Wainui Beach Management Strategy (WBMS) -

Surf break Protection

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Introduction

A management strategy is being devised for Wainui Beach to address coastal erosion. Work to date has identified the key community values to be encapsulated in this strategy are:

- Protection of surf breaks of national significance,
- Property Protection,
- Maintain natural beach processes (and natural character),
- Protect the foredune, and
- Maintain public access to the beach

The management strategy will address and examine these values. In this report, the focus is surf break protection and required answers to three key questions or queries:

1. An explanation of how surf breaks are formed and the related beach processes;
2. What are the high level design considerations or factors to consider to protect surf breaks when developing [protection] options? and
3. Are current protection works and dune care work impacting on surf break and to what extent?

The community values indicate the management strategy will need to satisfy multiply needs, and therefore, should follow the key "good design" principle of 'solving more than one problem at a time'. In this respect, the community wants a management strategy that will satisfy these values: surf break protection *and* property protection *and* maintain natural beach processess (and therefore natural character) *and* protect the foredune *and* maintain public access. Therefore, a holistic approach was taken so that connections between these values are identified and explanations provided alongside answering the 3 key questions.

This report is provided in two parts: (a) a brief summary - a single paragraph answer to the specified questions; and (b) an expanded explanation (or context) to support the brief summary. Therefore, the brief summary should be read in conjunction with the expanded explanations as laid out in paragraphs 1 through 16. This context is essential for those unfamiliar with coastal dynamics and geomorphology, and for complete understanding of surf breaks and beaches. It is provided at a basic level.

(a) Brief Summary

Natural Processes associated with Surf breaks

The main coastal processes responsible for surf break formation are **cross-shore and longshore sand movements** - in particular, the offshore & alongshore movement of sand that form underwater sandbars. This offshore & alongshore sand movement needs to occur between (a) the dunes and beach, *and* (b) the beach and offshore underwater section of the beach.

Coastal Processes Requiring Protection

The natural offshore and alongshore movement of sand is the key process to be protected for Wainui surf breaks. This offshore & alongshore sand movement needs to occur between (a) the dunes and beach, *and* (b) the beach and offshore underwater section of the beach. Further, these natural sand movements need to be safeguarded not only in the designated surf break area, but for the entire sandy shoreline of Wainui Beach. This is because the moving sand that forms the surf breaks is locally sourced and distantly sourced (being dependent on wave and storm conditions).

Current Protection Works and Surf breaks

No known methodology could be found that assesses the impacts of hard coastal protection works on surf breaks of sand-bottomed beaches. Based solely on visual assessments, it is not possible to make a conclusive statement on the impacts of current protection structures on Wainui surf breaks. In the Stock Route area, the existing emergency rocks (rip-rap) do not appear to be affecting the surf breaks as the size and scale of this structure does not prevent waves from reaching the dunes and sourcing dune sands during large storm events (i.e. storm waves still reach behind these rocks to obtain dune material). Current literature on coastal protection and surfing provides the following key messages: 1) the potential impacts of coastal protection structures on surfing resources is poorly understood and rarely quantified; 2) a range of coastal activities and structures can alter or destroy surf breaks and the wave quality via the processes of wave reflection (backwash), wave refraction, blocking effects, and modified sand transport; and 3) surf breaks are near impossible to replicate or repair once they have been destroyed.

Dune care or coast care planting will assist surf breaks by building the dunes and enhancing the store of sand required (the storm 'cut') during storm events. Dune planting will not prevent offshore and alongshore sand movements, only increase the volume of sand along the shore.

(b) Expanded Explanations to the 3 Key Questions on Surf break Protection

Surf break Formation and Related Beach Processes

[Provide an] explanation of how surf breaks are formed and the related beach processes

1. Wainui Beach is an example of an open-ocean sandy shoreline (or beach). It is best described as one of NZ's premier 'beach breaks' and produces plunging-type breaking waves (e.g. hollow, tube-riding waves). It is a predominantly sandy recreational beach, backed by a line of significant sand dunes, and has an offshore zone characterised as a rocky basement with a thin sand layer. Throughout the entire Wainui Beach system, sand is in constant motion. This sand-moving process is performed by breaking waves and nearshore currents.

2. Breaking waves and nearshore currents 'connect' all parts of the Wainui Beach system - in the alongshore direction (from one headland to the other, and back again) and across-shore (from dunes to sandy recreational beach to under the water and vice versa). And, therefore, sand moves in all of these directions. Both alongshore and cross-shore sediment transport occur simultaneously on open-ocean sandy beaches.

3. The sand dunes, the sandy (recreational) beach, and the area seaward under the waves ('surf zone' & underwater sandbars) all share the sand between them. This "sand-sharing" process takes two main forms:

- sand moves from the underwater sandbars towards and along the shore (onshore and alongshore) onto our beaches after storms (and eventually can be wind-blown into the dunes); and
- sand moves from the dunes and sandy dry beach seawards and alongshore (offshore) to form underwater sandbars during storm events (or periods of storm waves).

4. This process is often referred to as the beach "cut and fill" cycle - the "cut" part of the cycle occurs during large storm events, and involves sand shifting from the dry beach (and dunes) and being deposited underneath the waves in the form of a sandbar. The "fill" part occurs after the storm has passed and the wave size starts decreasing.

5. The <u>offshore (and alongshore) movement of sand</u> create underwater sandbars and it is these sandbars that create the nationally and internationally recognised Wainui surf breaks. Oram & Valverde (1994), in regard to beach beaches, also indicate that the bottom contour (sandbar) is the most important factor and requires an influx of sand to create the sandbar. Said another way, the underwater sandbars *are* the surf breaks. The recognition of Stock-Route, Pines and Whales as 'surf breaks of national significance' indicate that these are locations along Wainui Beach whereby underwater sandbars are near-permanent features that wax and wane under different storm/swell conditions, and are shaped in a way to create consistent high-quality surfable breaking waves year-round.

6. The <u>offshore (and alongshore) movement of sand</u>, and the associated formation of underwater sandbars, not only create surf breaks, but provide natural coastal protection. Sandbars force the large incoming storm waves to break on the sandbar that is often far offshore and in deep water (i.e. at the 'surf break'). With waves forced to break on the sandbar, this becomes the zone where waves release their

enormous amounts of energy. From the breakpoint through the surf zone, this wave energy is dissipated so that little of the original wave energy arrives near the dry beach. In other words, the breaking of storm waves on the underwater sandbar is a natural protection mechanism for those at the coast because large, powerful storm waves are prevented from reaching the shore.

Summary

The main coastal processes responsible for surf break formation are **cross-shore and longshore sand movements** - in particular, the offshore & alongshore movement of sand that form underwater sandbars. This offshore & alongshore sand movement needs to occur between (a) the dunes and beach, *and* (b) the beach and offshore underwater section of the beach.

Taking a holistic view, the natural processes that produce surf breaks are the same as those that provide natural coastal protection. Furthermore, protecting surf breaks acts to maintain and protect natural beach processes and the natural character of Wainui Beach, and in no way impedes or interferes with public access. All of these factors represent identified community values. That is, protecting surf breaks also provides protection of private property and maintains natural character and its associated natural beach processes. This is a win-win-win situation.

What coastal processes should be protected

What are the high level design considerations or factors to consider to protect surf breaks when developing options?

7. The natural offshore and alongshore movement of sand are the key processes that need to be safeguarded for surf break protection. This natural movement of sand complies with and supports NZCPS Policy 13 (Preservation of Natural Character). To be more specific, the offshore & alongshore movement of sand from the dry, recreational beach ***and*** from the dunes needs safeguarding. During large storm events, the formation of the underwater sandbars depends on a larger volume of sand and in places, this volumetric sand requirement is obtained from that stored in sand dunes.

8. Whilst one can identify the main natural processes associated with surf breaks (cross-shore & longshore sand movement & the formation of underwater sandbars), we must remember that waves and nearshore currents connect all parts (or sections) of Wainui Beach. This raises another fundamental point - the formation of the sandbar is dependent on sand moving ***into*** that area, and it can arrive from nearby (local source) and/or originate from areas at a great distance (distant source) from the sandbar itself. Using the Stockroute surf break as an example, under northeasterly storm waves, this surf break receives sand from upstream locations i.e. say, from the Pines area southwards; in southerly storm conditions, this surf break receives sand from Tuaheni Point northwards to Stockroute.

9. The implications of the above paragraph (#8) is that whilst we can identify the surf break locations, and put general boundaries around them, their essential feature - the sandbar - will be formed from sand that originates from outside (and inside) the designated surf break zone. Therefore, the offshore and longshore sand transport process needs to be safeguarded not only in the designated surf break areas but also at great distances from them.

10. A common metric to provide for the offshore (and longshore) sand movement during storms is a 'storm cut volume' or linear distance inland from the dune toe. In the assessment of coastal hazard zones, the extreme erosion risk zone specifies a magnitude of storm erosion, as either a volume (m^3/m) or as a linear distance, which can correlate to 'storm cut'. For Wainui Beach, Gibb (2001) has quantified both:

- Extreme erosion risk zone (EREZ) - 20-30m (includes maximum storm cut, S_{max} and angle of repose□);
- Maximum short-term erosion volume (S_{max}) - 105 m^s/m (Tuahine Crescent to Wainui Stream), 110 m^3/m (Wainui Stream to Wainui School), and 155 m^3/m (Wainui School to Hamanatua Stream); and
- Maximum short-term erosion linear distance (S_{max}) - 15m

These metrics can be used to represent the offshore & alongshore movement of sand required for surf break protection. As mentioned above (#8 and #9), the parameter must be provided for within and outside the designated surf break areas. One option would be to apply the chosen storm cut parameter to the entire Wainui Beach sandy shoreline.

11. There is an existing theory amongst some of the Wainui community that the dunes backing Wainui Beach do not consist of sandy material. This is an argument thrown around to support why some sections of the beach do not need to provide for storm erosion (or a storm cut volume), as the dunes will not release sand-based material needed for sandbar formation. This argument is yet to be substantiated and therefore remains as conjecture. Further investigations should be undertaken to either confirm or dispute this theory (e.g. photographic evidence, sediment coring, etc).

12. It is possible to have property protection options and simultaneously protect surf breaks. This involves placing potential hard engineering structures on the landward edge of the EREZ or S_{max}. That is, the EREZ or S_{max} will provide for surf break protection; provide natural coastal protection during storms; and maintain the natural character of coast. (Note - these factors represent many of the key values identified by the community and stakeholders). Then, in exceptional storm events, when the storm cut volume has been exhausted, a hard structure will come into effect and act to protect any residential developments that may become at risk. This possible strategy provides property protection from both natural coastal processes and engineering solutions (i.e win-win). This proposed strategy is an example of 'good design' - design that solves more than one problem at a time.

13. It is acknowledged that there will be some parts of the beachfront where residential homes fall *within* the EREZ or S_{max} value. The identification (and number) of houses that fall into this category is essential. With this information, additional strategies should be genuinely explored to complement the possible strategy outlined above (#12).

Current Protection Works and Surf breaks

Are current protection works and dune care work impacting on surf breaks and to what extent?

□ When sand dunes collapse, they reach an angle that keeps it stable; this is called angle of repose (depends on grain size and dune height). For the area south of Pines, angle of repose is 40^o according to Gibb (2001).

14. In general, the current protection works - in the form of rip-rap and seawall-type structures - act to interfere with natural sand movement and cut-off sand supply from the dunes (behind them) during extreme storm events. Given the vertical nature of some of the hard engineered structures, wave reflection effects and local eddy formations can create enhanced scouring, and can affect sandbar formation and the wave quality. There will, no doubt, be other complexities associated with these structures given the dynamic nature of coasts.

15. The following comments, paragraphs 16-17, are based on visual analyses only and personal experiences at Wainui by the author. In the Stockroute vicinity, taken in current form ('emergency' rock dump, or rip-rap), the author does not believe the surf breaks are being negatively affected - during large storm events, the waves are still able to erode behind these low-lying rocks and source the required sand. Furthermore, as explained in paragraph 8 and 9, the sand required to build underwater sandbars can be sourced from a large area of the beach and backing dunes (i.e. be both locally-sourced and distantly-sourced), not solely from the area immediate around the surf breaks.

16. Further southward of Stockroute (south of Cooper St to Tuaheni Crescent), where a mix of solid wooden walls, rip-rap and a log-rail wall make up the shoreline, it is not possible to say whether these structures are affecting surf breaks over and above natural variability. A logical argument says the blocking of sand from the dunes can lead to imbalances in offshore bathymetry, and sandbar formation, and this will impact the surf breaks and surf quality. However, the separation of this effect from natural variability would be extremely difficult to quantify (if not impossible). It would be more appropriate to state that these structures act to translate the volumetric sand requirement needed during large storm events onto the fronting sandy beach; that is, the locally-sourced sand (direct offshore sand movement) that partially or fully builds the underwater bar will come from immediately in front of the structures. As a result, these sections of the beach will lose its 'sand' cover and expose the underlying cobbles and rocky basement i.e. become a temporary cobble/rocky beach. Said another way, the locally-sourced sand that would, under natural conditions, flow from the backing dunes is now sourced from the next best location - the fronting beach (and any nearby unprotected sections of sand dunes and any distance sources). This also acts to lower the beach profile, and can lead to increased incidence of wave reflection (backwash) and local eddy features which can change the sandbars and wave characteristics (wave quality).

17. It is appropriate, at this stage, to indicate that these structures also interfere with other large-scale coastal processes. For example, shorelines will undergo a re-orientation or 'rotation' when storm waves arrive obliquely at the shore. When the shoreline is armoured with immovable structures, such processes are prevented, and the ability of the beach to 'protect' itself and reduce the amount of wave energy arriving at the shore is diminished. Under natural conditions, beaches "turn" to face the most powerful waves and, therefore, aim to face the waves in parallel or front-on. Holding shorelines in place prevents this rotational effect, and act to hold the shoreline planform in a position seaward of the location it would naturally take if the shoreline was allowed to equilibrate with the physical processes controlling its shape (Brew *et al.,* 2011).

18. Several peer-reviewed journal articles on coastal management or protection and implications for surfing (Nelsen *et al.,* 2013; Scarfe *et al.,* 2009a,b; Corne, 2009; Oram & Valverde, 1994) provide some very important insights. Firstly, two studies highlight that once surf breaks or surf spots are destroyed, it is 'virtually impossible' to replicate them or repair them (Nelsen *et al.,* 2013; SCT, 2011). Secondly, Corne

(2009) states 'impacts of coastal protection on surfing resources is poorly understood and rarely quantified prior to construction'. This is reiterated by Scarfe *et al.,* 2009a,b who stress the importance of collecting baseline information on existing surf breaks if future changes are to be properly assessed. Lastly, Corne (2009) indicates that wherever coastal protection is constructed in proximity to a surfing resource, there is usually an impact. In other words, a change in sand movements can lead to changes to bathymetry, which flows on to changes in wave quality. Corne (2009) also indicates that engineered structures can change local hydrodynamics and bathymetry to the extent that waves can change from the plunging type to the lesser quality spiller type.

19. Scarfe *et al.,* (2009a) lists the main coastal activities and engineering structures that can alter wave quality and surf breaks as beach nourishment, port developments, jetties, outfall pipes, breakwaters, seawalls, piers, dredging, boat ramps, dumping of dredge spoil, marinas and groins. This list includes activities both seaward (offshore) and landward of surf breaks. Nelsen *et al.,* (2013) and Oram & Valverde (1994) state that shoreline structures such as seawalls, revetments, jetties, groins and other structures may destroy surfing areas by reflecting, refracting or blocking waves and can compromise wave quality or create dangerous surfing conditions. Furthermore, it appears that the size and/or location of those structures are important factors to consider. For example, Scarfe *et al.,* (2009a) found that small engineered structures (boat ramp, and short breakwater) have negatively impacted the Manu Bay surfbreak in Raglan through alterations in seabed morphology (or bathymetry) and at a distance from the site of the engineering. Therefore, engineered structures do not have to be immediately adjacent to surf breaks in order to impact upon them.

20. The formation of surf breaks at Wainui Beach are discussed in Scarfe *et al.,* 2009b, whereby they infer complex offshore wave transformations (or wave focussing) create the sandbars and associated rips. Scarfe *et al.,* 2009b also reveal that at different surf breaks the contributions of offshore processes and nearshore features (sandbars) varies. Like Whangamata Bar, Wainui Beach is an example of a beach system whose surf breaks are created by both these factors - offshore processes and nearshore features. In the context of this report, the nearshore features have been the main coastal process highlighted (or the focus point) given that coastal management and shoreline engineering is the aspect that will impact on surf breaks.

21. Dune care planting will not negatively impact surf breaks, only have positive effects. Dune care activities will build up sand dunes and this does not impede the offshore movement of sand during storms (i.e. does not interfere with wave-driven sand transport that underwater sandbars are dependent on). Dune planting will build the reservoir or store of sand in dunes - increase the size of sand dunes - by catching wind-blown sand. Therefore, they effectively increase the volume of sand along the shore and available for the storm 'cut' process. This is also beneficial for natural coastal protection.

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