Muhunoa Forest Park:

Stream Erosion Hazard and Potential Management Options

Prepared for Vincero Holdings Ltd

Eco Nomos Ltd

Thames

June 2022

Report:	Muhunoa Forest Park: Stream Erosion Hazard and Potential Management Options
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Executive Summary

Southwards longshore migration of the Waiwiri Stream entrance has significantly eroded the dunes seaward of the Muhunoa Forest Park over the last 10-15 years, giving rise to concerns with potential coastal hazard risk and difficulties with access between the properties and the beach.

This report was commissioned to review coastal processes to assess existing and future issues/risks and recommend appropriate management action for consideration. During the preparation of this report (in June 2022 following completion of the draft report but prior to the final) the stream once again broke seaward more directly, reducing immediate concerns. Nonetheless future longshore migration of the stream is likely and therefore the recommendations are of continued relevance, though there is less immediate urgency.

The assessment of coastal processes indicates that:

- House sites are presently well protected from coastal hazards (i.e. both coastal erosion and coastal storm inundation) by the wide high dunes seaward of the property.
- Southwards migration of the stream entrance has been common over the past 120 years for which records exist, reflecting the strong net southwards littoral drift along this coast.
- The longshore migration of the stream erodes the dunes seaward of the property, typically by widths of up to 75-80 metres (relative to the natural duneline along the coast) in central and northern areas, though up to 90-00 metres at the extreme northern of the properties.
- The shoreline seaward of the Muhunoa Forest Park is accreting, with an existing time-averaged rate of shoreline advance in the order of 1.8-1.9 metres per year.
- Ongoing natural shoreline advance has markedly increased the width of the reserve seaward of the properties, with the reserve width now typically about 135-140m, as measured from the most seaward toe of dune.
- Consequently, the present width of the protective dune buffer considerably exceeds the maximum width of dune erosion observed over the last 100-120 years. The existing risk from coastal erosion and/or coastal storm inundation is assessed as very low.
- Despite projected future sea-level rise, considerable further net shoreline advance (at least 70-110m) is likely to occur over the next 100 years. Accordingly, the current very low risk from coastal hazards will continue to decrease over time.
- Nonetheless, it would be wise to have contingency action identified in case of unusually severe stream erosion.
- The primary erosion hazard issue is assessed to be the difficulties with access between the properties and the beach posed by southwards longshore stream migration.

Various management options have been considered to address the existing issues, including:

- No intervention
- Periodic minor earthworks to divert the stream entrance further northwards
- Entrance training structure(s)

- Dune management

The options have been assessed in terms of practicality and effectiveness at this site, environmental effects, design and consenting requirements, and both capital and maintenance costs.

The “no intervention” option does not provide any contingency in case of unusually severe stream erosion and does not address the access difficulties and associated risks to human health and safety.

Periodic earthworks to divert the stream entrance more directly seaward would enable both access issues and any unusually severe stream erosion to be effectively addressed. This option would have only minor and temporary environmental effects. The consent status of this option is unclear and would benefit from planning input.

An entrance training structure would be very expensive and involve considerable uncertainties. It would also have adverse environmental effects. .

Limited dune management and minor earthworks is a very simple and cheap option that is likely to be readily implementable. This option would not address all management issues but would significantly improve access and reduce both the potential safety hazards and dune damage associated with access over the current steep eroded dune face. Adverse effects would be less than minor.

It is recommended that:

- The limited dune management and minor earthworks option be adopted and implemented to improve beach access and reduce potential future impediments to natural stream break outs. This work should be able to be implemented relatively quickly and with limited cost.
- Following natural stream break-outs in floods, consider (very minor) earthworks to place a sand stop in the old channel south of the break-out to help prevent return any return of flow to the abandoned channel and assist with beach access.
- Consideration could also be given to seeking authorisation for rare minor earthworks to re-direct the stream entrance - subject to appropriate conditions/triggers to ensure the work is only undertaken when required (see further discussion in Section 4.3). If and when required, this option would enable all relevant management issues to be effectively addressed with only minor and temporary adverse effects.

  The consenting requirements for this option are unclear and, in the first instance, it is recommended that input be sought from a planning practitioner.

  Given the recent (June 2022) more direct breakout of the stream to the sea, there is no immediate urgency for re-direction of the stream entrance. Nonetheless, further southwards alongshore migration will occur in the future and so it is still worth considering whether or not to pursue authorisation for this option. The recent stream break-out provides more time for this consideration.

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1 Introduction

1.1 Background and Purpose

The Muhunoa Forest Park rural estate is located on the coast of Horowhenua District coast, between the end of Muhunoa West Road and the Waiwiri Stream (Figure 1). The estate is fronted by a wide esplanade reserve (Lot 4 DP 44581) vested in the Horowhenua District Council.

The Waiwiri Stream discharges to the sea to the north of the property (Figure 1). In recent years, the stream entrance has migrated southwards alongshore eroding the dunes seaward of the property (Figure 2 and Figure 3). By early 2022, the stream erosion extended more than 600m alongshore, commonly eroding the dunes up to 75m inland of the natural dune toe and in places in excess of 125m. The high dune seaward of the Muhunoa Forest Park provides protection from coastal erosion and coastal storm inundation. Landowners are concerned at the potential for the stream to increase coastal hazard to the Forest Park properties over time.

The Muhunoa Forest Park also has two designated beach accessways (easements) (see bottom diagram in Figure 1); the northern of these easements lying between beachfront sections 7 and 8, and the southern between sections 4 and 5 (Figure 2). The stream channel and the steep eroded dune face (Figure 3) complicate beach access via the northern beach access easement.

Eco Nomos has been engaged by Vincero Holdings Ltd and the Ohau Sands Residents Association to advise on:

- Any existing or potential future hazard posed by the stream erosion to the Muhunoa Forest Park properties and planned building sites (shown in Figure 3), and mitigation options
- Mitigation of adverse effects of the erosion on beach access

1.2 Data and Information

The geomorphic history of the site was compiled from a wide range of information, including:

- Field inspections: A site inspection was conducted in February 2022, with Eco Nomos having also conducted prior inspections of the dunes in this general area in December 2020 and October 2010.
- Drone photography flown in January and February 2022, supplied by Vincero Holdings Ltd and local landowners
- Historic surveys and aerial photographs dating from 1900 through to 2022 compiled from various sources (Appendix A)
- Previous investigations along this coast (e.g. Bell, 2015; DoC, 2016; Eco Nomos, 2010 & 2021; Tonkin and Taylor, 2013 & 2018).

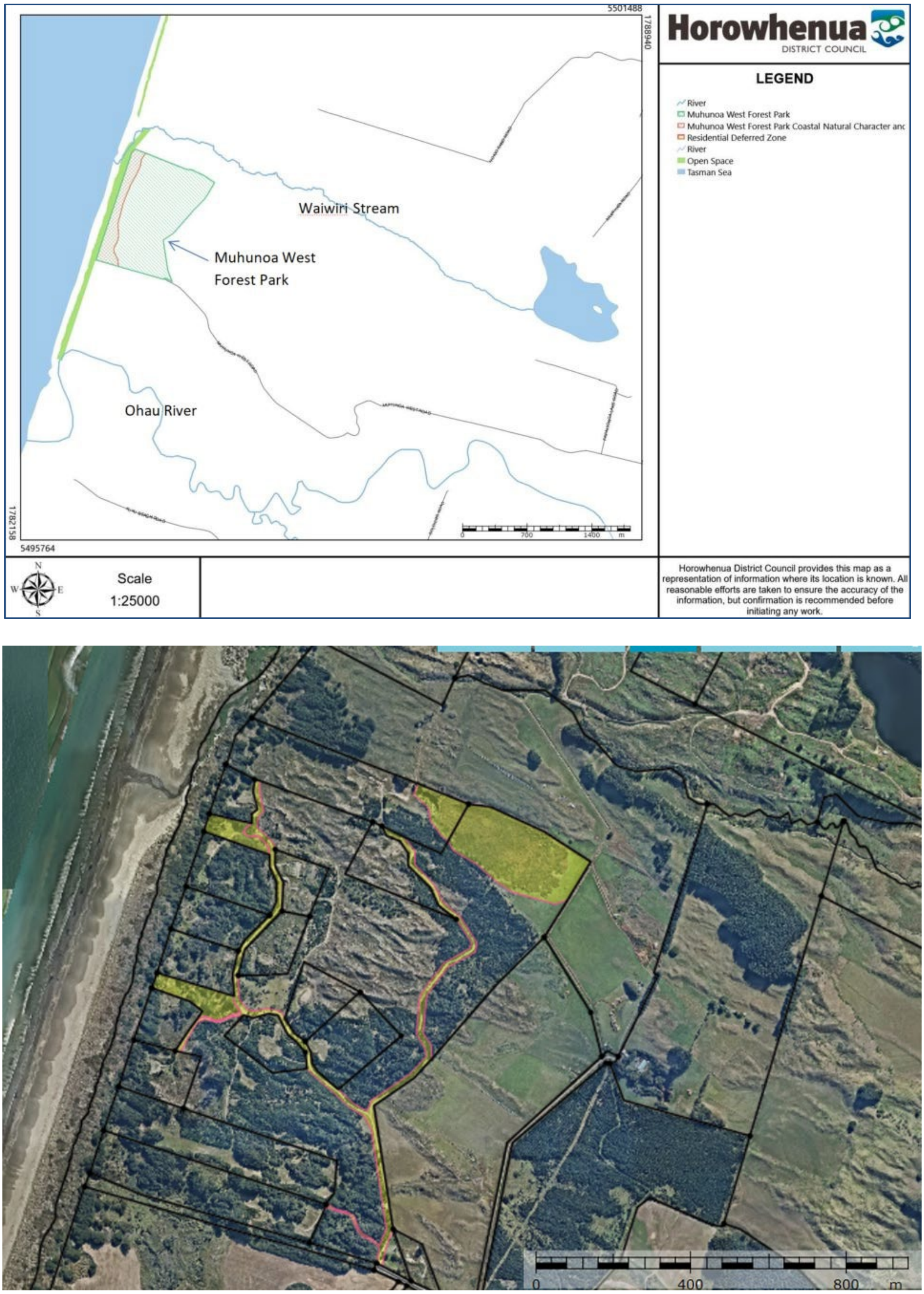

Figure 1: Views showing location (top) and details (bottom) of Muhunoa Forest Park. The yellow highlighted areas in the bottom diagram show the access areas (easements) discussed in the text. (Diagram compiled from information on Horowhenua District Council online maps. Aerial imagery in lower diagram dates from 2019).

Figure 2: View of Muhunoa Forest Park superimposed May 2021 aerial photography showing property and building sites. (Supplied by Vincero Holdings Ltd)

Figure 3: View of Waiwiri Stream entrance showing alongshore migration of the stream entrance and associated dune erosion and scarps. (Photos taken February 2022).

2 Site Description

2.1 Property and Coast

The site is located between the Ohau River and Waiwiri Stream on the southern Manawatu coast, and immediately north of the seaward end of Muhunoa Road West (Figure 1). The seaward edge of the property is fronted by a wide frontal foredune with a maximum height of up to about 11 m. Further landwards, the ground level drops and is typically about 4 m above mean sea-level (Eco Nomos, 2010).

The coast is subject to strong onshore winds, particularly from the west-northwest. Historically, the Manawatu coast has experienced significant periods of wind erosion and inland migrating sands over the Holocene, associated with both natural and (over the last 1000 years) human disturbance of stabilising dune vegetation (Cowie, 1963; Muckersie and Shepherd, 1995, Hesp, 2001). The WNW alignment of the transgressive dunes is similar to the wind resultant vector for sand-moving winds calculated for the Manawatu coast by Clement et al. (2010). Many of the more inland areas of the Muhunoa Forest Park were still characterised by migrating sands at the time of the earliest aerial photograph in 1957, but have since been stabilised by extensive re-vegetation work.

The property is fronted by a wide esplanade reserve, which is accreting seaward over time (Eco Nomos, 2010; see also Section 3 later in this report). In areas undisturbed by stream erosion, the dune area of the reserve in 2019 (the date of the most recent imagery on the Horowhenua District Council) was typically about 140m wide, as measured from the property boundary to the seaward toe of the dunes. In northern areas, the property boundary with the reserve typically coincides approximately with the crest of the wide frontal foredune, but lies further landward in central and southern areas.

The beach to seaward is a wide sandy dissipative beach, with a low flat average beach slope (typically about 1V:55H) (Tonkin and Taylor, 2013); characterised by fine grained sands (Clement et al., 2010).

The strong onshore winds give rise to high wave energy. Sediment transport is strongly wave-dominated, with waves from the west-northwest predominating. This gives rise to a net southwards longshore drift along the coast (Clement et al., 2010) supplying large volumes of sediment derived from areas further north; including rivers and cliff erosion (Clement et al., 2010). The large volumes of sand moved into the area by littoral drift result in the Manawatu being a constructional coast – i.e. a coast that is advancing seaward over time.

2.2 Waiwiri Stream

The Waiwiri Stream drains approximately 6 km westward from Lake Waiwiri (also commonly known as Lake Papaitonga), a dune lake near Levin (Allen et al., 2012; Collis, 2018). The lake and stream have a total surface water catchment area of approximately 1520 ha (DoC, 2016; Collis, 2018), though Collis (2018) notes that groundwater research by Horizons indicates that the groundwater capture zone for the lake may extend nearly to the foothills of the Tararua Range. The stream is very gradient and typically characterised by relatively low flows. Mean flow from the lake via the Waiwiri Stream was estimated at 0.018 m^3/s (i.e. 18 litres/second) by Vale (2011).

Land use in the 1,500 hectare Waiwiri catchment is dominated by high–producing exotic grassland (74%), associated mostly with dairy and beef farming (Allen et al., 2012). Pine forest covers approximately 13% of the catchment and native vegetation approximately 6%. The remaining 7% is mostly covered by lakes and coastal sand (Allen et al., 2012).

Prior to 1887, lands within the Horowhenua region were still in Māori ownership and much of the land in the Waiwiri area was predominantly in its natural state (Allen et al., 2012).

The stream, Lake Waiwiri/Papaitonga, and most of the catchment have since been extensively modified by human activities; including drainage and ongoing drain clearing, loss of riparian vegetation, clearing of lowland forests, pastoral farming, forestry, and both groundwater and surface water takes (Allen et al., 2012; Collis, 2018). Detailed studies indicate the stream is now in a poor state of health with significant nutrient and faecal contamination, with the dominant source of faecal contamination being manure from cows (Allen et al., 2012). Substantial faecal contamination was also found in shellfish collected from the mouth of the stream (Allen et al., 2012). Much of the catchment steam channel is extensively covered and choked with macrophytes (James and Joy 2009), which also extend over significant areas of the channel bed at the entrance (Figure 4).

Figure 4: View of dense macrophytes, common in the channel bed near the stream entrance

2.3 Coastal Inundation Hazard

The hazard posed by coastal storm inundation on this coast was assessed for Himatangi Beach to the north by Horizons (2015). The results of their assessment are shown in Table 1.

Parameter	Scenario		
	Existing	2065	2115
MHWS (m above Wellington Datum)	0.561	0.561	0.561
Sea level rise (m)	0	0.31	0.95
Storm surge (m)	0.9	0.9	0.9
Sea level variation (m)	0.25	0.25	0.25
Wave run-up (m)	6.35	6.35	6.35
Total CIHZ elevation (m above Wellington Datum)	**8.06**	**8.37**	**9.01**

Table 1: Coastal inundation hazard zone (CIHZ) elevations as assessed by Horizons (2015) – their Table 5.3 from p20 of their report.

The results suggest that storm wave run-up could potentially reach to elevations of RL 8.06m above Wellington Vertical Datum 1953 (WVD-53), increasing commensurably with future sea-level rise (Table 1).

However, it is important to note that the RL 8.06m figure is primarily composed of wave run-up (6.35m), which component only applies in the very nearshore areas exposed to wave run-up. At present, the Muhunoa Forest Park is separated from the sea by a wide and high frontal dune which provides complete protection from wave run-up.

According, only the static component of the assessed coastal inundation hazard applies to the properties - a total CIHZ elevation of about RL 1.71m WVD-53 (i.e. 8.06-6.35m = 1.71m). Current mean sea-level is about 0.28m above WVD-53 because of ground movement and sea level rise since 1953[1]. Accordingly, the static CIHZ elevation is equivalent to about RL 2m with respect to current mean sea-level – whereas the property elevations are typically about 4m above mean sea-level or higher (Eco Nomos, 2010).

Accordingly, coastal inundation poses no significant risk to the properties and is unlikely to do so (even with 1-1.5m m sea-level rise over the next 100-150 years) unless the frontal dune is lost to erosion. If the frontal dune is lost to erosion, then the protection from wave run-up would be reduced or lost and the risk from coastal inundation would likely become significant.

The potential for the dune to be lost to erosion is considered in chapters 4 and 5.

[1] https://wellington.govt.nz/wellington-city/maps/maps-terms-and-conditions

3 Historic Shoreline Changes

There are two significant natural geomorphologic processes at the stream entrance which determine the hazard posed to the forest park:

- A long-term trend for shoreline accretion (i.e. net shoreline advance), and
- The nature and scale of the erosion associated with stream entrance movements

This section reviews these processes to assess existing and potential future hazard risk to the Muhunoa Forest Park.

3.1 Long Term Shoreline Advance

The shoreline in this location is advancing seaward over time due to the large volumes of sand delivered to the coast by longshore drift, with most of this sediment derived from rivers and cliff erosion further north. This long term accretion is significant as, over time, it tends to move the shoreline area affected by periodic stream erosion seaward – thereby reducing erosion risk to the forest park estate.

The existing rate of shoreline advance was assessed by considering shoreline change using historic surveys and aerial photographs.

In 1975, the seaward "edge of vegetation" was fixed by survey (DP 44581). The net shoreline advance seaward of the property since the 1975 survey was assessed using 2019 aerial imagery on the Horowhenua District Council online maps site (Figure 5).

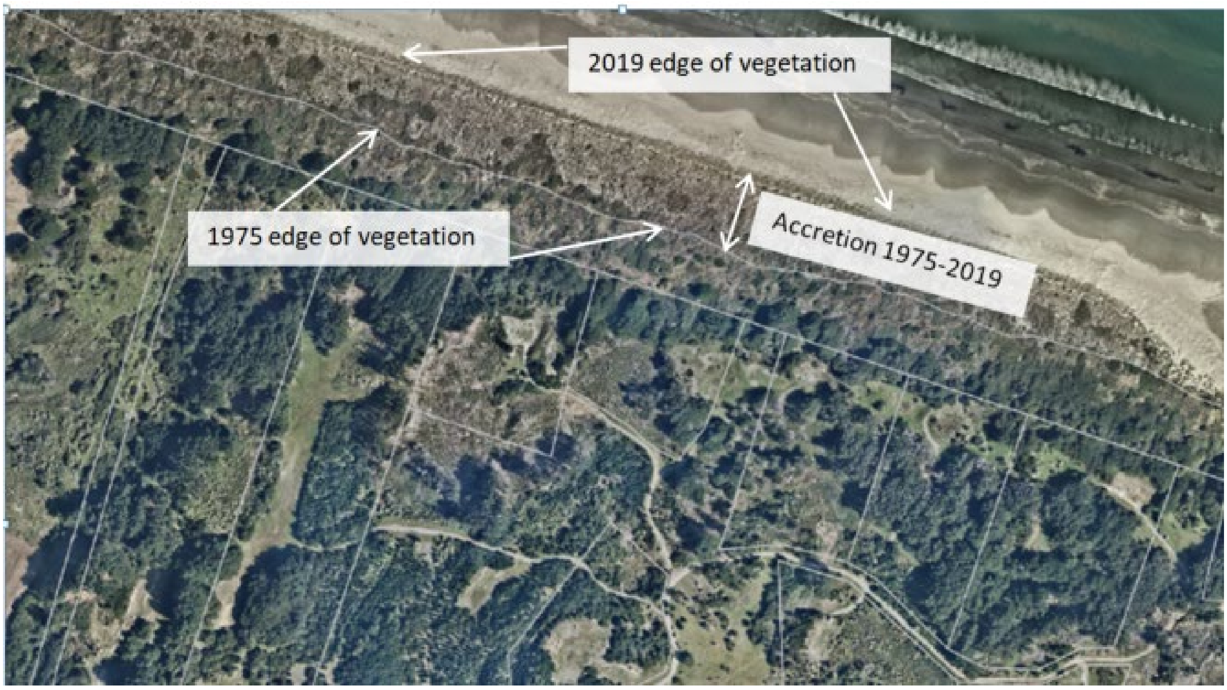

Figure 5: Accretion seaward of Muhunoa Forest Park between 1975 and 2019. (Note: Aerial photograph dates from 2019 – HDC online maps site).

The assessment of accretion seaward of the property focused on the shoreline areas unaffected by stream entrance changes. The assessment indicated an average shoreline advance of approximately

79.2m over the 44 year period between 1975 and 2019, an average long term rate of accretion of about 1.8 m/yr.

The existing rate of accretion was also assessed for the period from February 2005 to January 2022 (i.e. approximately 17 years) using Google Earth imagery, with correction for slight rectification differences between the two aerial photos. Over a 785m length unaffected by stream entrance effects, an average shoreline advance of 32.8m was assessed for the 17 year period – yielding an average accretion rate of approximately 1.9 m/yr.

These long-term rates of accretion are consistent with, though slightly higher than, previous work on nearby areas of this coast. For example, Bell (2015) assessed an average long-term rate of accretion of about 1.5 m/yr. for Himatangi Beach for the period between 1963 and 2011, this site about 29-30 km north of the Muhunoa Forest Park shoreline. Similarly, Tonkin and Taylor (2019) noted an average long term accretion rate of 1.5 m/yr. for Waikawa, located about 7 km further south of the Muhunoa Forest Park.

Accordingly, existing (time-averaged) accretion rates in this area are assessed at 1.5 to 1.9 m/yr., being lower and upper end estimates, respectively. In simple terms, if existing rates continued in the future, the shoreline is likely to advance seaward by somewhere between 150-190m over the next 100 years.

However, over the next 100 years and beyond, the historic rates of accretion may be affected by projected future sea-level rise. Current climate change guidelines for NZ (MfE, 2017) project that sea-level rise of 0.55-1.36 m may occur over the next 100 years to 2120, depending on future emissions scenarios (Figure 6 and Table 2).

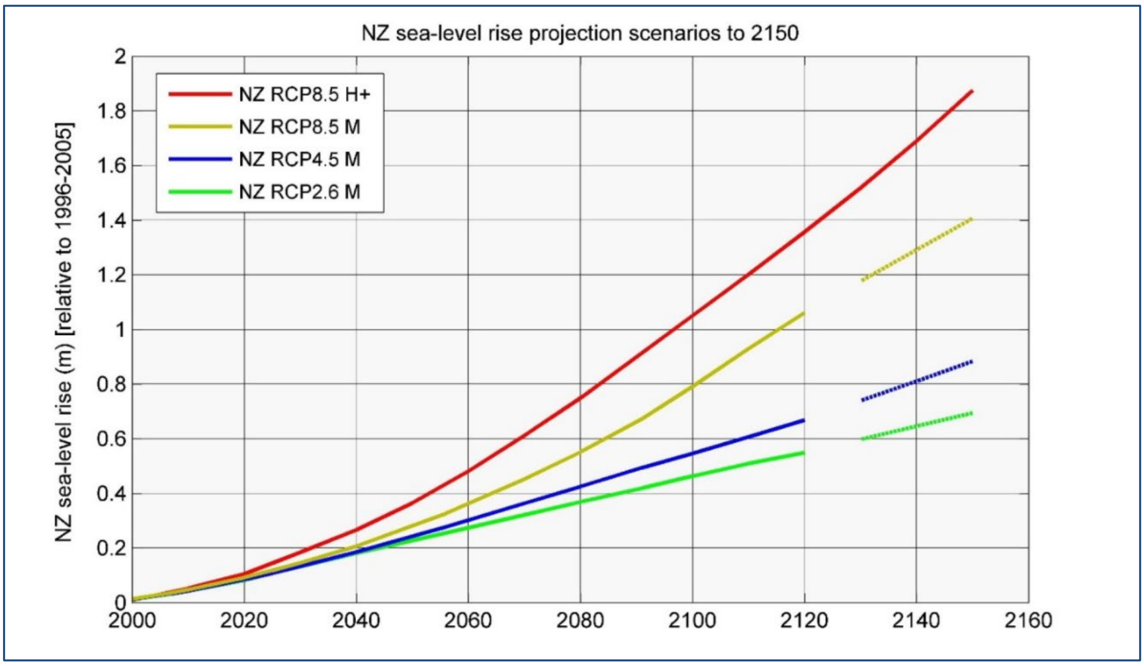

Figure 6: NZ sea-level rise projections to 2150 from current government guidelines. (Figure 27 from MfE, 2017).

NZ SLR scenario Year	NZ RCP2.6 M (median) [m]	NZ RCP4.5 M (median) [m]	NZ RCP8.5 M (median) [m]	NZ RCP8.5 H+ (83rd percentile) [m]
1986–2005	0	0	0	0
2020	0.08	0.08	0.09	0.11
2030	0.13	0.13	0.15	0.18
2040	0.18	0.19	0.21	0.27
2050	0.23	0.24	0.28	0.37
2060	0.27	0.30	0.36	0.48
2070	0.32	0.36	0.45	0.61
2080	0.37	0.42	0.55	0.75
2090	0.42	0.49	0.67	0.90
2100	0.46	0.55	0.79	1.05
2110	0.51	0.61	0.93	1.20
2120	0.55	0.67	1.06	1.36
2130	0.60*	0.74*	1.18*	1.52
2140	0.65*	0.81*	1.29*	1.69
2150	0.69*	0.88*	1.41*	1.88

Table 2: Decadal increments for projections of future sea-level rise for NZ - for the various emissions scenarios (RCPs) shown in Figure 6. (Table 10 from MfE, 2010).

In general, sea level rise is expected to exacerbate coastal erosion due to cross-shore profile adjustments, with various methods available to provide indicative assessments of this effect (e.g. Bruun, 1962 & 1983; Komar et al., 1999).

Using local beach profile characteristics and the method of Komar et al (1999), Shand (2008) estimated that erosion of just under 30m could occur at Foxton with 0.5m sea-level rise. As the beach at this site is similar to that at Foxton, his indicative estimate has also been adopted for this site. Accordingly, the upper limit estimate of sea level rise of 1.36m over the next 100 years (Table 1) could reduce net shoreline advance over that period by approximately 82 m. Given the existing long-term accretion rates of 150-190 m/century (being lower and upper limit estimates, respectively), net shoreline advance over the next century would effectively be reduced to 68-110m. With lesser future sea level rise, greater shoreline advance would be likely.

Accordingly, even with present best estimates of projected future sea level rise (Table 2), significant shoreline advance is still likely to occur over the next 100 years.

3.2 Stream Entrance Changes

Historic surveys and aerial photographs were collated (Appendix A) and examined to assess the nature of stream entrance changes over the past 100-120 years.

Early surveys and maps covering the period from circa 1900 (ML 1654) to 1949 (NZMS 12, Sheet 60) (Appendix A) do not provide significant detail on the stream entrance. However, these various plans do indicate southwards alongshore migration/deflection of the stream entrance (Figure 7 and Figure 8). The 1920 survey also shows some flaring of the entrance, indicating that dunes to the north of the stream were also periodically eroded – though not as significantly as the dunes to the south (Figure 7).

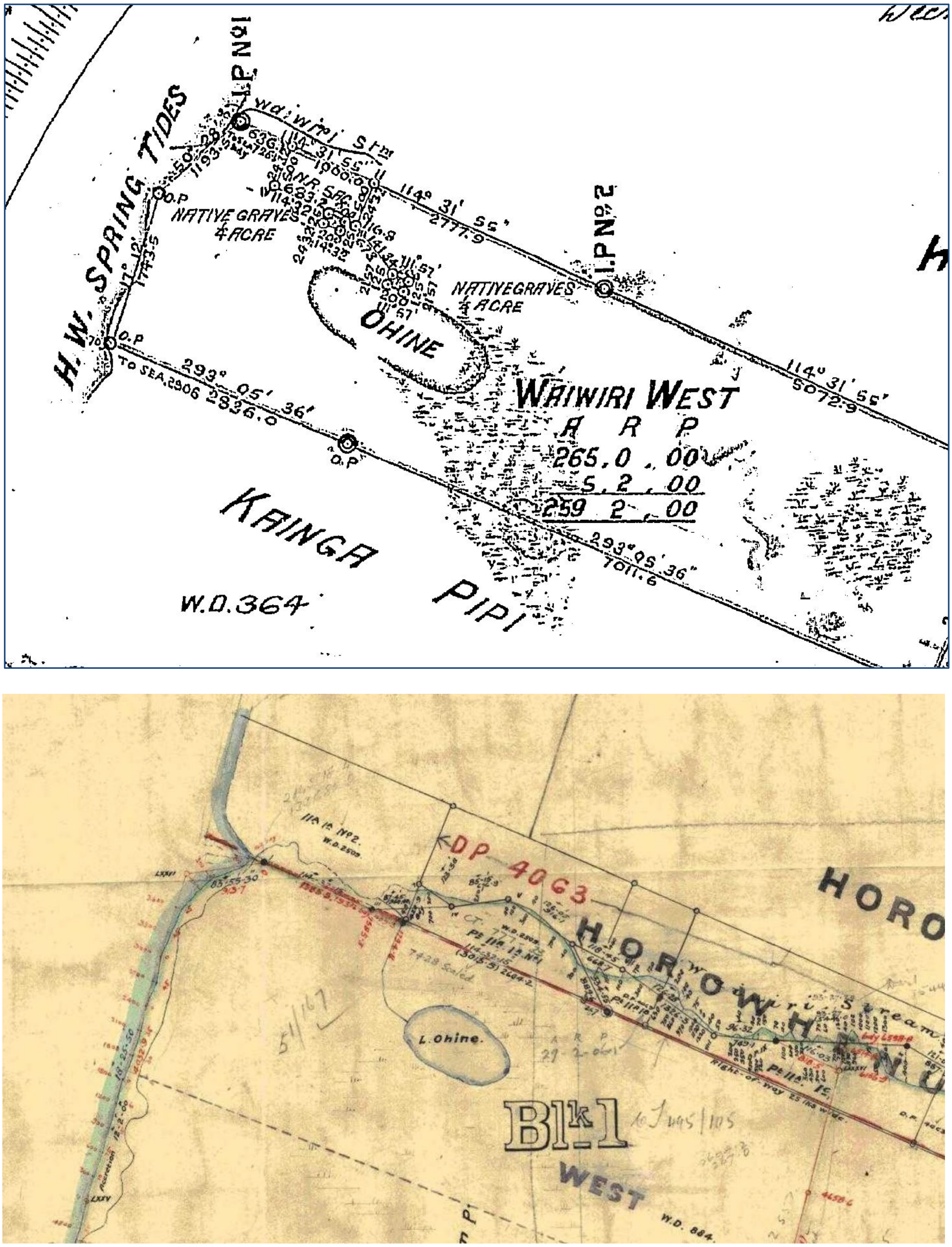

Figure 7: Snips from surveys in 1887 (ML 884) (top) and 1920 (DP 6120) (bottom). Both surveys indicate some southwards alongshore migration of the stream entrance. The 1920 survey shows also flaring of the entrance to the north, indicating that dunes north of the entrance were also periodically eroded by entrance changes. (Note: The inner shoreline evident south of the stream in the 1920 image is from an earlier survey and shows accretion in the period to 1920).

Figure 8: Portion clipped from 1942 topographic map (top) and 1949 cadastral map (NZMS 013, WN60 - Waitohu Survey District) (bottom) - both showing the Waiwiri Stream deflected to the south in the entrance area.

The earliest aerial photograph able to be located dated from 1957. An enlargement of the Waiwiri Stream entrance area from this photography is shown in Figure 9. It indicates that the stream entrance at that time was deflected southwards by a vegetated spit, discharging to sea about 400m southwards from the point of southwards deflection. Historic dune erosion scarps evident on the photography (marked with dashed lines in Figure 9) indicate that, prior to 1957, the stream entrance had extended even further southwards alongshore; eroding the dune up to about 450-470m south of the point where the stream was first deflected southwards. An historic erosion scarp on the northern side (dashed green line in Figure 9) indicates that the stream had also been deflected northwards sometime prior to 1957, eroding dunes on the northern sides.

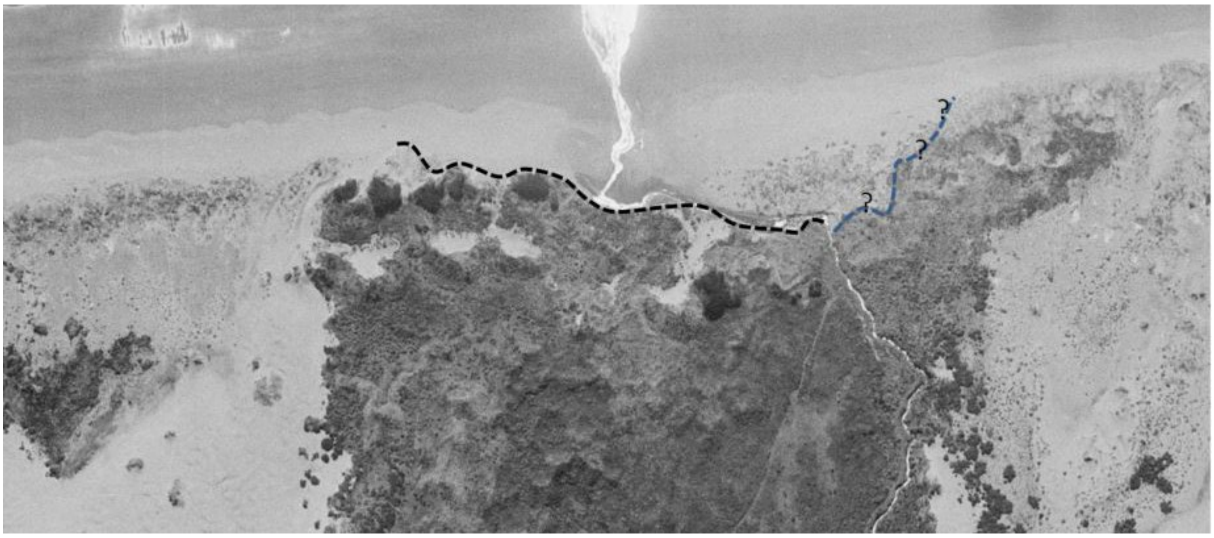

Figure 9: 1957 aerial photograph showing stream entrance deflected to the south by a spit. The dashed lines indicate earlier dune erosion evident scarped dunes.

By 1967, the stream entrance was still deflected southwards, but discharged more directly to sea than in 1957 (Figure 10).

There is also evidence that some dune erosion had occurred on the northern side between 1957 and 1967 (see dashed black line to the north of the stream in Figure 10); indicating that the stream entrance had also been deflected northwards at some time during this period. However, notably, the erosion this time did not affect the dune as far landward as had occurred with the earlier northwards deflection prior to 1957 (shown by the dashed green line in Figure 10).

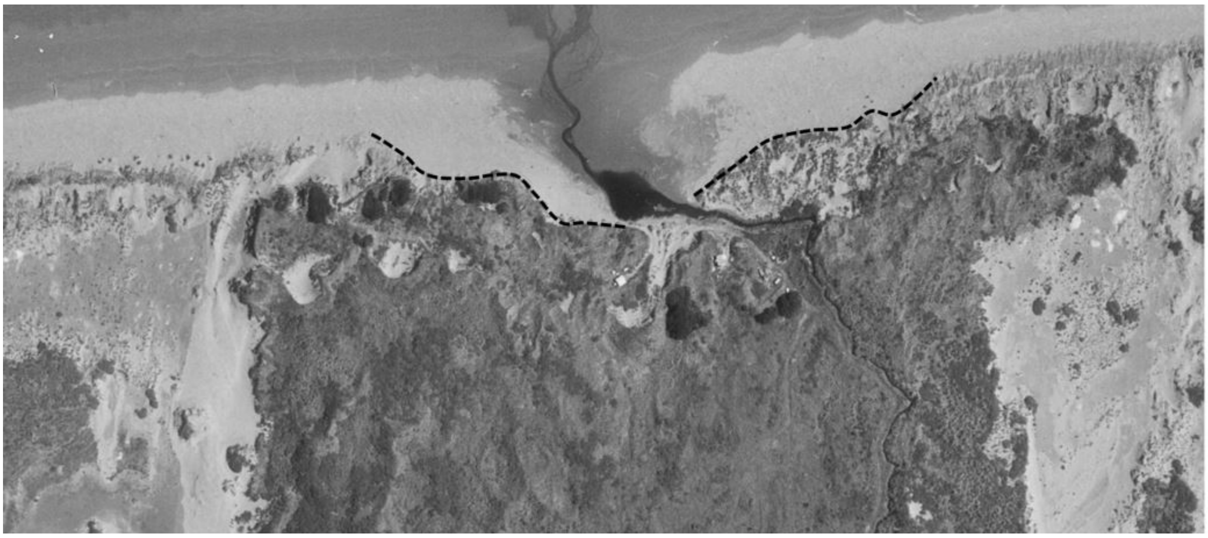

Figure 10: 1967 aerial photograph showing location of the stream entrance at that time. The dashed lines indicate earlier dune erosion scarps.

By 1972, the stream entrance had rotated northwards and was eroding the dunes on the northern side of the entrance (Figure 11). However, once again, this dune erosion remained well seaward of the dune erosion that had ocurred on the northern side sometime prior to 1957 (the latter shown by the dashed blue line in Figure 9).

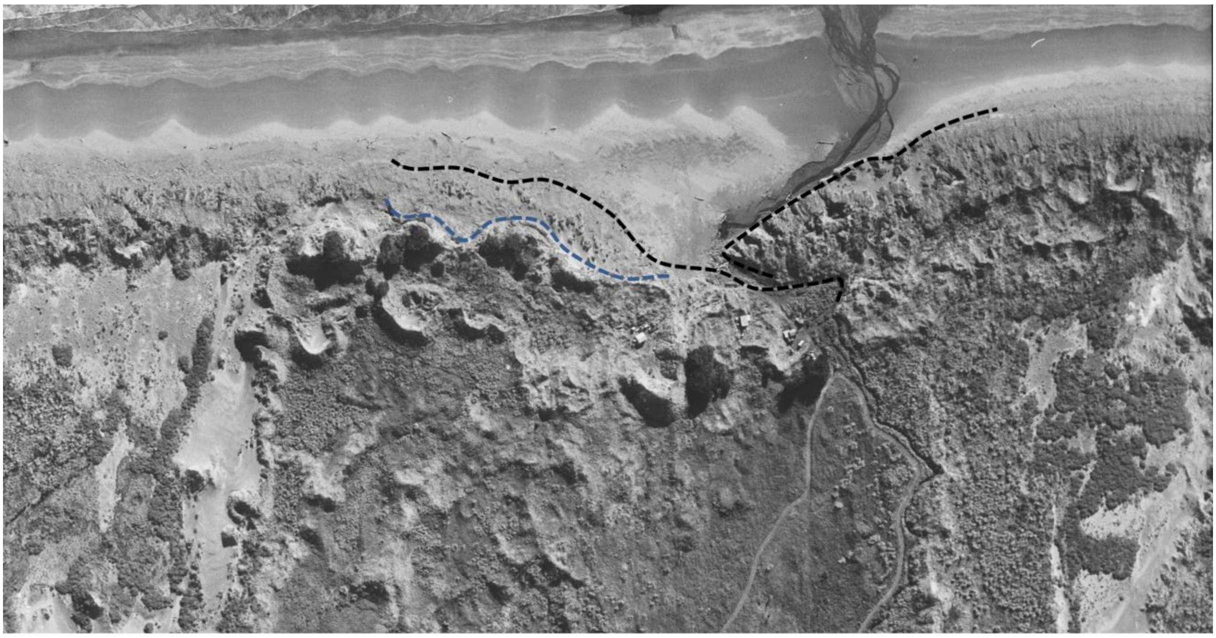

Figure 11: 1972 aerial photograph showing northwards rotation of the stream entrance since 195 67. The dashe dblack lines indicate the seaward edge of vegeation at this time. The dashed blue line indicates the historic dune erosion evident in the earlier 1957 aerial photography.

By 1972, the dune erosion on the southern side was recovering; with the seaward edge of dune vegetation at that time shown by the black dashed line in Figure 11. The blue dashed line further landward (Figure 11) shows the eroded dune toe evident at the time of the earlier 1957 aerial photograph.

By 1978, the stream discharged almost directly seaward (Figure 12), with the dunes to both the north and the south recovering.

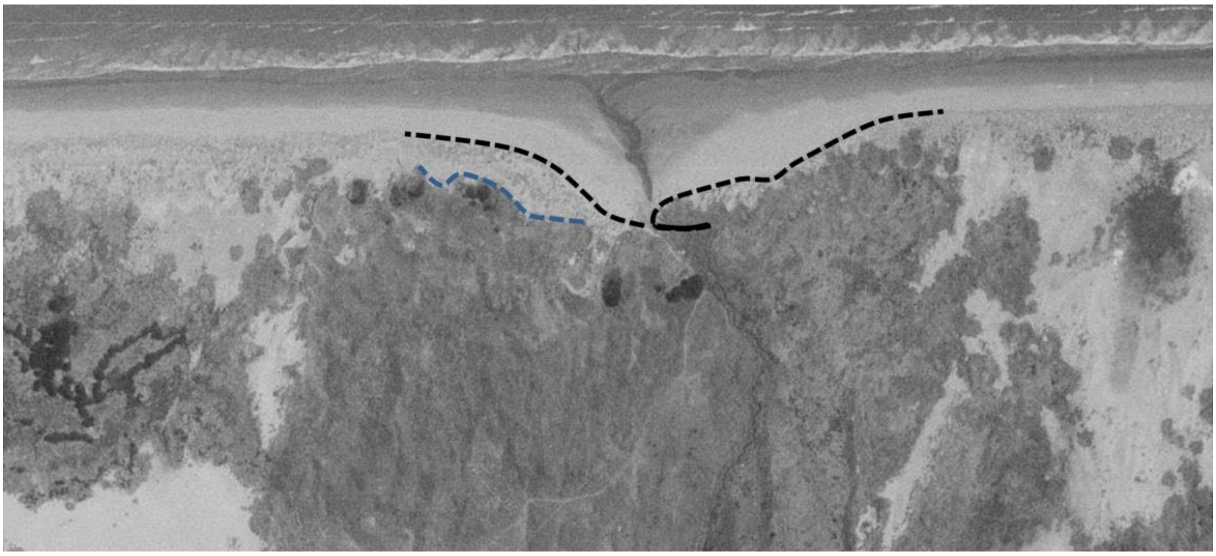

Figure 12: 1978 aerial photograph

By 1983, the stream entrance had once again been deflected significantly (>400m) to the south (Figure 13). However, the eroded dune toe in this area (black dashed line in Figure 13) was not as far landward as had occurred in 1957 (dashed blue line in Figure 13) when the stream was also deflected significantly southwards.

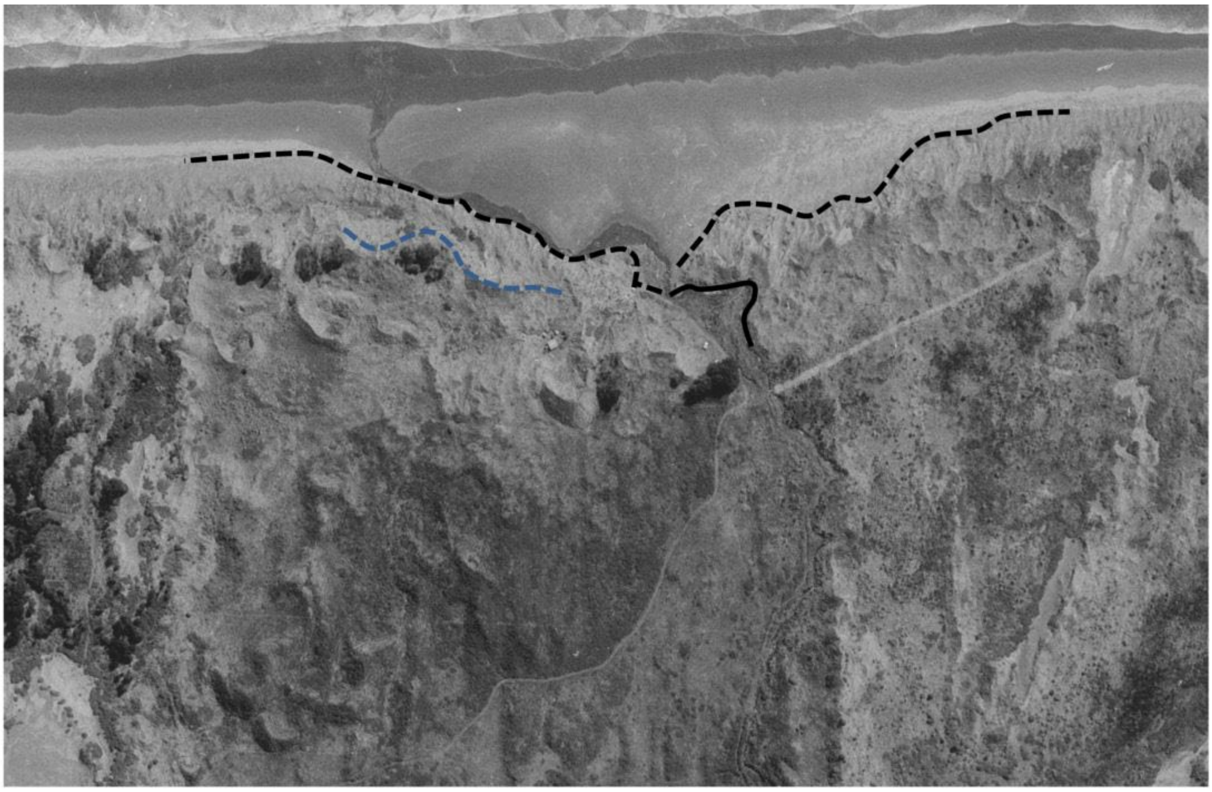

Figure 13: 1983 aerial photograph of stream entrance area.

The next available aerial photography (2005 Google Earth imagery – Appendix A) indicates the stream entrance had broken seaward more directly, though still deflected southwards alongshore

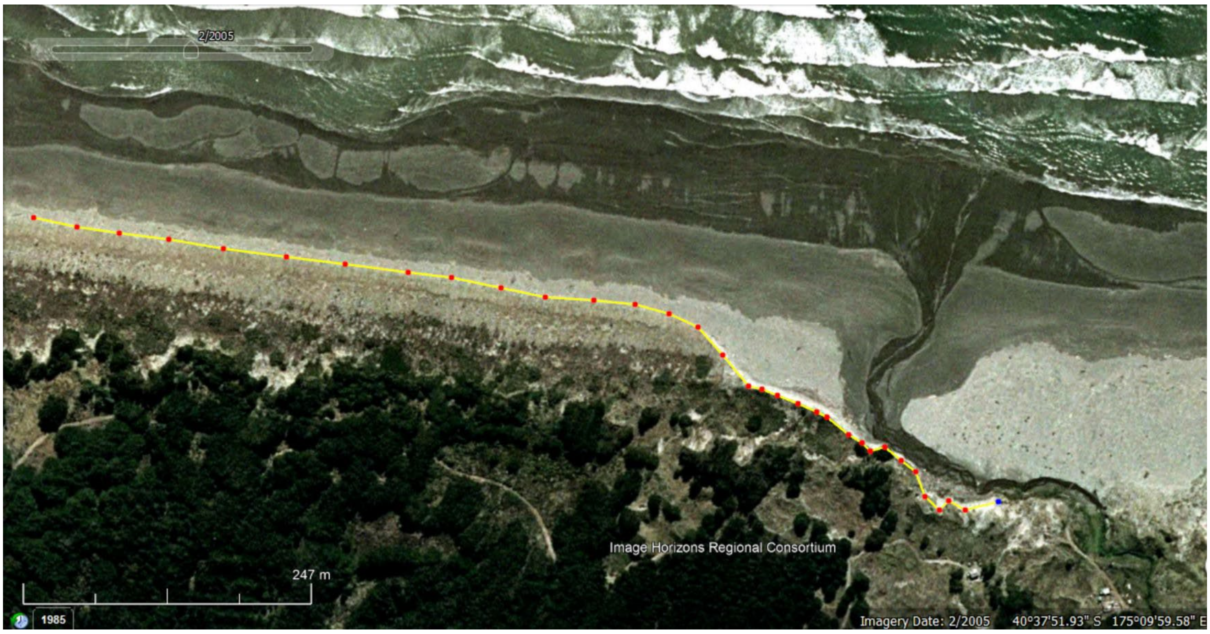

Figure 14: 2005 Google earth aerial photograph of stream entrance area.

Subsequent aerial photography indicates the stream entrance was progressively deflected southwards until mid-2015; discharging approximately 550m south of the point of deflection by early 2015 (Figure 15) and eroding dunes over a width up to 75-80m inland from the natural toe of dune. However, it is notable that although the stream was deflected considerably further southwards alongshore, no additional dune erosion occurred in the areas affected by erosion in 2005 (Figure 15).

Figure 15: January 2015 aerial photograph with 2005 dune toe (yellow line) superimposed.

By late 2015, the stream entrance had broken more directly seaward (Figure 16), discharging to sea over 420m north of the stream entrance position earlier that year. This more northerly break-out most probably occurred during the major storm of June 2015, which caused significant flooding in the Taranaki, Whanganui and Manawatu districts. Indicative rainfall return periods for the storm event generally ranged from 20-50 years, with higher return periods of 50-100 years in localised parts of the Whanganui and Rangitikei Districts (MPI, 2015).

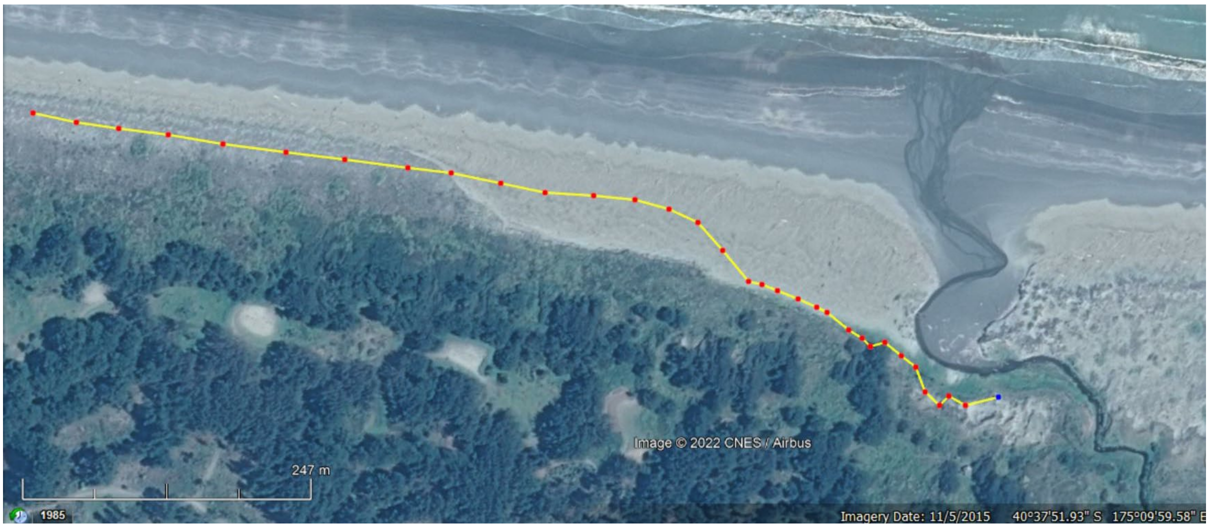

Figure 16: November 2015 aerial photography with 2005 dune toe (yellow line).

Since late 2015, the stream entrance has progressively been deflected further southwards once again, eroding dunes over a distance of >700m south of the point of deflection by January 2022

(Figure 17). However, notably, this post-2015 alongshore stream extension did not cause any additional dune erosion in the areas already affected in January 2015 and the main stream channel actually moved further seaward away from the due toe in these areas (Figure 17).

Figure 17: January 2022 aerial photography with the January 2015 eroded duneline (white line) superimposed.

Field inspection in February 2022 indicated that the dune areas eroded in 2005 and up to 2015 have now revegetated, with no ongoing active erosion (Figure 18). The stream channel in the areas was also now some distance seaward of the dunes, with the intervening beach area vegetated, and slightly higher in elevation than the existing stream channel.

Southwards migration of the stream entrance continues at the time of this report (June 2022).

3.3 Summary

Historical evidence extending over the last 120 years indicates:

- A long-term trend for shoreline advance seaward of the Muhunoa Forest Park – averaging 1.8-1.9 m/year over the 44 year period between 1975 and 2019.
- Periods of significant southwards deflection of the stream entrance by longshore drift, interspersed with periods where the stream discharged more directly seawards and sometimes even with periods of (relatively minor) northwards deflection.

The available evidence suggests the stream entrance tends to be deflected southwards alongshore by the predominant southwards littoral drift during periods of low and normal stream flow, breaking more directly seawards during periods of high stream flow (as in June 2015). I.e. southwards alongshore migration of the stream entrance is the norm, with more direct seaward discharge following high stream flows.

Figure 18: Views of northern dune area in February 2022 – showing the areas that were actively eroding in 2005 (top) an 2015 (bottom). The dunes have now revegetated and are no longer subject to active erosion. The stream channel is also now some distance seaward of the dune toe, with the intervening area vegetated and slightly higher in elevation.

The occasional periods of minor northwards deflection most likely relate to periods with waves from WSW or more southerly directions; probably when such waves occur shortly after the stream has broken more directly to sea.

In areas seaward of the Muhunoa Forest Park properties, historic stream entrance changes (both in recent decades and earlier) have generally eroded the dunes landward by up to 70-80m, relative to the natural duneline at that time. Dune erosion of up to 90-100m has however occurred at the very northern end of the properties, close to where the stream is first deflected alongshore.

With the significant rate of net shoreline advance (averaging 1.8-1.9m/yr. over the last 44 years), the risk from stream erosion has decreased markedly over time. The seaward boundary of the Muhunoa Forest Park properties is now typically about 135-140m inland of the natural toe of dune (as measured in areas removed from stream influence).

Accordingly, the typical width of stream erosion (70-80m) will not affect the properties. Even in northern areas, where the width of dune erosion can be up to 100m, neither the property nor the high dune to seaward is likely to be affected.

Moreover, as the stream is deflected southwards alongshore at any given date, the stream channel in the areas further north tends to move seawards away from the eroded dune toe (e.g. Figure 17 and Figure 18).

Accordingly, the risk from stream erosion to the properties is now assessed as very low. On the basis of historic evidence, neither the properties nor the high dune along the immediate seaward margin of the properties are likely to be impacted by erosion associated with stream entrance changes.

As noted in Section 3.1, ongoing shoreline advance is likely to continue over the next century even with projected sea-level rise. For example, even considering potential higher sea-level rise scenarios up to 1.36m, the duneline is likely to advance seaward by at least 68-110m over the next century. Accordingly, the risk posed by erosion will continue to decrease over time.

Nonetheless, a precautionary approach to the erosion is warranted and measures to reduce risk need to be considered – so that prompt action can be taken if and when required. Moreover, while the alongshore stream migration and accompanying dune erosion, it does significantly impact on beach access due to the steep eroded dune face and the presence of the stream channel (Figure 19).

Figure 19: View of northern beach access easement (orange poles in centre of photo) showing steep dune face and stream.

4 Management Options

The assessment of coastal processes in Section 3 indicates that the stream erosion is unlikely to pose a threat to the Muhunoa Forest Park properties, or to remove the high dune along the seaward margin of the properties which provides effective protection from coastal flooding. The very low risk will also reduce further over time with continued net shoreline advance.

Nonetheless, management options are required by way of contingency, with suitable triggers for implementation. In addition, the alongshore stream migration and associated erosion does significantly complicate beach access, particularly via the northern of the two easements.

The following management options have been assessed:

- No intervention
- Periodic excavation of the stream entrance
- Entrance training structure(s)
- Dune management

The following options assessment describes each option and provides a brief consideration of practicality and effectiveness, environmental effects, design and consenting requirements, and costs (capital and maintenance). Recommendations are then provided.

4.1 No Intervention

Description

This option involves living with natural coastal processes, which at this site will include periodic southwards alongshore migration of the stream entrance and associated dune erosion. As noted earlier, the erosion will likely be confined within the reserve, with only a very low risk it will ever affect the Muhunoa Forest Park properties

Practicality and effectiveness at this site

The option is obviously practicable and has been the approach adopted by Muhunoa Forest Park landowners to date.

If stream erosion follows historic patterns and scale, the option will also effectively protect the Muhunoa Forest Park properties from erosion damage. However, if the properties were ever seriously threatened by stream erosion (e.g. future erosion was of larger scale than observed over the last 120 years), additional intervention would be required. Accordingly, even if this option were adopted the adaptive management strategy for the properties would need to include a “trigger” for additional action to manage erosion by way of contingency.

The option also does not address the beach access difficulties imposed by the stream erosion, as discussed in Section 3. With this option, landowners would have to access to and from the beach over a steep bank - with associated access difficulties, safety risks and dune damage. Accordingly, the option is not adequate to address beach access difficulties and associated risks.

Environmental effects

The primary adverse environmental effects of the option relate to access to and from the beach. As discussed in Section 3, the periodic southwards stream migration and associated erosion significantly complicates access to and from the beach. Access over the steep, eroded bank and the stream channel pose safety risks to users. Regular human access over the steep bank may also disturb stabilising vegetation over time and increase the risk of wind erosion damage.

Design and consenting requirements

The option has no design and consenting requirements

Capital and maintenance costs

The option does not involve any intervention and therefore does not include any capital or maintenance costs. However, the safety hazards involved will likely require some intervention and costs to mitigate risks to human safety and associated liability.

Summary

The access difficulties and associated risks to human health and safety rule out this option as the sole approach to managing the erosion. In addition, the option would not be adequate to protect the Muhunoa Forest Park properties in the event of unusually severe stream erosion.

Accordingly, if this option is adopted as part of the management strategy, it will need to be complemented by additional measures and associated triggers to provide for safe access and any unusually severe stream erosion.

4.2 Periodic Excavation and Relocation of the Stream Entrance

Description

This option involves periodic excavation of a narrow stream channel across the low dune seaward of the stream to relocate the stream entrance further north; the excavated channel best located where the stream naturally breaks seaward during large flows (e.g. the June 2015 flood) (Figure 20). Some of the excavated sand would also be used to infill the old channel (Figure 20). The works should also include placing a narrow sand stop (i.e. infilling) in the abandoned channel south of the diversion and regrading of the steep dune face in the area of the northern beach access easement.

The option would require a trigger, which would depend on the purpose.

If included in the management strategy simply as a contingency to manage rare and severe erosion that could affect the properties, the trigger would relate to a defined landward extent of erosion (e.g. erosion where the top edge of the eroded dune scarp lay within a certain distance of the property boundaries – probably in the order of 15-20m). In this case, the option would very rarely if ever be used, simply included as a contingency.

If used to also maintain beach access, the work would be triggered by alongshore stream migration and erosion affecting the northern and, if ever required, the southern beach accessways. In this latter case, the option would be used more often, but still relatively infrequently - possibly once every 3-5 years on average.

Figure 20: Indicative details for excavation option

Practicality and effectiveness at this site

This option is widely used at stream entrances including sites on the west coast (e.g. Kapiti Coast).

The approach can also be used to successfully manage either rare and extreme erosion and/or beach access.

The stream entrance will migrate southwards again after re-direction; so the work will need to be periodically repeated – the frequency depending on the purpose and the trigger as noted above. To minimise expense, triggers for the work should be set so that it is only undertaken when required.

Environmental effects

With appropriate design and consent conditions, the environmental effects of this work will be both minor and temporary. The work simply involves excavating a narrow channel across the wide low spit that periodically forms on the seaward side of the stream channel; with lesser disturbances than periodic natural stream breakouts in the same area.

Nonetheless, appropriate design and management will be required to ensure disturbances to natural vegetation, shore birds, shellfish and any other relevant biota (e.g. inanga or whitebait) are minimised. Some of these values may also affect timing of the works. Other potential adverse effects (e.g. on public access along the beach) will also need to be avoided or appropriately mitigated. All of these considerations can be met relatively simply.

As the outlet migrates alongshore, hydraulic efficiency of the channel is also likely to decrease – which may cause a consequent increase in flood levels upstream. Accordingly, periodic cutting of the entrance directly seaward may also have some positive environmental effects in regard to flooding of low-lying areas further upstream.

However, while the potential effects of the activity are both minor and temporary (and well within the scale of natural change at the site), significant environmental reporting and consultation may be required (see discussion under design and consenting below).

Design and consenting requirements

The design of the work is relatively simple but, depending on consent requirements, environmental reporting and consultation requirements may be significant.

The consent status of the activity is unclear and will require further clarification with Horizons and/or a planning practitioner. The work would largely be undertaken within the Coastal marine Area (CMA), as defined in the Horizons Regional Council One Plan – therefore falling under Section 18 of the One Plan. Rule 18-24 of the One Plan provides for minor disturbances of this nature (including clearance of stream entrances) as a permitted activity, but only when undertaken by a local authority or its authorised contractors (Condition a) of Rule 18-24 – see Appendix B). It is not clear if Rule 18-24 allows for the work to be also undertaken by private landowners provided an authorised contractor is used. Further discussion with a planning practitioner would assist.

As the CMA boundary (as presently defined in the One Plan) cuts through the area of the required excavation (i.e. part of the area is above the CMA), Section 16 of the One Plan may also apply.

In addition to any resource consent requirement and associated reporting, landowner permission will also be required from the management agency owning and/or managing the reserve (i.e. either Horowhenua District Council and/or DoC).

Environmental reporting and consultation is likely to be required, even if the work qualifies as a permitted activity; as the work would be subject (as a minimum) to the relevant conditions (being the general conditions in Table 18.1 of the One Plan – see Appendix B). These conditions may also affect timing when the work could be conducted (e.g. if the stream and/or adjacent beach areas are significant for shore birds, inanga, whitebait and/or shellfish gathering). While any mature shellfish beds are not likely to be disturbed by the activity (the works being limited to upper intertidal beach), any consent would likely include a requirement for prior inspection (e.g. to ensure juvenile spat are not present within the area to be disturbed).

The earthworks are not likely to disturb cultural deposits as the work is restricted to beach and dune areas which have been deposited in recent decades, and the area is also periodically disturbed by natural stream break-outs (see Section 3).

Consultation requirements will likely depend on the activity status.

Capital and maintenance costs

The costs of the earthworks is likely to be relatively minor, with the works probably able to be completed within 1-2 days, depending on scope and on tide/weather conditions.

Maintenance costs would depend on how often the works needed to be repeated, which in turn will depend on natural conditions and on the purpose of the work as noted above. However, it is probable the work will typically only be required relatively infrequently.

Summary

The option would provide effective protection against rare and severe erosion and could also be used to maintain reasonable beach access. While the work would need to be repeated over time (particularly if used to provide reasonable beach access), the frequency and costs are unlikely to be significant.

However, environmental reporting is likely to be required regardless of the consent status of the activity. Accordingly, if this option is included as an element in the management strategy and resource consent proves to be required, it would be wise to seek the maximum consent duration possible for activities in the CMA (i.e. 35 years). Consent conditions are likely to include various reporting and notification requirements each time the work is conducted – probably also some limited monitoring (e.g. before and after photographs from appropriate fixed points).

4.3 Entrance Training Structure

Description

This option would involve a rock groyne located to minimise longshore migration of the stream entrance and/or divert the stream seaward to minimise dune erosion.

Practicality and effectiveness at this site

The use of groynes to train stream flows on this high energy and dynamic coast is very complex, with such structures subject to considerable uncertainties in regard to ongoing effectiveness, unexpected adverse effects and maintenance costs. The problems experienced with such structures at the Waikawa Stream mouth (Tonkin and Taylor, 2019) well illustrate these difficulties.

While it is possible that an appropriately designed and located structure could minimise alongshore stream migration, there is also potential for the structure to lead to unpredictable effects on the stream channel, especially to the immediate south. In particular, there is potential to exacerbate stream erosion immediately downstream of the groyne under some conditions – so that dune erosion could be exacerbated rather than reduced.

Environmental effects

The use of a permanent engineering structure will have adverse visual effects on both landscape amenity and on natural character, introducing a significant human-built element into a landscape presently dominated by natural processes and features.

As noted above, there is also potential for unexpected effects and particularly for exacerbation of erosion immediately south of the groyne under some circumstances.

Installation and maintenance of the structure would also involve considerable disturbance, though these effects would be relatively minor and temporary.

Design and consenting requirements

The work would require significant engineering design and maybe publicly-notified resource consent. The consenting work would also require significant environmental reporting and consultation.

Structures of this nature are less favoured by both national and regional coastal policy and would be subject to a rigorous "alternatives" test. As there are alternative options that could achieve the desired outcomes with a higher level of certainty, and with both lesser and only temporary adverse effects (e.g. see Section 4.2), consenting would likely be difficult.

Capital and maintenance costs

The costs of works including design, consenting and construction would likely be significant – probably in the order of $0.5 million or more. Ongoing maintenance may also be required after major storm wave and/or flood events. Such maintenance requirements may include repair work on the structure and/or the mitigation of unexpected effects.

Summary

This option has considerable uncertainties in regard to both effectiveness and ongoing adverse effects, would be costly and also subject to lengthy and probably difficult consenting issues.

Given the very low risk posed by stream erosion and other less complex and less costly options which can achieve desired outcomes, this option is not recommended.

4.4 Minor Dune Management and Earthworks

Description

This option would involve:

- Periodic removal (probably spraying) of any marram clumps on the spit seaward of the stream
- Minor localised earthworks to provide safe access over any erosion scarped dune

After natural breakouts of the stream entrance during floods (e.g. such as the recent June 2022 event or the earlier June 2015 event) there would also be merit in minor earthworks to place a sand stop within the abandoned channel south of the breakout. This would help avoid any return of the stream to the abandoned channel and therefore slow any subsequent southwards alongshore movement of the stream entrance.

Available aerial photography indicates that there was rapid southward alongshore movement of the stream channel and entrance between June 2016 and October 2018, the stream moving over 330m southward in this period (Figure 21). The location of the stream entrance in October 2018 (Figure 21) was very similar to the location prior to the natural breakout in June 2015. This suggests that the stream may have returned to the channel abandoned in the June 2015 breakout, facilitating the significant southwards alongshore movement seen in recent years (i.e. in the period up until the recent natural breakout in June 2022). Closing off the abandoned channel by placing a sand stop 4-5m wide across the channel would help prevent any rapid return. Such stops would require only minor earthworks – pushing in sand from either bank to close off the channel, with less than minor effects. Any sand stop should be located within 40-50m south of the breakout location, ideally in the narrowest part of the abandoned channel within that area.

Figure 21: Google Earth aerial photograph dating from October 2018. The blue line shows the entrance location and the stream path in the preceding Google Earth aerial (June 2016), indicating significant (about 330m) southwards alongshore migration of the stream in the relatively short interval between the photos. This rapid alongshore migration may have been aided by return of the stream to the southern channel abandoned when it broke seawards in the flood event of June 2015. Following natural breakouts (like the recent June 2022 breakout and the earlier June 2015 event) undertaking very minor earthworks to place a sand stop across the abandoned channel may markedly slow subsequent southwards alongshore migration by preventing the stream from returning to the abandoned channel.

The marram removal would be designed simply to prevent this exotic species from widespread establishment on the low spit that forms seaward of the diverted stream. Marram is known to build steep, high dunes over time on this coast (Esler, 1969 & 1970). Field inspection indicates clumps of marram already occur on the spit and it would be wise to remove these. Widespread establishment of marram in this area could significantly lift dune elevations over time, complicating periodic natural breakout of the stream through the spit. The native spinifex is less of a concern as this species builds much lower and aerodynamic dunes. Spinifex is not likely to significantly complicate periodic spit breaching by the stream within the short (2-3 decades) timeframe that erosion hazard remains a potential risk (albeit low, as discussed in Section 3).

The minor earthworks would involve reshaping the face of eroded dunes adjacent to either of the beach access locations to cut a gently sloping pedestrian accessway across the steep dune face. This work would be very localised and limited to that required to provide a safe access path. It would likely require no more than 2-4 hours work with a digger or bobcat at any location. A narrow sand stop would probably require a similar minor scale of work.

Practicality and effectiveness at this site

The works required are eminently practicable and very simple.

In regard to effectiveness, marram removal would reduce the risk of the low spit building up over time and complicating natural break-out of the stream. Similarly, formation of the lateral beach accessway would eliminate difficulties with access over the steep dune face, though the stream crossing would remain an obstacle. Placing a sand stop within the abandoned channel following stream breakouts would help reduce the risk of the stream returning to the abandoned channel.

Environmental effects

Marram removal from the dunes would positively impact the natural character of this feature. Formation of a graded accessway down the steep dune face would involve very minor vegetation disruption but these effects would be temporary.

Design and consenting requirements

No resource consents would be required for either the marram removal or the minor dune earthworks required to form the accessway across the steep dune face. However, landowner permission will be required from the district council for these activities.

Capital and maintenance costs

The costs of the minor dune works would be minimal.

Summary

The minor dune works are simple and low cost actions that would improve beach access and help minimise longer term dune build-up. The works would not provide a total solution but would improve beach access and lessen the risk that natural stream break-outs could be complicated by formation of a high marram dune seaward of the stream over time.

5 Summary and Recommendations

5.1 Issues

Southwards longshore migration of the Waiwiri Stream entrance has significantly eroded the dunes seaward of the Muhunoa Forest Park over the last 10-15 years.

The dune erosion has given rise to various management issues, including:

- Concerns that the high dunes seaward of the properties may be removed by erosion at some future date, exposing the low-lying properties further landward to risks from coastal erosion and coastal inundation
- Difficulties with access between the properties and the beach due to high, steep dune erosion scarps and the additional impediment posed by the stream channel. Stream crossing also poses a health hazard as the stream has serious bacterial pollution and is densely clogged with exotic aquatic vegetation.

This report was commissioned to assess existing and future issues and risks and to recommend appropriate management action.

5.2 Coastal Processes and Hazard

The assessment of coastal processes in Section 3 indicates that:

- While some house sites within the Muhunoa Forest Park are relatively low lying, they are presently well protected from coastal storm inundation by the wide high dunes on seaward areas of the property and on the reserve to seaward.
- As long as the high dunes remain in place, the properties are not likely to be impacted by coastal storm flooding, even considering the higher sea-level rise scenario (RCP8.5) over the next century.
- Southwards migration of the stream entrance has been common over the past 120 years for which records exist, reflecting the strong net southwards littoral drift along this coast.
- The longshore migration of the stream erodes the dunes seaward of the property, typically by widths of up to 75-80 metres (relative to the natural duneline along the coast) in central and northern areas, though up to 90-00 metres at the extreme northern of the properties.
- The shoreline seaward of the Muhunoa Forest Park is accreting, with an existing time-averaged rate of shoreline advance in the order of 1.8-1.9 metres per year.
- This ongoing natural shoreline advance has markedly increased the width of the reserve seaward of the properties since the reserve was surveyed in 1975, with the reserve width seaward of the property now typically about 135-140m, as measured from the most seaward toe of dune.
- Consequently, the present width of the protective dune buffer seaward of the properties considerably exceeds the maximum width of dune erosion observed with stream erosion over the last 100-120 years.
- As a result, the dune erosion associated with southwards alongshore stream migration is very unlikely to completely erode the high dunes seaward of the Muhunoa Forest Park and the existing risk from coastal erosion and/or coastal storm inundation is assessed as very low.
- In the future, projected sea-level rise may slow the rate of shoreline advance. Nonetheless, consideration of this effect using best present information suggests that considerable net shoreline advance is still likely to occur.
- By way of example, even with the higher sea-level rise scenario (RCP8.5) currently recommended for consideration in central government climate change guidelines, further net shoreline advance in the order of 70-110m is likely to occur over the next 100 years.
- Accordingly, the current very low risk from coastal hazards (either coastal erosion or coastal storm inundation) is likely to continue to decrease over time.
- Nonetheless, it would be wise to have contingency action identified in case of unusually severe stream erosion.
- At present, the primary erosion hazard issue is assessed to be the difficulties with access between the properties and the beach posed by southwards longshore stream migration.

5.3 Management Options

Various management options have been considered to address the existing erosion issues, including:

- No intervention
- Periodic minor earthworks to divert the stream entrance further northwards
- Entrance training structure(s)
- Dune management

The options have been assessed in terms of practicality and effectiveness at this site, environmental effects, design and consenting requirements, and both capital and maintenance costs.

The "no intervention" option does not provide any contingency in case of unusually severe stream erosion and does not address the access difficulties and associated risks to human health and safety.

Periodic earthworks to divert the stream entrance more directly seaward would enable both access issues and any unusually severe stream erosion to be effectively addressed. As the risk from erosion to the properties is low, the work may only be required for improving the ease and safety of beach access, particularly via Seagate 7/8.

This option would have only minor and temporary environmental effects. The consent status of this option is unclear and advice from a planning practitioner is required. If it proves to be a discretionary activity and requires notified resource consent and associated environmental reporting and consultation, the costs and difficulty of this process would need to be considered.

An entrance training structure would be very expensive and involve considerable uncertainties. It would also have adverse effects on landscape values and natural character.

Limited dune management is a very simple and useful option that is readily implementable. While the option would only partly address relevant management issues, it would significantly improve beach access via Seagate 7/8 and reduce both dune damage and the safety hazard associated with navigating a steep eroded bank.

5.4 Recommendations

It is recommended that:

- The limited dune management option be adopted and implemented to improve beach access, reduce the potential for the stream to return quickly to the recently (June 2022) abandoned channel, and reduce potential future impediments to natural stream break outs. This work should be able to be implemented relatively quickly and with limited cost.
- Consideration be given to seeking resource consent for periodic minor earthworks to re-direct the stream entrance - subject to appropriate monitoring and triggers to ensure the work is only undertaken when required (see further discussion in Section 4.3). This option would enable all relevant management issues to be effectively addressed reduced with only minor and temporary adverse effects.

The consenting requirements for this option are unclear and, in the first instance, it is recommended that discussions be held with Horizons Regional Council to confirm consenting requirements and the scope of work likely to be required.

If resource consent is required and it is decided to proceed with consenting of the option, the maximum term of 35 years should be sought. The option is likely to be only rarely required.

Given the recent natural breakout of the stream, the urgency for any stream re-diversion has been reduced. However, southwards migration of the stream entrance will occur again in the future.

References

Adkin, L. 1948: Horowhenua, its Maori place names & their topographic & historical background. Department of Internal Affairs, Wellington.

Allen, C; Sinner, J, Banks, J, Doehring, K. 2012: Waiwiri Stream: Sources of poor water quality and impact on the coastal environment. Manaaki Taha Moana Report, No 9.

Ausseil,O., Death, F. and Feck, A. 2016: Water quality and ecology of Waiwiri Stream 2013-2016, Aquanet Consulting Ltd.

Bruun, P. 1962: Sea-level rise as a cause of shore erosion. Proceedings of the American Society of Civil Engineers. Journal of the Waterways and Harbors Division 88: 117 – 130.

Bruun, P., 1983: Review of conditions for use of the Bruun Rule of erosion. Coastal Engineering 7: 77-89.

Buller, W.L., 1894: The story of Papaitonga or, a page of Maori history. Transactions and Proceedings of the Royal Society of New Zealand, Vol.26, 1893, p 572-79.

Collis, H. 2018: Waiwiri Lake, Stream & Environs: He Taonga: Cultural impact assessment report for the three affected Ngāti Raukawa hapū – Ngāti Kikopiri, Ngāti Pareraukawa, Ngāti Hikitanga. Report funded by the Horowhenua Distric Council, March 2018. 118p.

Esler A.E. 1969: Manawatu sand plain vegetation. Proceedings of the New Zealand Journal of Ecological Society 16: 32-35.

Esler A.E. 1970: Manawatu sand dune vegetation. Proceedings of the New Zealand Ecological Society, 17: 41-46.

Horizons, 2015: Himatangi coastal hazards assessment Manawatu District. Report produced by Horizons Regional Council, July 2015. Report No: 2015/EXT/1422. 40p.

James, A. and Joy, M. 2009: Prioritisation for restoration of out-flow stream habitat of coastal wetlands on the west coast of the Manawatu-Wanganui region. Report prepared for Horizons Regional Council, May 2009. 110p.

Komar, P.D., McDougal, W.G., Marra, J.J., and Ruggiero, P.: 1999. The rational analysis of setback distances: applications to the Oregon Coast. Shore and Beach, 67 (1): 41-49.

MPI, 2015: June 2015 Taranaki and Horizons Regions storm: Primary sector impact. MPI Technical Paper No 2015/28, Preprepared by Ministry for Primary Industries 31 August 2015. 35p.

Smith, S.M. 2007: Hei Whenua Ora: hapu and iwi approaches for reinstating valued ecosystems within cultural landscape. D.Phil Thesis in Maori Studies, Massey University, Palmerston North. November 2007. 321p.

Tonkin and Taylor. 2013: Coastal hazard assessment - Waikawa to Waitarere. Horizons Regional Council. 25p.

Tonkin and Taylor. 2019: Waikawa Beach. Coastal geomorphological assessment and management options. Prepared for Horizons Regional Council, March 2019. 47p.

Vale, S. 2011: GIS coupled water budget for spatial and temporal analysis of water resources: Horowhenua, New Zealand. M.Sc. Thesis Geography, Massey University. 138p.