8 Te Puna West

8.1 Site description

Te Puna West is located in the southern basin of the Tauranga Harbour, south of Plummer's Point. The shoreline comprises approximately 1.4 km of cliffs and 0.8 km of unconsolidated shoreline. Most of the shoreline is extensively modified with protection structures. The site is split into 9 cells based on differences in exposure, morphology and shoreline elevation (Figure 8-1).

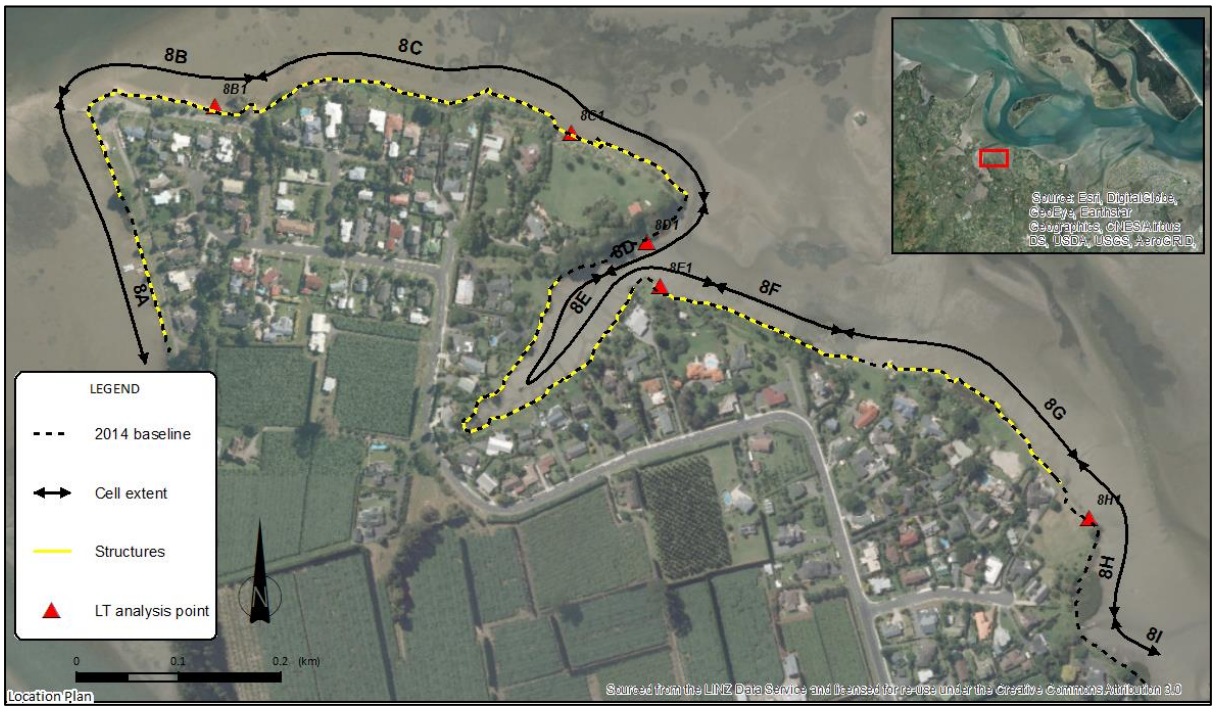


Figure 8-1 Location and cell extent for the Te Puna West shoreline within Tauranga Harbour.

Around Waitui Reserve the shoreline is low elevation with a combination of protection structures, including seawalls, groynes and rock revetment (Figure 8-2A). The west-facing side of Waitui Reserve is relatively sheltered with an average fetch of 0.5 km (Cell 8A). The north-facing section of Waitui Reserve is slightly more exposed with an average fetch of 4 km from the northeast (Cell 8B). The shoreline is characterised by a small unconsolidated sandy beach in between a groyne field (Figure 8-2B).

East of Waitui Reserve is a section of north-facing coastal cliffs that ranges in elevation from RL 7 to 9 m and are mostly vegetated with grass and shrubs (Cell 8C). Along most of the cliff toe is an engineered rock revetment ranging in height from 1 to 3 m RL (Figure 8-2C).

The shoreline continues to wrap around to a sheltered intertidal area where there is a section of unprotected, southeast-facing cliffs, ranging in elevation from RL 7 to 9 m (Cell 8D). Within the sheltered intertidal area below Wallace Road the shoreline is characterised by a low bank, ranging in elevation from RL 1 to 2 m. This area transitions to low angle cliffs which gradually rise to elevations ranging from RL 5 to 7 m (Cell 8E).

Further east is a small section of unprotected shoreline, followed by another section of north-facing cliffs, ranging in elevation from RL 10 to 13 m (Cell 8F). The cliffs are exposed to an average fetch of approximately 2 km from northeast. Both the upper section and toe of the coastal cliff is extensively engineered with retaining walls, gabions and revetment.

Further south-east around Te Kopa O Te Hotu Reserve, the shoreline comprises unconsolidated sediment with patches of salt marsh and mangroves along the fringe (Cell 8H) (Figure 8-2D).

Figure 8-2 Site photos for Te Puna West. (A) Aerial shot of Te Puna West shoreline (Cells 8A & 8B), (B) groynes along the unconsolidated shoreline (Cell 8B), (C) revetment at the base of the cliffs (Cell 8C), (D) unconsolidated shoreline around Te Kopa O Te Hotu Reserve (Cell 8H).

8.2 Geology

The geological map of the area[9] 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.

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° along the unconsolidated areas, and between 20° to 45° in areas of banks or low cliffs. The range of stable slope angles for Te Puna West are shown in Table 8-1 below.

The failure types observed around Te Puna West were typically shallow surface failures. The likelihood of deep seated movement is low.

[9] 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.

8.3 Coastal processes

Due to the extensive structures around Te Puna West it is difficult to determine long term shoreline trends. However, the presence of structures suggests that coastal erosion is an issue. Around Waitui Reserve the shoreline is relatively sheltered with regression analysis indicating an average long term erosion rate of -0.08 m/yr within Cell 8B. Cell 8A is exposed to smaller fetches than Cell 8B, hence the average long term erosion rate is assumed to be -0.05 m/yr. Sediment accumulation along the eastern side of the groynes indicates there is some westward sediment transport (Figure 8-2A).

Based on a 2.5 km fetch from the northeast, the theoretical significant wave height along Cell 8B is estimated to be 1 m. Based on model results the short term storm cut is estimated to range from 3 to 8 m. Short term erosion within the sheltered Cell 8A is estimated to be between 1 to 3 m.

Along the north-facing cliff (Cell 8C) there is evidence of slips occurring with the debris being removed by waves overtopping the rip rap. Regression analysis shows an average long term erosion rate of -0.1 m/yr, which is also consistent with the estimate by Opus (2015). Cell 8C is the section most exposed to wind waves, with the relatively large fetch from the northeast. Regression analysis indicates slightly lower average erosion rates for Cell 8D. This is due to the smaller fetch from the south. Wave energy within Cell 8E is likely to be minimal due to the very sheltered, shallow intertidal area. The average long term erosion rate is estimated to be -0.03 m/yr.

Although there is a series of structures along Cell 8F, there is evidence of bank erosion behind the structures in several locations, indicating wave overtopping and undermining of the toe. Due to the similar exposure as Cell 8C, the average long term erosion rate within 8F is estimated to be -0.1 m/yr. Cell 8G is slightly more sheltered than Cell 8F and therefore the average long term erosion rate for Cell 8G is estimated to be -0.05 m/yr. Within Cell 8H the unconsolidated shoreline shows an average long term erosion rate of -0.1 m/yr.

Due to the relatively low exposure to large fetches, the SLR response factors for the consolidated shoreline around Te Puna West range from 0.1 to 0.3.

8.4 Local considerations

Most of the Te Puna West shoreline is extensively modified with protection structures (Figure 8-3). While some of the structures are appear well engineered and effective (Figure 8-3A), there are other structures which are ad-hoc and deteriorating (Figure 8-3C).

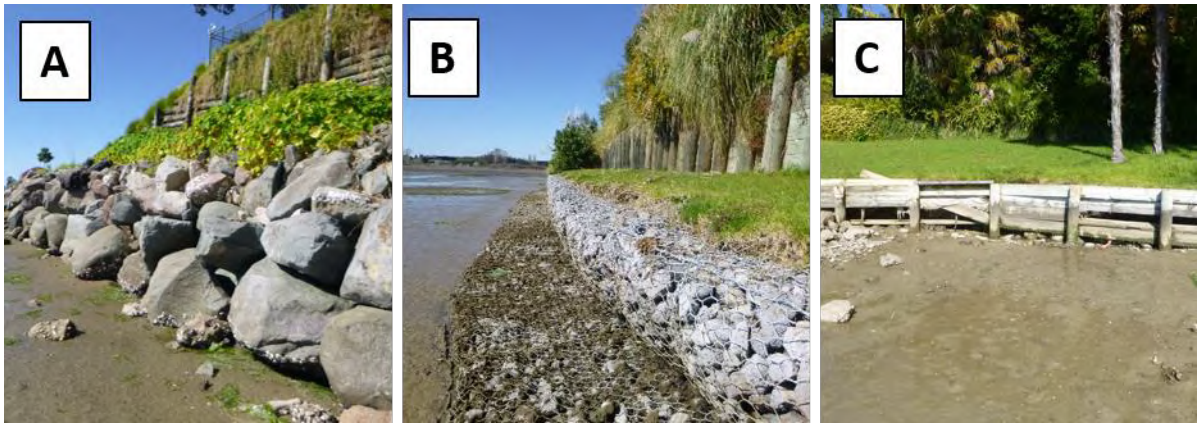


Figure 8-3 Examples of coastal protection structures around Te Puna West. (A) Large revetment below retaining walls (Cell 8C), (B) gabion baskets (8C), (C) timber wall (8E).

8.5 Adopted component values

Adopted component values are presented within Table 8-1. 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 8-1 Adopted component values for the Te Puna West shoreline.

Site		**8. Te Puna West**								
Cell		**8A**	**8B**	**8C**	**8D**	**8E**	**8F**	**8G**	**8H**	**8I**
Cell centre (NZTM)	**E**	1868979	1869012	1869322	1869472	1869307	1869598	1869791	1869926	1869943
	N	5827442	5827574	5827578	5827429	5827245	5827350	5827295	5827143	5827020
Morphology		Unconsolidated	Unconsolidated	Consolidated	Consolidated	Consolidated	Consolidated	Consolidated	Unconsolidated	Consolidated
Geology		Sands	Sands	Matua Subgroup	Matua Subgroup	Matua Subgroup	Matua Subgroup	Matua Subgroup	Sands	Matua Subgroup
Exposure (average fetch/direction)		0.5 km (SW)	4 km (NE)	4 km (NE)	<0.5 km (SE)	<0.5 km (N,S)	2 km (NE)	0.5 km (east)	0.5 km (east)	0.5 km (NE)
State		Protected	Protected	Protected	Natural	Protected	Protected	Protected	Natural	Natural
Short-term (m)	Min	1	3	0	0	0	0	0	1	0
	Mode	2	6	0	0	0	0	0	2	0
	Max	3	8	0	0	0	0	0	3	0
Dune/Cliff elevation (m above toe or scarp)	Min	1	1.3	6.5	7	1	9	1	0.5	4
	Mode	1.2	1.4	7.5	8	1.5	11	1.5	1	4.5
	Max	1.3	1.6	9	9	2	13	2	2	5
Stable angle (deg)	Min	30	30	24	24	24	24	24	30	24
	Mode	32	32	26	26	26	26	26	32	26
	Max	34	34	45	30	30	30	30	34	30
Long-term (m)	Min	-0.08	-0.14	-0.2	-0.1	-0.05	-0.2	-0.1	-0.15	-0.1
	Mode	-0.05	-0.08	-0.1	-0.05	-0.03	-0.1	-0.05	-0.1	-0.05
	Max	-0.02	-0.02	-0.08	-0.02	-0.02	-0.08	-0.02	-0.05	-0.02
Closure slope (beaches)/SLR response factor (cliffs)	Min	0.05	0.05	0.1	0.1	0.1	0.1	0.1	0.05	0.1
	Mode	0.07	0.09	0.2	0.2	0.2	0.2	0.2	0.06	0.2
	Max	0.1	0.15	0.3	0.3	0.3	0.3	0.3	0.08	0.3

8.6 Coastal erosion hazard assessment

Coastal erosion hazard distances for Te Puna West are presented within Table 8-2 and an overview map in Figure 8-4. Histograms of individual components and resultant erosion hazard distances using a Monte Carlo technique are shown in Appendix B. For the purpose of this assessment all coastal erosion protection structures have been ignored (refer to main report Section 4.5.4).

The current $P_{66\%}$ erosion hazard distance ranges from -3 m to -8 m along the sheltered, unconsolidated shoreline and is up to -23 m within Cell 8F, which has the highest sections of cliff.

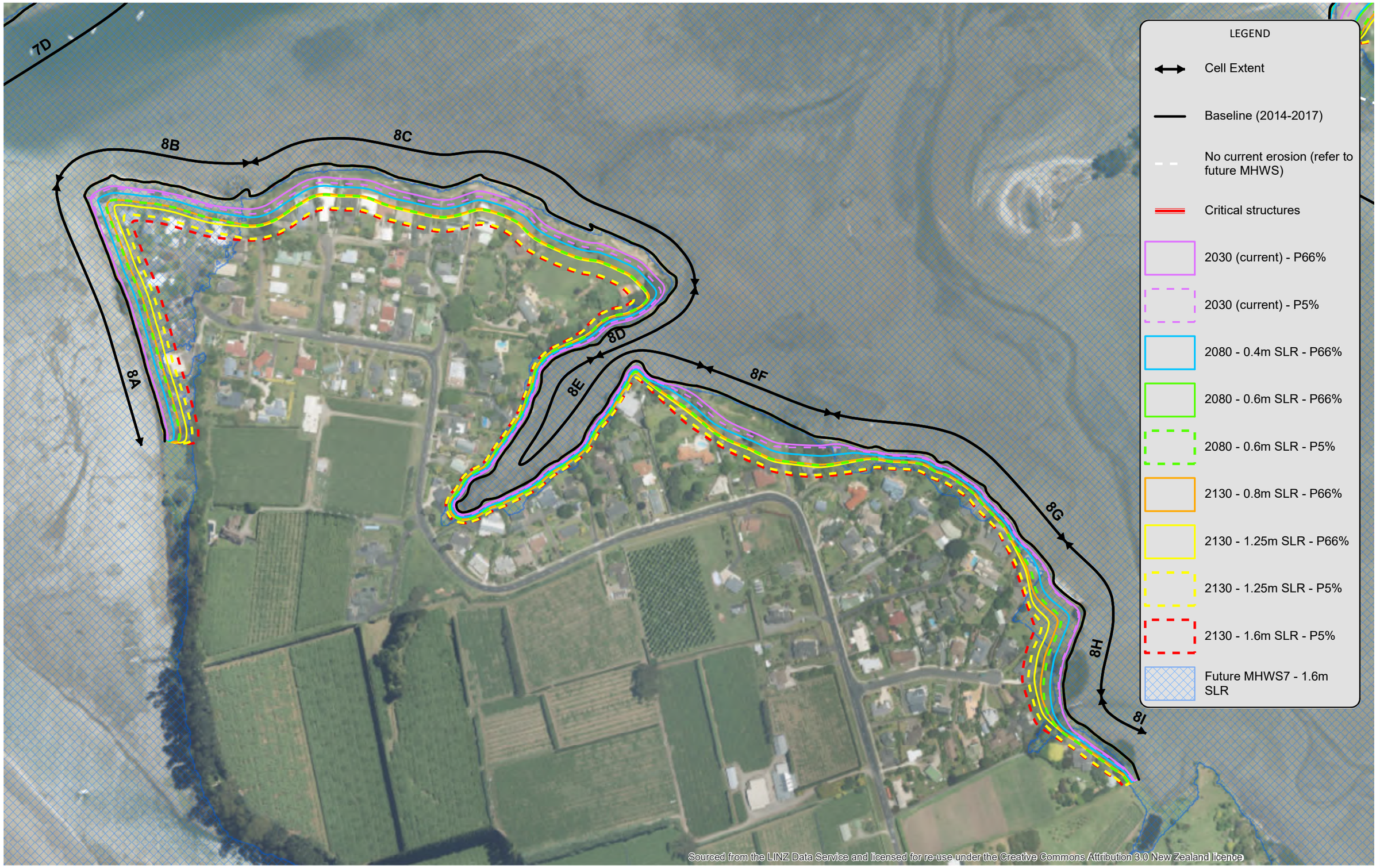
The future $P_{5\%}$ for 1.6 m SLR in 2130, ranges from -15 m to -42 m along the unconsolidated shorelines and is up to -53 m along the cliffs.

Table 8-2 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
Te Puna West	8A	Current	0.03	-2	-3	-4	-4	-5	-5
		50yr (2080)	0.12	-3	-6	-6	-8	-8	-9
			0.2	-4	-7	-7	-9	-9	-10
			0.4	-7	-10	-10	-12	-12	-14
			0.6	-9	-12	-13	-15	-16	-18
		100yr (2130)	0.22	-5	-8	-9	-11	-12	-13
			0.6	-9	-13	-14	-17	-18	-19
			0.8	-11	-16	-17	-20	-21	-23
			1.25	-15	-22	-23	-27	-29	-32
			1.6	-19	-26	-28	-33	-36	-39
	8B	Current	0.03	-5	-8	-8	-10	-10	-11
		50yr (2080)	0.12	-6	-11	-12	-15	-16	-17
			0.2	-7	-12	-13	-16	-17	-19
			0.4	-9	-14	-15	-18	-20	-22
			0.6	-10	-16	-17	-21	-22	-25
		100yr (2130)	0.22	-7	-15	-16	-21	-23	-24
			0.6	-11	-19	-20	-25	-27	-30
			0.8	-12	-21	-22	-28	-30	-33
			1.25	-15	-25	-27	-34	-37	-42
			1.6	-18	-29	-31	-39	-43	-49
	8C	Current	0.03	-8	-13	-14	-18	-20	-22
		50yr (2080)	0.12	-13	-19	-21	-26	-27	-31
			0.2	-13	-20	-21	-27	-29	-32
			0.4	-14	-21	-23	-28	-31	-34
			0.6	-14	-22	-24	-30	-32	-36

Site	Cell	Timeframe	SLR (m)	Probability of Exceedance					
				Min	$P_{66\%}$	$P_{50\%}$	$P_{5\%}$	$P_{1\%}$	Max
Te Puna West	8C	100yr (2130)	0.22	-17	-25	-27	-34	-36	-41
			0.6	-19	-28	-30	-38	-42	-48
			0.8	-19	-29	-31	-40	-43	-51
			1.25	-20	-30	-33	-42	-46	-55
			1.6	-21	-31	-34	-44	-48	-58
	8D	Current	0.03	-3	-5	-6	-7	-7	-8
		50yr (2080)	0.12	-4	-8	-8	-10	-11	-12
			0.2	-4	-8	-9	-11	-12	-13
			0.4	-5	-9	-9	-12	-13	-14
			0.6	-5	-9	-10	-13	-14	-15
		100yr (2130)	0.22	-5	-10	-11	-15	-16	-17
			0.6	-6	-11	-12	-17	-18	-20
			0.8	-6	-12	-13	-18	-19	-21
			1.25	-6	-13	-14	-19	-21	-23
			1.6	-6	-13	-14	-20	-22	-24
	8E	Current	0.03	-2	-3	-3	-4	-4	-5
		50yr (2080)	0.12	-3	-5	-5	-6	-7	-7
			0.2	-3	-5	-5	-6	-7	-8
			0.4	-4	-5	-6	-7	-7	-8
			0.6	-4	-6	-6	-7	-8	-9
		100yr (2130)	0.22	-5	-6	-7	-8	-9	-10
			0.6	-5	-7	-8	-9	-10	-11
			0.8	-5	-7	-8	-10	-11	-12
			1.25	-5	-8	-8	-11	-11	-13
			1.6	-5	-8	-9	-11	-12	-14
	8F	Current	0.03	-18	-23	-24	-27	-29	-31
		50yr (2080)	0.12	-22	-29	-30	-35	-36	-41
			0.2	-23	-30	-31	-36	-38	-42
			0.4	-23	-31	-32	-37	-40	-44
			0.6	-24	-32	-33	-39	-41	-46
		100yr (2130)	0.22	-26	-35	-36	-43	-45	-50
			0.6	-28	-38	-39	-47	-50	-54
			0.8	-29	-39	-40	-49	-52	-57
			1.25	-30	-40	-42	-51	-55	-61
			1.6	-31	-41	-43	-53	-57	-64
	8G	Current	0.03	-2	-4	-4	-5	-5	-5

Site	Cell	Timeframe	SLR (m)	Probability of Exceedance					
				Min	$P_{66\%}$	$P_{50\%}$	$P_{5\%}$	$P_{1\%}$	Max
Te Puna West	8G	50yr (2080)	0.12	-4	-6	-7	-9	-9	-10
			0.2	-4	-6	-7	-9	-10	-11
			0.4	-4	-7	-8	-10	-11	-12
			0.6	-4	-7	-8	-11	-12	-13
		100yr (2130)	0.22	-5	-9	-9	-13	-14	-15
			0.6	-5	-10	-11	-15	-16	-18
			0.8	-5	-10	-11	-16	-17	-19
			1.25	-5	-11	-12	-17	-19	-22
			1.6	-6	-11	-13	-18	-20	-23
	8H	Current	0.03	-3	-4	-4	-5	-6	-7
		50yr (2080)	0.12	-5	-9	-9	-12	-12	-14
			0.2	-6	-10	-11	-13	-14	-15
			0.4	-9	-13	-14	-16	-17	-18
			0.6	-12	-16	-17	-20	-21	-22
		100yr (2130)	0.22	-8	-13	-14	-18	-20	-21
			0.6	-14	-19	-21	-25	-26	-28
			0.8	-17	-23	-24	-28	-29	-31
			1.25	-23	-30	-31	-36	-37	-40
			1.6	-27	-35	-36	-42	-44	-47
	8I	Current	0.03	-8	-10	-10	-11	-11	-12
		50yr (2080)	0.12	-9	-12	-13	-15	-16	-17
			0.2	-9	-12	-13	-15	-16	-18
			0.4	-9	-13	-14	-16	-17	-19
			0.6	-9	-13	-14	-17	-18	-20
		100yr (2130)	0.22	-10	-15	-15	-19	-20	-21
			0.6	-10	-16	-17	-21	-23	-24
			0.8	-11	-16	-17	-22	-23	-26
			1.25	-11	-17	-18	-23	-25	-28
			1.6	-11	-17	-18	-24	-26	-29



Notes: Aerial photograph sourced from the LINZ Data Service (dated 2015)

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Tauranga Harbour Coastal Erosion Assessment

Erosion Hazard Overview

Site 8: Te Puna West

FIGURE No.: Figure 8-4

Rev.: 0

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