REPORT

HAWKE'S BAY REGIONAL COUNCIL

Cliff Hazard Zone Delineation

Tonkin & Taylor

ENVIRONMENTAL AND ENGINEERING CONSULTANTS

REPORT

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Report prepared for:
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Executive summary

Tonkin and Taylor previously identified coastal hazard zones for soft shores along the coast line of the Hawke's Bay Regional Council as part of the Regional Coastal Hazard Study (Tonkin & Taylor, 2004). As part of the original brief, a zone that identifies the potential for hazards from coastal cliffs was also to be undertaken.

This report contains the methodology of mapping cliff toe and cliff hazard zones for the Hawke's Bay region. Associated with the Cliff hazard zones are areas where the soft shore hazard lines converge with the cliff hazard zones.

The data in ESRI shape file format is included on the CD attached with this document. Contents of the CD are attached in Appendix B. This document should be used as Metadata for the provided data.

1 Introduction

Tonkin and Taylor previously identified coastal hazard zones for soft shores along the Hawke's Bay Regional Council (HBRC) coast line as part of the 'Regional Coastal Hazard Study' project (Tonkin & Taylor, 2004).

Due to the lack of detailed topographic information along the cliff areas it was not possible to accurately identify the cliff toe or the landward extent of the hazard zone. Subsequent to the regional hazard assessment council commissioned a high resolution aerial survey of large areas of the cliff coastline and georeferenced photogrammetric analysis was carried out for other areas, enabling mapping of this area to be completed.

This report identifies and maps the Cliff Shore Hazard Zone along the HBRC coast line and should be included with the suite of reports presented to HBRC.

2 Cliff toe/base extraction

A delineation of the cliff toe (base) was obtained for all areas along the Hawke's Bay coast where predominate cliffs exist in the immediate backshore area of the shoreline. The cliff toe/base was identified as the point where the backshore area of the beach changed slope dramatically to form a cliff. There was no discrimination as to the geology of the cliff; therefore the cliff could range from 'soft', erosion prone material or 'hard', erosion resistant material.

The cliff toe was identified and digitised from four sources:

- stereophotogrammetry aerial photographs (undertaken by New Zealand Aerial Mapping)
- LIDAR derived elevation data (supplied by HBRC)
- georeferenced aerial photography (monophotogrammetry)
- LINZ 260 Map Series digital data 1:50000 digital elevation and coastline data.

One continuous cliff toe line (along cliff shores) was obtained as a polyline from these sources.

Errors in identifying the cliff toe (or base) differ between sources. The LIDAR data was provided as a GRID with data points every 10 m. Therefore, although the LIDAR horizontal accuracy was ~ 0.5 m, a horizontal error of cliff toe position is up to +/- 5 m. Vertical accuracy of LIDAR is between 0.11 and 0.15 m.

While more accurate, stereophotogrammetry techniques can still have horizontal errors of 2 to 5 m. Identification of the cliff toe can prove difficult due to shadows or poor resolution that can increase the total error. The total error for stereophotogrammetry is assessed to be between 2 and 8 m.

The monophotogrammetry technique involves geo-referencing of photographs and identification of the cliff toe. Horizontal accuracy of aerial photographs range from 2.5 to 12.5 m depending on the source data used to geo reference the aerial and the resolution of the photo. Identification of the cliff toe can also be difficult due to only having 2D aspect. The total error for monophotogrammetry is assessed to be between 2 and 15 m

LINZ, 2002 state that the planimetric (x,y) accuracy of the data is defined as "90% of well defined points are within ±22 m of their actual position" with vertical accuracy defined as

"90% of well defined points are within ±5 m of their actual height and contour lines are within ±10 m of their actual position. However, at the coastal margins elevation resolution is only 10 -20 m and the coastline is defined as either 'wet line' 'vegetation line' or some other feature and is not consistent. Cliff toe extraction from LINZ data was undertaken by estimating the cliff toe in relation to characteristics of the elevation data and coastline geomorphology. The total error for LINZ data is assessed to be between 2 and 25 m.

3 Cliff Shore Hazard Zone

The estimate of cliff erosion zones was made based on inferred distances from the NZMS topographic information and checked based on the following formula:

$$Hz = 2H + (LT \times T)$$

Where:

Hz	=	the width of the hazard zone,
H	=	the height of the cliff above its toe
LT	=	the long term rate of horizontal shoreline movement (m/year) as determined by expert opinion, based on site inspection and a comparative review of historic and recent aerial photographs. This was taken uniformly to be 0.1 m/yr, or 10 m over the planning period
T	=	Planning time period (100 years)

This method was proposed by the California Coastal Zone Conservation Commission for slopes of low stability and is considered suitable for competent cliffs in rural zoned areas and reserve areas. Only one zone was established along cliff shores, which comprised the larger of the two methods.

It is noted that in the original assessment a 2(H):1(V) slope was applied uniformly across the entire region. With the new LIDAR data it is possible to evaluate actual slopes and trends region by region. The potential slopes of the main cliff areas was reviewed based on 34 representative cliff sections and the horizontal and vertical distance measured from the cliff crest and the cliff toe. The results of the analysis are shown in Table 3.1.

Table 3.1. Cliff Shore Hazard Zone

Location	Area on Arcview	Section No.	Horizontal toe to top distance (m)	Toe Contour (m)	Top Contour (m)	Slope angle (degrees)	Slope angle (H:1)
N/A	8	-					
Blackhead point to Black head	7	a	147	20	120	34	1.5
Blackhead point to Black head	7	c	275	20	170	29	1.8
Blackhead point to Black head	7	d	228	20	160	32	1.6
Blackhead point to Black head	7	e	174	20	110	27	1.9
Average						***30***	***1.7***
Pourerere to Paoanui	6	a	182	0	80	24	2.3
Pourerere to Paoanui	6	b	109	0	60	29	1.8
Average						***26***	***2.0***
Waimarama to Ocean Beach	5	a	240	0	120	27	2.0
Waimarama to Ocean Beach	5	b	203	0	80	22	2.5
Waimarama to Ocean Beach	5	c	140	0	60	23	2.3
Average						***24***	***2.3***
Mohaka River to Waihua	4	a	142	20	120	35	1.4
Mohaka River to Waihua	4	b	230	20	160	31	1.6
Mohaka River to Waihua	4	c	228	0	120	28	1.9
Mohaka River to Waihua	4	d	211	20	100	21	2.6
Mohaka River to Waihua	4	e	120	20	100	34	1.5
Average						***30***	***1.8***
Waipatiki to Morangiangi	3	a	95	2	100	46	1.0
Waipatiki to Morangiangi	3	b	108	20	100	37	1.4
Waipatiki to Morangiangi	3	c	103	0	80	38	1.3
Waipatiki to Morangiangi	3	d	200	0	180	42	1.1
Waipatiki to Morangiangi	3	e	203	0	140	35	1.5

Location	Area on Arcview	Section No.	Horizontal toe to top distance (m)	Toe Contour (m)	Top Contour (m)	Slope angle (degrees)	Slope angle (H:1)
Waipatiki to Morangiangi	3	f	158	0	160	45	1.0
Waipatiki to Morangiangi	3	g	136	0	160	50	0.9
Waipatiki to Morangiangi	3	h	260	0	240	43	1.1
Average						***42***	***1.1***
Tongoio to Waipatiki	2	a	55	0	60	47	0.9
Tongoio to Waipatiki	2	b	37	0	40	47	0.9
Tongoio to Waipatiki	2	c	57	0	40	35	1.4
Tongoio to Waipatiki	2	d	69	0	60	41	1.2
Average						***43***	***1.1***
Ocean Beach to Cape Kidnappers	1	a	275	0	160	30	1.7
Ocean Beach to Cape Kidnappers	1	b	187	0	100	28	1.9
Average						***29***	***1.8***
Cape Kidnappers to Clifton	1	c	145	0	100	35	1.5
Cape Kidnappers to Clifton	1	d	81	0	100	51	0.8
Cape Kidnappers to Clifton	1	e	84	20	100	44	1.1
Cape Kidnappers to Clifton	1	f	64	20	100	51	0.8
Cape Kidnappers to Clifton	1	g	127	0	130	46	1.0
Cape Kidnappers to Clifton	1	h	108	0	120	48	0.9
Average						***46***	***1.0***

The average slope for each section is also included. Evaluating the slope statistics for all 34 sites, the Mean slope is 1.5(H):1(V) and Mean + 1 standard deviation is 2.0(H):1(V). Analysis of the individual cliff sections show the use of a 2(H):1(V) slope is reasonable for most cliff areas, although there are areas with both flatter and steeper slopes identified. Based on these results there may be the ability to use a slightly steeper slope for the cliff areas between Cape Kidnappers to Clifton and from Tongoio to Waipatiki and flatter slopes from Waimarama to Ocean Beach.

Cliff slopes are also at risk from landslide. However, potential risks for landslides have not considered in this report. We recommend more detailed analysis of the LIDAR data, with the raw data re-sampled to provide more detailed topographic information (say 2 m contours) and that this data be assessed in terms of stable slope and landslide susceptibility prior to refining the coastal erosion hazard lines. We would also expect that a more risk based assessment could then be carried out, with a range of likelihoods of risk identified, which would be more consistent with the approach used for the soft shore coasts. Alternatively, this more detailed approach could be recommended to people wishing to develop in this area.

Hazard zone widths and coastal zones derived from the 2003 study are included in Appendix A. At this stage, we recommend retaining these widths, until more detailed assessments are completed, which may alter these widths, or provide

The Cliff Shore Hazard Zone (CSHZ) was created in GIS by using the BUFFER function in ArcView 3.x on each relevant stretch of cliff toe polyline to create a polygon representing the CSHZ.

4 Cliff Shore/Soft Shore Hazard Transition Zone

Where areas of the CSHZ intersected with areas of the Soft Shore Hazard Zone, a transitional zone has been created (Figure 1). Within this zone the potential hazard could be due to coastal processes, cliff processes or a combination of the two.

It is important that this zone is not treated as solely a coastal hazard or cliff hazard, but an area which may need more investigation (if development is to occur), due to multiple complex processes potentially occurring in these areas.

As the CSHZ is a polygon feature and the Soft Shore Hazard Zone is a line feature, the Hazard Transition Zone is a line feature which is a CLIP of the Soft Shore Hazard Zone where the CSHZ overlays.

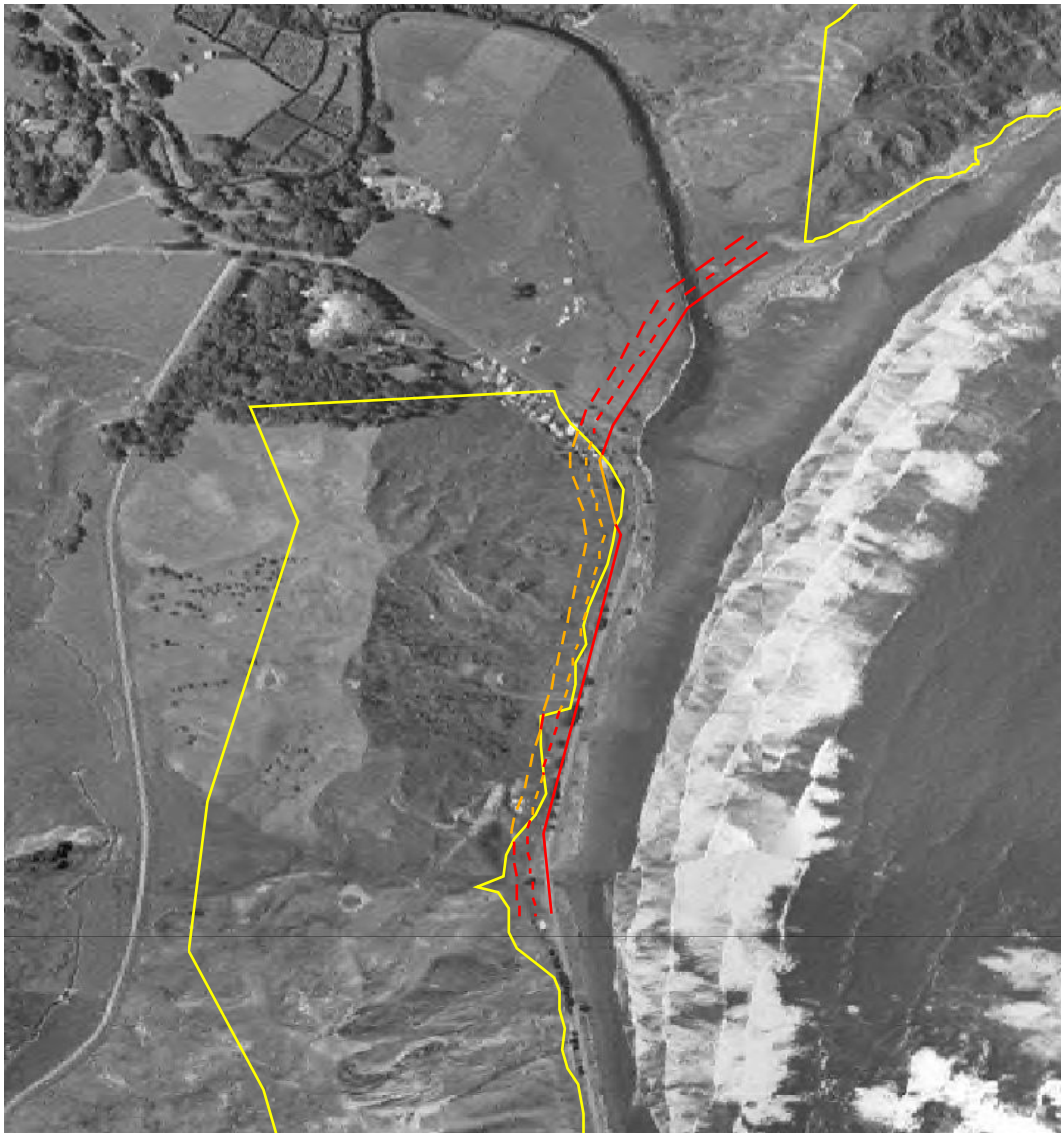

Figure 1. Example of Cliff Shore Hazard Zone (yellow) and Soft Shore Hazard Zone (Red) intersection that produces the transition Zone (orange).

The Soft Shore Hazard Zone includes the Current erosion risk (CERZ), 2060 erosion risk (2060ERZ) and 2100 erosion risk (2100ERZ) setbacks and is identical to the data supplied to HBRC by Tonkin and Taylor (2003)

5 Data Desciptions

All GIS files are held on the accompanying CD (Appendix B).

A PDF version of this report is also contained on this CD.

All data is in the New Zealand Map Grid (NZMG) projection using New Zealand Geodetic Datum 1949 (NZGD49).

[CSHZ.shp] contains the Cliff Shore Hazard Zone Polygons

[HTZ.shp] contains the Hazard Transition Zone which is the CLIPPPED Soft Shore Hazard Zone polylines that overlay the CSHZ polygons

6 Applicability

This report has been prepared for the benefit of Hawke's Bay Regional Council with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

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Appendix A: Cliff Shore Hazard Zone set back distances

Table A.1: Coastal **Erosion Hazard Widths for Cliff Shores**					
Location	**Max cliff height (m)**	**Coastal Hazard Zone from Cliff Toe**			**Source**
		calculated (m)	**inferred from topo map (m)**	**Published sources (m)**	
Southern boundary to Blackhead Pt.			900		
Blackhead Pt to Blackhead	200	410	450		
Blackhead to Aramoana	200	410	450		
Aramoana to Pourerere	160	330	350		
Pourerere to Paoanui Pt	110	230	250		
Paoanui Pt to 4 km south of Mangakuri Beach	210	430	900		
4 km south of Mangakuri Beach to Mangakuri Beach	130	270	500		
Mangakuri Beach to Kairakau	140	290	500		
Kairakau to Waiomana	150	310	300		
Waiomana to 2 km north of Waiomana	150	310	350	250	Pettinga (1980)
2 km north of Waiomana to Karamea Island	300	610	900	900	Pettinga (1980)
Karamea Island to Waimarama	110	230	400	400	Pettinga (1980)
Waimarama to Ocean Beach	100	210	250	250	Pettinga (1980)
Ocean Beach to Cape Kidnappers	130	270	300		
Cape Kidnappers to Clifton	140	290	300		
Clifton to Tangoio	N/A	N/A	N/A		
Tangoio to Waipatiki	130	270	300		
Waipatiki to Moeangiangi	160	330	350		

Table A.1: Coastal **Erosion Hazard Widths for Cliff Shores**					
Location	**Max cliff height (m)**	**Coastal Hazard Zone from Cliff Toe**			**Source**
		calculated (m)	**inferred from topo map (m)**	**Published sources (m)**	
Moeangiangi to 6 km north	390	790	800		
6 km north of Moeangiangi to Waikari River	100	210	250		
Waikari River to Mohaka River	130	270	300		
Mohaka River to Waihua	130	270	300		
Waihua to Whakamahi	100	210	250		
Whakamahi to Opoutama	100	210	250		
Optoutama to Mahia Beach	N/A	N/A	N/A		
Mahia Beach to Ahuriri Pt	150	310	350		
Ahuriri Pt to Kahutara Pt	180	370	400		
Kahutara Pt to Oraka	100	210	250		

Appendix B: Data CD

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