

6 Motuhoa Island

6.1 Site description

Motuhoa Island is located in the middle section of Tauranga Harbour, approximately 1.5 km south-east from Omokoroa Peninsula. The island is characterised by approximately 5 km of cliff shoreline and 0.45 km of low-lying, unconsolidated shoreline. The site is split into 8 cells based on differences in morphology, exposure and shoreline elevation (Figure 6-1).

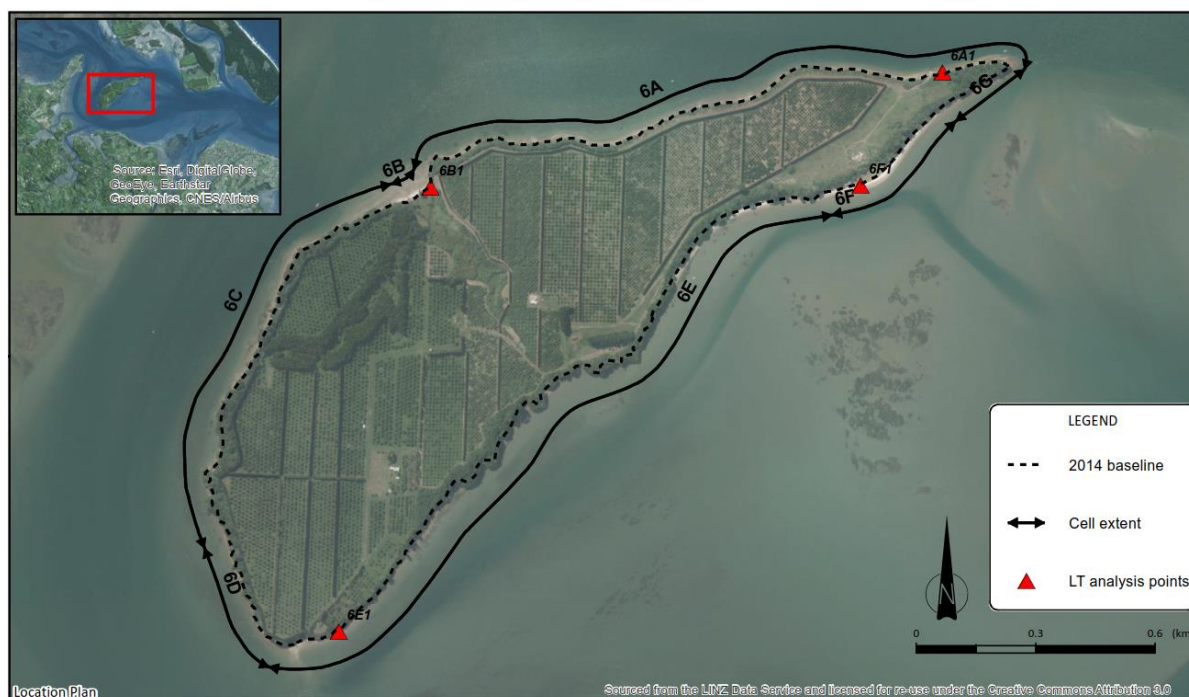


Figure 6-1 Location and cell extent for the Motuhoa Island shoreline within Tauranga Harbour.

Along the northern side of the island (Cell 6A) the cliffs are orientated directly towards the north and range in elevation from RL 8 to 12 m. The average fetch is approximately 8 km from the northwest. The cliffs are very exposed with almost no vegetation on the cliff face (Figure 6-2A). Towards the west (Cell 6B) there is a small section of low-lying, unconsolidated shoreline that gradually rises to a backshore elevation of 2 m to 3 m. The shoreline in this area comprises a small high-tide beach which is backed by a grass area.

Further towards the west is a section of cliffs that gradually wrap around to face the north-west and west (Cell 6C). The cliff elevations range from RL 20 m to 25 m and are mostly vegetated, however there are sections where large slips have occurred (Figure 6-2B). Further south, the cliffs are orientated towards the southwest and are exposed to an average fetch of 1 km. The cliff face is well-vegetated with large pohutakawa trees (Cell 6D) (Figure 6-2C).

The southern end of the island also comprises of well-vegetated coastal cliffs. The southeast-facing cliffs range in elevation from RL 12 m to 15 m high (Cell 6E).

At the eastern end of the south-facing shoreline there is an unconsolidated beach (Cell 6F) (Figure 6-2D). The beach has a berm width of approximately 3 m to 6 m above the high-tide line. East from the beach is a small section of southeast-facing cliffs (Cell 6G) which wrap around to the cliffs within Cell 6A. The cliffs have a small amount of vegetation across the cliff face, however similarly to the

cliffs along Cell 6A, there is evidence of multiple slips. The average fetch is approximately 4 km from the southeast.

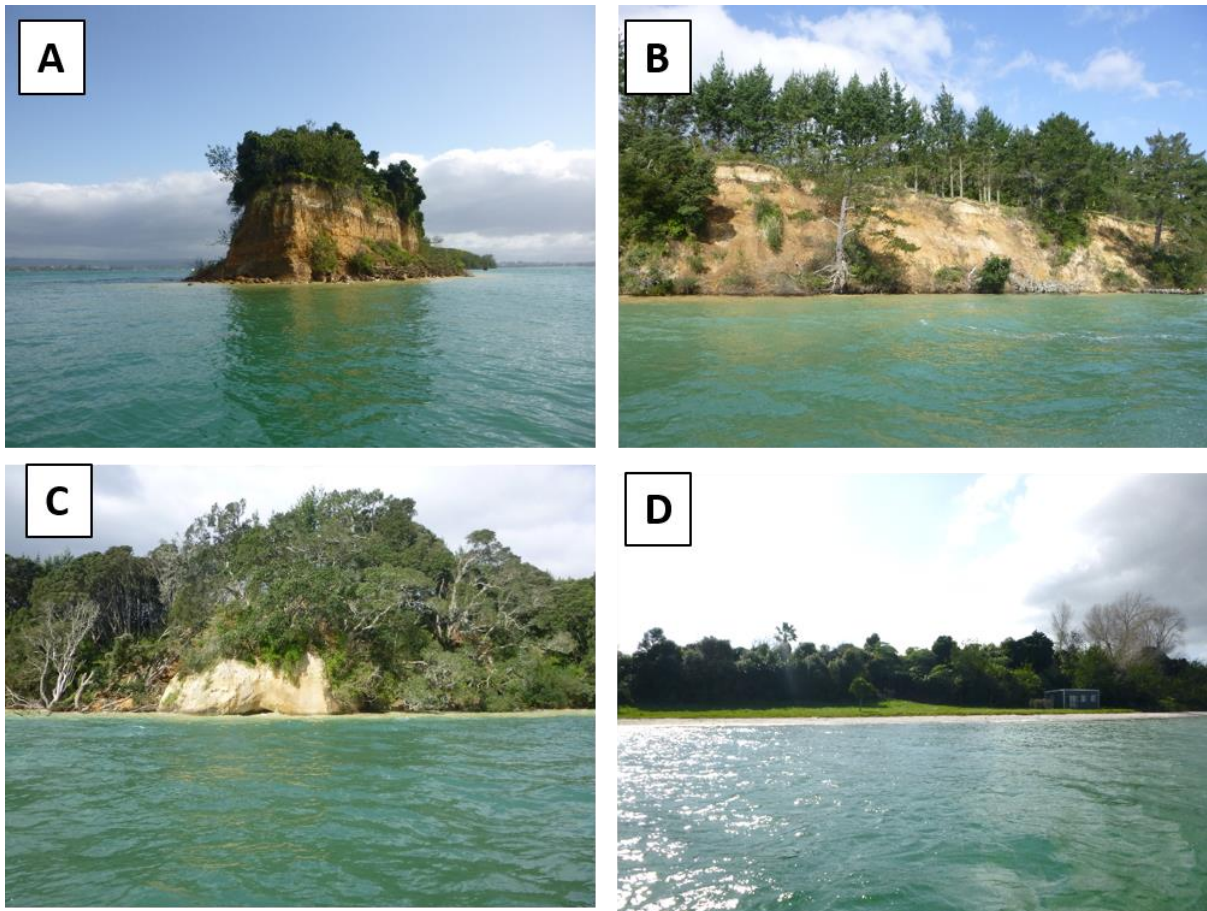


Figure 6-2 Site photos for Motuhoa Island. (A) Exposed eastern tip (Cell 6A), (B) exposed northwest-facing cliffs (Cell 6C), (C) well-vegetated cliffs (Cell 6D), (D) low-lying, unconsolidated shoreline (Cell 6F).

6.2 Geology

The geological map of the area⁷ indicates that the site comprises:

- Matua Subgroup: Poorly to moderately sorted gravel with minor sand and silt underlying terraces; includes minor fan deposits and loess.
- Chimp Formation: Non-welded, poorly consolidated rhyolite ignimbrite, with minor fall deposits.
- Pakaumanu Group: Partially welded, pumice and crystal rich ignimbrite
- Middle Pleistocene sedimentary rocks: Marine mudstone and sandstone, volcanic fall deposits and alluvium.

Field observations of cliff exposures include interbedded ash layers at the top of the cliffs and reworked ignimbrites at the base of the cliffs.

The existing slope angles in this area are between 3° to 20° in unconsolidated areas, and between 25° to 70° in areas of banks or low cliffs. The range of stable slope angles for Motuhoa Island are shown in Table 6-1 below.

⁷ Leonard, G.S.; Begg, J.G.; Wilson, C.J.N. (compilers) 2010: *Geology of the Rotorua area*. Institute of Geological & Nuclear Sciences 1:250,000 geological map 5. 1 sheet + 102 p. Lower Hutt, New Zealand. GNS Science.

The failure types observed around Motuhoa Island were typically shallow surface failures. The likelihood of deep seated movement is low to moderate.

6.3 Coastal processes

Cell 6A is the most exposed section of Motuhoa Island. Based on regression analysis, long term erosion rates are estimated to be up to -0.4 m/yr. This is consistent with the maximum erosion rates estimated by Healy et al. (2010). The high erosion rate is due to the shoreline's exposure to large fetches and the deep tidal channel. A combination of wind waves and strong tidal currents is likely to contribute to toe erosion along the cliffs. Based on field observations the cliffs appear to be currently unstable and retreating.

Although Cell 6B is a similar orientation to Cell 6A, the small beach is partially sheltered by Omokoroa Peninsula and approximately 80 m of shallow intertidal flat that extend from the shoreline. Based on the regression analysis the maximum long term erosion rate is estimate to only be -0.05 m/yr. Periods of sediment accretion are also likely to have reduced the overall long term erosion rate. Based on a 4 km fetch from the northwest, the theoretical significant wave height is estimated to be 1 m. Based on model results the short term storm cut is estimated to range from 5 to 9 m.

Due to tree coverage along the cliffs in Cells 6C and 6D it is difficult to determine long term erosion rates. Cells 6C and 6D are exposed to similar strength tidal currents as Cell 6A, however the shoreline is more sheltered from large fetches as it is in the lee of Omokoroa Peninsula. From field observations the cliffs within Cell 6C also appear slightly more stable compared to those within Cell 6A. Based on observations and comparison with Cell 6A the inferred long term erosion rates within Cells 6C and 6D are estimated to be between -0.1 and -0.2 m/yr.

While the deep tidal channel does not run adjacent to the shoreline on the south-eastern side of Motuhoa Island, the southeast-facing cells are exposed to relatively large fetches. Regression analysis indicates the long term erosion rate within Cell 6E ranges from -0.1 to -0.3 m/yr. This is consistent with the maximum erosion rate estimated by Opus (2015) (-0.3 m/yr). Due to similar orientation and exposure, it is assumed that the cliffs within Cell 6G have the same long term erosion rates as Cell 6E.

Historic aerials indicate that the long term erosion rate along the beach within Cell 6F is less than the adjacent cliffs. The regression analysis shows erosion rates ranging from -0.04 to -0.09 m/yr. Based on a 4 km fetch from the southeast, the theoretical significant wave height is estimated to be 1 m. Based on model results the short term storm cut is estimated to range from 5 to 9 m.

SLR response factors range from 0.2 to 0.4 for most of the consolidated cliffs, except the highly exposed cliffs within Cell 6A which range from 0.3 to 0.5.

6.4 Local considerations

There is a small boat ramp approximately 0.2 km from the eastern tip of the island along the northern shoreline (Cell 6A).

6.5 Adopted component values

Adopted component values are presented within Table 6-1. The short term values are equal to zero for the consolidated cells as short term erosion is not applicable for consolidated shorelines (see section 4.6.2 in main report).

Table 6-1 Adopted component values for the cells around Motuhoa Island.

Site		6. Motuhoa Island						
Cell		6A	6B	6C	6D	6E	6F	6G
Cell centre (NZTM)	E	1871405	1870718	1870326	1870792	1871440	1871869	1872073
	N	5830110	5829907	5829522	5829140	5829810	5829945	5830148
Morphology		Consolidated	Unconsolidated	Consolidated	Consolidated	Consolidated	Unconsolidated	Consolidated
Geology		Matua Subgroup	Sands	Marine mudstone	Ignimbrite Chimp Formation	Matua Subgroup	Sands	Matua Subgroup
Exposure (average fetch/direction)		8 km (NW)	4 km (NW)	1.5 km (NW)	1.5 km (NW)	5 km (SE)	6 km (SE)	7 km (SE)
State		Natural	Natural	Natural	Natural	Natural	Natural	Natural
Short-term (m)	Min	0	5	0	0	0	5	0
	Mode	0	7	0	0	0	7	0
	Max	0	9	0	0	0	9	0
Dune/Cliff elevation (m above toe or scarp)	Min	8	1	11	11	10	1	9
	Mode	10	2	19	14	11	1.5	10
	Max	13	2.5	24	18	12	2	13
Stable angle (deg)	Min	24	30	24	30	24	30	24
	Mode	26	32	26	34	26	32	26
	Max	70	34	60	50	60	34	70
Long-term (m)	Min	-0.4	-0.05	-0.2	-0.2	-0.3	-0.1	-0.3
	Mode	-0.2	-0.02	-0.15	-0.15	-0.2	-0.07	-0.2
	Max	-0.1	0.02	-0.1	-0.1	-0.1	-0.04	-0.1
Closure slope (beaches)/SLR response factor (cliffs)	Min	0.3	0.05	0.2	0.2	0.2	0.05	0.2
	Mode	0.4	0.08	0.3	0.3	0.3	0.08	0.3
	Max	0.5	0.12	0.4	0.4	0.4	0.15	0.4

6.6 Coastal erosion hazard assessment

Coastal erosion hazard distances for Motuhoa Island are presented within Table 6-2 and an overview map in Figure 6-4. Histograms of individual components and resultant erosion hazard distances using a Monte Carlo technique are shown in Appendix B.

The current $P_{66\%}$ erosion hazard ranges from -6 m along the sheltered unconsolidated shoreline (Cell 6B) to -12 m along the highest cliff sections (Cell 6C).

The future $P_{5\%}$ for 1.6 m SLR in 2130, ranges from -34 m to -39 m along the unconsolidated shorelines and are up to -101 m along the cliffs. The future erosion distances are greatest along the north-facing cliffs (Cell 6A) where fetch exposure, long term erosion rate and cliff height are relatively high.

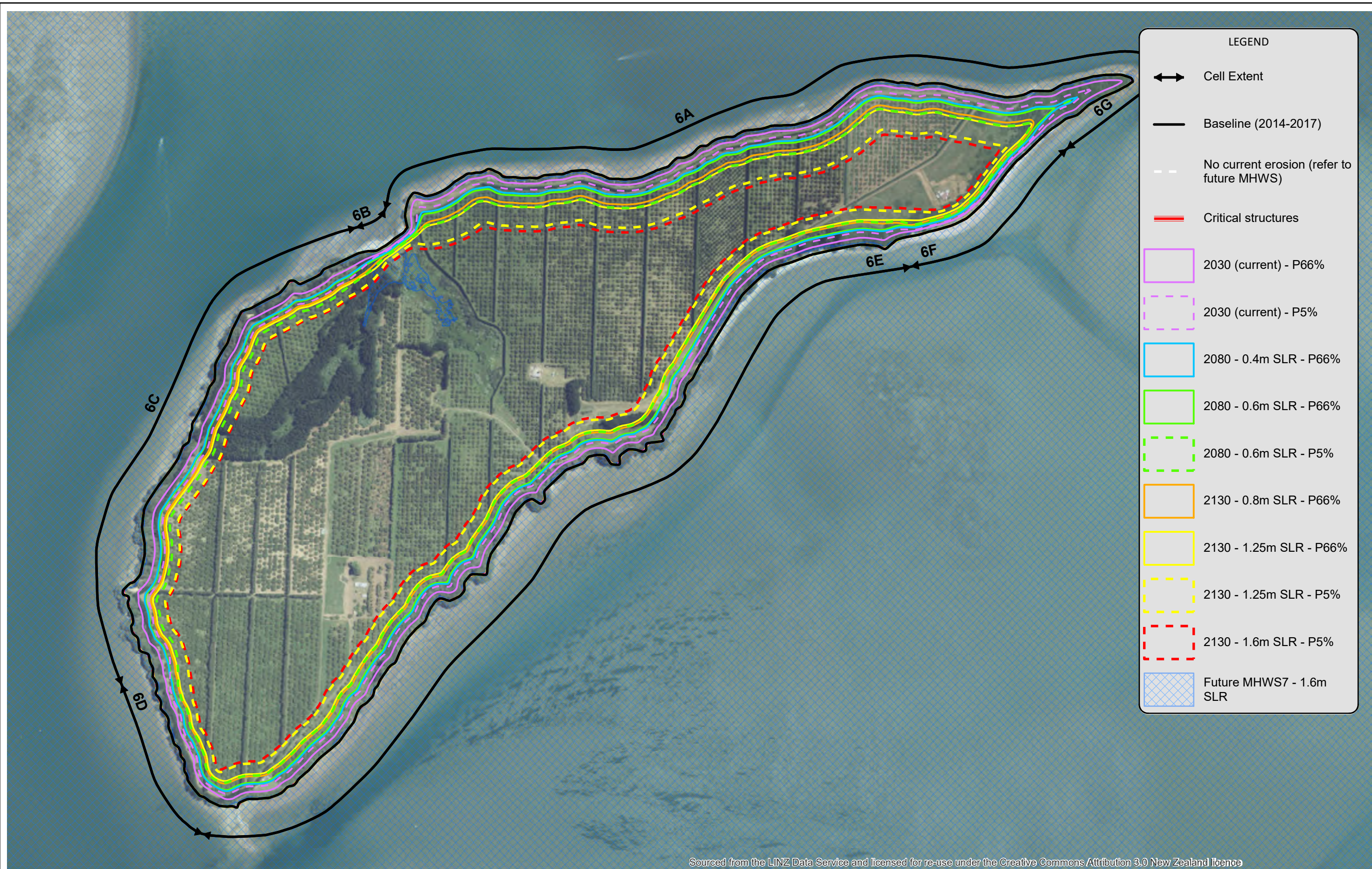
Table 6-2 Coastal erosion hazard widths (m) for current, 2080 and 2130 timeframes.

Site	Cell	Timeframe	SLR (m)	Probability of Exceedance						
				Min	$P_{66\%}$	$P_{50\%}$	$P_{5\%}$	$P_{1\%}$	Max	
Motuhoa Island	6A	Current	0.03	-5	-11	-13	-23	-27	-32	
		50yr (2080)	0.12	-11	-22	-25	-37	-41	-49	
			0.2	-13	-25	-28	-41	-46	-55	
			0.4	-15	-31	-34	-49	-55	-66	
			0.6	-17	-34	-38	-55	-62	-74	
		100yr (2130)	0.22	-16	-33	-37	-52	-58	-71	
			0.6	-21	-45	-50	-71	-79	-94	
			0.8	-23	-49	-54	-79	-87	-102	
			1.25	-27	-56	-63	-92	-102	-121	
		1.6	-29	-61	-68	-101	-113	-134		
		6B	Current	0.03	-6	-8	-9	-10	-11	-11
			50yr (2080)	0.12	-6	-9	-10	-12	-12	-13
	0.2			-7	-10	-11	-13	-13	-15	
	0.4			-8	-12	-13	-15	-16	-19	
	0.6			-10	-15	-15	-18	-19	-22	
	100yr (2130)		0.22	-5	-10	-10	-13	-14	-16	
			0.6	-8	-14	-15	-18	-20	-22	
			0.8	-10	-17	-18	-21	-23	-26	
			1.25	-14	-22	-23	-28	-30	-35	
	1.6		-17	-26	-27	-34	-37	-41		
	6C		Current	0.03	-9	-20	-23	-40	-46	-54
			50yr (2080)	0.12	-15	-27	-31	-48	-54	-63
		0.2		-16	-29	-33	-50	-55	-65	
		0.4		-18	-32	-35	-52	-58	-69	
0.6		-19		-34	-37	-54	-60	-72		

Site	Cell	Timeframe	SLR (m)	Probability of Exceedance						
				Min	P _{66%}	P _{50%}	P _{5%}	P _{1%}	Max	
Motuhoa Island	6C	100yr (2130)	0.22	-21	-35	-39	-56	-62	-70	
			0.6	-25	-41	-45	-62	-69	-78	
			0.8	-26	-44	-47	-64	-71	-81	
			1.25	-28	-47	-51	-68	-76	-86	
			1.6	-29	-49	-53	-71	-78	-89	
	6D	Current	0.03	-12	-19	-20	-26	-29	-32	
		50yr (2080)	0.12	-17	-26	-28	-34	-36	-40	
			0.2	-18	-28	-29	-36	-38	-42	
			0.4	-20	-30	-32	-39	-41	-46	
			0.6	-21	-32	-34	-41	-44	-49	
		100yr (2130)	0.22	-23	-33	-35	-42	-45	-51	
			0.6	-26	-39	-41	-49	-53	-60	
			0.8	-27	-41	-43	-52	-55	-63	
			1.25	-28	-45	-47	-57	-61	-69	
			1.6	-29	-47	-49	-60	-64	-73	
		6E	Current	0.03	-9	-14	-16	-25	-27	-29
			50yr (2080)	0.12	-14	-24	-26	-36	-39	-43
				0.2	-15	-26	-28	-38	-42	-46
	0.4			-17	-30	-32	-43	-46	-52	
	0.6			-18	-32	-34	-46	-50	-57	
	100yr (2130)		0.22	-20	-34	-37	-48	-52	-59	
			0.6	-24	-42	-45	-58	-63	-72	
			0.8	-25	-44	-48	-62	-68	-78	
			1.25	-27	-49	-52	-69	-75	-88	
			1.6	-28	-51	-55	-73	-80	-95	
	6F		Current	0.03	-7	-9	-9	-11	-11	-12
		50yr (2080)	0.12	-9	-12	-13	-15	-15	-16	
			0.2	-10	-13	-14	-16	-16	-17	
			0.4	-11	-15	-16	-18	-19	-21	
			0.6	-13	-17	-18	-21	-22	-24	
		100yr (2130)	0.22	-11	-16	-16	-19	-20	-21	
			0.6	-15	-20	-21	-24	-25	-27	
0.8			-16	-22	-23	-27	-28	-31		
1.25			-19	-26	-28	-33	-36	-39		
1.6	-22		-30	-32	-39	-42	-46			
6G	Current	0.03	-7	-9	-9	-11	-11	-12		
	50yr (2080)	0.12	-11	-21	-23	-34	-38	-45		
		0.2	-12	-23	-25	-37	-41	-48		
		0.4	-13	-26	-29	-41	-45	-53		
		0.6	-14	-28	-31	-44	-49	-58		

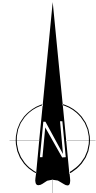
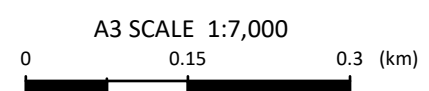
Site	Cell	Timeframe	SLR (m)	Probability of Exceedance					
				Min	P _{66%}	P _{50%}	P _{5%}	P _{1%}	Max
	6G	100yr (2130)	0.22	-17	-30	-33	-46	-51	-58
			0.6	-21	-38	-41	-56	-61	-71
			0.8	-21	-41	-44	-59	-65	-76
			1.25	-23	-45	-49	-66	-72	-85
		100yr (2130)	1.6	-24	-48	-52	-70	-77	-91

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Tauranga Harbour Coastal Erosion Assessment
 Erosion Hazard Overview
 Site 6: Motuhoa Island

FIGURE No. Figure 6-4

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