TARANAKI SURF BREAKS OF NATIONAL SIGNIFICANCE

Characterisation of the functional aspects of the Taranaki surf breaks and guidelines for their protection

Prepared for the Taranaki Regional Council

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1. INTRODUCTION

1.1. Background and scope

The Taranaki Regional Council (TRC) has commissioned MetOcean Solutions Ltd (MSL) to produce a desktop study that will inform new regional policy and rules around the protection of surf breaks of national significance identified in Schedule 1 of the New Zealand Coastal Policy Statement (NZCPS) and surf breaks of regional significance identified in Appendix II of the Regional Policy Statement (RPS). Within Taranaki, there are 81 surf breaks listed in the RPS, and four of these are surf breaks of national significance, which have protected status in law.

The scope of this report is to provide a functional characterisation of the four nationally significant surf breaks, and identify the types of activities that may directly or indirectly have an impact on them. The ultimate objective of the TRC is to develop guidelines relating to the magnitude and types of activities that could have a 'more than minor' effect on the nationally and regionally significant surf breaks in Taranaki.

1.2. Structure

The report is structured as follows. A summary of the main types of surf breaks and the accepted surfing wave parameters is provided in Section 2. In Section 3, the functional aspects of the Stent Road surf breaks are discussed from the limited amount of data available. Information about the seabed shape is readily available within New Plymouth area, allowing a more detailed analysis of the Waiwakaiho surf break to be undertaken (Section 4). The Waiwakaiho surf break is presented as a case study on potential direct and indirect effects that can influence surfing wave quality, along with the importance of quantifying the physical processes that give rise to the valued surf conditions. Recommendations are presented in Section 5, including the need for baseline data on the seabed shape and the appropriate consideration of temporal scales when making effects-based assessments. References cited are listed in the final Section 6.

For context, a summary of the wave conditions around the Taranaki volcanic apron is provided in the following subsection.

1.3. Wave climate summary

Taranaki is valued as a surf destination for several reasons. The hemispheric volcanic apron allows favourable wind conditions to be found under a range of synoptic weather patterns, and there is good exposure to the Sothern Ocean swells as well as waves generated in the Tasman Sea. This variety in coastal orientation is coupled with a nearshore marine environment that is interspersed with rocky reefs formed by volcanic debris and lahar agglomerates. The result is a province with a high concentration of quality surf breaks.

There is a gradient in wave energy (Figure 1.1), with the zone from Cape Egmont to Opunake receiving the largest wave heights, on average. From Stent Road northwards, average wave heights steadily decrease (Table 1.1) due to the progressive refraction of the dominant swell waves arriving from the Southern

Ocean and the southern Tasman Sea. This refraction is evident in the wave roses around the Headland (Figure 1.2).

The incident wave climate in 50 m depth offshore of Cape Egmont is presented as the annual joint probability distributions of wave height, peak wave period and mean wave direction (Tables 1.2 and 1.3). The wave climate is dominated by long period (10-14 s) conditions from the southwest sector.

Table 1.1 Significant wave height statistics at 6 locations on the 20 m depth contour around the Taranaki Headland, derived from a 36 year hindcast. Note that p50, p70 etc is the percentile non-exceedance level).

	Location		**Significant wave height (m)**						
Site	**Longitude**	**Latitude**	**mean**	**p50**	**p70**	**p80**	**p90**	**p95**	**p99**
P1	174.22187	38.95647	1.48	1.31	1.68	1.96	2.42	2.87	3.94
P2	174.03660	39.04087	1.10	0.92	1.27	1.56	1.99	2.41	3.30
P3	173.86059	39.13357	1.66	1.51	1.88	2.15	2.63	3.07	4.17
P4	173.73481	39.27341	2.33	2.20	2.62	2.91	3.43	3.97	5.17
P5	173.78597	39.43432	2.26	2.13	2.55	2.83	3.35	3.86	5.04
P6	174.06566	39.61073	1.87	1.75	2.12	2.38	2.83	3.28	4.25

Table 1.2 Joint probability distribution (parts per thousand) of significant wave height and mean wave direction at 50 m depth off Cape Egmont.

	Wave direction (coming from)								
Hs (m)	**N**	**NE**	**E**	**SE**	**S**	**SW**	**W**	**NW**	**Total**
0-0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
0.5-1	0.1	0.0	0.0	0.0	0.2	7.1	1.5	0.2	9.1
1-1.5	1.3	0.0	0.0	0.1	1.0	71.2	10.0	1.7	85.3
1.5-2	3.9	0.1	0.0	0.0	2.8	193.2	27.3	7.1	234.4
2-2.5	6.4	0.1	0.0	0.0	3.6	196.4	39.7	12.4	258.7
2.5-3	5.1	0.0	0.0	0.0	3.6	125.6	42.4	12.3	189.1
3-3.5	3.8	0.0	0.0	0.0	3.6	59.3	34.6	9.2	110.5
3.5-4	1.7	0.0	0.0	0.0	2.4	23.7	24.3	6.6	58.7
4-4.5	0.6	0.0	0.0	0.0	1.3	8.9	15.0	3.5	29.3
4.5-5	0.2	0.0	0.0	0.0	0.6	2.6	8.1	1.6	13.1
5-5.5	0.1	0.0	0.0	0.0	0.2	0.9	4.3	0.9	6.5
5.5-6	0.0	0.0	0.0	0.0	0.1	0.3	2.0	0.3	2.7
6-6.5	0.0	0.0	0.0	0.0	0.0	0.1	1.1	0.1	1.4
6.5-7	0.0	0.0	0.0	0.0	0.0	0.1	0.6	0.0	0.7
7-7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.3
7.5-8	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1
8-8.5	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1
8.5-9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	23.3	0.2	0.0	0.1	19.3	689.4	211.5	56.1	1000.0

Table 1.3 Joint probability distribution (parts per thousand) of significant wave height and peak wave period at 50 m depth off Cape Egmont.

Hs (m)	**Peak wave period (s)**																		
	2-3	**3-4**	**4-5**	**5-6**	**6-7**	**7-8**	**8-9**	**9-10**	**10-11**	**11-12**	**12-13**	**13-14**	**14-15**	**15-16**	**16-17**	**17-18**	**18-19**	**19-20**	**Total**
0-0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
0.5-1	0.0	0.1	0.0	0.3	0.2	0.0	0.2	0.4	1.8	2.1	1.4	1.2	0.5	0.4	0.3	0.1	0.0	0.0	9.1
1-1.5	0.0	0.0	0.2	1.3	2.1	1.7	1.1	3.6	16.8	23.0	13.4	11.7	4.2	2.9	1.6	1.1	0.4	0.3	85.3
1.5-2	0.0	0.0	0.0	1.0	5.2	7.4	5.4	7.8	26.2	60.3	48.2	41.7	13.8	8.1	4.3	2.9	0.9	1.0	234.4
2-2.5	0.0	0.0	0.0	0.1	3.5	12.6	11.5	9.4	16.0	41.4	53.3	66.4	24.0	11.0	4.9	2.4	1.3	0.8	258.7
2.5-3	0.0	0.0	0.0	0.0	0.7	8.6	15.1	11.0	10.0	18.0	29.1	50.9	26.0	12.2	4.6	1.9	0.7	0.4	189.1
3-3.5	0.0	0.0	0.0	0.0	0.0	2.7	12.8	9.8	6.2	8.3	11.6	26.1	17.4	10.8	3.3	0.9	0.4	0.2	110.5
3.5-4	0.0	0.0	0.0	0.0	0.0	0.3	5.0	9.4	4.9	4.1	4.4	9.6	8.7	8.4	3.0	0.7	0.3	0.1	58.7
4-4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.7	5.1	4.3	2.6	1.8	4.3	3.5	4.7	1.8	0.4	0.1	0.0	29.3
4.5-5	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.7	2.8	1.5	1.1	1.6	1.5	1.7	0.9	0.3	0.0	0.0	13.1
5-5.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.5	1.1	0.6	0.7	0.7	1.0	0.4	0.2	0.0	0.0	6.5
5.5-6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.7	0.5	0.2	0.3	0.4	0.1	0.0	0.0	0.0	2.7
6-6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4	0.2	0.2	0.2	0.3	0.0	0.0	0.0	0.0	1.4
6.5-7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.7
7-7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3
7.5-8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
8-8.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
8.5-9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.0	0.1	0.2	2.8	11.8	33.2	51.7	58.3	91.1	163.6	165.9	214.8	101.1	62.1	25.2	10.9	4.2	2.9	1000.0

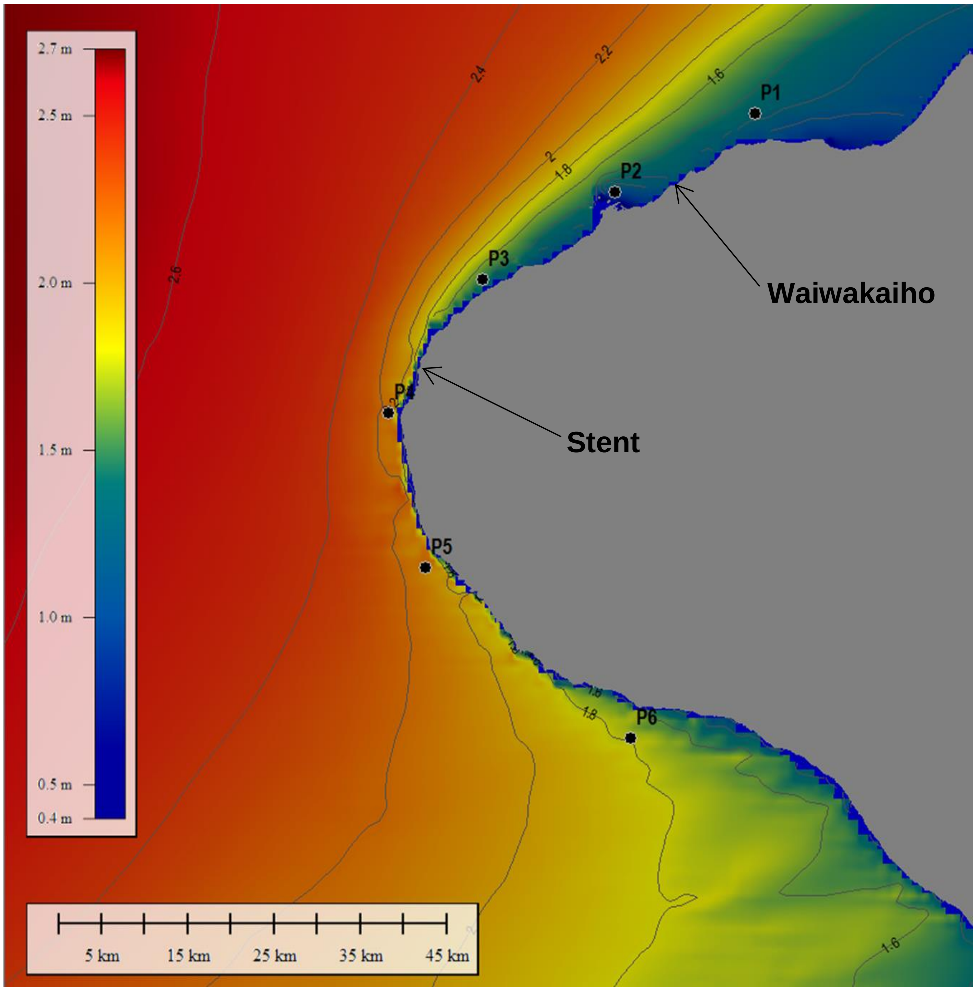

Figure 1.1 Map showing the average significant wave height from a 36-year hindcast. Locations for the statistics along the 20 m depth contour presented in Table 1.1 are also shown on this map.

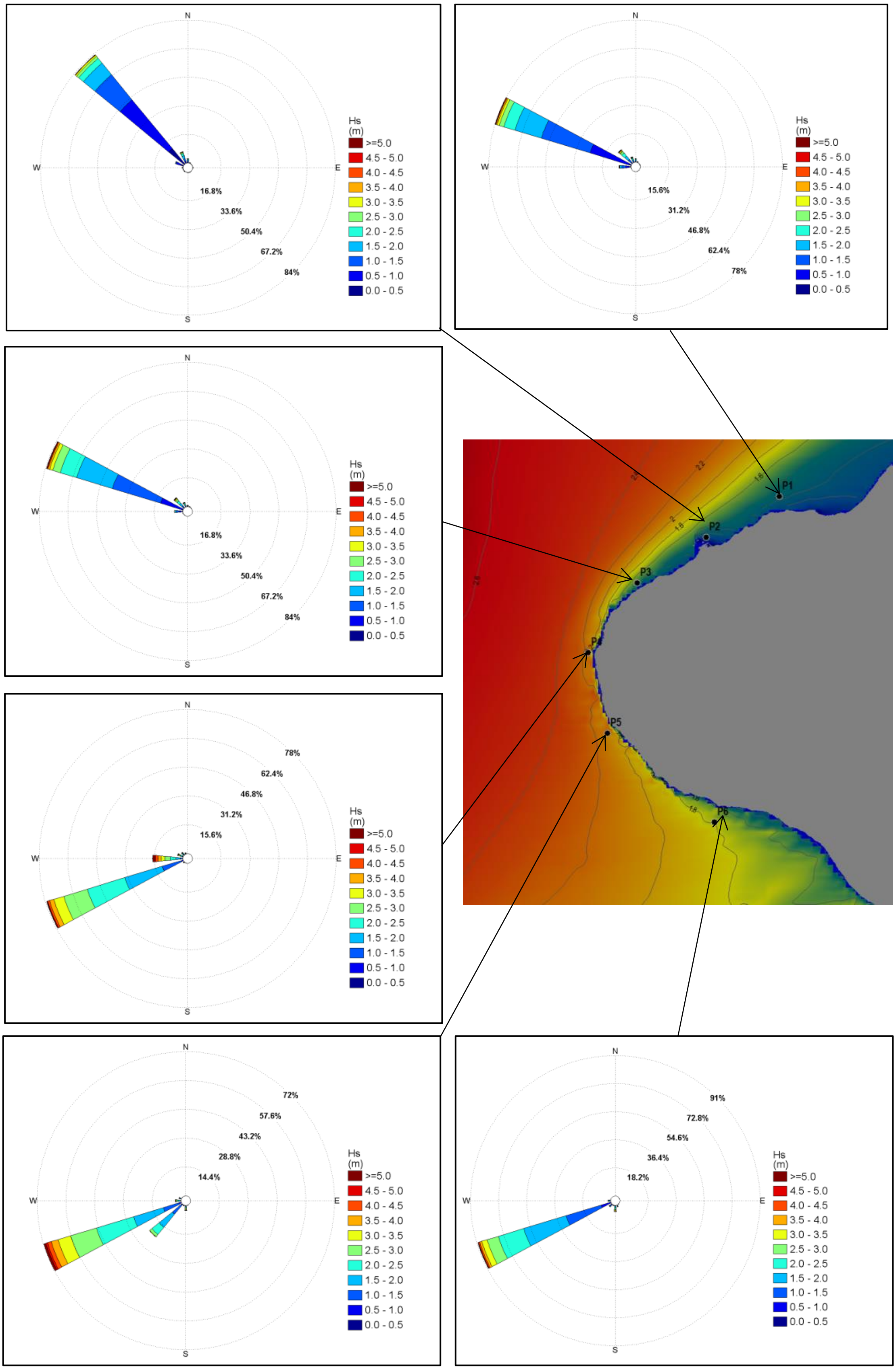

Figure 1.2 Annual wave roses derived from a 36-year hindcast at sites on the 20 m depth contour.

2. FUNCTIONAL ASPECTS

The New Zealand Coastal Policy Statement (2010) defines a surf break as:

"*A natural feature that is comprised of swell, currents, water levels, seabed morphology, and wind. The hydrodynamic character of the ocean (swell, currents and water levels) combines with seabed morphology and winds to give rise to a 'surfable wave'. A surf break includes the 'swell corridor' through which the swell travels, and the morphology of the seabed of that wave corridor, through to the point where waves created by the swell dissipate and become non-surfable. 'Swell corridor' means the region offshore of a surf break where ocean swell travels and transforms to a 'surfable wave'. 'Surfable wave' means a wave that can be caught and ridden by a surfer. Surfable waves have a wave breaking point that peels along the unbroken wave crest so that the surfer is propelled laterally along the wave crest."*

The formal definition of swell is ocean wave energy that is not being actively generated by wind. That is, swells are waves that have travelled beyond the area of active generation, whereas sea waves are being actively generated by wind. For surfing waves, it is typically the far-field storm activity that generates long period swells that produce the optimum wave conditions for surfing. However, swell waves can exhibit a range of frequencies, not just the long period conditions.

2.1. Types of breaks

Surf breaks were categorised by Mead *et al*. (1998) into four main types:

- Headland or point breaks – where wave refract around a topographic feature before breaking, usually over a rocky seabed or reef. Local examples are the Kumara Patch and Stent.
- Beach breaks – sandy or gravel beaches that may or may not have offshore features that modify the incoming waves to produce favourable surfing conditions. For example, Fitzroy is a beach break but the offshore bathymetry causes a well-defined nearshore wave height gradient and therefore zones of preferential wave peeling.
- River / estuary bars – topographical variability that can be conducive to a well-formed surf break, such as the Waitara Rivermouth.
- Reef breaks – stable features that provide consistent wave breaking characteristics. Most breaks in Taranaki are rocky reefs, which have relatively shallow gradients due to their cobble / boulder composition.

Surf breaks are often a combination of these categories, such as a headland and reef break like Stent. Beamsley and Black (2003) identified that while wave height reinforcement due to focussing by an offshore bathymetric feature plays a vital role in creating a surf break, the process of crest-snapping was equally important at many of the renowned breaks around the world. Crest-snapping can occur over a range of bathymetric features, and it is caused by the difference in wave speed over adjacent areas of seabed due a strong depth gradient. Linear wave crests become offset (or snapped) as a result, and this can produce exceptional surf, such as occurs at Pipeline on Ohau (Hawaii). Local New Zealand examples where crest-snapping governs wave quality include Matakana Island, The Pipe in

Gisborne, and Aramoana Beach in Dunedin. However, negative effects can also arise from crest-snapping. In Taranaki, the offshore Waiwakaiho Reef distorts the linear wave crests by crest-snapping but only during long period swells (greater than 16 s) and on the low tide, thereby deteriorating the wave quality at the break point.

2.2. Surfing wave parameters

A detailed review of surfing wave parameters was made by Scarfe (2003), and the four most important parameters are described here:

- **Breaking wave height.** This is considered to be one of the most important parameters at a surfing break. Typically, the arrival of waves is modulated into groups (sets) and surfers seek to ride the largest waves in these groups. Accordingly, the average of the top 10 % of waves is the best statistic for description of the surfable waves, rather than the significant wave height, which is approximately the average of the highest third of the waves.

- **Wave peel angle**. This is the angle (from 0-90°) between the trail of broken white-water and the crest of the unbroken wave as it propagates shoreward. Low peel angles create fast surfing waves, while angles approaching 0° result in a closeout, whereby the wave face collapses and ends the ride. High peel angles create slow waves which are less challenging to surf. The wave peel rate describes how fast the wave breakpoint advances laterally along the wave crest, and this is closely related to the wave peel angle.

- **Wave breaking intensity.** The seabed gradient controls the wave breaker intensity, which is categorised into spilling, plunging, surging, or collapsing breakers. The best surfing waves are those with very steep (plunging) faces. Breaker intensity is also influenced by the wind conditions; increasing in offshore winds and decreasing in onshore and cross-shore conditions. Offshore wind conditions act to delay wave breaking, causing the wave to break in shallower water and thereby increasing the breaker intensity.

- **Wave section length.** Variations along the wave crest (i.e. due to unorganized swells, wave focusing and undulating bathymetry) can cause wave face to exhibit a varying character along the length of the ride. The section length describes the surf ride for specific wave height, peel angle and breaker intensities. At most surf spots, especially the point and reef breaks, a uniform and linear wave crest is most favourable as it facilitates a longer wave section length. However, short section lengths on beach breaks also produce quality surf conditions, and crest-snapping is a good example of this.

2.3. Swell corridors

The NZCPS describes the swell corridor as being the region offshore of a surf break where ocean waves travel and transform to a ‘surfable wave’. This definition has no spatial constraint, and could be interpreted as extending thousands of kilometres away, as swell waves can and do travel considerable distances. However, in practical terms the propagation and transformation of waves over the continental shelf is most relevant, and in most cases the proximity to the surf break will be highly correlated to effects. The two most likely effects on swell corridors will be due to modification of the bathymetry and attenuation of the wave energy flux.

Ocean waves start to become influenced by the seabed when the water depth is approximately less than half the wavelength of the waves. Shoreward from here, water depth starts to govern the propagating wave speed, and wave refraction, shoaling and frictional attenuation all become important processes. Wavelength is a property of wave period, so the long period wave conditions favoured for surfing can be influenced by the bathymetry of the entire continental margin – out to around 200 m depth.

Changes to the seabed morphology within the swell corridor can have significant effects on the surf quality, particularly if the function components (Section 2.1) are altered. However, this is not the only possible effect. Attenuation of the wave energy flux or distortion of wave crests (e.g. full or partial crest-snapping) can be influential as well. Offshore structures such as floating or fixed production facilities and wave energy converters have the potential to create impacts, which will be determined by the scale and distance from the surf break.

If an activity has the potential to; i) give rise to a change in the bathymetry that modifies wave transformation or ii) has an attenuating effect on the wave energy, then further investigation would be warranted.

2.4. Wind

Ocean waves are generated by the interactions between wind and the surface of the ocean, with the resultant wave height and period a function of the winds duration, fetch and velocity. Near the shore, wind speed and direction influence the quality of a breaking wave for surfing, with offshore-directed winds being most favourable. In contrast, strong alongshore directed winds are least favourable and can produce short choppy waves with crests orientated perpendicular to the swell wave crest, adversely effecting surfing conditions. Light onshore directed winds are less likely to affect the surface conditions of the surfable wave (e.g. Figure 2.1).

2.5. Surfability

The ‘threshold of surfability’ depends on the type of board, the ability of the surfer and the mix of wave height, wave period, wind strength and direction. Attenuation in wave height is an important aspect of a negative effect on surf, as a relatively small decrease can mean the surfable threshold is not reached.

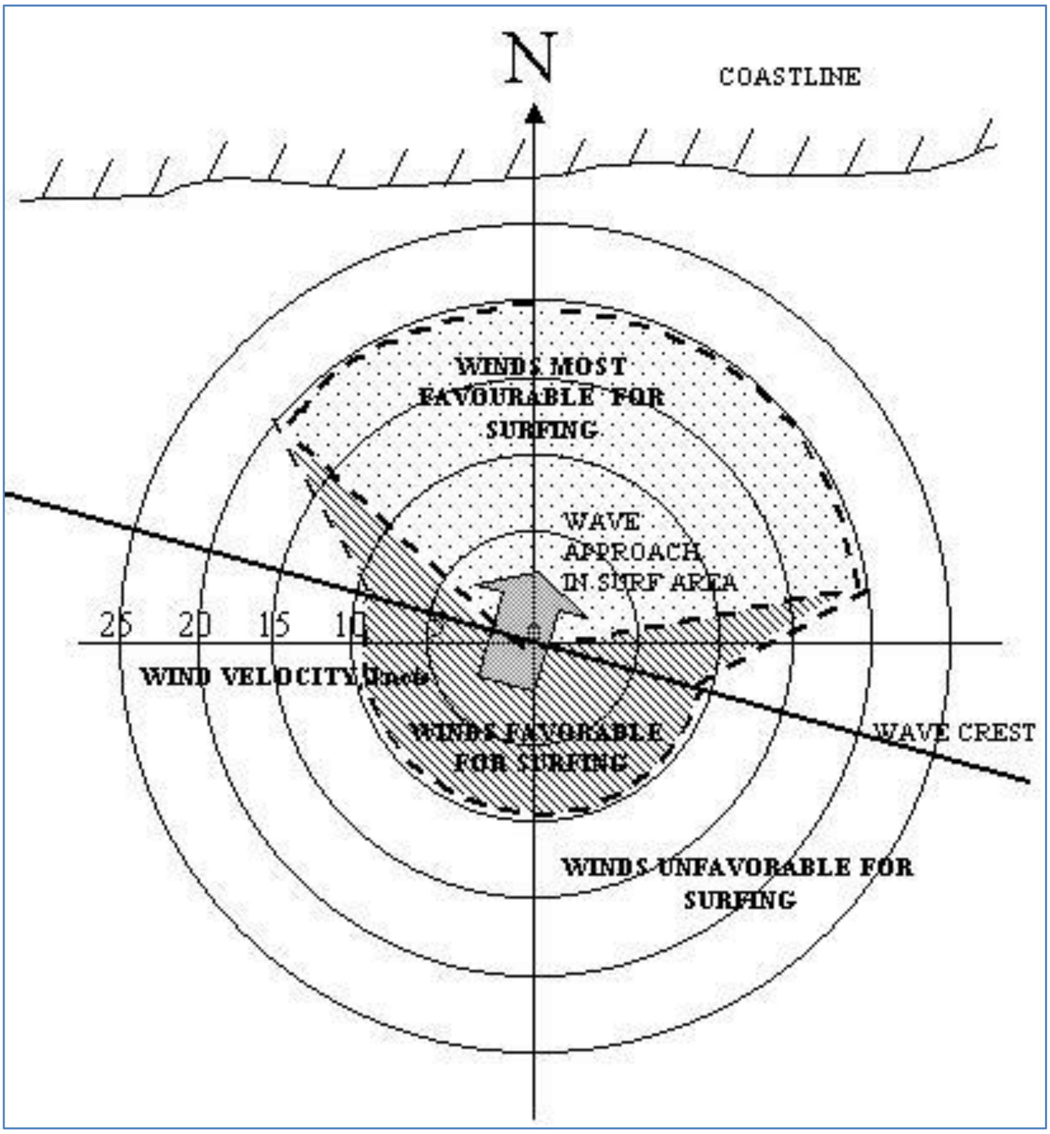

Figure 2.1 Wave rose depicting the effects of wind strength (knots) and direction on surfing waves (modified from Walker, 1997).

3. STENT ROAD SURF BREAKS

The surf breaks of national significance at Stent Road are shown on Figure 3.1. Of these three, Stent is the most popular due to its consistency, power and length of ride. Together, the three breaks at Stent Road provide surfers with choice based on tide level, wind speed and direction, and wave height. Also, given the popularity of this surf destination, having a number of breaks in close proximity can reduce the crowd pressure in the water. An overview of the three breaks is as follows:

- **Farmhouse** is the least surfed wave of the three; typically ridden over the high tide and during larger wave conditions. A southeast wind is approximately offshore here and the wave is not favoured during a northeasterly wind. The wave peeling is relatively slow and the wave face is generally not very steep. The wave breaks left along a subtidal reef platform.

- **Stent** has features consistent with a headland or point break, but there is strong focussing of the wave energy toward the point due to the shape of the seabed further out to sea. This combination makes Stent a world-class right hand wave when the conditions are perfect. The wave can be surfed at all tides, and at high tide in northeast winds there is a degree of shelter from the adjacent point, allowing a clean wave face when it would otherwise be choppy and distorted.

- **Backdoor** (also known as **Stent Left**) is often favoured during smaller wave conditions because it attracts a lot of wave energy, and also during southeasterly winds because of the shelter afforded by its orientation. The wave can be surfed on all tides, and there is a short right hand wave, and a longer left hander that peels away to the northeast over a boulder reef platform.

Beyond the 10 m depth contour offshore of Stent Road, the bathymetry (Figure 3.2) shows evidence of large-scale reef structures that are expected to rotate and focus the wave energy toward the break locations. This effect can be qualitatively validated by observation – particularly at Stent and Farmhouse where the wave heights are much larger than adjacent parts of the coastline. However, the surf quality at all three of the breaks is likely due to the combination of offshore focusing and boulder reef platforms that extend from the intertidal to the shallow subtidal zone and facilitate a peeling wave with a surfable face. Accordingly, the quality surf conditions at Stent are a result of a two-stage process that starts with offshore pre-conditioning of the waves and ends with nearshore wave peeling over a stable substrate.

It is notable that the high concentration of quality surf breaks between Stent and the Patch (see Figure 3.2) coincide with the presence of large distended offshore reef systems. These features have a morphology consistent with eroded lahar deposits and are typically interspaced with areas of mobile sandy deposits (Crofskey, 2007).

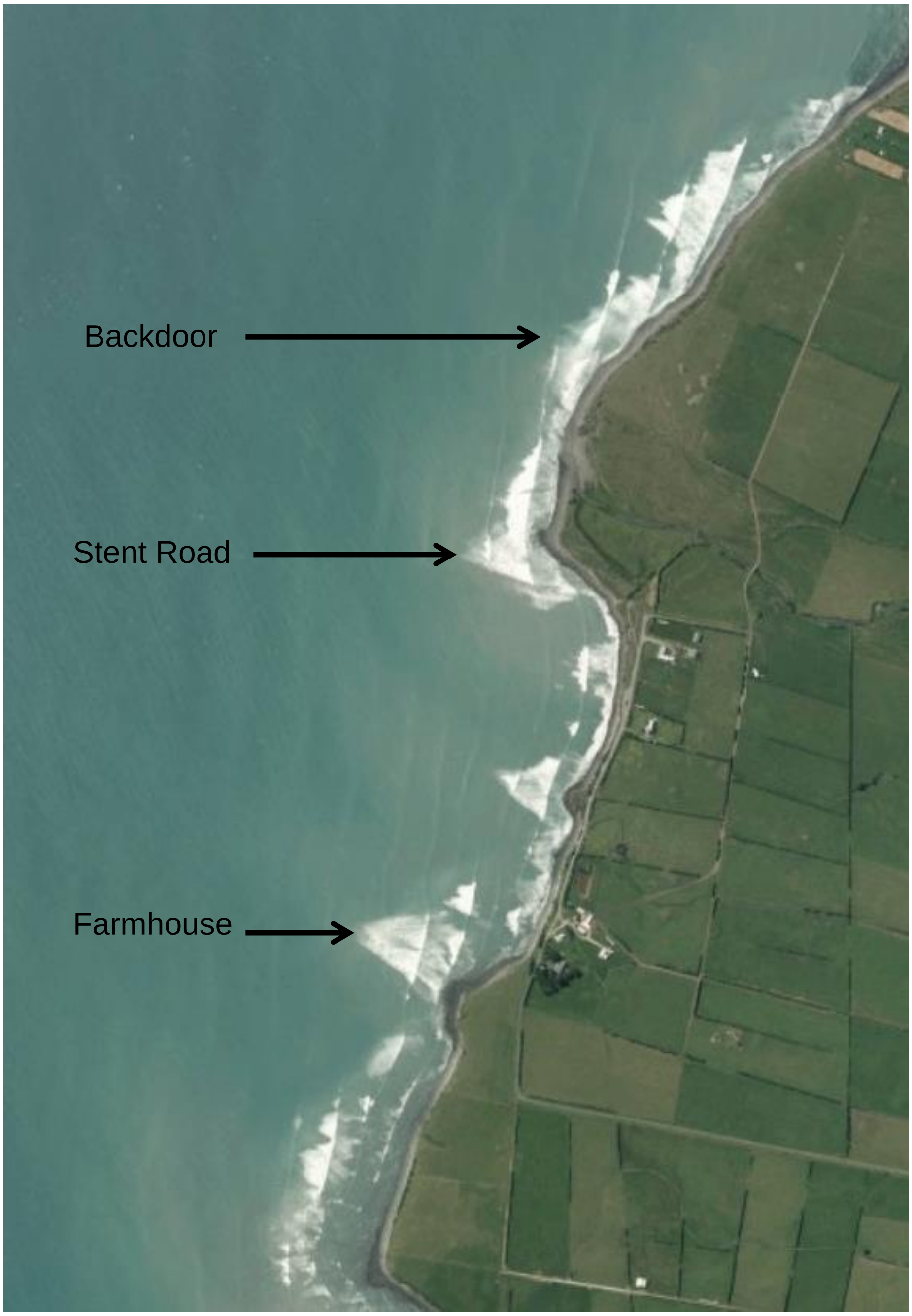

Figure 3.1 Aerial photograph showing of the three surf breaks of national significance at Stent Road.

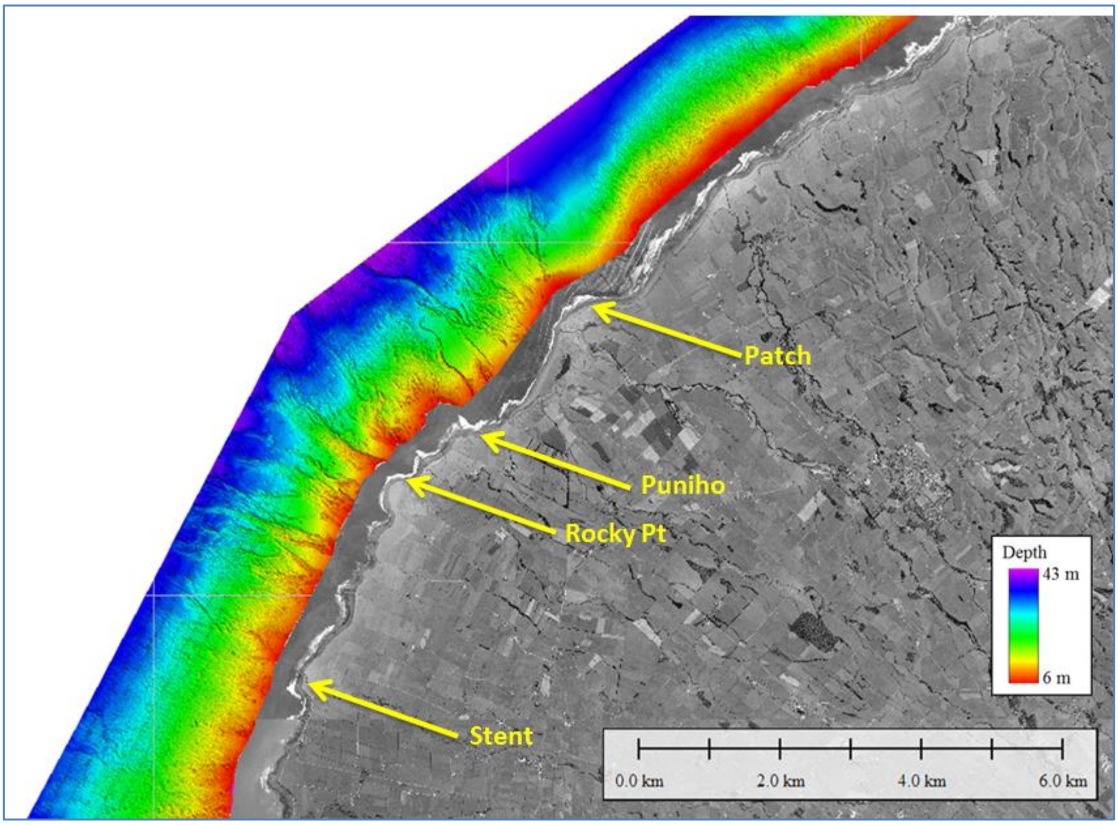

Figure 3.2 The complex bathymetry of the Taranaki coast is revealed from high resolution MBES survey data, reproduced here with permission from Fugro BTW Ltd.

4. WAIWAKAIHO SURF BREAK

The surf break of national significance at the Waiwakaiho Rivermouth is shown on Figure 4.1, and the underlying bathymetry is presented on Figure 4.2. Waiwakaiho is a left and right hand break; however the right is most favoured for its wave shape and size. The break is highly exposed to the predominant southwesterly winds, and is best surfed in light conditions or offshore (southeasterly) winds. Traditionally the mid to high tide level was the best state for this wave. However, there is anecdotal evidence of degradation in wave quality over the last decade, particularly at high tide. The observation is the breaking wave face is less steep and less defined in terms of breaker location, particularly during smaller wave conditions. During large swell events however, the wave generally shows similar form that led to its selection as a surf break of national significance.

The break features a well-defined focus zone located approximately 1.2 km offshore and to the northwest of the river mouth. The incoming swell waves refract around and shoal over an extensive bathymetric feature. Wave heights increase locally through this process and as they propagate toward the break point, this amplification is maintained. The subtle seabed morphology between the offshore reef and the nearshore surf zone is conducive to preserving a strong wave height gradient, thereby allowing a favourable peel angle. A series of numerical wave model simulations (Figures 4.3 and 4.4) clearly illustrates these processes.

The surf riding section of the wave is over the shallow and intertidal region, and the underlying morphology of this zone is the delta formed by the Waiwakaiho River. Deposition of small boulders, cobbles and gravels over many years has defined the shape of the coast here, and an alluvial fan created by the river is clearly evident in the aerial photographs. In 1981, a rock groyne of 100 m length was constructed west of the river mouth, and extended to approximately 150 m length in 1996. Note the length of this groyne has been misreported over the years, possibly because sediment has accumulated on the western flank of the structure.

Historical aerial photographs were analysed to show the changes in the vegetated shoreline margin (Figure 4.5) and river location (Figures 4.6) over time. The historical data confirms that the presence of the groyne has had a significant effect on the local sediment and river mouth dynamics. The mouth has migrated west to become permanently located adjacent to the groyne; an offset of some 150-170 m from the historical alignment. West of the groyne the shoreline has prograded by at least 50 m, and a new fillet of sand extends some 500 m toward Fitzroy Beach.

It has been speculated that the extension of the groyne by 50 m and associated realignment of the river mouth has led to the degradation of surf quality at the break. A qualitative assessment from the historical aerial images would support that concept. The delta morphology has undoubtedly changed (Figure 4.9 and 4.10) - the eastern shoreline has retreated while the western side has prograded. Changes to the intertidal and shallow subtidal morphology are evident, likely because the alongshore flux of sand is altered by the groyne and new river position, plus the zone of direct deposition of the coarser fluvial material (cobbles and gravels) has shifted westwards. A lowering of the intertidal and shallow subtidal delta in the area of the surf breaker zone is consistent with the surfer observations of degraded wave quality.

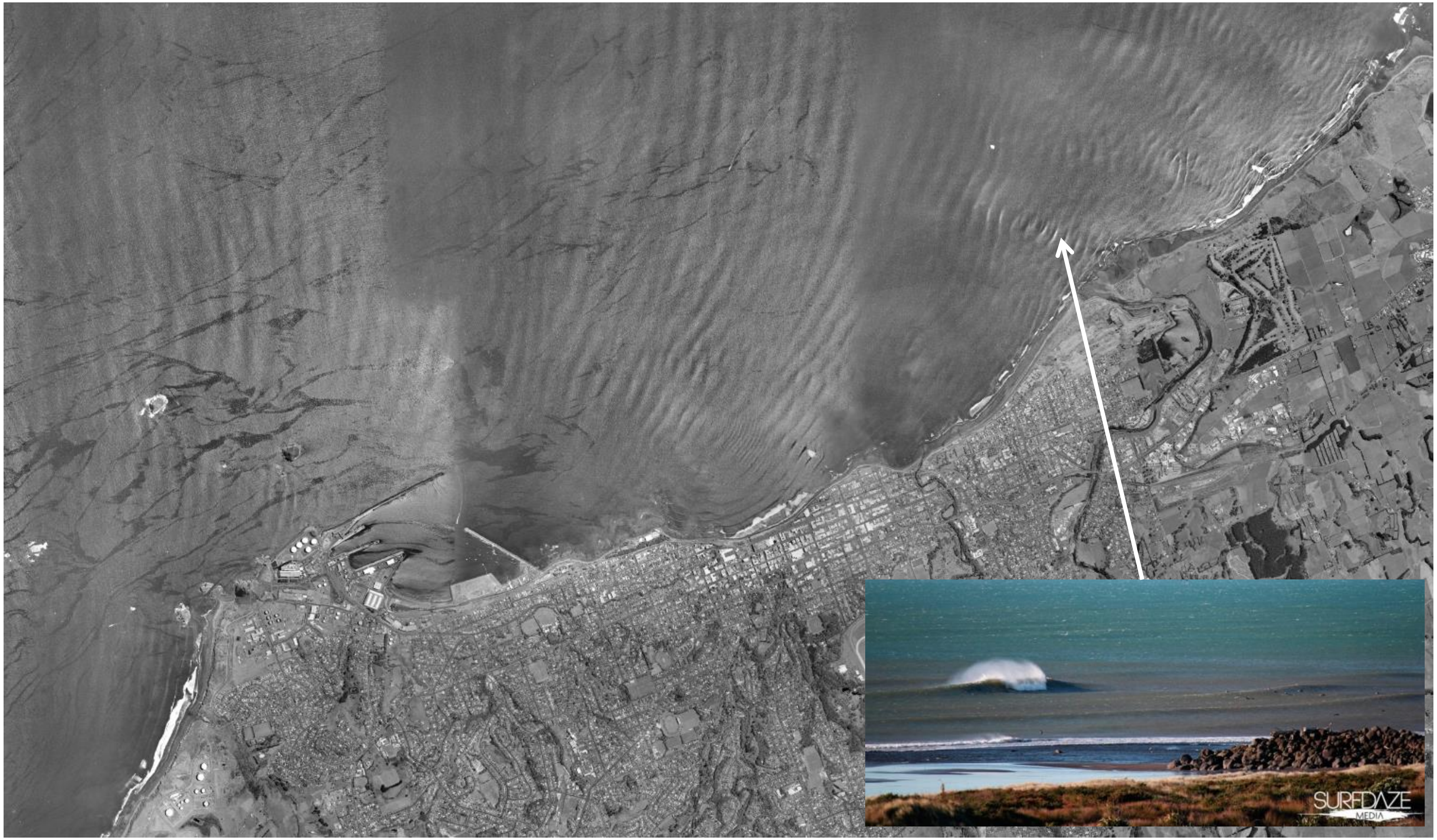

Figure 4.1 Aerial photo and inset oblique photo showing the Waiwakaiho surf break. Note the refraction of the swell waves arriving west of the port and the strong refraction and focussing of wave energy offshore of the rivermouth.

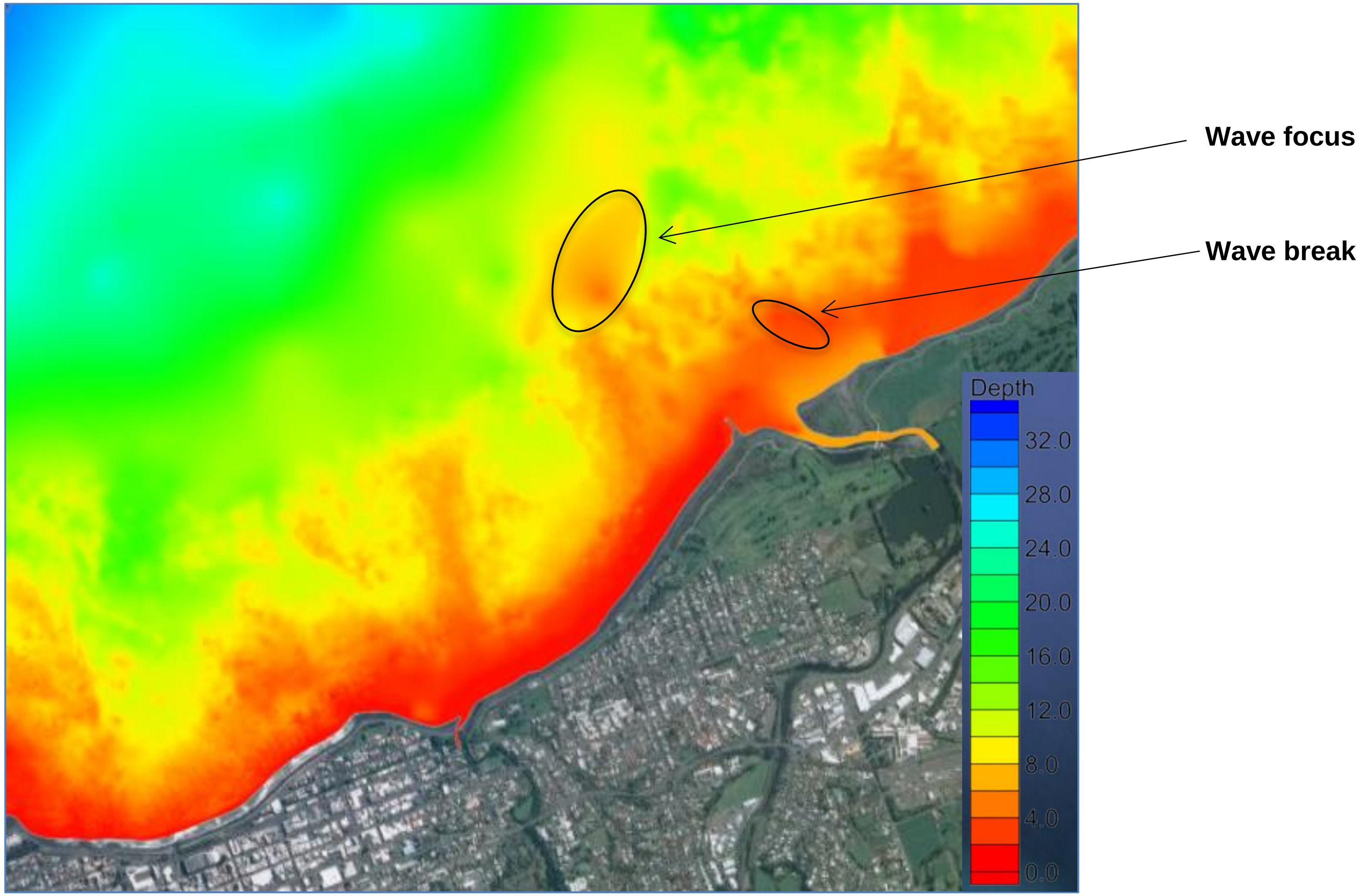

Figure 4.2 Bathymetry of the New Plymouth region, with notation for the zones of wave focussing and breaking at the Waiwakaiho surf break.

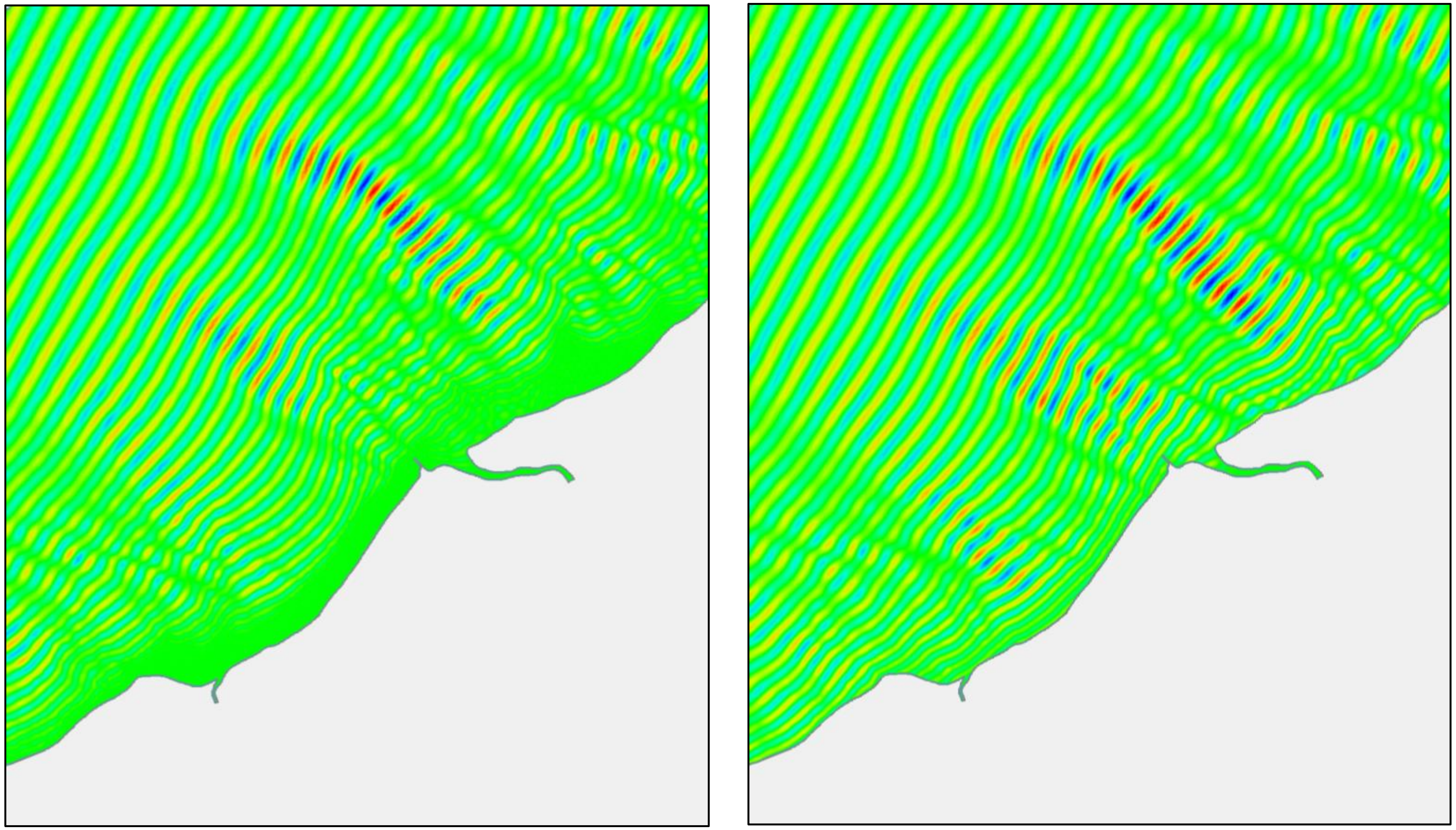

Figure 4.3 Model result for Waiwakaiho, showing wave crest patterns at low tide (left) and high tide (right) during typical energetic swell conditions (Tp=14 s).

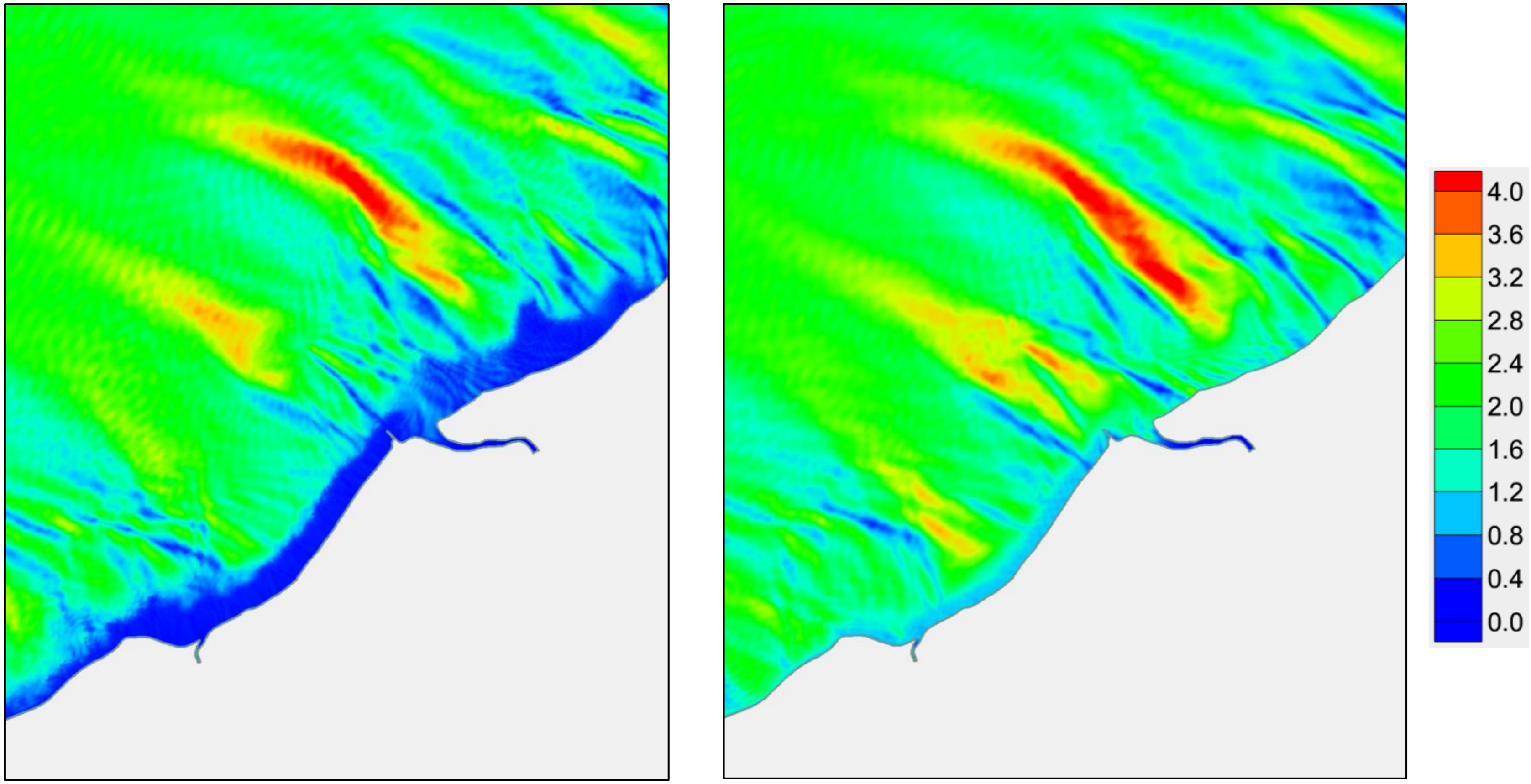

Figure 4.4 Model result for Waiwakaiho, showing wave height patterns at low tide (left) and high tide (right) during typical energetic swell conditions (Tp=14 s).

Figure 4.5 Change in seaward extent of vegetation (2012 base aerial photography).

Figure 4.6 Aerial photographs from 1970 (left) and 2012 (right), comparing the river position and shape of the intertidal delta.

5. DISCUSSION AND RECOMENDATIONS

There are six key components to surf breaks that can be used to inform generic guidelines for their protection, and these are discussed as follows.

5.1. Seabed morphology

The morphology of the seabed plays a crucial role in defining surfing waves, and the physical processes that describe the way waves interact with the seabed are well understood. Wave refraction and diffraction, frictional attenuation and other transformational processes can be reliably simulated with numerical models if the shape of the seabed is precisely known. It has been well-documented that changes to the bathymetry can lead to changes in the offshore to nearshore wave transformations, so numerical models can be used effectively to predict such outcomes. Note that changes due to the shape of the seabed can be expressed in a variety of ways, such as wave phase or wave crest linearity's (i.e. crest-snapping), as well as in the height and direction of the waves. The distance offshore and the water depth, along with the scale of change will all influence the degree of effect on the surf break and the wave quality.

A local example is the Belt Road surf break. The most recent capital dredging to deepen the shipping channel at the entrance to Port Taranaki has had a subtle effect on the way that waves propagate past the main breakwater tip and toward the surf break. This does not change to total wave energy flux, but it has reduced the alongshore wave height gradient and the resultant peel angle, thereby having a detrimental effect on the quality of the left hand rides.

It is not considered appropriate to prescribe a threshold in rules based on the magnitude of change in bathymetry or seabed shape as a guideline. For example, a relatively small change in the seabed shape (say 5 % of depth) over a long distance (say 1 km) can have a very significant effect on waves at the shore due to the progressive refraction and diffraction processes. Accordingly, a “buffer zone” identified on a case-by-case basis via the resource consents process may be more effective.

It is further suggested that a change to the seabed that has the potential to give rise to a change in the wave transformation process should require further assessment through the resource consents process, which is aligned with the intent of the NZCPS. Potential activities which may give rise to a change in the wave transformation are outlined in Table 5.1 below and in Section 5.7 where the unique attributes for the surf breaks of national significance are documented. This can be readily tested by analytical or numerical modelling means. The requirement for further assessment should not be constrained by water depth or spatial extent, and nor should it be triggered by activities that have a very small magnitude and small footprint – such as the disturbance caused by the anchor of a cargo vessel in 50 m water depth. Conversely, an activity such as sand mining, dredge spoil disposal or pipeline installation on the seabed would indeed merit a detailed examination of the effects.

There are other processes that can lead to detrimental bathymetric changes, possibly over relatively long time scales. An example is the extraction of gravel and boulders from a river, thereby depriving the adjacent coast source of suitably coarse material to maintain its morphology. Another example is dredging a shipping channel within an ebb tide delta, leading to loss of material over time and a change in the wave transformation over the subtidal structure. In both of these examples, it may be decades until negative effects on surf are realised. In all cases, baseline data on the bathymetry offshore of the break (i.e. in the key parts of the swell corridor) as well as at the wave breaking location is crucial for an effective protection regime.

5.2. Coastal structures and coastal processes

Changes to the coastal orientation due to erosion or accretion have the potential to affect the surf quality - by direct or indirect means. An example is Waiwakaiho, where the progressive construction of the groyne has caused considerable accretion and realignment of the adjacent beach with a zone of progradation that extends approximately 500 m to the west. This offset of at least 50 m in the beach face at the groyne has changed the sediment dynamics of the river mouth, and led to a permanent westward reorientation of the mouth by 150-170 m. The intertidal morphology east of the groyne as has responded to this change and it is considered likely that the morphology of the larger subtidal delta is also evolving. Here, cobbles and gravels provide the basis for the wave breaker zone, and there is anecdotal evidence that erosion of material from this zone has led to loss of wave quality over the past decade. An adequate monitoring and reporting regime on the intertidal and coastal environment will allow identification of such changes, particularly if the potential impacts on the surf quality are known to the regulators.

Wave reflection off coastal structures is another potential impact on surf quality, and may be of importance in the future – particularly with rising sea levels. Reflected waves can interfere with the surfing wave shape. An example is St Clair beach in Dunedin, where the surf has suffered degradation due to a poorly designed coastal structure and dangerous reflection of a sea wall. This has also created access problems and risk to surfers entering and exiting the water at high tide.

5.3. Surfer access

Access to the surf is an important component to preservation of the use and enjoyment of the breaks. As noted above, this can include the entry / exit locations, but also vehicle or pedestrian access. Another example from Otago is the closure of beaches to surfing in preference to wild life tourism activities. Public access on the coast is primarily a district council responsibility but could be addressed in the policy framework of the Coastal Plan.

5.4. Wind

The wind speed and direction governs surf quality at many (if not all) the breaks in Taranaki. In most cases, a reduction in wind speed would be considered a beneficial effect at many of the surf breaks. Note however, sports that use wave and wind (kitesurf and windsurf) would generally value wind, and would view shelter or distortion as a negative effect.

5.5. Wave energy attenuation and wave crest distortion

Aside from bathymetric effects, surf quality can be negatively impacted by the attenuation of the incoming wave energy and distortion of the wave crests. Offshore structures such as floating or fixed production facilities and wave energy converters have the potential to create impacts, but only if they are deployed in an array (i.e. groups of structures) or are very close to the surf break.

5.6. Water quality

The water quality is a relevant component to preservation of the use and enjoyment of the breaks. Sewerage and river discharges in the vicinity of a surf break may affect the water quality, making it unsafe or inappropriate to surf. Changes to flow regimes and sediment supply can affect the shape of the rivermouth and therefore the surf quality.

5.7. Overview of effects on key components of surfbreaks

The types of activity that could potentially affect the key components of all surf breaks are summarised in Table 5.1.

5.8. Breaks of National Significance

Summary information of the four Taranaki surf breaks of national significance are presented below, including the key components that are specific to each breaks to serve as a general guideline for their protection. The information outlined in Table 5.1, which applies to all surf breaks, should also be considered when assessing whether an activity could potentially have an effect on a functional aspects of a surf break and/or the recreational experience.

Table 5.1 Examples of generic activities and effects on surf breaks.

Key component	Activity	Affect
Seabed morphology	Dredging and mining	Changes to the seabed shape in the swell wave corridor to the surf break can affect the wave crest linearity as well as the wave height and direction.
Coastal structures and coastal processes	Sea wall, pipeline, groyne, breakwater and jetty	Numerous types of effects can arise from a coastal structure. An expert interpretation is recommended to assess each case.
Surfer access	Disruption of access	Access to the surf is an important component to preservation of the use and enjoyment of the breaks, including entry / exit locations for pedestrians and vehicular access to the coast.
Wind	Windfarm	Modification of wind speed and direction may affect surf breaks. A reduction in wind speed could be a beneficial effect in many cases. However, sports as kitesurf and windsurf would generally view shelter or distortion as a negative effect.
Wave energy attenuation and crest distortion	Offshore structures	Floating or fixed production facilities and wave energy converters have the potential to modify wave conditions. However the effects are strongly dependent on scale and proximity.
Water quality	Sewage discharge	Sewage discharge in the vicinity of a surf break may affect the water quality of the area and make it unsafe or inappropriate to surf.
	River discharges	River water quality can affect the water quality in the adjacent surf break and make it unsafe or inappropriate to surf. Changes to flow regimes and sediment supply can affect the shape of the rivermouth and therefore the surf quality.

	**Name**	Waiwakaiho River Mouth
	Relevance	Nationally significant
	Location	1695806.23E, 5678732.33N
	Type	Reef break
	Formed by	Offshore focussing of wave energy onto a river delta formed by cobbles and boulders.
	Currently modified by	- Wastewater discharge from the adjacent outfall - Groyne
	Could potentially be adversely affected by	- Changes to the shape of the offshore focussing reef - Changes to the alignment of the river - Changes to the shape of the river delta - Changes to the sediment flux from the river - Deterioration of water quality of the river - Deterioration of the quality of the wastewater discharge from the adjacent outfall
	Activities with potential to cause adverse effects*	- Gravel extraction from the river - Continuation of the groyne in its existing form - Industrial or agricultural discharges into the river - Untreated sewage discharge

*Also the activities outlined in Table 5.1 which apply to all surf breaks.

	Name	Back of Stent
	Relevance	Nationally significant
	Location	1667064.80E, 5658567.36N
	Type	Reef break
	Formed by	Cobble and boulder reef platform.
	Currently modified by	- Adjacent stream - Pedestrian access
	Could potentially be adversely affected by	- Deterioration in water quality from the adjacent stream - Restrictions to pedestrian access
	Activities with potential to cause adverse effects*	- Agricultural discharges into the stream - Array of offshore wave energy converters - Gas pipeline construction - Offshore sand mining

*Also the activities outlined in Table 5.1 which apply to all surf breaks.

<table>
<tr><td rowspan="8"></td><td>Name</td><td>Stent Road</td></tr>
<tr><td>Relevance</td><td>Nationally significant</td></tr>
<tr><td>Location</td><td>1667003.61E, 5658226.38N</td></tr>
<tr><td>Type</td><td>Headland reef break</td></tr>
<tr><td>Formed by</td><td>Wave focusing from an offshore reef to a stable boulder platform that extends to form a headland.</td></tr>
<tr><td>Currently modified by</td><td></td></tr>
<tr><td>Could potentially be adversely affected by</td><td>- Changes to surfer access
- Changes to the shape of the offshore focussing reef</td></tr>
<tr><td>Activities with potential to cause adverse effects*</td><td>- Array of offshore wave energy converters
- Gas pipeline construction
- Offshore sand mining</td></tr>
</table>

*Also the activities outlined in Table 5.1 which apply to all surf breaks.

Name	Farmhouse Stent
Relevance	Nationally significant
Location	1666933.58E, 5658086.35N
Type	Reef break
Formed by	Boulder reef platform
Currently modified by	
Affected by	
Examples of activities	- Array of offshore wave energy converters - Gas pipeline construction - Offshore sand mining.

*Also the activities outlined in Table 5.1 which apply to all surf breaks.

5.9. Recommendations for regionally significant surf breaks

A workshop should be undertaken with interested parties to confirm the location and identify the unique aspects of all of the 81 regionally significant surf breaks. This will provide additional site specific data for those breaks similar to the tables we have for the nationally significant breaks. This will help us ensure that we identify all types of activities that could potentially affect these regionally significant surf breaks.

5.10. Further recommendations to assist with monitoring and implementation

- A baseline survey of the bathymetry at the Stent Road and Kumara Patch breaks is strongly recommended. This should include the adjacent offshore regions to characterise the wave preconditioning zones, and extend through the break and include the upper shore and coastal margin.

- A regional high quality bathymetric database should be established, and access to the data in Figure 1.2 negotiated. Further survey to fill in the gaps toward the shore and around the other breaks of regional significance should be promoted over time, including those required via the consenting process. Of particular merit is the zone from Stent to the Kumara Patch. This is a region that would suit MSc research projects, thereby minimising cost and optimising the community knowledge gains.

- An open data policy is also advocated, which will allow interest groups and researchers the opportunity to undertake independent studies.

- Recommendation to develop a “buffer zone” that associates “size” and “scale” of an activity and the possible effect on the surf breaks. See Table 5.1 as an example.

6. REFERENCES

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