Topographic mapping of Mangawhai sand spit and development of a draft framework for monitoring future changes

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EXECUTIVE SUMMARY A survey of the topography of Mangawhai Spit was conducted in 2024 using a dronebased LiDAR system, which allowed for a comparison of topographic changes with data from an earlier aircraft-based LiDAR survey conducted in 2018. A web-platform is provided to visualize digital elevation models (DEMs) as well as historic photographs and digitised coastlines, which provide an overview of historic changes to Mangawhai Spit. Water levels were calculated for extreme events, including the future effects of sea level rise (SLR). This enabled maps to be drawn identifying potential points for breakthroughs by the sea and flow paths through which water might penetrate the spit leading to potential flooding from the sea. The information provides baseline data against which to monitor future change. The report concludes with guidance and options for monitoring future change.

Key findings:

• The topography of the low-lying interior of the spit has not appreciably changed between 2018 and 2024.

• Lateral erosion of the bay-side spit has occurred while the ocean-facing dunes in the northern part of the spit have increased in elevation.

• Considerable (10-25 m) landward (westward) movement of the large dunes in the southern part of the spit has occurred between 2018 and 2024; it is not clear whether this is part of a longer-term westward movement of the dunes, but it is notable that decadal-scale landward erosion of the ocean-facing dunes has occurred at average rate of about 1.4 m/y and that other paleo-environmental research suggests east-to-west movement of dunes over centuries.

• Net loss of sand over the spit between 2018 and 2014 is ~260,000 m3, which is equivalent to 26,000 standard dump trucks (~10 cubic metres per load) or about 8 cm over the entire spit, representing about 1.8% of the total spit sand volume.

• Bathtub modelling indicates that a typical annual storm coinciding with spring high tide is unlikely to inundate the spit, but there are at least two areas toward the southern end of the spit that have local low points in the dunes that could potentially overtop.

• Relatively modest increases in sea level by 2040 are unlikely to materially change inundation and breaching risk associated with the typical annual storm.

• By 2080, if the morphology of the spit does not naturally adjust upward in response to SLR, the annual storm is likely to inundate the spit both through the distal northern portion of the spit

and at several discrete locations on the oceanside of the spit where the dunes are low-lying and discontinuous.

• A storm with similar properties to the 1978 storm would likely produce total water levels of around 3.2 m that would inundate large portions of the barrier with over washing in several ocean-side locations that could potentially stimulate breaching; however, today the spit is notably wider than it was in 1978 meaning that the spit is less vulnerable to breaching today than it was in 1978.

• Extreme dynamic total water levels of 4.7 m (with runup) have been modelled for the open coast of Mangawhai by Tonkin and Taylor (2021, Table 2.5 and Appendix C) based on a 1% Annual Recurrence Interval. Such an extreme storm would overtop the dunes in many places and create conditions under which breaching is likely.

• The bathtub models provided in this report rely on an assumption that a constant elevated water surface remains for the length of time required to achieve that 4 level of inundation. However, storms may not elevate the water level for a sufficient time to inundate the spit in the way bathtub models suggest. Detailed dynamic modelling is required to investigate these effects, which was beyond the scope of this study.

• Using slope maps and simple hydraulic modelling we estimate likely flow paths across the spit. The distal northern area of the spit contains a local low point that can be inundated by elevated water levels. Several possible overwash/inundation locations on the open coast of the spit are also identified, one of which nearly connects through to a flow path on the bay side of the spit.

• We draw attention to historic movements of the estuary channel leading up to breaching in 1978. It appears that potential bay-side breach initiation is likely to be controlled by the position of the harbour channel. The spit neck was unusually narrow prior to breaching in 1978 and the harbour shoal adjacent to the spit neck was unusually wide. Between 1963 and 1978 the channel flow appeared to be focused on the narrow portion of the spit neck leading to its progressive narrowing. The direction of flow appears to have been influenced by the widening of the adjacent shoal. The narrow width of the spit neck made the spit particularly vulnerable to breaching during the extreme 1978 storm.

• We recommend monitoring of Mangawhai spit, with particular focus on the position of the estuary channel, the growth of the estuary shoal adjacent to the spit neck, the width of the spit neck, and ongoing east-to-west movement of the beach shoreline and spit dunes. 5