ATTACHMENT I

PREVIOUS SHORELINE CHANGE AND COASTAL PROCESSES DESCRIPTION

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Land Development, Resource Consent and Planning Specialists.

could cause the bay to resonate at its natural period, possibly amplifying the waves by 10- or even 100-fold in size (Goring, 1999).

5.0 Shoreline Change and Coastal Processes

The Holocene dune barrier backing Buffalo Beach is the widest in the Coromandel, the beach having gradually built seaward by about 2800 metres over the last 6500-7000 years (Dahm and Munro, 2000). The seaward advance of the beach arose from the deposition of large volumes of sand – derived both from onshore movement of sands and from the catchment of Whitianga Harbour (Dahm and Munro, 2000).

The rate of seaward advance was initially slow (about 0.08 m/yr) but had accelerated to rates of about 0.5-0.6 m/yr by 4500 years ago (Dahm and Munro, 2000). However, in more recent centuries the rate of progradation appears to have slowed considerably, probably averaging only 0.1-0.15 m/yr over the last 500-800 years (Dahm and Munro, 2000).

Evidence from shoreline changes over the last 50-60 years suggests that the shoreline may now be in dynamic equilibrium, the beach fluctuating backward and forward over that time with little evidence of any trend for net seaward advance (Dahm and Munro, 2000).

These shoreline fluctuations appear to occur over time-scales of decades, with particular periods characterised by net accretion and others characterised by erosion. For instance, the shoreline in front of the houses at the northern end of the beach appears to have experienced a period of erosion prior to the early 1960s, a survey conducted in 1958 showing the shoreline in a similar position to its present location. The second stage of subdivision in this area (i.e. northern sections created by DPS 7101, deposited 1961) required a greater reserve setback as a consequence of the erosion. Subsequently, in the period to 1995, the beach showed an overall trend for net accretion – with the toe of the dune moving seaward by about 15m over that time (Dahm and Munro, 2000). There were obviously instances of erosion during this time associated with storms, but the overall trend was for accretion. However, over the last 5-6 years, there has been significant trend for erosion (Figure 4) and the accretion of the previous 3-4 decades has largely been removed, the shoreline now being in a similar position to that surveyed in 1958.

The factors that determine the nature and scale of the dynamic shoreline changes at Buffalo Beach are not well understood, but it appears that the large, low ebb tidal delta complex located offshore plays a significant role.

This ebb tidal delta, extending seaward more than 1700 metres off the centre of the beach (Figure 4), is dynamically linked to the beach-dune system by an anti-clockwise net sediment transport loop. Sandy sediments from the lower harbour are transported out and deposited on the ebb tidal delta by discharging ebb flows. The sediments are then moved gradually landwards from the ebb tidal delta to the beach by wave action. Over time, beach sediments show a net southward drift towards and into the harbour entrance. Finer sediments (e.g. muds from the Whitianga Harbour catchment) tend to be recirculated seaward out of Mercury Bay (Smith, 1980).

A relationship between the shoreline changes on Buffalo Beach and the ebb tidal delta is suggested by the comparison of offshore surveys conducted when the beach was in an accreted state (January 91) and an eroded state (July 1999) (Figure 4). It can be seen that the recent period of beach erosion was accompanied by bed lowering/deepening over those areas of the ebb tide delta immediately offshore from the beach.

Locals also report that those areas of the ebb tide delta further offshore have actually built up over the last few years (Mr Max Booker and Mr Peter Johnson, pers. comm., October, 2001). This suggests that much of the sand eroded from the beach over the last few years may have moved southwards into the lower regions of the estuary and then been transported to the offshore bar by discharging ebb flows. Over time, it can be expected that these sediments will also be moved landward to the beach.

Similar patterns of sediment circulation and a close dynamic relationship between the ebb tide delta and adjacent shoreline areas have been reported at various other sites around New Zealand and the world. It is well known in the coastal geomorphological literature than shorelines adjacent to ebb tidal deltas can be very dynamic over periods of several decades.

The periods of increased erosion may also be partially related to climate changes such as ENSO (El Nino Southern Oscillation) cycles that can affect the frequency of storm events (Dahm and Munro, 2000). During periods with a higher frequency of coastal storms, sediments tend to moved offshore resulting in beach erosion. There is some evidence that beaches along the eastern Coromandel have shown an increased tendency for erosion over the last 5 years (Dahm and Munro, 2000) and this may be a response to the recent change in the ENSO cycle.

The maximum scale of the dynamic shoreline fluctuations which can occur at Buffalo Beach is unknown and this makes it difficult to estimate how much more shoreline erosion may occur at the northern end of the beach.

Previous investigations suggest the duneline typically fluctuates backward and forward by less than 30-35m at most Coromandel beaches, except in the vicinity of stream and estuary entrances or near major stormwater outlets where much larger fluctuations can occur (Dahm 1999b; Dahm and Munro, 2000). Therefore, there is concern that further erosion of up to 15-20m might be experienced if no action was taken. In the event of erosion of this magnitude, most of the properties would be seriously impacted and the dwellings would either be lost or have to be relocated.

There is also some evidence that even more serious erosion may occur. Local Iwi note that they have survey data and other information which indicates that the shoreline lay somewhere along the line of the road behind the properties in the mid-late 1800s (Mr Peter Johnson, pers. comm., October 2001). There is also some evidence of this from other lines of data, though the data has associated uncertainties (Dahm and Munro, 2000).

If the shoreline was as far landward in the mid 1800s, then there are two possible explanations:

- The beach is continuing to advance seaward at very high rates (about 0.5 m/yr), similar to those observed over the previous 6000 years. This is possible, but it is unlikely as it is inconsistent with detailed evidence that suggests little to no net shoreline accretion over the last 50-60 years (Dahm and Munro, 2000).

- Dynamic shoreline fluctuations can be very severe at this site – possibly reflecting the added influence of the ebb tide delta on coastal behaviour. Quite large shoreline changes are commonly noted adjacent to ebb tide deltas (Dahm, 1983; Dahm and Munro, 2000).

Further work would be required to confirm how far landward the shoreline lay in the mid 1800s and the reasons for any significant differences from the present shoreline.

In the longer term, there is also potential for erosion to be aggravated by changes likely to accompany predicted global warming, including a projected rise in mean sea level of 0.3-0.5m by 2100 AD (IPCC, 2001; Bell *et. al.*, 2001).

Therefore, there is clearly reason for considerable concern in regard to the potential future impact of coastal erosion on properties at the northern end of Buffalo beach.

There is also potential for coastal inundation to be an issue where the foredune has been removed by erosion.