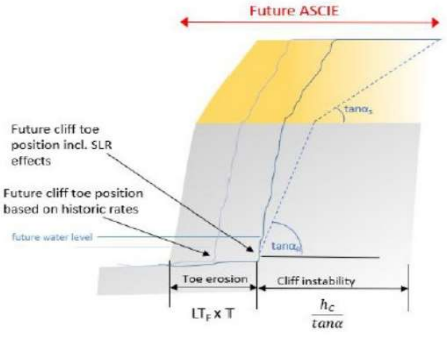

Figure 4: Definition sketch for Areas Susceptible to Coastal Instability and/or Erosion on consolidated (cliff) shoreline.
Soil is shown in yellow, with rock below in grey.

Area Susceptable to Coastal Instability and Erosion

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Project No:	67471		
Project:	Campana Road, Plan Change		
Calc:	SE	**Date:**	11/11/2024
Check:		**Date:**	

Details: Calculation based on the Site specific geology ,the typical slope angles and cliff heights.
Values are used for calculation of Future ASCIE for LOT2 DP 402013; LOT2 DP 71211; LOT1 DP 402013; LOT3 DP

The areas susceptable to coastal instability and erison has been calculated as per Auckland Council Technical Report 2020/021.

Values used for the calculation of Future ASCIE for Campana Road, Wiri, Auckland.

Approximate Existing Cliff Profile

						Existing	"Typical slope" based on local Geology
Cliff height	m	5	Cliff face rock slope **(αr):**	°	45	42
Cliff face rock height **(hcr):**	m	5	Cliff face soil slope **(αs):**	°		36
Cligg face soil height **(hcs):**	m	0	Cliff face rock slope **(αr):**	rad	0.79	0.73
Years **(T)**		106	Cliff face soil slope **(αs):**	rad	0.00	0.63
Typical Height	m	37				

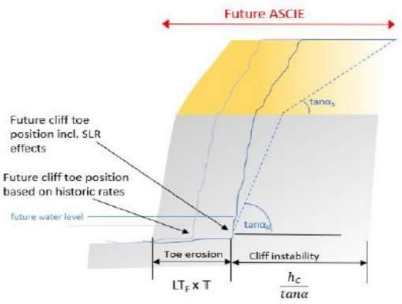
Toe Erosion

Geological Unit	AVF			
Exposure (environment energy)	Low			
Long-term historical retreat **LTRH**	0.060	m/yr	average of min and max	*(Robert,R.,(2020)) Apendix D cp 1.1 Tbl 1.3*
Geological Stability Index **GSI**	70	-	*(Robert,R.,(2020)) Apendix D cp 5.2*	
Consolidated response factor **(m)**	0.1	-	Based on Table 5.6 for Auckland geological units and exposures	
Historic toe erosion	0.18-3.41	m/yr	Based on review of public information (e.g, aerial photographs, site records, property file information).	
Historic sea level rise **(sh)**	0.0017	m/yr	*(Robert,R.,(2020)) cp 2.7.3*	
Theoretical sea level rise **(sf)**	0.0206	m/yr	*((RCP8.5H+)) + T)*	
Theoretical toe erosion **(LTf)**	0.077	m/yr	*(Robert,R.,(2020)) cp 5.5.2 Eq.5.3*	
Theor. SLR **(RCP8.5H+VLM)**	2.18	m	www.searise.takiwa.co	(year 2130)

Future ASCIE

Cliff Toe Erosion	**8.2**	m	*Cliff Toe Erosion = LTF*T*	
Current ASCIE (from existing toe)	**5.00**	m	*Current ASCIE = $(h_{Cr}/\tan\alpha_r) + (h_{Cs}/\tan\alpha_s)$*	(Equation 4.3)
Future ASCIE (from existing toe)	**13.2**	m	*Future ASCIE = $(LT_F \times T) + (h_{Cr}/\tan\alpha_r) + (h_{Cs}/\tan\alpha_s)$*	(Equation 4.4)
Future ASCIE	**0.12**	m/yr		

A sketch summarising the definition of the ASCIE for cliffs and beaches is given in Figure 4 and Figure 5.



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Soil is shown in yellow, with rock below in grey.

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Details: Calculation based on the Site specific geology ,the typical slope angles and cliff heights.
Values are used for calculation of Future ASCIE for LOT2 DP 402013; LOT2 DP 71211; LOT1 DP 402013; LOT3 DP

The areas susceptable to coastal instability and erison has been calculated as per Auckland Council Technical Report 2020/021.

Values used for the calculation of Future ASCIE for Campana Road, Wiri, Auckland.

Approximate Existing Cliff Profile

						Existing	"Typical slope" based on local Geology
Cliff height	m	5	Cliff face rock slope **(αr):**	°	40	42
Cliff face rock height **(hcr):**	m	5	Cliff face soil slope **(αs):**	°		36
Cligg face soil height **(hcs):**	m	0	Cliff face rock slope **(αr):**	rad	0.70	0.73
Years **(T)**		106	Cliff face soil slope **(αs):**	rad	0.00	0.63
Typical Height	m	37				

Toe Erosion

Geological Unit	AVF			
Exposure (environment energy)	Low			
Long-term historical retreat **LTRH**	0.060	m/yr	average of min and max	*(Robert,R.,(2020)) Apendix D cp 1.1 Tbl 1.3*
Geological Stability Index **GSI**	70	-	*(Robert,R.,(2020)) Apendix D cp 5.2*	
Consolidated response factor **(m)**	0.1	-	Based on Table 5.6 for Auckland geological units and exposures	
Historic toe erosion	0.18-3.41	m/yr	Based on review of public information (e.g, aerial photographs, site records, property file information).	
Historic sea level rise **(sh)**	0.0017	m/yr	*(Robert,R.,(2020)) cp 2.7.3*	
Theoretical sea level rise **(sf)**	0.0206	m/yr	*((RCP8.5H+)) + T)*	
Theoretical toe erosion **(LTf)**	0.077	m/yr	*(Robert,R.,(2020)) cp 5.5.2 Eq.5.3*	
Theor. SLR **(RCP8.5H+VLM)**	2.18	m	www.searise.takiwa.co	(year 2130)

Future ASCIE

Cliff Toe Erosion	**8.2**	m	*Cliff Toe Erosion = LTF*T*	
Current ASCIE (from existing toe)	**5.96**	m	*Current ASCIE = $(h_c/\tan\alpha_r) + (h_c/\tan\alpha_s)$*	(Equation 4.3)
Future ASCIE (from existing toe)	**14.1**	m	*Future ASCIE = $(LT_F \times T) + (h_c/\tan\alpha_r) + (h_c/\tan\alpha_s)$*	(Equation 4.4)
Future ASCIE	**0.13**	m/yr		

A sketch summarising the definition of the ASCIE for cliffs and beaches is given in Figure 4 and Figure 5.

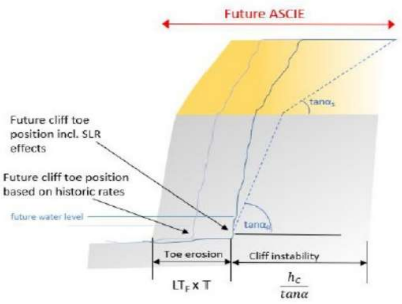

Figure 4: Definition sketch for Areas Susceptible to Coastal Instability and/or Erosion on consolidated (cliff) shoreline.
Soil is shown in yellow, with rock below in grey.

Area Susceptable to Coastal Instability and Erosion

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Project No:	67471		
Project:	Campana Road, Plan Change		
Calc:	SE	**Date:**	11/11/2024
Check:		**Date:**	

Details: Calculation based on the Site specific geology ,the typical slope angles and cliff heights.
Values are used for calculation of Future ASCIE for LOT2 DP 402013; LOT2 DP 71211; LOT1 DP 402013; LOT3 DP

The areas susceptable to coastal instability and erison has been calculated as per Auckland Council Technical Report 2020/021.

Values used for the calculation of Future ASCIE for Campana Road, Wiri, Auckland.

Approximate Existing Cliff Profile

						Existing	"Typical slope" based on local Geology
Cliff height	m	5	Cliff face rock slope **(αr):**	°	35	42
Cliff face rock height **(hcr):**	m	5	Cliff face soil slope **(αs):**	°		36
Cligg face soil height **(hcs):**	m	0	Cliff face rock slope **(αr):**	rad	0.61	0.73
Years **(T)**		106	Cliff face soil slope **(αs):**	rad	0.00	0.63
Typical Height	m	37				

Toe Erosion

Geological Unit	AVF			
Exposure (environment energy)	Low			
Long-term historical retreat **LTRH**	0.060	m/yr	average of min and max	*(Robert,R.,(2020)) Apendix D cp 1.1 Tbl 1.3*
Geological Stability Index **GSI**	70	-	*(Robert,R.,(2020)) Apendix D cp 5.2*	
Consolidated response factor **(m)**	0.1	-	Based on Table 5.6 for Auckland geological units and exposures	
Historic toe erosion	0.18-3.41	m/yr	Based on review of public information (e.g, aerial photographs, site records, property file information).	
Historic sea level rise **(sh)**	0.0017	m/yr	*(Robert,R.,(2020)) cp 2.7.3*	
Theoretical sea level rise **(sf)**	0.0206	m/yr	*((RCP8.5H+)) + T)*	
Theoretical toe erosion **(LTf)**	0.077	m/yr	*(Robert,R.,(2020)) cp 5.5.2 Eq.5.3*	
Theor. SLR **(RCP8.5H+VLM)**	2.18	m	www.searise.takiwa.co	(year 2130)

Future ASCIE

Cliff Toe Erosion	**8.2**	m	*Cliff Toe Erosion = LTF*T*	
Current ASCIE (from existing toe)	**7.14**	m	*Current ASCIE = $(h_c/\tan\alpha_r) + (h_c/\tan\alpha_s)$*	(Equation 4.3)
Future ASCIE (from existing toe)	**15.3**	m	*Future ASCIE = $(LT_F \times T) + (h_c/\tan\alpha_r) + (h_c/\tan\alpha_s)$*	(Equation 4.4)
Future ASCIE	**0.14**	m/yr		

A sketch summarising the definition of the ASCIE for cliffs and beaches is given in Figure 4 and Figure 5.

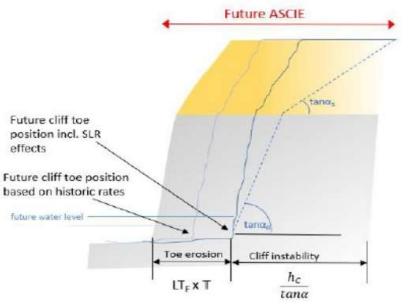

Figure 4: Definition sketch for Areas Susceptible to Coastal Instability and/or Erosion on consolidated (cliff) shoreline.
Soil is shown in yellow, with rock below in grey.

Area Susceptable to Coastal Instability and Erosion

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Project No:	67471		
Project:	Campana Road, Plan Change		
Calc:	SE	**Date:**	11/11/2024
Check:		**Date:**	

Details: Calculation based on the Site specific geology ,the typical slope angles and cliff heights.
Values are used for calculation of Future ASCIE for LOT2 DP 402013; LOT2 DP 71211; LOT1 DP 402013; LOT3 DP

The areas susceptable to coastal instability and erison has been calculated as per Auckland Council Technical Report 2020/021.

Values used for the calculation of Future ASCIE for Campana Road, Wiri, Auckland.

Approximate Existing Cliff Profile

						Existing	"Typical slope" based on local Geology
Cliff height	m	5	Cliff face rock slope **(αr):**	°	30	42
Cliff face rock height **(hcr):**	m	5	Cliff face soil slope **(αs):**	°		36
Cligg face soil height **(hcs):**	m	0	Cliff face rock slope **(αr):**	rad	0.52	0.73
Years **(T)**		106	Cliff face soil slope **(αs):**	rad	0.00	0.63
Typical Height	m	37				

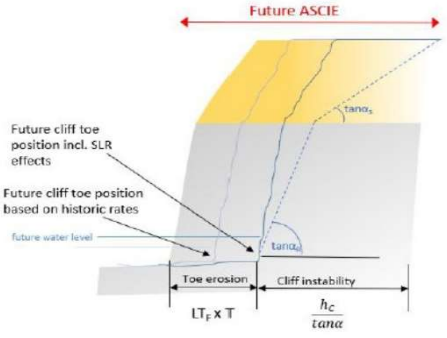
Toe Erosion

Geological Unit	AVF			
Exposure (environment energy)	Low			
Long-term historical retreat **LTRH**	0.060	m/yr	average of min and max	*(Robert,R.,(2020)) Apendix D cp 1.1 Tbl 1.3*
Geological Stability Index **GSI**	70	-	*(Robert,R.,(2020)) Apendix D cp 5.2*	
Consolidated response factor **(m)**	0.1	-	Based on Table 5.6 for Auckland geological units and exposures	
Historic toe erosion	0.18-1.02	m/yr	Based on review of public information (e.g, aerial photographs, site records, property file information).	
Historic sea level rise **(sh)**	0.0017	m/yr	*(Robert,R.,(2020)) cp 2.7.3*	
Theoretical sea level rise **(sf)**	0.0206	m/yr	*((RCP8.5H+)) + T)*	
Theoretical toe erosion **(LTf)**	0.077	m/yr	*(Robert,R.,(2020)) cp 5.5.2 Eq.5.3*	
Theor. SLR **(RCP8.5H+VLM)**	2.18	m	www.searise.takiwa.co	(year 2130)

Future ASCIE

Cliff Toe Erosion	**8.2**	m	*Cliff Toe Erosion = LTF*T*	(Equastion 1-2)
Current ASCIE (from existing toe)	**8.66**	m	*Current ASCIE = $(h_{Cr}/\tan\alpha_r) + (h_{Cs}/\tan\alpha_s)$*	(Equation 4.3)
Future ASCIE (from existing toe)	**16.8**	m	*Future ASCIE = $(LT_F \times T) + (h_{Cr}/\tan\alpha_r) + (h_{Cs}/\tan\alpha_s)$*	(Equation 4.4)
Future ASCIE	**0.16**	m/yr		

A sketch summarising the definition of the ASCIE for cliffs and beaches is given in Figure 4 and Figure 5.



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Details: Calculation based on the Site specific geology ,the typical slope angles and cliff heights.
Values are used for calculation of Future ASCIE for LOT2 DP 402013; LOT2 DP 71211; LOT1 DP 402013; LOT3 DP

The areas susceptable to coastal instability and erison has been calculated as per Auckland Council Technical Report 2020/021.

Values used for the calculation of Future ASCIE for Campana Road, Wiri, Auckland.

Approximate Existing Cliff Profile

						Existing	"Typical slope" based on local Geology
Cliff height	m	5	Cliff face rock slope **(αr):**	°	25	42
Cliff face rock height **(hcr):**	m	5	Cliff face soil slope **(αs):**	°		36
Clig face soil height **(hcs):**	m	0	Cliff face rock slope **(αr):**	rad	0.44	0.73
Years **(T)**		106	Cliff face soil slope **(αs):**	rad	0.00	0.63
Typical Height	m	37				

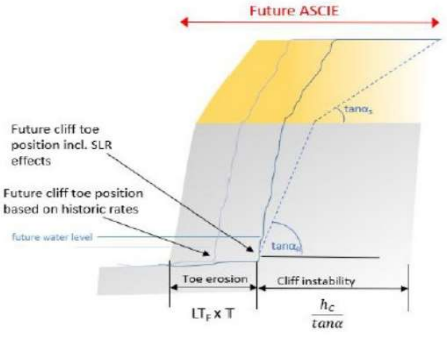
Toe Erosion

Geological Unit	AVF			
Exposure (environment energy)	Low			
Long-term historical retreat **LTRH**	0.060	m/yr	average of min and max	*(Robert,R.,(2020)) Apendix D cp 1.1 Tbl 1.3*
Geological Stability Index **GSI**	70	-	*(Robert,R.,(2020)) Apendix D cp 5.2*	
Consolidated response factor **(m)**	0.1	-	Based on Table 5.6 for Auckland geological units and exposures	
Historic toe erosion	0.18-1.02	m/yr	Based on review of public information (e.g, aerial photographs, site records, property file information).	
Historic sea level rise **(sh)**	0.0017	m/yr	*(Robert,R.,(2020)) cp 2.7.3*	
Theoretical sea level rise **(sf)**	0.0206	m/yr	*((RCP8.5H+)) + T)*	
Theoretical toe erosion **(LTf)**	0.077	m/yr	*(Robert,R.,(2020)) cp 5.5.2 Eq.5.3*	
Theor. SLR **(RCP8.5H+VLM)**	2.18	m	www.searise.takiwa.co	(year 2130)

Future ASCIE

Cliff Toe Erosion	**8.2**	m	*Cliff Toe Erosion = LTF*T*	(Equastion 1-2)
Current ASCIE (from existing toe)	**10.72**	m	*Current ASCIE = $(h_c/\tan\alpha_r) + (h_c/\tan\alpha_s)$*	(Equation 4.3)
Future ASCIE (from existing toe)	**18.9**	m	*Future ASCIE = $(LT_F \times T) + (h_c/\tan\alpha_r) + (h_c/\tan\alpha_s)$*	(Equation 4.4)
Future ASCIE	**0.18**	m/yr		

A sketch summarising the definition of the ASCIE for cliffs and beaches is given in Figure 4 and Figure 5.



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Soil is shown in yellow, with rock below in grey.

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Calc:	SE	**Date:**	11/11/2024
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Details: Calculation based on the Site specific geology ,the typical slope angles and cliff heights.
Values are used for calculation of Future ASCIE for LOT2 DP 402013; LOT2 DP 71211; LOT1 DP 402013; LOT3 DP

The areas susceptable to coastal instability and erison has been calculated as per Auckland Council Technical Report 2020/021.

Values used for the calculation of Future ASCIE for Campana Road, Wiri, Auckland.

Approximate Existing Cliff Profile

						Existing	"Typical slope" based on local Geology
Cliff height	m	5	Cliff face rock slope **(αr):**	°	20	42
Cliff face rock height **(hcr):**	m	5	Cliff face soil slope **(αs):**	°		36
Clig face soil height **(hcs):**	m	0	Cliff face rock slope **(αr):**	rad	0.35	0.73
Years **(T)**		106	Cliff face soil slope **(αs):**	rad	0.00	0.63
Typical Height	m	37				

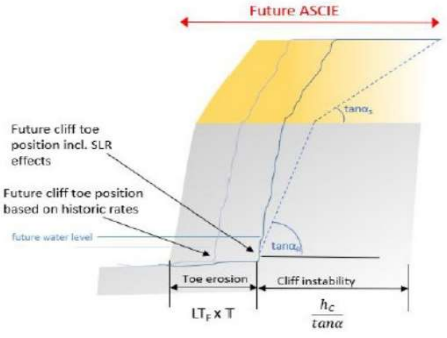
Toe Erosion

Geological Unit	AVF			
Exposure (environment energy)	Low			
Long-term historical retreat **LTRH**	0.060	m/yr	average of min and max	*(Robert,R.,(2020)) Apendix D cp 1.1 Tbl 1.3*
Geological Stability Index **GSI**	70	-	*(Robert,R.,(2020)) Apendix D cp 5.2*	
Consolidated response factor **(m)**	0.1	-	Based on Table 5.6 for Auckland geological units and exposures	
Historic toe erosion	0.18-1.02	m/yr	Based on review of public information (e.g, aerial photographs, site records, property file information).	
Historic sea level rise **(sh)**	0.0017	m/yr	*(Robert,R.,(2020)) cp 2.7.3*	
Theoretical sea level rise **(sf)**	0.0206	m/yr	*((RCP8.5H+)) + T)*	
Theoretical toe erosion **(LTf)**	0.077	m/yr	*(Robert,R.,(2020)) cp 5.5.2 Eq.5.3*	
Theor. SLR **(RCP8.5H+VLM)**	2.18	m	www.searise.takiwa.co	(year 2130)

Future ASCIE

Cliff Toe Erosion	**8.2**	m	*Cliff Toe Erosion = LTF*T*	(Equastion 1-2)
Current ASCIE (from existing toe)	**13.74**	m	$Current\ ASCIE = (h_{Cr}/\tan\alpha_r) + (h_{Cs}/\tan\alpha_s)$	(Equation 4.3)
Future ASCIE (from existing toe)	**21.9**	m	$Future\ ASCIE = (LT_F \times T) + (h_{Cr}/\tan\alpha_r) + (h_{Cs}/\tan\alpha_s)$	(Equation 4.4)
Future ASCIE	**0.21**	m/yr		

A sketch summarising the definition of the ASCIE for cliffs and beaches is given in Figure 4 and Figure 5.



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Calc:	SE	**Date:**	11/11/2024
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Details: Calculation based on the Site specific geology ,the typical slope angles and cliff heights.
Values are used for calculation of Future ASCIE for LOT2 DP 402013; LOT2 DP 71211; LOT1 DP 402013; LOT3 DP

The areas susceptable to coastal instability and erison has been calculated as per Auckland Council Technical Report 2020/021.

Values used for the calculation of Future ASCIE for Campana Road, Wiri, Auckland.

Approximate Existing Cliff Profile

						Existing	"Typical slope" based on local Geology
Cliff height	m	5	Cliff face rock slope **(αr):**	°	15	42
Cliff face rock height **(hcr):**	m	5	Cliff face soil slope **(αs):**	°	0	36
Clig face soil height **(hcs):**	m	0	Cliff face rock slope **(αr):**	rad	0.26	0.73
Years **(T)**		106	Cliff face soil slope **(αs):**	rad	0.00	0.63
Typical Height	m	37				

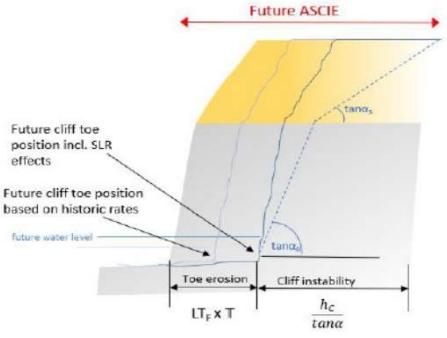
Toe Erosion

Geological Unit	AVF			
Exposure (environment energy)	Low			
Long-term historical retreat **LTRH**	0.060	m/yr	average of min and max	*(Robert,R.,(2020)) Apendix D cp 1.1 Tbl 1.3*
Geological Stability Index **GSI**	70	-	*(Robert,R.,(2020)) Apendix D cp 5.2*	
Consolidated response factor **(m)**	0.1	-	Based on Table 5.6 for Auckland geological units and exposures	
Historic toe erosion	0.18-1.02	m/yr	Based on review of public information (e.g, aerial photographs, site records, property file information).	
Historic sea level rise **(sh)**	0.0017	m/yr	*(Robert,R.,(2020)) cp 2.7.3*	
Theoretical sea level rise **(sf)**	0.0206	m/yr	*((RCP8.5H+)) + T)*	
Theoretical toe erosion **(LTf)**	0.077	m/yr	*(Robert,R.,(2020)) cp 5.5.2 Eq.5.3*	
Theor. SLR **(RCP8.5H+VLM)**	2.18	m	www.searise.takiwa.co	(year 2130)

Future ASCIE

Cliff Toe Erosion	**8.2**	m	*Cliff Toe Erosion = LTF*T*	(Equastion 1-2)
Current ASCIE (from existing toe)	**18.66**	m	$Current\ ASCIE = (h_{Cr}/\tan\alpha_r) + (h_{Cs}/\tan\alpha_s)$	(Equation 4.3)
Future ASCIE (from existing toe)	**26.8**	m	$Future\ ASCIE = (LT_F \times T) + (h_{Cr}/\tan\alpha_r) + (h_{Cs}/\tan\alpha_s)$	(Equation 4.4)
Future ASCIE	**0.25**	m/yr		

A sketch summarising the definition of the ASCIE for cliffs and beaches is given in Figure 4 and Figure 5.



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Project No:	67471		
Project:	Campana Road, Plan Change		
Calc:	SE	**Date:**	11/11/2024
Check:		**Date:**	

Details: Calculation based on the Site specific geology ,the typical slope angles and cliff heights.
Values are used for calculation of Future ASCIE for LOT2 DP 402013; LOT2 DP 71211; LOT1 DP 402013; LOT3 DP

The areas susceptable to coastal instability and erison has been calculated as per Auckland Council Technical Report 2020/021.

Values used for the calculation of Future ASCIE for Campana Road, Wiri, Auckland.

Approximate Existing Cliff Profile

						Existing	"Typical slope" based on local Geology
Cliff height	m	5	Cliff face rock slope **(αr):**	°	10	42
Cliff face rock height **(hcr):**	m	5	Cliff face soil slope **(αs):**	°	0	36
Clig face soil height **(hcs):**	m	0	Cliff face rock slope **(αr):**	rad	0.17	0.73
Years **(T)**		106	Cliff face soil slope **(αs):**	rad	0.00	0.63
Typical Height	m	37				

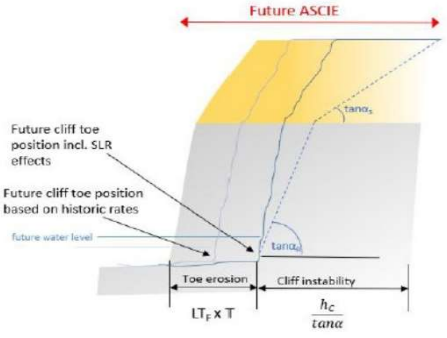
Toe Erosion

Geological Unit	AVF			
Exposure (environment energy)	Low			
Long-term historical retreat **LTRH**	0.060	m/yr	average of min and max	*(Robert,R.,(2020)) Apendix D cp 1.1 Tbl 1.3*
Geological Stability Index **GSI**	70	-	*(Robert,R.,(2020)) Apendix D cp 5.2*	
Consolidated response factor **(m)**	0.1	-	Based on Table 5.6 for Auckland geological units and exposures	
Historic toe erosion	0.18-1.02	m/yr	Based on review of public information (e.g, aerial photographs, site records, property file information).	
Historic sea level rise **(sh)**	0.0017	m/yr	*(Robert,R.,(2020)) cp 2.7.3*	
Theoretical sea level rise **(sf)**	0.0206	m/yr	*((RCP8.5H+)) + T)*	
Theoretical toe erosion **(LTf)**	0.077	m/yr	*(Robert,R.,(2020)) cp 5.5.2 Eq.5.3*	
Theor. SLR **(RCP8.5H+VLM)**	2.18	m	www.searise.takiwa.co	(year 2130)

Future ASCIE

Cliff Toe Erosion	**8.2**	m	*Cliff Toe Erosion = LTF*T*	(Equastion 1-2)
Current ASCIE (from existing toe)	**28.36**	m	$Current\ ASCIE = (h_{Cr}/\tan\alpha_r) + (h_{Cs}/\tan\alpha_s)$	(Equation 4.3)
Future ASCIE (from existing toe)	**36.5**	m	$Future\ ASCIE = (LT_F \times T) + (h_{Cr}/\tan\alpha_r) + (h_{Cs}/\tan\alpha_s)$	(Equation 4.4)
Future ASCIE	**0.34**	m/yr		

A sketch summarising the definition of the ASCIE for cliffs and beaches is given in Figure 4 and Figure 5.



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Project No:	67471		
Project:	Campana Road, Plan Change		
Calc:	SE	**Date:**	16/08/2024
Check:		**Date:**	

Details: Calculation based on the Site specific geology ,the typical slope angles and cliff heights.
Values are used for calculation of Future ASCIE for LOT2 DP 402013; LOT2 DP 71211; LOT1 DP 402013; LOT3 DP

The areas susceptable to coastal instability and erison has been calculated as per Auckland Council Technical Report 2020/021.

Values used for the calculation of Future ASCIE for Campana Road, Wiri, Auckland.

Approximate Existing Cliff Profile

						Existing	"Typical slope" based on local Geology
Cliff height	m	5	Cliff face rock slope **(αr):**	°	5	42
Cliff face rock height **(hcr):**	m	5	Cliff face soil slope **(αs):**	°	0	36
Cligg face soil height **(hcs):**	m	0	Cliff face rock slope **(αr):**	rad	0.09	0.73
Years **(T)**		106	Cliff face soil slope **(αs):**	rad	0.00	0.63
Typical Height	m	37				

Toe Erosion

Geological Unit	AVF			
Exposure (environment energy)	Low			
Long-term historical retreat **LTRH**	0.060	m/yr	average of min and max	*(Robert,R.,(2020)) Apendix D cp 1.1 Tbl 1.3*
Geological Stability Index **GSI** ±5	70	-	*(Robert,R.,(2020)) Apendix D cp 5.2*	
Consolidated response factor **(m)**	0.1	-	Based on Table 5.6 for Auckland geological units and exposures	
Historic toe erosion	0.18-1.02	m/yr	Based on review of public information (e.g, aerial photographs, site records, property file information).	
Historic sea level rise **(sh)**	0.0017	m/yr	*(Robert,R.,(2020)) cp 2.7.3*	
Theoretical sea level rise **(sf)**	0.0206	m/yr	*((RCP8.5H+)) + T)*	
Theoretical toe erosion **(LTf)**	0.077	m/yr	*(Robert,R.,(2020)) cp 5.5.2 Eq.5.3*	
Theor. SLR **(RCP8.5H+)**	2.18	m	www.searise.takiwa.co	(year 2130)

Future ASCIE

Cliff Toe Erosion	**8.2**	m	*Cliff Toe Erosion = (LTRH+LTF)*T* (Equastion 1-2)
Current ASCIE (from existing toe)	**57.15**	m	
Future ASCIE (from existing toe)	**65.3**	m	
Future ASCIE	**0.62**	m/yr	

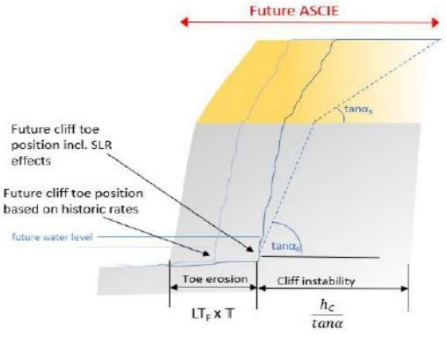
Equation 1-4: Current ASCIE

$$\text{Current ASCIE} = (h_{cc}/\tan\alpha_r) + (h_{cc}/\tan\alpha_s)$$

Equation 1-5: Future ASCIE

$$\text{Future ASCIE} = ((LT_H \times LT_F) \times T) + (h_{cc}/\tan\alpha_r) + (h_{cc}/\tan\alpha_s)$$

A sketch summarising the definition of the ASCIE for cliffs and beaches is given in Figure 4 and Figure 5.



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